Journal of Neurological Disorders

J Neurol Disord
Volume 11:4, 2023

Research Article

Open Access

Postural Balance Control and its Relation to Daily Living Skills in Patients with Autism Spectrum Disorder: A Systematic Review

Brito Mayara Pacífico and Boffino Catarina Costa*

Department of Psychopathology and Psychiatric Therapeutics, Institute of Psychiatry, Brazil

Abstract

Introduction: Autism Spectrum Disorder (ASD) is a condition that involves a spectrum of manifestations, including alterations in restricted and repetitive sensory motor behavior and social communication deficits that expresses in activities of daily living. The functionality of posture and balance is investigated by observing aspects related to physical measures and clinical characteristics of the center of pressure sway and daily living skills (DLS) in individuals with ASD.

Objective: To characterize the functionality of postural control in patients diagnosed with ASD and to observe correlations between changes in postural control in clinical features and DLS.

Methodology: This study conducted a bibliographical survey in the PubMed, SciElo, PEDro, and Bireme databases. The inclusion criteria included studies from 2011 to 2021, free texts in Portuguese and English, and articles of evaluations in children up to the age of adults (44 years) that were within the study objective. Articles excluded described coordination and balance disorders other than ASD, studies proposing treatment protocols, and evaluations of adults older than 45.

Results: Five pieces compose this review in which the characteristics observed show postural balance changes. There is a difference in the performance of individuals with ASD and typical development (TD), showing a longer time for postural development and difficulties in DLS.

Conclusion: Although the studies present different ways of evaluating postural and balance development, balance disorders are evident, considering a correlation between DLS and IQ.

Keywords: Autistic spectrum disorder • Postural balance • Patients

Introduction

The function regarding posture and balance involves sensory-motor components with various features in the individual, task, environment, and context domains [1,2]. These functions can be as simple as brushing teeth or eating when an orthostatic or seating posture is needed to create a reference of the motor program and allow daily living activity.

Motor control stems from physiological characteristics related to nervous system functions. Motor control of postural balance comes from characteristics that integrate developmentally related reflexes, reflexes from sensory and sensorimotor systems, developmental postural reactions, integrative tasks, adaptive features, sensory integration, functional and cognitive aspects, and strategy formation [1-3]. The concern is a complex skill that reports to behavior. The integration of these reflexes and systems can aid in the formation of a neural system that assists in the construction of strategies and adaptation of neural circuits [1-3].

Posture and balance characteristics can be assessed in computerized dynamic posturography through force platforms and scales [4-6]. The kinetic measures, particularly those related to the center of pressure, are used to assess postural balance in different diseases. The center of pressure tells us about the body's control in different postures and how it organizes its forces to maintain it. Also, different aspects of the center of pressure's measures, varying the tasks proposed, can assess the postural balance in different conditions [1,3], for example, a task to maintain posture during a visual stimulus [4]. Thus, the function of postural balance in people with Autism Spectrum Disorder (ASD) can explain the real difficulties underlying sensory and motor behaviors and daily living skills.

Postural control and its sensory-motor components are required for daily living skills as it establishes the reference posture for the activity in each context. This study aimed to characterize the disorders of postural control in individuals diagnosed with Autistic Spectrum Disorder (ASD) and to observe the correlations of postural control manifestations in clinical ASD patients and their daily life skills.

Materials and Methods

To conduct this literature review, a bibliographic search was made following the PRISMA Criteria [7] and accessed the following databases: PubMed, SciELO, PEDro, and Bireme, using the English descriptors "Autism Spectrum Disorder" and "Postural Balance" associated with Boolean descriptors ("AND") to direct the study better. Two reviewers independently complete the research process.

Eligibility criteria

Articles selected followed inclusion and exclusion criteria. We included articles published between 2011 and 2021 that were within the focus of this study, which is to characterize the functionality of posture and balance and its sensorimotor components in children and adults with Autism Spectrum Disorder (ASD). Selected articles on postural balance and gait could report evaluations if the balance and or stability function were outcomes. The inclusion criteria were also English and Portuguese studies in individuals

***Address for Correspondence:** Boffino Catarina Costa, Department of Psychopathology and Psychiatric Therapeutics, Institute of Psychiatry, Brazil, Email: boffinocb@gmail.com*

Received: 04-July-2023, Manuscript No. jnd-23-104825; **Editor assigned:** 06-July-2023, PreQC No. P-104825 (PQ); **Reviewed:** 20-July-2023; QC No. Q-104825; **Revised:** 25-July-2023; Manuscript No. R-104825 (R); **Published:** 01-August-2023, **DOI:** 10.4172/2329-6895.11.4.561

with Autistic Spectrum Disorder.

Regarding age, the articles considered were about evaluations in children and adolescents up to the age of adults (44 years) [8]. Studies about other coordination and balance disorders, such as Coordination Disorders, were excluded. The exclusion criteria were also about studies that considered treatment protocols.

Research strategy

Data collection was performed on 10/28/2021 by the two reviewers independently. In the studied platforms (PubMed, SciElo, PEDro, and Bireme), the search was made in the "Advanced Search" option, using the descriptors and MeSH Terms (Medical Subject Headings) in English "Autism Spectrum Disorder" and ("AND") "Postural Balance." Filters such as article publication period (2011-2021), article availability (only freely available articles, and article type (we searched for Clinical Trials and Randomized Controlled Trials). The Bireme search also allowed using the filters Main Subject (Postural Balance, Autism Spectrum Disorder, Posture, and Gait) and Type of Study (Controlled Clinical Trial, Observational Study, Prognostic Study, Prevalence Study)-the same strategy performed for the SciELO and PEDro platforms.

Study selection

Articles were selected using the "MyEndNoteWeb" database (MyEndNoteWeb https://access.clarivate.com/login?app=endnote). The articles imported to the EndNote Web platform came from the two reviewers and completed 190 articles. At this point, duplicate articles were identified and removed. Articles of the last 10 years, free full texts written in Portuguese and English, were selected, 24 articles. Then the abstracts of the articles were read, and the exclusion criteria for the sample were applied, duplicated articles, some treatment proposed, not only ASD, older individuals (45+), motor training based-paper, other issues, a review study, and not free-full texts were excluded. At the same time, the full articles assessed for the review made up the sample, and the final selection included five articles.

Data extraction

A table form to extract data from each study and randomly fill out by the two reviewers. The table included the year, author, objective, subjects, method, variables, results/outcomes, and conclusion. Both reviewers read all articles. Discrepancies in the completion of the table were brought up and resolved in a discussion between the reviewers.

Bias risk assessment

The risk of bias was assessed by the Downs and Black checklist [9]. For each article, a score was made, including punctuation of 0-28 ("power" is one on a maximal score in this classification) of "excellent" (24-28 points), "good" (19-23 points), "regular" (14-18 points) or "poor" (<14 points) was assigned [10].

Results

All the selected studies were experimental, some being case-control studies and the others evaluating only characteristics of the Autism Spectrum Disorder group. In the PubMed platform, 37 articles were found by one reviewer and 38 by the second reviewer; in Bireme, the search carried out with the descriptors selected 52 articles for one reviewer and 61 for another; the search carried out by SciELO, with access to 2 articles and PEDro, with access to 0 articles. Results were finished in 5 selected articles (Figure 1).

After reading the selected articles, the information was recorded so that comparisons and analyses could be made in the table prepared to evaluate the articles. The based table included data on the year, author, objective, subject groups, method (evaluation), variables, results/outcomes, and conclusion, and those data are reported below in the text. Table 1 resumed the study type, diagnostic criteria, and methods to study postural control, sample, age, and conclusion.

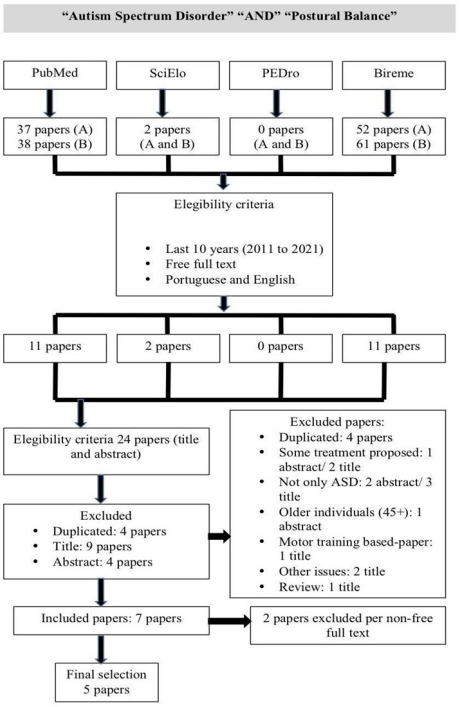

Figure 1. Flowchart of the review article selection process

Table 1. Articles selected for this study following the inclusion and exclusion criteria

Author Year	Study type	Diagnostic	Methods to study postural control, sample, and age	Conclusion
Greffou et al., 2012	Case-control, experimental	Autism Diagnosis Interview-Revised and the Autism Diagnosis Observation Schedule, and expert (but not standardized) clinical DSM-IV diagnosis of autism (no information of ASD level)	Virtual reality Cave ®environment 16 ASD individuals and 34 controls 12-15 years and 16 to 33 years	ASD participants showed postural hypo-reactivity to visual information, and that is contingent on both visual environment and development.

Fisher et al., 2018	Case, experimental	Autism Diagnostic Observation Scale-2nd edition (ADOS-2) (meeting criteria for ASD on Modules 3 or 4 on ADOS-2)	BOT-2 (Bruininks-Oseretsky Test of Motor Proficiency-2ªedition), VABS-II (Vineland Adaptative Behavior Scale-2nd edition), Daily Living Scale (DLS), WASI-II (Wechsler Abbreviated Scale of Intelligence-2nd edition) e ADOS-2 (Autism Diagnostic Observation Scale-2nd edition) 52 ASD individuals between 6 to 17 years	In ASD, intelligence could contribute to established compensatory strategies on DLS, associating the context of broader cognitive and environmental factors.
Bojanek et al., 2020	Case-control, experimental	Autism Diagnostic Inventory-Revised (ADI-R), the Autism Diagnostic Observation Schedule–Second Edition (ADOS-2), and expert clinical opinion based on DSM-5 criteria (One participant completed Module 2, 14 participants completed Module 3, and two participants completed Module 4 for ADOS-2. Three ASD participants' parents could not complete the ADI-R, but these participants met ASD classification on the ADOS-2 and DSM-5 criteria for ASD).	Postural control (quiet stance and step) in force platform 17 ASD individuals with age between 6 to 19 years 20 paired controls (age, sex, non-verbal IQ and body mass index)	ASD cannot coordinate joint movements during dynamic postural adjustments and has motor rigidity that interferes with posture and gait. Those features correlate with repetitive behaviors
Cordeiro et al., 2021	Case, experimental	DSM-V (level one)	The Sensory Organization Test and the Pediatric Balance Scale 12 ASD individuals between 7 to 11 years.	The participants had no difficulties with the postural balance scales performed.
Li, Liu, Venuti, 2021	Case, experimental	DSM-V (level one-mild)	Eyes-open and eyes-closed conditions of quiet posture in force platform 29 ASD individuals (level 1) between 6 and 14 years separated in three groups ((6-8 years (U8), 9-11 years (U11) e 12-14 years (U14).)	Children with ASD could slowly develop postural stability but only demonstrate significant changes over a long period.

Note: ASD: Autism Spectrum Disorder; DLS: Daily living skills; ADI-R: Autism Diagnostic Inventory-revised, ADOS-2: The Autism Diagnostic Observation Schedule-Second Edition, IQ: Intelligence Quotient.

The first article was from Greffou et al. and studied the postural control of ASD patients in an immersive visual field (checkerboard, CAVE System ®) [11]. The second study was from Fisher et al. (2018), who studied the relationship between postural control and daily living skills (DLS) in ASD children and adolescents (52 individuals) with ages between 6 and 17 years with an intelligence quotient between 67 and 104 [12]. The third article was from Bojanek et al. (2020) and studied three aspects of postural control in ASD children and adolescents: Feedback mechanisms to maintain the stability of postural control, anteroposterior and mediolateral adjustments and step/step initiation for feedback and feedforward of gait [13]. The Fourth study of this review was from Cordeiro et al. (2021) they used postural control scales (Sensory Organization Test and Pediatric Balance Scale) to assess the postural control and characterize their postural control stability [14]. The fifth study was from Li, Liu, and Venuti (2021) they proposed to study age's influence on the postural control of ASD individuals using amplitude and entropy of postural control sway in ASD individuals [15].

In the third study from Bojanek et al. (2020), the ASD group was diagnosed using for that the Autism Diagnostic Inventory-Revised (ADI-R), the Autism Diagnostic Observation Schedule-Second Edition (ADOS-2), and an expert clinical opinion based on DSM-5 criteria [13]. The measures of postural control used three initial postures tests during standing, neutral standing (stood with feet shoulder width), Romberg one stance with feet close together, and with feet shoulder-width apart and swaying in a circular motion. Those measures were tested in a force platform, observing the anteroposterior and mediolateral center of pressure (COP) sway and COP trajectory length. Also, they calculated a measure of mutual information (MI) for postural balance in a circular motion. After that, a stepping task was performed using the two force platforms adjusted in sequence together. Measures for the amplitude and duration of Anticipatory Postural Adjustments (APAs), COP sway measures in the first step, maximum lateral sway, and velocity was calculated. Those measures were compared to diagnostic measures and correlated. The fourth study was from Cordeiro et al. (2021); they observed postural control using for those two scales,

the Sensory Organization Test and the second the Pediatric Balance Scale. The Sensory Organization Test is a standard gold test in the force platform. They applied through scale and used four conditions to assess balance: Eyes open with the fixed platform, eyes closed with the fixed platform, eyes open with a sway-referenced platform, and eyes closed with the sway-referenced platform. The Pediatric Balance Scale assesses postural balance through 14 items giving a numerical score ranging from 0 to 4 points. The ASD individuals were diagnosed using the DSM-V criteria, and an interdisciplinary team evaluated the patients. The fifth study from Li, Liu, and Venuti (2021) studied the postural control through age in ASD individuals using for that an evaluation on a force platform with barefoot standing stationary with both feet on the platform with eyes open and eyes closed for about 15 seconds (short period) [15]. The diagnosis of ASD in this study was conducted using DSM-V criteria.

The outcomes and conclusions for each study were as follows. The study of Greffou et al. (2012) showed that at the highest oscillations of the checkerboard on the immersive virtual reality tunnel, younger autistic participants showed significantly less instability than typical development participants, with no differences like this in the older groups [11]. No differences were found in static or without visual information conditions. They concluded that autistic participants showed postural hypo-reactivity to visual information, contingent on both the visual environment and development. The study of Fisher et al. (2018) showed that global multiple regression predicting DLS as a function of balance, IQ, and age was significant [12]. In special, balance changes correlate with DLS only in IQ between 67 and 104. The authors concluded that their study contributes to understanding the motor challenges of DLS in autism and that intelligence could contribute to established compensatory strategies on DLS, associating the context of broader cognitive and environmental factors. In the study of Bojanek et al. (2020), ASD individuals showed increased center of pressure (COP) trajectory length across stance conditions and reduced mutual information (MI) in circular sway [13]. They found no differences in anticipatory postural adjustments during the step. Only differences were found in the initial step in mediolateral sway, reduced body transfer duration, and increased body transfer velocity. The study concluded that ASD individuals presented a reduced ability to coordinate joint movements during dynamic postural adjustments and also showed motor rigidity that may interfere with balance and gait. Those features were related to repetitive behaviors in ASD individuals indicating that motor rigidity and key clinical issues may overlap pathological processes. In the study of Cordeiro et al. (2021), the authors found that all the participants achieved the top score on the Sensory Organization Test Scale and top or near the top on Pediatric Balance Scale [14]. The authors concluded that the individuals with ASD in their study had no difficulty completing the tests proposed. Li, Liu, and Venuti's (2021) study showed differences regarding the age effect for the mediolateral center of pressure displacement and sway distance [15]. In post hoc analyses, the younger group (6-8 years) showed more significant measures compared to the older (12-14 years), and no differences between the younger and the middle group (9-11 years) and the middle and older groups were found, suggesting that children with ASD could slowly develop postural stability. However, differences can only be detected over long periods.

Moreover, they believe that programs aimed to improve the complexity of postural control may be beneficial to ASD individuals.

Quality assessment

The Downs and Black checklist was used to assess the quality of the included articles and the risk of bias. To this end, the article by Cordeiro et al. (2021) was rated "regular," as articles by Bojanek et al., 2020 and Li, Liu, Venuti (2021), and the article by Fisher et al., 2018 had "good" quality rating as well as the article by Greffou et al., 2011 [11-15]. Following the scale above, the item "Internal validity: Bias" was where the articles scored the lowest, and the items "Presentation of data" and "Power" was where the articles scored the highest in proportion to the value of each item [16] (Figure 2).

Table 2 summarizes the values obtained for quality and bias assessment by by the scale sub-items, total and qualitative assessment [9,10].

Table 2. Quality and bias values of selected articles according to the Downs and Black scale

	Category	Greffou et al., 2012	Fischer et al., 2018	Bojanek et al., 2020	Cordeiro et al., 2021	Li, Liu, Venuti, 2021
Reporting	0-11	11	10	10	7	10
External validity	0-3	1	3	0	0	2
Bias	0-7	3	3	2	3	2
Confounding	0-6	5	2	2	3	1
Power	0-5 (1)	4 (1)	5 (1)	5 (1)	5 (1)	5 (1)
Total	0-32 (0-28)	24(21)	23 (19)	17 (15)	18 (14)	20 (16)
Classification	-	Good	Good	Regular	Regular	Regular

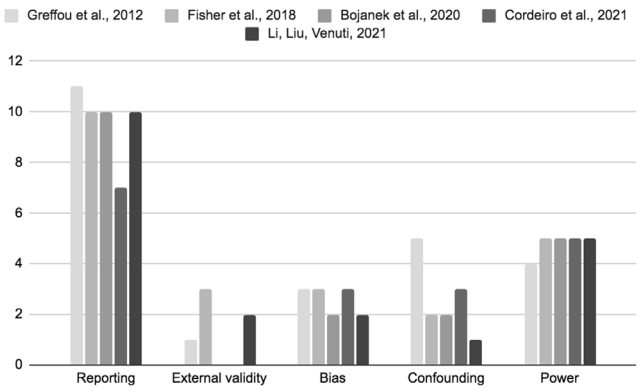

Figure 2. Downs and Black scale scores by sub-items of the articles selected for this study

Discussion

ASD is a condition that involves a spectrum of manifestations that include disorders in restricted and repetitive sensory motor behavior and social communication deficits that are associated with a genetic component expressed in skills of daily living [17-19].

Revision value

The study on postural balance in ASD individuals can help to understand the possibility of phenomenological changes that occur in ASD individuals, such as the movements expressed during the day and difficulties in quiet stance during daily living skills. In an objective, quantitative way, this correlation shows whether these patients' balance varies from a range of patterns and interferes with daily living skills.

In this review, most of the articles identified that patients with ASD have sensory-motor disorders concerning postural balance, compromising this function in orthostatic posture (or standing posture) that is a reference posture to daily living activities such as brushing teeth, home-activities and also, walking [11-15].

Eventually, reduced postural stability of these individuals occurs in the somatosensory system demand responsible for the muscle and joint information. However, also, visual and vestibular systems information can be damaged regarding the type of tasks performed in the papers that found impaired postural balance in ASD individuals [12-15]. This damage is called functional, or in hypothesis, an expression of neural circuits not recruited. Also, these studies could express sensory integration damage, which is the function of joining the sensory systems information to construct internal body mapping and guide motor responses to the environment, task, and context [1-3,20]. It was observed that the majority of articles, that is, four articles out of the 5 articles selected in this study, showed decreased postural stability in subjects with ASD, and these changes are quantifiable in different tasks, as already described by Minshew et al. (2004) in sensory organization test [20].

The only article that registered opposite findings was conducted by Cordeiro et al. [14]. In this study, no difficulties in manifestations of postural balance in individuals with ASD were observed. This article presents a methodology that scores "regular." They used the Sensory Organization Test (scale) and the Pediatric Balance Scale. The patients achieved the maximum score; however, the main concern is about the sensitivity of these scales to describe the quality of execution of the proposed activities and detect differences among these patients. Also, this study investigated postural balance only in the individuals that finished the scales in the complete form. The individuals included in this study were with low severity levels.

Considering postural control's interaction with the daily living skills scale (DLS), we only obtained one article [12]. They observed that it is not a direct relationship between DLS and postural balance. They proposed that this correlation is under the possibility that the ASD individual could develop adaptation strategies to complete their activities and that this occurs depending on the IQ score.

Limitations of the included studies

The main limitation of the studies, when we think about the population of the evaluations of the cited studies, was that the individuals were not representative of the population due to local samples [9].

The evaluations performed, such as posturography or postural balance assessments with a force platform, are not easily found and available to all patients; because they are particular studies, there are still no references for the ASD population in general. On methodological levels, according to the Downs and Black Scale, the four articles that showed balance changes were characterized with "good" or "regular" [16]. These articles did not receive higher scores because, in their construction, due to not blinding.

Future prospects

Thinking about the balance and posture assessments presented in this review, these could be adopted more broadly by the population for the ASD group, seeking to understand in more detail the daily life skills of these individuals bringing to clinical posturography situations. These assessments can quantify and delimit gains and losses in each age group in different tasks.

The studies in this review considered different tasks such as the step strategy, the static and dynamic balance, the virtual reality tunnel (immersive tunnel), and scales for postural balance, each with its task and evaluation, but in no study was replicability of the strategies. Although the studies in the present review are of regular and good methodological quality, the method needs replicability.

Conclusion

The balance manifestation is more evident in ASD individuals than typical development individuals; even though the studies presented different tasks in their proposes, they represented in their outcomes covalent information in their majority. Postural balance manifestations in patients with ASD are increasingly better described and show disorders in postural balance and correlation with daily living skills in these individuals.

Funding

Not Applicable.

Acknowledgement

Not Applicable.

Conflict of Interest

There is no conflict of Interest.

References

1. Shumway, C, Woollacot MH. “Motor Control: Theory and Practical Applications.” 2010.
2. Aires, Margarida DM. “Basic Physiology: Ed Guanabara Koogan.” 1986.
3. Kandel, ER, Schwartz JH and Jessel TM. “Principles of Neural Science.” 2000.
4. Boffino, CC, De Sá CSC, Gorenstein C and Brown RG, et al. “Fear of Heights: Cognitive Performance and Postural Control.” *Eur Arch Psychiatry Clin Neurosci* 259(2009): 114-119.
5. SA, CDSC, Boffino CC, Ramos RT and Tanaka C. “Development of Postural Control and Maturation of Sensory Systems in Children of Different Ages: A Cross-Sectional Study.” *Braz J Phys Ther* 22 (2018): 70-76.
6. Horak, FB, Wrisley DM and Frank J. “The Balance Evaluation Systems Test (BESTest) to Differentiate Balance Deficits.” *Phys Ther* 89(2009): 484-498.
7. Paje, MJ, McKenzie JE, Bossuyt PM and Boutron I, et al. “The Prisma 2020 Statement: An Updated Guideline for Reporting Systematic Reviews.” *BMJ* 372(2021): 372.
8. Mantovani, EP. “O processo de Envelhecimento e Sua Relação com a Nutrição e a Atividade Física.”
9. Downs, SH and Black N. “The Feasibility of Creating a Checklist for the Assessment of the Methodological Quality of both Randomised and Non-Randomised Studies of Health Care Interventions.” *J Epidemiol Community Health* 52(1998): 377-384.
10. O’connor, SR, Tully MA, Ryan B and Bradly JM, et al. “Failure of a Numerical Quality Assessment Scale to Identify Potential Risk of Bias in a Systematic Review: A Comparison Study.” *BMC Res Notes* 8(2015): 224.
11. Greffou, S, Bertone A, Hahler EM and Hanssens JM, et al. “Postural Hypo-Reactivity in Autism is Contingent on Development and Visual Environment: A Fully Immersive Virtual Reality Study.” *J Autism Dev Disord* 42(2011): 961-970.
12. Fisher, A, Engel C, Geist R and Lillie K. “Brief Report: Brief Report:

Postural Balance and Daily Living Skills in Children and Adolescents with Autism." *J Autism Dev Disord Madison* 48(2018): 3210-3215.

13. Bojanek, EK, Wang Z, White SP and Mosconi MW. "Postural Control Process during Standing and Step Initiation in Autism Spectrum Disorder." *J Neurodev Disord* 12(2020): 1.
14. Cordeiro, ESG, Aprígio LCS, Azoni CAS and Gazzola JM. "Postural Balance in Children with Autistic Spectrum Disorder." *Revista CEFAC* 23(2021): e0921.
15. Li, Y, Liu T and Venuti CE. "Development of Postural Stability in Children with Autism Spectrum Disorder: A Cross-Sectional Study." *Int Biomech* 8(2021): 54-62.
16. Downs, SH and Black N. "Checklist Downs & Black."
17. Silva, M and Mulick JA. "Diagnosing Autistic Disorder: Fundamental Aspects and Practical Considerations." *Psychol Sci Prof* 29(2009): 116-131.
18. Lord, C, Elsabbagh M, Baird G and Vanderweele JV. "Autism Spectrum Disorder." *Lancet* 392(2018):.508-520.
19. Wiggins, LD, Rice CE, Barger B and Soke GN, et al. "DSM-5 Criteria for Autism Spectrum Disorder Maximizes Diagnostic Sensitivity and Specifity in Preschool Children." *Soc Psychiatry Psychiatr Epidemiol* 54(2019): 693-701.
20. Minshew, NJ, Sung K, Jones BL and Furman JM. "Underdevelopment of the Postural Control System in Autism." *Neurology* 63(2004): 2056-2061.

How to cite this article: Pacífico, BM and Costa BC. "Postural Balance Control and its Relation to Daily Living Skills in Patients with Autism Spectrum Disorder: A Systematic Review." *J Neurol Disord*. 11(2023):561.