

Critically Appraised Topic Template

Title: There is emerging low level evidence for stability ball use for children who seek vestibular and proprioceptive input and children with apparent attention concerns. There is no evidence for stability ball use in improving attention for typically developing children.

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Date: 12/07/2016

CLINICAL SCENARIO

Condition

Children with Autism Spectrum Disorder and Attention Deficit Hyperactivity Disorder are the conditions we will focus on:

Autism Spectrum Disorder (ASD):

Autism Spectrum Disorder is a developmental disability identified in early childhood. According to Brasic (2015), neuroanatomic and neuroimaging studies reveal that children with ASD show abnormal cellular groupings in the frontal lobe, temporal lobe, and cerebellum. Noterdaeme et al. (2000) finds that executive components of attention such as planning, flexibility and working memory, as well as alertness and sustained attention are functions of the frontal lobe and subcortical regions. According to Bagatel et al. (2010), difficulty sitting, attending and engaging in the classroom are some of the behavioral concerns for children with ASD.

Attention Deficit Hyperactivity Disorder (ADHD):

Children with ADHD appear to have difficulties in school, and the ability to attend is one of them. According to Shire (2016), children with ADHD have an imbalance of the dopamine and norepinephrine neurotransmitters. Dopamine and norepinephrine are associated with a child's thinking and attention abilities (NAMI, 2016). Children with ADHD experience academic and sensory motor difficulties in school (Mulligan, 2001). Sensory modulation strategies have been found to increase the child's classroom performance (Mulligan, 2001).

Incidence/Prevalence

Autism Spectrum Disorder:

- Incidence:
 - According to the Centers for Disease Control (2016), 1 in 68 children are diagnosed with ASD.
- Incidence varies by gender:
 - 1 in 42 males are diagnosed with ASD.
 - 1 in 189 females are diagnosed with ASD.
- According to the National Institute of Child Health and Development (NICHD, 2013), ASD occurs in all racial, ethnic, and socioeconomic groups.

- Prevalence:
 - According to the NICHD (2013), it is unknown how many people in the United States have ASD. The NICHD (2013) attributes the unknown prevalence to broader definitions of ASD, better efforts in diagnosing ASD, and greater awareness regarding symptoms of ASD.
- Risk Factors associated with ASD diagnosis:
 - Boys are 4-5x more likely than girls to have ASD.
 - Families that have one child with ASD have a 2%-8% chance that another child will be diagnosed with ASD.
 - If the individual has other developmental disorders such as Fragile X syndrome or tuberous sclerosis they are more likely to be diagnosed with ASD.
 - Babies that are born before 26 weeks are at risk of ASD.
 - Babies who are born to older mother and fathers are at risk of being diagnosed with ASD.

Attention Deficit Hyperactivity Disorder (CDC, 2016):

- Prevalence: 11% (6.4 million) of children aged 4 to 17 have been diagnosed with ADHD as of 2011.
- Incidence: "The American Psychiatric Association states in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) that 5% of children have ADHD". However, studies done on community samples in the US have found higher rates.
- Boys are more likely than girls to be diagnosed with ADHD (13.2% compared to 5.6%).

Impact of the Problem on Occupational Performance

IADL-Education: The child's diagnosis of either ASD or ADHD and the characteristic of decreased attention makes it difficult to complete their school work effectively, thus decreasing their educational academic performance. According to Mulligan (2001), children diagnosed with ADHD often experience significant academic and sensory motor problems that make typical school activities a challenge. Goldstein and Goldstein (1992) identified sitting and paying attention as problems for these children in the classroom, and Barkley (1990) noted that children with ADHD often fail to complete assignments or underperform academically. According to Schilling and Schwartz (2004), children with ASD commonly have difficulty with engagement, attention, and appropriate behavior in the classroom which interfere with student's ability to participate in the educational mainstream.

Intervention: Describe Intervention of 3 Articles

All the studies reviewed shared similar stability ball intervention approaches. Student participants received a stability ball in lieu of chair seating in the classroom. Students in all studies were provided a period of time to allow the novelty effect of the ball to wear off or normalize. The novelty period ranged from 2 days to 2 weeks. In two studies, the ball was fitted to the child prior to the intervention. In the other study, it was not mentioned whether the children were fitted. Use of the stability balls ranged from 16 minutes/day to the full school day. The duration of the intervention ranged from 2 weeks to 9 months.

OT Theoretical Basis

Sensory Integration (and Processing): A component of the SI approach focuses on modifying negative classroom behaviors by providing children an ability to modulate sensory input (Schilling, 2004). One method used to modulate sensory input is a stability ball. Proprioceptive input, vestibular input, and tactile input the children receive through the ball is believed to allow the child to find their optimal state of arousal needed to successfully engage and remain attentive during classroom tasks. This belief/hypothesis is both supported and refuted in research. Research completed by Schilling (2001) is supportive of the hypothesis, whereas a randomized control trial by Fedewa (2015), refutes the hypothesis.

Science Behind the Intervention

Children with ASD and ADHD are found to respond to sensory stimuli differently than typically developing peers (Baranek et al., 1997; Mulligan 2001). A stability ball is a type of sensory stimuli that modifies the central nervous system and intended to help the body attain its optimal state of arousal required for learning (Shilling, 2003). A child sitting on a stability ball is experiencing a sense of instability that differs from a regular classroom chair. This instability allows the child to engage their vestibular, proprioceptive, and tactile systems while in their seat which aids the child in organizing and integrating sensory information (Bagatell, 2010). These systems are movement dependent which facilitate cerebellar functioning. The cerebellum helps coordinate movements for these instabilities occurring on the ball, so the child is able to stay upright. Research has shown that the cerebellum also plays a role in attention, spatial perception, long-term memory, and impulse control. With increased input to the cerebellum there is increased input to the pre-frontal cortex where attention is housed (Lengel & Kuczala, 2010). The goal of this change is intended to increase a child's attention while sitting on the stability ball to engage in classroom tasks.

Why is this intervention appropriate for OT?

Occupation-based: An important occupation in childhood is the ability to participate in the classroom. One factor that impacts participation may be attention. Providing a stability ball to a child aims to improve attention and in turn increase participation in the classroom. Participation is within the scope of occupational therapy practice making it an appropriate context for intervention.

FOCUSED CLINICAL QUESTION:

Are stability balls more effective than a standard classroom chair to improve attention in student's kindergarten through 5th grade with attention concerns?

SEARCH SUMMARY:

In order to review applicable literature, Google Scholar and UW-La Crosse Murphy Library databases were searched. Eight articles matching our search criteria were located; which included one randomized control trial (RCT), six case series, and one survey (Refer to Table 2.) The RCT article was chosen because it was the only RCT found in our search and offered greater evidence. The two-case series were chosen because they were relatively recent (within the past 5 years), matched our search criteria, and offered the greatest strength based on the Center for Evidence

TABLE 1: SEARCH STRATEGY

Search Terms	Inclusion and Exclusion Criteria
<p>"stability balls for attention" "stability balls and ADHD" "therapy balls and classrooms" "swiss ball and classroom behavior" "alternative seating" "occupational therapy classroom seating" "therapy balls in the classroom occupational therapy" "therapy balls and ADHD" "therapy balls and Autism" "wiggle cushion"</p>	<p><u>Inclusion criteria:</u> Full free text available English only Peer reviewed</p>
<p>Based Management's "Critical Appraisal of a Case Study" form. Due to minimal RCTs, small sample sizes, and poor methodology, the evidence was limited and not rigorous.</p>	

CLINICAL BOTTOM LINE:

There is emerging low level evidence for stability ball use for children who seek vestibular and proprioceptive input and children with apparent attention concerns. There is no evidence for stability ball use in improving attention for typically developing children.

Limitation of this CAT: This critically appraised paper was reviewed by occupational therapy graduate students and the course instructor.

TABLE 2: SUMMARY OF STUDY DESIGNS OF ARTICLES RETRIEVED

Level	Study Design/ Methodology of Articles Retrieved	Total Number Located	Citation (Name, Year)
1a	Systematic Reviews or Metanalysis of Randomized Control Trials	0	
1b	Individualized Randomized Control Trials (RTC)	0	
2a	Systematic reviews of cohort studies	0	
2b	Individualized cohort studies and low quality RCT's (PEDro ≤ 4)	1	(Fedewa, 2015)
3a	Systematic review of case-control studies	0	
3b	Case-control studies and non-randomized controlled trials (quasi experimental or clinical trials)	0	
4	Case-series and poor quality cohort and case-control studies	6	(Bagatell et al., 2010) (Schilling, 2003) (Burgoyne, 2015) (Fedewa, 2011) (Schilling, 2004) (Wu, 2012)
5	Expert Opinion (Survey)	1	(Mulligan, 2001)

TABLE 3: STUDIES INCLUDED

	Study 1 Fedewa, 2015	Study 2 Fedewa, 2011	Study 3 Bagatell et al., 2010
Design	RCT	Single Subject A-B continuous time series	Single Subject Design ABC Design A=baseline condition B=intervention phase C= choice condition
Level of Evidence	2b	4	4
Rigor Score	4/11	8/10 on the Center for Evidence Based Management's "Critical Appraisal of a Case Study" form	8/10 on the Center for Evidence Based Management's "Critical Appraisal of a Case Study" form
Population	<p>Four classrooms of 2nd grade students in a rural elementary school in Southeastern USA</p> <p>67 students returned consent (32 girls, 35 boys)</p> <p>16 children were observed (Four per classroom)</p> <p>None of the students had physical or cognitive limitations</p>	<p>Eight students in 3rd-5th grades in rural central Kentucky</p> <p>Observed students across four classrooms who classified as having the most severe issues on the ADHDT assessment</p>	<p>Six boys with moderate/severe ASD who attended a public school in a large urban school district</p> <p>The students were in kindergarten and 1st grade</p>
Intervention Investigated	Stability balls	Stability balls	Stability balls
Comparison Intervention	Standard classroom chairs	No control due to study design	No control due to study design
Dependent Variables	<p>On Task Behavior</p> <p>Achievement in math & literacy</p>	<p>In-seat behavior</p> <p>On-task behavior</p> <p>ADHDT score</p>	<p>In seat behavior</p> <p>Engagement</p> <p>Teacher preference</p>

	Discipline Referrals		Child Preference
Outcome Measures	<p>On-task behavior was assessed via momentary time sampling (MTS)</p> <p>Achievement in math and literacy were measured using: Measures of Academic Progress</p> <p>Discipline referrals were collected via "clip downs"</p>	<p><u>ADHDT scores</u> 3 subscales (hyperactivity, impulsivity, & inattentiveness), completed 2 weeks before and 2 weeks after intervention</p> <p><u>Momentary time sampling</u>- every 30 seconds for 30 minutes the observer recorded the student's behavior based on classroom behavioral classifications.</p> <p><u>Teacher Social Validity Scale</u></p> <p>A questionnaire given to teachers at the end of the study to determine effects of using the stability ball</p>	<p>Sensory Processing Measure-Main Classroom form</p> <p>Teacher perception & social validity</p>
Results	<p><u>Treatment:</u> Mean of 32 discipline referrals</p> <p>Mean achievement score in literacy was 178.66</p> <p>Mean achievement score in math was 180.34</p> <p>Mean % of On-Task Behavior: 77%</p> <ul style="list-style-type: none"> Working with peers=13% 	<p>ADHDT pre-test scores: $t(71)=9.8$, $d=0.79$, $CI=42.6,64.4$</p> <p>ADHDT post test scores: $t(6)=6.1$, $d=0.67$, $CI=11.8,26.9$.</p> <p>In-seat time went from 45% before intervention to 94% after intervention. On task behavior went from 10% before</p>	<p>Results of this study were mixed</p> <p>Each child had individual results for in-seat behavior and engagement, however, results varied amongst children based on their scores from the outcome measure.</p>

	<ul style="list-style-type: none"> • Doing Independent work=29% • Interacting with teacher=35% <p><u>Control:</u> Mean of 22.38 discipline referrals</p> <p>Mean achievement score in literacy was 173.12</p> <p>Mean achievement in math was 178.19</p> <p>Mean % of On-Task Behavior: 87%</p> <ul style="list-style-type: none"> • Working with peers: 15% • Doing independent work: 39% • Interacting with teacher: 33% 	intervention to 80% after intervention.	
Effect Size	Refer to Table 2 in article	ADHDT pre-test scores: $d=0.79$ ADHDT post test scores: $d=0.67$	Not listed
Conclusion	<ul style="list-style-type: none"> • Study did not find use of stability balls for entire general education classrooms to be a practical use of resources for schools. • Stability ball use did not result in greater on-task behaviour • Intervention group demonstrated improvements with teacher interaction • Academic achievement was 	All students demonstrated improvements in attention and hyperactive levels when using the stability balls. However, children who scored higher on the ADHDT demonstrated significant gains for in-seat and on-task behavior.	Children with proprioception and vestibular seeking input made the most noticeable improvements and decreased their time they spent out of seat.

	not dependent on intervention.		
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SYNTHESIS SECTION:

PICO Question:

Are stability balls more effective than a standard classroom chair to improve attention in student's kindergarten through 5th grade with attention concerns?

Overall Conclusions:

- The outcome variable of our PICO question is attention. In the three articles reviewed, attention was defined as engagement and on-task behavior. According to the Bagatell et al. (2010), as cited by Schilling and Schwartz (2004), the definition of engagement was described as "oriented towards appropriate classroom activity such as instructional materials, activity, or teacher and either interacting with the materials, responding to the speaker, or looking at the speaker" (Bagatell et al., p. 898, 2010). Two of the three studies reviewed were rigorous with poor methodology. The RCT (Fedewa, 2015) was the only study that utilized a control group but also demonstrated poor methodology.
- Results:
 - The RCT found there were no statistically significant differences in attention when comparing use of stability balls versus standard classroom chairs with typically developing children (Fedewa, 2015). The two case studies, which included children with attention deficits, had mixed results.
- Analysis of how differences impact results:
 - Treatment dosages: The studies varied based on length and intensity of the stability ball intervention. Length of the studies ranged from 19 days to 9 months and use of the ball ranged from 16 minutes per day to all day use. The high variability of procedures leads to different outcomes in the effectiveness of the intervention.
 - Additional Explanation for Improvement: One study stated that all participants received in-school speech therapy and occupational therapy services in addition to the intervention. The participant that improved the most in the study was receiving clinic based occupational therapy services involving sensory integration in addition to school based services (Bagatell et al., 2010).
 - Impact of Type of Test Used to Measure Attention: Two of the studies used momentary time sampling (MTS) whereas the other study reviewed 16 minutes of recorded video. Momentary Time Sampling involves monitoring participants at 30 second intervals and recording observations during each interval. MTS data collection was completed for each study for 30 minutes. The video recording allowed for more accurate analysis given the properties of rewinding and reassessing behaviours.
 - Variation in Population: One study examined typically developing second graders, another study examined six boys with Autism in kindergarten and 1st grade, and the final study examined students in 3rd-5th grade with ADHD. Results may be

varied based on the wide age range from kindergarten to 5th grade, developmental sequences, and diagnosis. The age range that demonstrated the greatest improvement while utilizing the stability ball were children in 3rd-5th grades.

- Novelty Effect: The novelty effect is the amount of time the researchers used to acclimate the students to the stability balls. The studies had varied time periods: two days, five days, and two weeks. The study that demonstrated the greatest improvement used two days to get acclimated to the stability ball.
- Summary: There is no evidence to support stability balls to improve attention deficits in the classroom.

Boundaries:

- Summary of Populations:
 - Typically developing children: Sixteen children in second grade with no physical or cognitive limitations.
 - Children with attention problems: Fourteen children kindergarten through 5th grade.
- Relevant Inclusion/Exclusion Criteria:
 - There were no clearly defined inclusion or exclusion criteria across the studies examined.

Implications for Practice:

- There is no evidence for the use of stability balls in the classroom to address attention in typically developing children when used over a nine-month period. The case study with eight participants suggest that children with the most difficulty with attention and hyperactivity demonstrated statistically significant improvement after 12 weeks of intervention. One child with ASD and sensory needs for vestibular and proprioceptive input also demonstrated improved attention while using the stability ball for 19 days.

REFERENCES:

Critiqued Articles

- Bagatell, N., Mirigliani, G., Patterson, C., Reyes, Y., & Test, L. (2010). Effectiveness of therapy ball chairs on classroom participation in children with autism spectrum disorders. *American Journal of Occupational Therapy*, 64(6), 895-903.
- Fedewa, A. L., & Erwin, H. E. (2011). Stability balls and students with attention and hyperactivity concerns: Implications for on-task and in-seat behavior. *American Journal of Occupational Therapy*, 65(4), 393-399.
- Fedewa, A., Davis, M. A., & Ahn, S. (2015). Effects of stability balls on children's on-task behavior, academic achievement, and discipline referrals: a randomized controlled trial. *American Journal of Occupational Therapy*, 69(2), 6902220020p1-6902220020p9.

Related Articles (Not Individually Appraised):

- Burgoyne, M. E., & Ketcham, C. J. (2015). Observation of Classroom Performance Using Therapy Balls as a Substitute for Chairs in Elementary School Children. *Journal of Education and Training Studies*, 3(4), 42-48.
- Mulligan, S. (2001). Classroom strategies used by teachers of students with attention deficit hyperactivity disorder. *Physical & Occupational Therapy in Pediatrics*, 20(4), 25-44.
- Schilling, D. L., & Schwartz, I. S. (2004). Alternative seating for young children with autism spectrum disorder: Effects on classroom behavior. *Journal of autism and developmental disorders*, 34(4), 423-432.
- Schilling, D. L., Washington, K., Billingsley, F. F., & Deitz, J. (2003). Classroom seating for children with attention deficit hyperactivity disorder: Therapy balls versus chairs. *American Journal of Occupational Therapy*, 57(5), 534-541.
- Wu, W. L., Wang, C. C., Chen, C. H., Lai, C. L., Yang, P. C., & Guo, L. Y. (2012). Influence of therapy ball seats on attentional ability in children with attention deficit/hyperactivity disorder. *Journal of Physical Therapy Science*, 24(11), 1177-1182.

Other Related Information

- Baranek, G. T., Foster, L. G., & Berkson, G. (1997). Tactile defensiveness and stereotyped behaviors. *American Journal of Occupational Therapy*, 51(2), 91-95.
- Barkley, R. (1990). *Attention deficit hyperactivity disorder: A handbook for diagnosis and treatment*. New York: Guilford.
- Brasic, J.R., (2015). *Autism*. MedScape. Retrieved on 10/10/2016 from: <http://emedicine.medscape.com/article/912781-overview>
- Centers for Disease Control and Prevention. (2016, October 5). Attention-deficit/hyperactivity disorder (ADHD). Retrieved from <http://www.cdc.gov/ncbddd/adhd/data.html>.
- Centers for Disease Control and Prevention. (2016, September 26). Data & Statistics. Retrieved October 13, 2016, from <http://www.cdc.gov/ncbddd/autism/data.html>
- Goldstein, S., & Goldstein, M. (1992). *Hyperactivity-Why won't my child pay attention?* New York: Wiley.
- Lengel, T., & Kuczala, M. (Eds.). (2010). *The kinesthetic classroom: Teaching and learning through movement*. Corwin Press.
- National Alliance of Mental Illness. (2016). ADHD. Retrieved from <http://www.nami.org/Learn-More/Mental-Health-Conditions/ADHD>.

- National Institute of Child Health and Department (2013, December 8). How many people are affected by autism spectrum disorder (ASD)? Retrieved October 13, 2016, from <https://www.nichd.nih.gov/health/topics/autism/conditioninfo/pages/at-risk.aspx>
- Noterdaeme, M., Amorosa, H., Mildenberger, K., Sitter, S., & Minow, F. (2001). Evaluation of attention problems in children with autism and children with a specific language disorder. *European child & adolescent psychiatry*, 10(1), 58-66.
- Shire, 2016. ADHD Institute, *Neurobiology*. Switzerland. Retrieved from: <http://www.adhd-institute.com/burden-of-adhd/aetiology/neurobiology/>