Clin Schizophr Relat Psychoses
Volume 15:1, 2021

Clinical Schizophrenia & Related Psychoses

Research Article

Hybrid Open Access

Postural Control in Schizophrenia: A Retrospective Cohort Study

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Abstract

The objective of this research was to establish the differences in postural control between people with and without schizophrenia. A retrospective cohort study was conducted with 41 people in both the control group (healthy) and those exposed (people with primary schizophrenia over 36 months of evolution). Postural control was assessed using Tinnetti balance test, sensory organization test, timed get up and go, 10-meter walk test, functional reach test, 360 degree turn test, sit-to-stand test performance, hand grip strength and bank of Wells test performance. Comparison of inter-sample means, and risk analysis was performed. Statistically significant differences were found between the means of all the variables studied for postural control ($p<0.050$). In all cases the performance was better in the group of healthy people and the individual risk was higher in the group of people with schizophrenia. Having schizophrenia is a risk factor for postural control alterations, specifically in balance, sensory orientation, speed and stability during gait, antigravity postural control, hand grip strength and elasticity of the posterior muscle chain.

Keywords: Postural balance• Age• Walking speed• Elasticity• Schizophrenia• Relative risk

Introduction

The World Health Organization (WHO) considers mental health, physical and social health as highly relevant aspects of people's lives, which are linked and mutually reliant on each other [1]. Mental health is conceived as a "state of well-being in which the individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community" [2]. Mental and behavioral disorders are estimated to account for 12% of the disease burden worldwide and 40% of the countries do not have a mental health policy [1]. The Pan American Health Organization indicates that one of four people in the Americas suffers from a mental health disorder [2]. The Colombian National Institute of Health estimates that the psychiatric and neurological conditions worldwide will increase from 10.5% of the total burden of all diseases to 15% by 2020 [3]. In the Department of Caldas, Colombia, mental and behavioral disorders rank first in the epidemiological profile, the increase in these conditions by age group was from 45% to 55% over a period of 4 years [4]. The current mental health statistics warn that nearly 450 million people worldwide are currently suffering from a mental or behavioral disorder such as depression, dementia, schizophrenia or drug addiction. They are among the top ten causes of global disability [2]. It is paramount to recognize the existing connection between mental health and physical health, which is demonstrated through neurophysiological routes in charge of their regulation, likewise, explaining how such routes influence on human behavior control. Mental disorders frequently exhibit a large number of physical or bodily manifestations revealing the close interaction between the body and the mind [5].

Schizophrenia is a serious and disabling condition of manifestation in adolescence or early adulthood in the majority of the cases; thus, leading to a large proportion of these people failing to develop personally or professionally [6]. Worldwide, a prevalence is estimated between 1.4 and 4.6 per 1,000 inhabitants and an incidence between 0.16 and 0.43. Its mortality which is associated with suicide and comorbidities such as diabetes, smoking and obesity, surpasses 50% of the general population. In Latin America schizophrenia is the nineteenth cause of disability [7]. In Colombia, the incidence is one per 10,000 inhabitants [8]. This condition is characterized by altering perception and cognitive processes, affecting behavior with atypical actions, communication problems, memory and concentration, social isolation, perception of strange experiences, poor personal hygiene and abandonment of daily tasks. It is accompanied by exacerbation episodes that include hallucinations, agitation, and distress [8]. It also exhibits motor deficiencies such as dyskinesias, psychotic tremor, catatonia, neurological soft signs and movement disorders related to cerebellar dysfunction of postural control and motor learning [9]. Teng et al. indicated a significantly poor balance in people with schizophrenia compared to healthy subjects. This was associated with compromised sensory integration and poor postural sequences, suggesting that postural control dysfunctions are part of the intrinsic nature of schizophrenia [10].

Likewise, movement disorders that may be related to dopamine blocking neuroleptics are evident, causing involuntary movements, deficits in motor coordination, decreased postural control and balance, which depend on the integration of information from three main sensory systems (vestibular, proprioceptive and visual systems) [11]. Other deficiencies observed are the presence of disabling gait, reflected in balance deficits, decreased gait speed and stride length, which means excessive energy expenditure and therefore a high level of physical fatigue [12]. The previously mentioned manifestations of motor control deficits lead to an inadequate excursion of the motor capacity from the biological, psychological and social sphere, as well as in the coordinating and conditional physical capacities [13].

As observed, postural control deficits have been described in isolation without considering all the components of postural control. Other studies

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Received 24 December, 2020; **Accepted** 05 January, 2021; **Published** 14 January, 2021

have focused on the application of therapeutic intervention techniques from physical activity and exercise [14-18], leaving aside objective assessment measures and the effect of neurobiological disorders of schizophrenia on neuromotor control.

Motor control is "is the process by which the Central Nervous System (CNS) receives, integrates, and assimilates sensory information with past experiences for planning and executing appropriate motor and postural responses" [19], it examines how the nervous system interacts with the rest of the body and the environment to produce a coordinated and purposeful movement [20]. On his behalf, Horak defines postural control as a complex skill based on the interaction of dynamic sensorimotor processes, whose functional objectives are postural orientation and balance for postural behavior. The first involves the active alignment of the body with respect to the gravity and information from somatosensory systems, while the postural balance involves the coordination of movement strategies to stabilize the center of mass during voluntary movements [21]. Postural control is considered a complex motor skill derived from the interaction of different sensorimotor processes. For optimal functioning, it needs: sensory orientation, stability during walking, balance, antigravity postural control and biomechanical strategies [21]. These were the basis in the present study for the evaluation of postural control with standardized tests and measures that allowed us to identify its deficits.

The objective of this is to establish the differences in postural control among People With Schizophrenia (PWS) and Psychotypical People (PTP), under the hypothesis that the former have a significant decrease or deficit in their performance in all components. This study provides professionals in the field of mental health, especially in the area of neurorehabilitation, an evaluation model in PWS that allows to obtain a more objective and comprehensive view of their function, functionality and functioning, and thus improving the rehabilitation processes. In addition, it can support future research in a field that has been little explored, such as Neurorehabilitación in mental health.

Materials and Methods

Study design

Under an empirical-analytical approach, a retrospective cohort study was carried out, approved by the Bioethics Committee of the Universidad Autónoma de Manizales (minute 080, August 15th, 2018) and San Juan de Dios Psychiatric Clinic, Manizales (Colombia). This complies with the principles set forth in the Helsinki Declaration of the World Medical Association and the guidelines of the Colombian Health Ministry on human being research. It was conducted between October 2018 and September 2019.

Sample and sampling

An intentional sampling, by quotas and conglomerate, of adults with and without schizophrenia who met the inclusion and exclusion criteria, and accepted participation in the study by signing the informed consent was carried out. In the case of institutionalized people with schizophrenia, informed consent was signed by a member of the ethics committee from the psychiatric clinic, the sample unit of this study. The sample size was calculated with the means comparison formula with a confidence level of 95% and a statistical power of 80%. The estimators for the different variables were obtained from previous studies in healthy Colombian people [22-24] for a minimum sample of 37 people in each group.

Participants

The cohort group consisted of people with a diagnosis of primary schizophrenia of more than 5 years of evolution. Those people with comorbidities, with health conditions or injuries that prevented postural control tests, with a diagnosis of secondary schizophrenia and with moderate or severe cognitive disabilities were excluded. The control group were healthy PTP, matched by sex and age with respect to the PWS group.

Procedure and instruments

A survey was conducted for sociodemographic data. The clinical data of the cohort group were obtained from their medical history. Weight and height measurements were taken and postural control measurements were carried out, as follows:

- Balance: Tinnetti balance test
- Sensory orientation: Sensory Organization Test (SOT)
- Speed and stability during walking: Timed get up and go (TUG) and 10-meter walk test
- Antigravity postural control: Functional reach test, 360 degree turn test and Sit-to-stand test performance
- Hand grip strength: dynamometry
- Posterior chain elasticity of the trunk and lower limbs: Bank of Wells test performance

Statistical analysis

The information processing was carried out with the statistical program SPSS version 25.0 (Statistical Package for the Social Science). The results are presented in four parts: a) Characterization of the participants: a univariate analysis of sociodemographic, anthropometric, clinical and postural control characteristics is performed; b) Normality test for the study variables: Shapiro-Wilk test; c) Confidence interval and comparison of means: inter-sample or independent sample analysis; and d) Hypothesis tests for analytical cohort studies: individual risk of exposed and unexposed group, relative risk, attributable risk and population attributable fraction. Most of the variables did not exceed the assumption of normality ($p<0.05$), therefore the comparison of groups is carried out with non-parametric statistics (Mann-Whitney U test). There was lost data during the harvesting and analysis of information.

Control of biases

PWS were duly diagnosed by a psychiatrist, PTP were matched by age and sex. Internationally validated measurement instruments with defined means and ranges for the Colombian population were used. The evaluation was carried out by duly trained and calibrated physiotherapists, neurorehabilitation master's students.

Results

Characterization of the participants

41 PWS between 23 and 58 years old (mean: 41 years old) were evaluated, the majority men (73%), and 41 PTP matched by sex and age (Tables 1 and 2). There were no significant differences between height and body mass index ($p>0.050$) that could explain differences in the execution of postural control tests (Table 3). Most were between normal weight and overweight.

Variable		Schizophrenia		Psychotypical	
		n	%	n	%
Sex	Male	30	73%	30	73%
	Female	11	27%	11	27%
Marital status	Single	33	80%	15	37%
	Free union			13	32%
	Married	4	10%	10	24%
	Widower			2	5%
	Divorced	4	10%	1	2%

Socioeconomic	Low	39	95%	30	73%
	Medium	1	2%	9	22%
	High	1	2%	2	5%
Employment situation	Employee		0%	27	66%
	Independent	3	7%	13	32%
	Student	1	2%	1	2%
	Retired	2	5%		
	Unemployed	35	85%		
Affiliation to social security in health	Unaffiliated	1	2%	1	2%
	Subsidized	19	46%	3	7%
	Contributory	10	24%	36	88%
	Special regime	3	7%	1	2%
	Prisoner	8	20%		
Weight status	Under weight	5	12%		
	Normal weight	18	44%	19	46%
	Overweight	13	32%	16	39%
	Obesity	5	12%	6	15%
Schizophrenia diagnosis	Undifferentiated	15	37%		
	Paranoid	11	27%		
	Others	7	17%		
	Not specified	5	12%		
	Residual	2	5%		
	Simple	1	2%		

Table 1. Descriptive of qualitative variables.

Most of the PWS were single, from low socioeconomic levels (95%), unemployed and affiliated with the subsidized health system. They had an average of 6.5 years of schooling and 7 years of evolution of their condition, according to data obtained from the clinical history; 37% with a diagnosis of undifferentiated schizophrenia and 27% paranoid schizophrenia (Tables 1 and 2). In contrast, most PPS had a partner (married or free union), employees or independent workers and affiliated to the contributory regime; 73% belonged to low socioeconomic levels (Tables 1 and 2). The descriptive statistics of the postural control tests, for both PWS and PTP, can be found in Table 2.

Comparison of means

As can be seen in Table 3, statistically significant differences were found between the means of all the variables studied for postural control (balance, sensory orientation, speed and stability during walking, antigravity postural control, hand grip strength and elasticity of the posterior chain of the trunk and lower limbs) ($p<0.050$), except in SOT with open eyes on firm surface ($p=0.080$). In all cases, performance was better in the PTP group. In the PWS group, the Functional reach test was less, the time and number of steps in the 360 degree turn test were greater, the duration of the Sit-to-stand test performance was greater, the Hand grip strength was lower; the time of the SOT with open and closed eyes on an unstable surface, as well as eyes closed on a firm surface were lower, the overall weighting of the Tinetti balance test was lower, the time in the TUG test was greater and they had less flexibility of musculature of the posterior train (evaluated with the Bank of Wells test performance). Table 4 shows their means and 95% Confidence Interval.

Variable		Schizophrenia (n=41)				Psychotypical (n=41)			
		Min	Max	Mean	SD	Min	Max	Mean	SD
Age (years)		23	58	40,95	10,54	23	58	40,95	10,54
Scholarship (years)		0	16	6,51	4,75	5	22	13,56	3,72
Weight (k)		40	98	68,60	14,46	54	103	73,07	11,81
Size (cm)		149	185	166,10	8,77	152	187	167,85	8,62
Body mass index (k/m2)		14	34	24,80	4,46	20	38	25,98	4,07
Evolution time of schizophrenia (months)		36	408	89,29	55,90				
Tinetti balance test (0-16)		8	16	13,83	2,13	15	16	15,80	0,40
Timed Get Up And Go (s)		6,90	17,25	9,99	2,43	5,9	11,59	7,94	1,24
Functional reach test (cm)		9,00	42	28,61	8,44	22	54	36,28	6,91
360 degree turn test-time (s)		1,35	5,15	2,98	0,85	1,16	4,16	2,54	0,66
360 degree turn test-steps (n)		3,00	11	5,15	1,61	3	6	4,12	0,87
Sit-to-stand test performance-five times (s)		5,60	21,1	13,32	3,82	6,37	17,61	11,04	2,21
10-meter walk test (s)		6,11	21,72	10,30	3,12	5,61	11,11	7,47	1,13
Hand grip strength (k)		8,00	50	28,20	10,22	21	55	39,22	9,74
Bank of Wells test performance (cm)		-26,00	11	-9,39	8,19	-16	15	-0,93	8,94
SOT (s)	Eyes open on firm surface	6,22	30	28,42	5,74	30	30	30,00	0,00
	Eyes closed on firm surface	2,49	30	27,60	6,86	30	30	30,00	0,00
	Eyes open on unstable surface	1,68	30	27,96	6,64	30	30	30,00	0,00
	Eyes closed on unstable surface	0,00	30	20,77	11,43	8,15	30	27,79	5,30

Note: Min: Minimum; Max: Maximum; SD: Standard Deviation; S: Seconds; SOT: Sensory Organization Test

Table 2. Descriptive of quantitative variables.

Variable	Schizophrenia			Psychotypical			Comparison of means		
	Mean	95% CI Low	95% CI High	Mean	95% CI Low	95% CI High	Mean Difference	Z	Sig.
Size (cm)	166,10	163,33	168,87	167,85	165,13	170,58	1,75	1,045	0,296
Body mass index (k/m2)	24,80	23,39	26,21	25,98	24,70	27,26	1,18	0,909	0,363
Tinetti balance test (0-16)	13,83	13,16	14,50	15,80	15,68	15,93	1,97	5,391	0,000
Timed Get Up and Go (s)	9,99	9,22	10,76	7,94	7,55	8,34	-2,04	4,475	0,000
Functional reach test (cm)	28,61	25,95	31,27	36,28	34,10	38,46	7,67	4,035	0,000
360 degree turn test-time (s)	2,98	2,71	3,25	2,54	2,33	2,75	-0,44	2,263	0,024
360 degree turn test-steps (n)	5,15	4,64	5,65	4,12	3,85	4,40	-1,03	3,221	0,001
Sit-to-stand test performance-five times (s)	13,32	12,11	14,52	11,04	10,34	11,73	-2,28	2,986	0,003
10-meter walk test (s)	10,30	9,32	11,28	7,47	7,11	7,83	-2,83	5,569	0,000
Hand grip strength (k)	28,20	24,97	31,42	39,22	36,14	42,29	11,02	4,391	0,000
Bank of Wells test performance (cm)	-9,39	-11,98	-6,80	-0,93	-3,75	1,89	8,46	3,906	0,000
SOT (s) – Eyes open on firm surface	28,42	26,61	30,00	30,00	30,00	30,00	1,58	1,753	0,080
SOT (s) – Eyes closed on firm surface	27,60	25,43	29,76	30,00	30,00	30,00	2,40	2,526	0,012
SOT (s) – Eyes open on unstable surface	27,96	25,86	30,00	30,00	30,00	30,00	2,04	2,037	0,042
SOT (s) – Eyes closed on unstable surface	20,77	17,17	24,38	27,79	26,12	29,47	7,02	2,938	0,003

Table 3. Confidence intervals and comparison of means.

Variable	Contingency table cells a	b	c	d	Total exposed	Total unexposed	Individual Risk Schizophrenia	Individual Risk Psychotypical	Relative Risk Value	95% Confidence Interval		Attributable Risk	Population Attributable Fraction
Tinetti balance test (0-16)	20	21	0	41	41	41	0,488	0,000				0,488	100,0%
Timed Get Up And Go (s)	31	10	12	29	41	41	0,756	0,293	2,583	1,557	4,287	0,463	61,3%
Functional reach test (cm)	34	7	19	22	41	41	0,829	0,463	1,789	1,252	2,558	0,366	44,1%
360 degree turn test-time (s)	26	15	18	23	41	41	0,634	0,439	1,444	0,952	2,192	0,195	30,8%
360 degree turn test-steps (n)	13	28	2	39	41	41	0,317	0,049	6,500	1,564	27,010	0,268	84,6%
Sit-to-stand test performance-five times (s)	24	17	13	28	41	41	0,585	0,317	1,846	1,100	3,099	0,268	45,8%
10-meter walk test (s)	28	13	4	37	41	41	0,683	0,098	7,000	2,696	18,173	0,585	85,7%
Hand grip strength (k)	35	6	15	26	41	41	0,854	0,366	2,333	1,529	3,560	0,488	57,1%
Bank of Wells test performance (cm)	33	8	24	17	41	41	0,805	0,585	1,375	1,020	1,853	0,220	27,3%
SOT (s) – Eyes open on firm surface	3	38	0	41	41	41	0,073	0,000				0,073	100,0%
SOT (s) – Eyes closed on firm surface	6	35	0	41	41	41	0,146	0,000				0,146	100,0%
SOT (s) – Eyes open on unstable surface	4	37	0	41	41	41	0,098	0,000				0,098	100,0%
SOT (s) – Eyes closed on unstable surface	18	23	8	33	41	41	0,439	0,195	2,250	1,105	4,583	0,244	55,6%

SOT: Sensory Organization Test; S: Seconds Cells; a: schizophrenics with the variable outside the normal range; b: schizophrenics with the variable within the normal range; c: psychotypic with the variable outside the normal range; d: psychotypic with the variable within the normal range

Table 4. Risk analysis.

Risk analysis

In all the variables studied, the individual risk was higher in the PWS group. The relative risk ranged from 1.38 (Bank of Wells test performance) to 6.50 (360 degree turn test steps) and was statistically significant for all variables, except for the 360 degree turn test time (Table 4). The foregoing shows that having schizophrenia is a risk factor for suffering postural control disorders (balance, sensory orientation, speed and stability during gait, antigravity postural control, hand grip strength and elasticity of the posterior chain of the trunk and lower limbs) assessed with the Tinetti balance test, SOT, TUG 10-meter walk test, Functional reach test, 360 degree turn test steps, Sit-to-stand test performance, dynamometry and the Bank of Wells test performance. Table 4 shows the Risk Attributable and the Population Attributable Fraction for each of these variables.

Discussion

The present study showed significant differences between the means of the clinical variables studied for postural control (sensory orientation, gait stability, balance, antigravity postural control and biomechanical strategies). In all cases, performance was better in the PTP group and individual risk was higher in the PWS group, which may indicate that having schizophrenia is a risk factor for postural control disorders, specifically in balance, orientation sensory, speed and stability during gait, antigravity postural control, hand grip strength and elasticity of the posterior chain of the trunk and lower limbs.

Teng et al. indicates that postural alterations are frequent in PWS, specifically in dynamic stability, sensory information and postural balance, which include dynamic and closed-eye tests [10]. Stensdotter et al. maintain that these alterations are due to disorders in the exploratory movements of the eye, the visual-vestibular reflex, body image and size perception [25].

Ikai et al. reached similar results to ours in the Romberg test with closed eyes [26]. Apthorp et al. indicate that, in the test with eyes open and closed and feet together, the schizophrenic group had poor balance compared to the unexposed group (controls), suggesting that these measures are appropriate to evaluate postural control from the sensorimotor aspect in disorders within the schizophrenia spectrum [27]. Aso and Okamura conclude that the alterations in these sensory orientation tests can be considered as a predictor of falls in this population [28].

Consistent with our findings, Matsuura et al. found that PWS showed greater postural instability with eyes closed than with eyes open. In general, a greater affectation of the sensory tests was obtained in the PWS than in the PTP, which is associated with difficulties in integrating visual information and proprioceptive signals [29].

On the other hand, consistent with our findings, Feldman et al. found significant deficiencies in gait, balance, mobility, and muscle strength in a group of people with psychiatric disorders, compared to a group of healthy people [30]. They argue that TUG and hand grip strength can reliably reflect mobility and prevent functional decline, disability, and mortality, and therefore these variables can be critical in the treatment and rehabilitation of this population.

The results in the TUG are similar to those found by Lallart et al. [31], their study showed that PWS took longer than PTP to run the test. Putzhammer et al. indicate that the reduction in walking speed is due to loss of step length [32]. In another study, they corroborated these results both in conventional walking conditions and on the treadmill [33]. These results were consistent with the study by Feldman et al. who evaluated walking performance, balance, mobility, and strength in psychiatric conditions, finding that participants were characterized by slower walking speed and decreased step length, while mobility limitations were evident [30].

On the other hand, the differences in Functional reach test reveal the existence of alterations in antigravity postural control in PWS. Consistently, Pérez-Cruzado et al. published lower performance in this test in people with psychotic disorders who did not practice regular physical activity [34]. It also coincides with the study by Tsuji et al., who found that both dynamic and static balance were lower in the population with hospitalized schizophrenia; reported a higher risk of falling associated with factors of the health condition, such as less physical ability or the consumption of multiple antipsychotic medications [35].

It was found that the time and number of steps in the 360 degree turn test were greater in PWS. Other studies show that this test is an important marker of alteration in postural control. In the number of steps component, Kent et al. found a greater area of oscillations in PWS, due to the involvement of the cerebellum and the circuits related to postural stability [36]. Likewise, Matsuura et al. showed significant associations between postural stability and psychiatric symptoms in PWS without movement disorders [29].

Likewise, it was found that in the test of moving from Sit-to-stand test performance the duration was longer for PWS. Melo and Roque report that schizophrenia is accompanied by disorders in the exploratory movements of the eye and the visual-vestibular reflex, which can affect the feedbacks in these channels and generate dysfunctions when standing up when the person is in a sitting position [37]. These findings coincide with Yoshida et al., who indicate that during the Sit-to-stand test performance, great muscular synergy is required, accompanied by feedback from the visual and vestibular channels [38]. When they do not work properly they can affect this activity as it could occur in a psychotic disorder such as schizophrenia, since one of the components of postural control that is deficient is the sensory one; the visual input is mainly in charge of receiving the stimulus and confronting it with the information that the body has of its spatial orientation, which allows the maintenance of the vertical position and therefore constitutes a neurological mechanism of great importance to maintain postural control [37].

The results of the present study show the decrease in the hand grip strength and flexibility of the muscles of the posterior train in PWS. With similar results, Vancampfort et al. maintain that it is possibly due to decreased physical condition in people with this health condition [39]. For Chen et al., the majority of PWS have prolonged periods of inactivity during most of the day, may have a poor cardiovascular state and be overweight or obesity [40].

Hand grip strength has been used in the clinical setting as an important marker of global strength, as well as to identify fragility or mobility limitations, especially in older adults [41]. Firth et al found a strong association between better cognition with greater hand grip strength, and although they did not find statistically significant differences with PTP, they did highlight the relationship between hand grip strength with working memory and reaction time, which are generally altered in PWS and are considered neuro-cognitive predictors for the social functioning of these people [42]. Likewise, Crespo et al. emphasize that PWS present a reduction in hand control for writing, resulting in deficiencies in speed and grasp; they found no difference in any handwriting measure based on the specific diagnosis or antipsychotic dose. In this way, they conclude that motor abnormalities are a central feature of various mental disorders and seem not to be related to pharmacological treatment [43].

Consistent with these findings, Yildirim et al. also found no relationship to the medication; in addition, they found a worse performance in hand grip strength for PWS compared to people with bipolar disorder and PTP, probably explained by the condition of voluntary sensorimotor control of the hand characteristic of this health condition [44].

In summary, the present findings regarding alterations in postural control could be explained by the neurophysiological deficiencies typical of schizophrenia, given by the dysfunction of brain neurotransmitters that have to do with the regulation of human behavior and with the control of voluntary movement. Furthermore, due to the somatosensory alterations that accompany the positive symptoms of schizophrenia, which act as the first channel of cortical feedback, distorting the image and body schema, reflected in the motor and postural behavior that finally disturb motor control.

All the evaluated PWS consumed some antipsychotic medication, however, in general terms, this is an inherent characteristic of this health condition, which means that the results of the current study can be generalized to this population. However, future research should investigate the weighted amount of antipsychotic drug use on postural control disturbances. In the present study, all PWS consumers of psychoactive substances were excluded, which made it difficult to obtain the sample due to its high prevalence in this population group [45,46]. Future studies could compare the components of postural control in PWS who use y no-use psychoactive substances.

Most similar studies analyze some components of postural control in isolation, while ours did so integrally from the different strategies proposed by Horak [20], which is why it is suggested that it to be applied globally in PWS neurorehabilitation processes.

Conclusion

The results obtained can become a reference for subsequent studies on neurorehabilitation interventions in postural control of PWS or other mental health condition. It provides scientific evidence in an under-explored field such as neurorehabilitation in mental health. In this way, it will allow physiotherapists and other professionals related to human body movement, to generate intervention strategies oriented from the improvement of postural control, which would result in better and more efficient processes of rehabilitation of PWS and with similar mental health conditions.

Conflicts of Interest

Authors state no conflict of interest. No author has any financial interest or received any financial benefit from this research.

Funding

This research was funded by the Universidad Autónoma de Manizales, Colombia, South America.

Acknowledgements

The authors thank the study participants and the management and health personnel of the San Juan de Dios Psychiatric Clinic in Manizales, Colombia. We also thank Mónica Naranjo, Julián Marín and Alice James who for the Translation Center of the Universidad Autónoma de Manizales (UAM), for translating and reviewing this final manuscript.

Authors' contribution

We note that intellectual participation in all phases of the research was fully shared by all the authors (Pérez-Parra JE, Morera-Salazar DA, Serna-Salazar AM): proposal and background review, project formulation, information gathering, processing, analysis and discussion of results and preparation of the scientific article. The students participated in the collection of information, analysis and discussion of results.

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How to cite this article: KMorera, Salazar DA, Angélica M Serna Salazar ,Julio E Pérez Parra, and Nicolás Agudelo Cardona, et al."Postural Control in Schizophrenia: A Retrospective Cohort Study" Clin Schizophr Relat Psychoses. Doi: 10.3371/CSRP.TLJT.012521.