

Special Article – Depression

Gait, Balance and Posture in Major Mental Illnesses: Depression, Anxiety and Schizophrenia

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Abstract

Background: Mental disorders are among the most common health issues worldwide. Changes in psychomotor behavior can be observed in gross motor skills. Gait is an example of behavior that reflects various levels of nervous system function. In psychiatric conditions, gait disturbances are thought to reflect defective brain function. Patients who suffer from gait disturbances tend to develop balance disorders as well as impaired body posture.

Objective: The purpose of this review is to examine current knowledge regarding gait and related physical aspects (balance and posture) in patients suffering from depression, anxiety or schizophrenia, and to formulate recommendations for the diagnosis and treatment of these patients.

Data Sources: A cross search was conducted in five databases, using the following keywords: body posture, balance, and gait. Each of these keywords was cross-referenced with specific mental illnesses: schizophrenia, depression and anxiety. Forty-eight suitable articles complying with criteria were chosen.

Major Finding: Our review indicates that patients suffering from mental disorders have a unique physical profile that is in keeping with the clinical diagnosis (schizophrenia, depression and anxiety): the physical profile of patients with schizophrenia is characterized by a slow gait and decreased stride length, patients suffering from anxiety disorders are characterized by balance disorders, and those suffering from depression - by a slow gait and slumped posture.

Conclusions: We would propose that when seeking to create an evaluation and treatment program for patients with mental illness, specific elements such as balance, gait patterns and posture, should also be taken into consideration.

Keywords: Gait; Balance; Depression; Anxiety; Schizophrenia

Introduction

Mental disorders are considered one of the most common health issues worldwide. National Alliance on Mental Illness (NAMI) data reveal that in any given year, one in every five adults (aged 18 plus) experience a mental illness and one in 25 adults experience a severe mental illness, that limits him in one or more of his major-life-activities. Anxiety and mood disorders are more common among women, while substance abuse is more common among men [1]. Gait and posture disorders are common among psychiatric patients. The reasons for these disorders are many, and include the illness itself, medication, and the psychosocial context [2].

Motor behavior is regulated by emotions and is an integral indicator of mental illness [3]. Motor manifestations are important criteria in the diagnostic method (DSM-5, ICD-10) applied in mood disorders and help to predict the course of the disease [4,5]. Changes in psychomotor behavior are evident in facial expressions, gestures, fine motor skills and gross motor skills [4].

Gait is an example of behavior that reflects various levels of nervous system function. In psychiatric conditions gait disturbances are thought to reflect impaired cortical and subcortical function [6].

In humans, gait develops simultaneously with the development of higher-level brain structures and functions (prefrontal cortex, basal ganglia and cerebellum). Since gait reflects the integrity of higher-level brain systems, it is well able to reflect psychiatric conditions [2]. Therefore, analysis of an individual's gait and posture provides a great deal of information about the capability of the musculoskeletal system to adjust to physical stressors [7].

Balance is maintained due to the integration of vestibular, somatosensory and visual inputs in the central nervous system, and due to the normal functioning of the motor system which compensates for postural disorders [8]. Dynamic balance control is adversely impacted by our mood state, most likely due to impaired integration of visual, vestibular and proprioceptive systems [9,10].

In general, patients with gait disturbances tend to simultaneously develop balance dysfunction and therefore, both disorders should be treated concurrently. Moreover, posture and postural control, two additional important, interrelated physical characteristics, are a crucial integral component of normal gait.

Gait and posture are influenced by body embodiment. Recent studies have demonstrated the relationship between embodiment

and mental illness [11-15]. Embodiment addresses the interrelation between mind and body. In psychological terms, embodiment has a reciprocal causality in both motor- body and cognitive- emotional dimensions. Emotional states are embodied in physical movement and emotion recognition plays an important role in social interactions. The crucial insight afforded by embodiment is that much of perceptual inference rests on selecting the correct kind of sensory information. Indeed the main obstacle is knowing how to react properly using the right way with our senses. A simple observation is that sadness is reflected by attenuated motor activity [12,14,15]. Consequently, a disorder in any of the above physical characteristics is able to cause gait disturbance.

Following the increase in the prevalence of mental disorders [1], today more than ever before, there is a growing need to investigate and understand their multiple causes and physical characteristics. This review focuses on a description of the motor characteristics and functional manifestations of patients who suffer from depression, anxiety and schizophrenia. The results of this review might provide a basis for the formulation of an evaluation and intervention program for these patients.

Methods

Data sources and search method

We performed a Meta search, on five databases (Google Scholar, PubMed, Science Direct, PsycINFO and Cochrane) using the following keywords: body posture, balance, and gait, cross-referencing each keyword with specific mental illnesses: schizophrenia, depression and anxiety. The search was conducted in May 2018 and updated in December 2018. No limiters were applied to the search (Figure 1).

Inclusion criteria: Interventional studies (clinical trials), cross-sectional studies, prospective cohort studies, literary reviews and meta-analysis; Studies researching schizophrenia, anxiety and depression and to gait/balance/posture; Studies published in English; Access to full-text; Studies conducted between 1997 and 2017.

Exclusion criteria: Case control or case descriptions; Letters to the editor; Studies published in languages other than English; No access to full-text.

Data synthesis and analysis

At the end of each search phase, the titles and abstracts of the articles were read systematically and screened according to the inclusion and exclusion criteria described above. Articles that appeared to be relevant to the review were read in their entirety. Finally, a search of the reference list of each article was conducted in an attempt to locate other articles relevant to the review (Figure 1).

Results

Forty eight articles, which satisfied the inclusion criteria of the study, were chosen. These articles examine the association between mental disorders, mental states and physical characteristics (Figure 1).

Depression

Posture and depression: There is a consensus among researchers that depression adversely affects posture [7,13,16]. Michalak et al. [13] recently found that sitting posture has a direct effect on

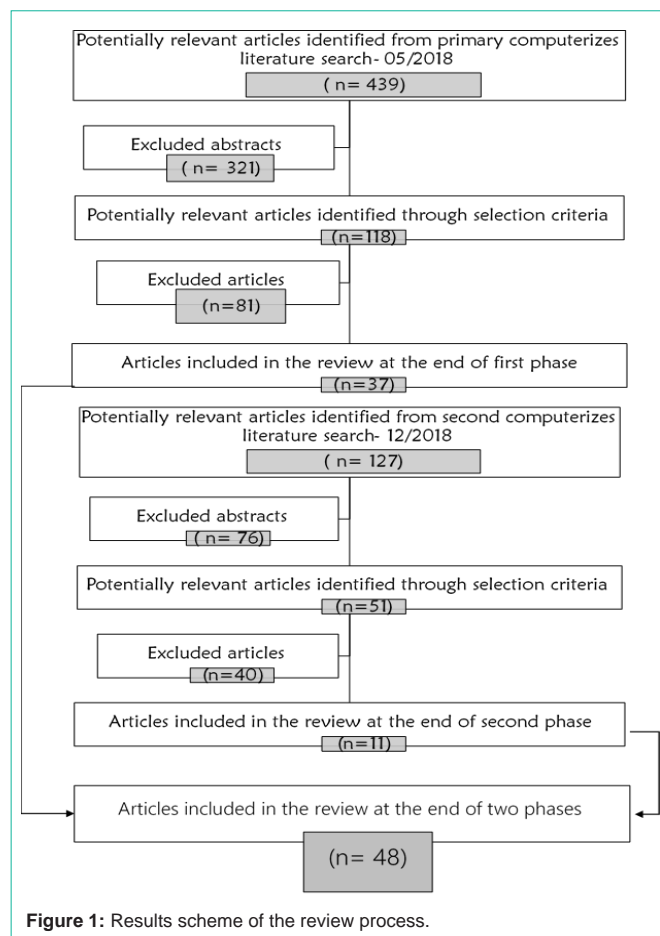


Figure 1: Results scheme of the review process.

memory among patients suffering from depression, and that a minor motor change – i.e. adopting an upright sitting posture rather than slump posture while sitting – has a beneficial impact on that aspect. Wilkes et al. [16] suggested that sitting upright reduces fatigue and increases positive affect among people exhibiting symptoms of depression. Canales et al. [7] studied posture and perceived body image in patients with clinical depression during depressive episodes and upon receiving drug treatment, compared to a healthy control group. They found that during depressive episodes patients with major depressive disorder (MDD), experience a change in posture (e.g., marked head flexion, scapular protraction, pelvic retroversion, greater thoracic kyphosis) and moderate dissatisfaction with body image. Furthermore, the study had demonstrated that recurrence of depressive episodes has a negative influence on postural alignment. This finding is consistent with the fact that both emotional and physical aspects are negatively influenced by depression.

Balance and depression: A number of studies have found balance disorders and depression to be related [17,18]. Dumas et al. [19] detected a considerable deficiency in dynamic balance in dual task performance among patients with depression compared to healthy controls. Recent studies stress the importance of various physical training programs in the treatment and amelioration of balance disturbances among patients with depression, and in the alleviation of symptoms of depression among healthy individuals [17,18]. Deschamps et al. [17] found that a walking program (supervised

one hour sessions, three times a week for two months at moderate intensity) has a direct influence on the ability of MDD patients to make efficient postural corrections. The authors emphasize the importance of including a balance assessment in the clinical screening routine in order to tailor a walking program for these patients.

Gait and depression: There is a strong association between MDD, psychomotor deterioration and gait components [12,20]. Lemke et al. [20] were the first to study spatiotemporal gait patterns among MDD patients compared to healthy controls. They found a significant reduce in gait velocity, reduced stride length, increased gait cycle duration and longer double limb support among depressed patients. The researches addressed to a link between the basal ganglia activity as part of the pathophysiological mechanism in gait disturbance. Michalak et al. [12] found that sadness and depression are characterized by reduced walking speed, arm swing and vertical head movements, and by greater lateral swaying movements of the upper body and a slumped posture. A link has been established between symptoms of depression, reduced walking speed and increased risk of falls among the elderly. Evidence shows that reduce gait speed is one of the symptoms of depression in older people, and that it directly contributes to increased fall risk. Early detection and integrated treatment of these elements could lower this risk [21]. Paleacu et al. [22] found that gait and cognitive function improved in response to the administration of antidepressants. In depression, the neuro circuit pathway related to gait alternations is controversial. While some researches state that gait changes associate with changes in brain structures e.g. basal ganglia and cognitive dysfunction [20,22], others do not point a specific underlying organic pathology [12,21].

In conclusion, patients with depression are characterized by slumped posture, impaired dynamic balance, and reduced gait velocity [2,12,13,16,20,23]. Their slumped posture is in all likelihood caused by impaired perceived body image, while reduced walking speed is apparently the result of impaired spatiotemporal parameters [20]. Future study should focus on the influence of intervention programs involving treatment for posture and gait on physical and mental characteristics of these patients.

Anxiety

Posture and anxiety: Very little information regarding posture and anxiety was found in the literature. Lipnicki and Byrne [24] found that study subjects asked to perform a difficult mental arithmetic task in standing position experienced anticipatory anxiety, as opposed to subjects who were required to perform the same assignment in supine condition. One of the explanations suggested is the difference in baroreceptor load when the body is in supine position. The paucity of information on the subject suggests an immediate need to examine whether a relationship exists between anxiety and posture.

Balance and anxiety: Researchers concur that anxiety is related to balance dysfunction [8,25,26]. Bart et al. [25] found a correlation between balance, anxiety disorders and low self-esteem in children under the age of 7. They also demonstrated that treatment targeting balance problems mitigates the dysfunction, greatly reduces anxiety and increases self-esteem among these children.

The neurological basis that links anxiety disorders and balance

control has been researched for many years [26]. It has been found that neural circuits that contain a number of pathways that mediate autonomic control, vestibulo-autonomic interactions and anxiety form the basis for this link. The core of this neural circuitry is the parabrachial nucleus (PBN), located in the medulla oblongata. This nucleus has an extensive network of relationships with a number of important brain structures responsible for movement and balance control, including the central amygdaloid nucleus, infralimbic cortex and hypothalamus. The PBN is the point of convergence of vestibular, visual and sensory information processing in pathways that are involved in anxiety, panic and avoidance situations. This neurological scheme creates a basis that explains the link between balance disorders and anxiety [26].

Yardley et al. [27] presented evidence of three psychological mechanisms that aggravate dizziness and delay recovery from balance disorders. The first mechanism is avoidance of performing the movements and of exposure to the environments that caused the symptoms. The second is increased anxiety, which intensifies the physical symptoms that accompany balance disorder, and the third is cognitive load, which can have an effect on the central processing of information needed to maintain control and perception of physical orientation.

Gait and anxiety: Gait has hardly been studied in anxiety disorder. It seems that anxiety requires greater attentional demands while walking. Anxiety influences oculo-motor and gaze control [28], thus linking anxiety to visual disturbances and balance disorders. Researchers agree that gait changes in anxiety disorders are a secondary component of the illness, not indicating a different or more severe state [28,29].

In conclusion, people who suffer from anxiety disorders are mainly characterized by deficiencies in the balance system [25-27]. This deficit in balance is related to increased fear of falling and reduced gait velocity. Future study should perform a more in depth research regarding the characteristics of gait and posture in patients suffering from anxiety. There is also a strong need for research that will explore the influence of intervention programs on posture, balance and gait in this population.

Schizophrenia

Posture and schizophrenia: Referring to body posture, it is well known that schizophrenic patients suffer from alterations in body perception, body representations and embodiment [11,14,30]. The significant affinity between emotion perception deficits in schizophrenia, suggests that such difficulties may be more directly related to the core features of this disorder [30]. Graham-Schmidt et al. [11] indicate that body structural description may be altered in schizophrenia in general, and body image alterations are worsened in passivity symptoms. Cristiano et al. [31] examined gross – body postural changes in different stages of schizophrenia and their relationship to pain. They had found that hyperlordosis and forward head posture were the most common postural features in both early and late stages of schizophrenia. These two postural changes are indicative of a lordotic or a swayback posture, which is more common in women. However, as the majority of cases occur in men, these changes may be attributable to schizophrenia itself as well as to body mass index (BMI), as overweight tends to lead to a swayback

posture. Cristiano et al. [31] also found that scoliosis is frequent amongst schizophrenic patients, characterized by BMI-independent muscle weakness.

Balance and schizophrenia: There is a consensus in the literature that balance in schizophrenia patients is deficient compared to healthy individuals, and that the degree of postural sway increases in this population. It has been found that there is a correlation between this increase and the severity of the symptoms of the disease [32-34]. One of the mechanisms suggested as causing balance dysfunction in schizophrenic patients is the reduced use of vision for balance control [35]. This finding points to impaired sensorimotor integration in these patients, where deficient vision control is most likely caused by defective processing of spatial elements of visual information and may be related to a visual impairment. Schizophrenic patients rely more on vestibular and proprioceptive information to maintain balance compared to healthy individuals [35].

Gait and schizophrenia: Much has been written about the association between gait and schizophrenia. There is general consensus among researchers that schizophrenia causes a primary disturbance in stride length regulation, which is manifested in a reduction in gait velocity compared to healthy controls [36]. Putzhammer et al. [36] found that this deficit is intensified by conventional antipsychotic treatment, whereas non-drug treatment does not lead to such intensification. Moreover, these researchers assessed gait patterns among schizophrenic patients by testing free gait and walking on a treadmill at various velocities. When walking freely, gait velocity of the patient group was found to be lower than that of the control group, primarily because of reduced stride length. When evaluating gait on the treadmill, differences between the patient group and control group in cadence and stride length were significant only at the very slow treadmill speed. When treadmill velocity was increased, all parameters in the patient group were equal to the corresponding parameters in the control group. This outcome indicates that gait disturbances among schizophrenic patients can be normalized by using external devices, such as a treadmill, which affords control over gait velocity. An additional option for achieving improvement in gait parameters among patients with schizophrenia was proposed by Heggelund et al. [37], who recommend maximal strength training – four repetitions * four sets – using a leg press machine (1RM – one rep max at 85%-90%) as a therapeutic tool in normalizing walking mechanical efficiency among patients with schizophrenia.

Schizophrenics also suffer from ataxic gait, and a correlation has been established between increasing age and ataxic gait among these patients [38,39]. Furthermore, Morgante et al. [40] provide evidence that older aged chronic schizophrenic patients, might present axial parkinsonian signs (trunk posture anomaly, reduced degree of facial expression and short step gait) as an early marker of parkinsonism in this illness.

Gait function among schizophrenics is in all likelihood affected as a result of impaired executive function [39]. Lallart et al. [39] examined the association between executive dysfunction and gait disturbance in recent-onset schizophrenia patients using the dual task paradigm. They established the existence of an inverse relationship between the complexity and difficulty of the task and the performance level, and concluded that schizophrenia is characterized not only by cognitive

impairment, but by coordination and motor functioning impairment as well.

There is a general agreement in the literature, that schizophrenic patients has primarily alteration in higher-level structures e.g. reduction in supplementary motor area activity, disturbed functioning in the basal ganglia and the thalamus and abnormal functional connectivity between the motor cortex and the cerebellum. This core illness deficit alters motor control and contributes to the impairments and reduction of gait control [22,28,29,36].

In conclusion, Schizophrenic patients are characterized by impaired gait, reduced acuity of the body structural description, as well as deficiencies in the balance system. The reduction in walking speed is most likely due to the fact that this illness involves executive dysfunction [39] whereas disembodiment and alterations in body representations contribute to deficits in their body posture [11,14]. Poor balance control is apparently linked to defective processing of spatial elements [32-35].

Future study should explore the influence of specific exercise programs on the posture, balance and gait of patients with schizophrenia.

Discussion

This review examined the link between physical characteristics (gait, posture and balance) and mental illnesses – depression, anxiety and schizophrenia. This review emphasizes the growing need for the creation of a diagnostic, treatment and intervention plan, specifically tailored to patients suffering from mental illnesses.

The results of this review show that gait, balance and postural disturbances are highly prevalent among the mentally ill in comparison to healthy individuals [2,12,39,20-22,28,29,36-38]. In light of this observation, we propose including tests for balance, gait, and posture to the evaluation of patients with psychiatric disorders.

More specifically, we have shown that patients with depression suffer from slumped posture, poor dynamic balance, and reduced gait velocity. Therefore we suggest that treatment plan for these patients might include practicing varying walking speeds and postural elements [12,13,16,20,23]. We propose the inclusion of a walking program (one hour sessions, three times a week at moderate intensity) as an integral component of the treatment program to improve balance in these patients [17].

Patients who suffer from anxiety disorders characterized by deficiencies in the balance system. Therefore they might benefit from the inclusion of exercise treatment that targets components of the balance system in their treatment program [25-27].

With regard to schizophrenic patients, evaluation and treatment programs might address physical aspects such as gait and balance. As perceptual elements and executive functions are impaired in this illness [39], these aspects should be taken into consideration when planning a treatment program. For the treatment of body posture representation, body-oriented psychological therapy should be applied together with specific spatial information exercises, referring to body parts [11,14,15]. Further, work should be done with patients on the components of balance control, particularly the visual aspect, which impacts the degree of postural sway [32]. Emphasis should be

placed on walking speed, since gait disturbances in schizophrenia patients can be normalized by using external devices, such as a treadmill [36].

Despite the extensive research on the effectiveness of systematic physical activity and exercises interventions for people with mental illness there is lack of information referring the question: does improvement in gait and balance affect the psychiatric illness, per se, or does it transiently affect the sense of well-being? [41-45].

A number of methodological limitations can be noted in the studies examined. Most of the research published to date was performed on a relatively small sample ($n < 30$) and no randomized controlled trials were conducted. Part of the studies were cross-sectional or consisted of reviews of the literature [14,15,17,18,21,26-28,36], and no follow-ups were made of a single cohort in the long term [16,24]. A small number of the studies do not take confounding factors into account, such as age, gender, cigarette smoking, alcohol consumption, socioeconomic status, general health condition, etc [19,24,39]. It is important to point out that some of the studies were carried out under laboratory conditions, thus affecting their external validity [7,11,12,24,39,46]. Another limitation is the difficulty of controlling and supervising the use of antipsychotics and their impact on research results [12,19,31,33]. It is important to note that although postural dysfunctions as well as motor abnormalities are often regarded as consequences of antipsychotic treatments [47], spontaneous involuntary movements have also been found in antipsychotic naïve patients [48].

This review did not address the importance of devising physical training or rehabilitation programs and their inclusion as an integral component of the rehabilitation process of population groups suffering from mental illness. The physical elements were examined individually and were not integrated in order to test the efficacy of their inclusion in treatment programs and their importance to this population. In other words, we did not, for example, explore the question as to whether a program that integrates balance and gait components is preferable to a treatment program that focuses on a single physical aspect.

Finally, additional, broader clinical research should be carried out on the association between walking and balance aspects and mental disorders, and the efficacy of exercise treatment plans. These physical elements are an important predictor of falls [21,36] and cognitive impairment, especially in the elderly population [38,39].

Conclusions

In summary, the clinician treating a patient with a particular mental disorder should take into consideration the physical aspects that are characteristic of the patient's mental condition, as part of the evaluation/treatment program. The correct identification of these physical components and appropriate treatment can contribute greatly to improve function and participation in this complex population.

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