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N°

PSYCHOMOTOR DISADAPTATION SYNDROME : LITERATURE REVIEW

LE SYNDROME DE DESADAPTATION PSYCHOMOTRICE : REVUE DE LA LITTERATURE

THESE
Présentée

à l'UFR des Sciences de Santé de Dijon
Circonscription Médecine

et soutenue publiquement le 7 Avril 2023

pour obtenir le grade de Docteur en Médecine

par MERENDINO Antonella
Née le 24/03/1990
A Palerme, (Italie)

Université de Bourgogne

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"Au moment d'être admis(e) à exercer la médecine, je promets et je jure d'être fidèle aux lois de l'honneur et de la probité.

Mon premier souci sera de rétablir, de préserver ou de promouvoir la santé dans tous ses éléments, physiques et mentaux, individuels et sociaux.

Je respecterai toutes les personnes, leur autonomie et leur volonté, sans aucune discrimination selon leur état ou leurs convictions.

J'interviendrai pour les protéger si elles sont affaiblies, vulnérables ou menacées dans leur intégrité ou leur dignité.

Même sous la contrainte, je ne ferai pas usage de mes connaissances contre les lois de l'humanité.

J'informerai les patients des décisions envisagées, de leurs raisons et de leurs conséquences.

Je ne tromperai jamais leur confiance et n'exploiterai pas le pouvoir hérité des circonstances pour forcer les consciences.

Je donnerai mes soins à l'indigent et à quiconque me les demandera.

Je ne me laisserai pas influencer par la soif du gain ou la recherche de la gloire.

Admis(e) dans l'intimité des personnes, je tairai les secrets qui me seront confiés. Reçu(e) à l'intérieur des maisons, je respecterai les secrets des foyers et ma conduite ne servira pas à corrompre les mœurs.

Je ferai tout pour soulager les souffrances. Je ne prolongerai pas abusivement les agonies. Je ne provoquerai jamais la mort délibérément.

Je préserverai l'indépendance nécessaire à l'accomplissement de ma mission. Je n'entreprendrai rien qui dépasse mes compétences. Je les entretiendrai et les perfectionnerai pour assurer au mieux les services qui me seront demandés.

J'apporterai mon aide à mes confrères ainsi qu'à leurs familles dans l'adversité.

Que les hommes et mes confrères m'accordent leur estime si je suis fidèle à mes promesses ; que je sois déshonoré(e) et méprisé(e) si j'y manque."

DEDICACES ET REMERCIEMENTS

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LISTE DES ABREVIATIONS

SDPM: Syndrome de désadaptation psychomotrice
PDS: Psychomotor disadaptation syndrome
MMT: Mini-motor test
MMSE: Mini-mental state examination
MoCA: Montreal cognitive assessment
VRET: Virtual reality exposure training
N: Number
PFS: Post-fall Syndrome
ANS: Autonomic Nervous System
WMC: White matter changes
FoF: Fear of Falling
BD: Backward disequilibrium
APA: Anticipatory postural adjustment
RCT: Randomized control trial
PTSD: Oost-traumatic stress disorder
VRET: Virtual reality training
STAI: State-trait anxiety inventory.

INTRODUCTION EN FRANÇAIS

Le syndrome de désadaptation psychomotrice (SDPM) est une entité gériatrique qui comprend des troubles posturaux, des troubles de la marche, des signes neurologiques et des troubles psycho-comportementaux. Il comporte une décompensation des fonctions posturales et des automatismes psychomoteurs, responsables de chutes [1].

Les chutes constituent un des plus importants problèmes de santé publique étant une très fréquente cause d'hospitalisation chez les personnes âgées [2], d'où l'importance pour le personnel médical et paramédical de connaître le SDPM.

Le SDPM a été décrite pour la première fois en 1986 à Dijon (France) par le professeur Gaudet et son équipe. Il a été nommé syndrome de régression psychomotrice, suite à l'observation clinique des patients hospitalisés pour chute, qui présentaient un tableau clinique comprenant des troubles moteurs sévères, ne pouvant être expliqués par aucune maladie neurologique connue antérieurement [1, 3]

En raison des progrès réalisés dans sa physiopathologie et sa prise en charge, dans les années 1990, le syndrome de régression psychomotrice a été rebaptisé SDPM, pour souligner la possibilité d'une évolution favorable grâce à une prise en soin urgente et adaptée.

Depuis les années 2000, le SDPM est également appelé syndrome de dysfonctionnement sous-cortico-frontal, en raison du rôle crucial joué par les lésions sous-cortico-frontales dans sa physiopathologie [4].

Le SDPM est une pathologie qui doit être bien connue des professionnels de santé, médecins et non médecins, notamment ceux prenant en soin des personnes âgées. En effet, sa prévalence ne cessera pas d'augmenter en raison du vieillissement de la population, sachant que ses conséquences peuvent être dramatiques. Aussi, dans ce travail, après avoir fait un rappel sur sa physiopathologie, sa clinique, sa prise en soin et son évolution, nous nous sommes intéressés à la littérature sur le SDPM, à savoir le nombre d'articles portant sur cette entité et sa connaissance dans la littérature internationale.

1. INTRODUCTION

Psychomotor disadaptation syndrome (PDS) is a geriatric syndrome that includes postural disorders, gait disorders, neurological signs and psycho-behavioral disorders. It consists in a decompensation of the postural function and psychomotor automatisms, responsible for falls [1].

Falls are one of the most significant health problems and a very frequent cause of hospitalization among older people [2], hence the importance for medical and paramedical personnel to know and recognize this PDS.

PDS was first described in 1986 in Dijon (France) by Prof. Gaudet and his team. They originally defined it as the psychomotor regression syndrome, following the clinical observation of patients hospitalized for falls and presenting with a clinical picture of severe mobility impairment not explainable by any previously known neurologic disease [1, 3].

After progress on its pathophysiology and management was made, in the 1990s it was renamed as PDS, in order to emphasize the possibility of a favorable course through timely and appropriate cares. Since the 2000s, the PDS is also called subcortical-frontal dysfunction syndrome, because of the crucial role played by sub-cortico-frontal lesions in its pathophysiology [4].

PDS is a syndrome that should be well known by health professionals, especially those taking care older adults, considering that its consequences can be dramatic.

Indeed, its prevalence will continue to increase due to the aging of population. Therefore, in this study, after a reminder on its physiopathology, clinical feature, care and evolution, we reviewed the literature on PDS, assessing the number of articles on PDS and its knowledge in the international literature.

1.1. PATHOPHYSIOLOGY OF PSYCHOMOTOR DISADAPTATION SYNDROME

Psychomotor disadaptation syndrome is characterized by the alteration of postural and motor programming, which causes a decompensation of posture, gait and psychomotor automatisms.

The integrity of the neurosensory afferents, the central nervous system and the effector system, underlies the preservation of appropriate postural and motor functions.

The main disorder in the occurrence of PDS is the alteration of central nervous system, specifically the subcortical-frontal structures.

The subcortex represents a transit zone for neurosensory messages to the cortex, which in turn induces an appropriate motor response [5].

In PDS, due to the presence of subcortical-frontal lesions, the neuro-sensory messages to the cortex are incorrect. This consequently leads to inappropriate postural and motor responses from the cortex [4-6]. This theory is supported by cerebral imaging of subjects who have PDS, which have shown a high frequency and severity of subcortical-frontal impairments, such as leukoaraiosis, vascular abnormalities of the white matter and enlargement of the ventricles [7]. These subcortical injuries in patients suffering from PDS are related to chronic hypoxia and/or ischemia [6].

The pathophysiology of PDS can be illustrated by the model of geriatric decompensation known as the “Bouchon’s model” in France. It includes three cumulative elements (1 + 2 + 3), corresponding respectively to aging, chronic disease or pathological situations, and acute factors. Firstly, aging is associated with a high frequency of leukoaraiosis, whose prevalence reaches 90% after 80 years. Secondly, chronic disease involved in the degradation of the subcortical-frontal circuits and therefore predisposing to PDS, can be classified into two main groups. The first includes degenerative diseases, in particular idiopathic Parkinson’s disease, multiple system atrophy, progressive supranuclear palsy and Lewy body disease. The second includes conditions linked to subcortical vascular damage (mainly leukoaraiosis, deficiencies or stroke), due to hypertension, atrial fibrillation and diabetes. Besides these two main entities, other chronic diseases such as normal pressure hydrocephalus or depression may predispose to PDS. Finally, acute factors can precipitate the onset of PDS in the presence of predisposing factors. These can be functional factors, such as falls, lack of use or bed rest. These can also be organic factors, such as fever, dehydration, some metabolic disorders, hypotension including orthostatic hypotension and all causes of hypoxia or decrease in cardiac output. Furthermore, certain drugs, acting on the central nervous system (benzodiazepines, antipsychotics and central analgesics), may be involved in the onset of PDS [1,4-6].

1.2. CLINICAL FEATURES OF PSYCHOMOTOR DISADAPTATION SYNDROME

Four main symptoms define PDS: postural impairments, non-specific gait disorders, neurological signs and psychobehavioural disturbances. Table 1 reports clinical signs of PDS.

1.2.1. Postural Impairments

Backward disequilibrium (also called retropulsion) is the main sign of PDS. It is always present: when either sitting or standing, as well as during the passage from sitting to standing, or vice versa [5].

It consists in a backward projection of the center-of-mass behind the support polygon, resulting in a backward projection of the trunk with an increased risk of falling. The sit-to-stand transition is characterized by an absence of anterior projection of the trunk with the feet forward, causing, in some severe cases, the inability to stand up with no help.

Some adaptive mechanisms, such as trunk anteflexion and knee flexion, can be observed in patients suffering from PDS, in order to maintain an upright position.

Backward disequilibrium can be very disabling, by limiting the performance of basic life activities, due to a feeling of insecurity in orthostatic position, when walking, and a higher risk of falling [4-6].

1.2.2. Non-specific Gait disorders

Gait abnormalities arise from balance and posture disorders, but are not specific to PDS, being present in any pathology affecting balance. They include freezing; i.e. a defect in gait initiation resulting from subcortical-frontal dysfunction, and walking with small, slipped steps, without rolling the foot on the ground, accompanied by an increase in the time spent in bipodal support [1,5,6].

1.2.3. Neurological signs

Neurological signs constitute, with gait disorders, the motor abnormalities observed in PDS. They comprise the following two groups. The first includes axial akinesia and

oppositional hypertonia, both related to a global subcortical alteration; while the second reflects the alteration of postural automatisms [5]. Oppositional hypertonia consists in an increase of the muscle tone during a traction movement exerted on the limb by a clinician, and a decrease when the patient is relaxed. This kind of hypertonia is variable and heterogeneous, depending on the force of traction applied on the limb.

The alteration of postural automatisms consists in a decrease or even a loss of postural adaptation reactions and/or protective reactions.

Postural automatisms can be tested with a slight push applied to the trunk, which leads to an inadequate stepping reaction in patients suffering from PDS, while normally it mobilizes the trunk on the sagittal plane to counteract the imbalance. Moreover, in patients with severe forms of PDS, the protective reactions of the upper limbs may disappear. Patients may consequently fall with no any protective reactions of the arms, resulting in multiple facial injuries [3,5].

1.2.4. Psychobehavioural signs

Psycho-behavioral disorders allow to distinguish the acute form from the chronic form of PDS.

The acute form, also called "post-fall syndrome," was first described by Murphy and Isaacs [8]. It corresponds to a functional sideration of motor automatisms, occurring most often after a fall, and associating to certain psycho-behavioral signs such as fear of falling, major anxiety, and fear of walking and/or heights [5].

The chronic form presents a more progressive and insidious onset. It comprises executive disorders (deficits of planning, initiation and organization) and/or conation disorders such as bradyphrenia, indifference, apathy, abulia and demotivation [1,5].

Table 1 : clinical signs of psychomotor disadaptation syndrome

Postural impairments	• Backward disequilibrium
Non-specific gait disorders	• Freezing • Walking with small slipped steps • Increased time spent in bipodal support
Neurological signs	• Axial akinesia • Oppositional hypertonia • Alteration of postural automatisms
Psychobehavioural signs	• **Acute PDS** or post-fall syndrome: including sideration of motor automatisms, fear of falling walking and/or heights, major anxiety • **chronic PDS**: including executive disorders and/or conation disorders

1.3. POSITIVE DIAGNOSIS OF PSYCHOMOTOR DISADAPTATION SYNDROME

To diagnose PDS as early as possible, some clinical tests allow to identify, before the onset of major postural impairments and falls, the existence of a fragility of motor automatisms.

Evaluation of gait speed shows its decrease in a single-task situation. In a dual-task situation (such as walking and performing a simple cognitive task at the same time), these alterations often increase and may even lead to a movement arrest [1,9]. The mini-motor test (MMT) is a necessary tool for the follow-up of patients suffering from PDS, and can also be used for early identification of these subjects. It is a 20-item scale, and allows the assessment of balance, mobility in lying, sitting position, standing position and gait. Finally, the existence of backward disequilibrium during sitting, standing and walking is also assessed. In addition, the clinician should inquire about a history of falls in the past six months and the ability to rise from the floor [9,10]. Executive functions are tested with a neuropsychological evaluation (e.g., Stroop test, Rey's figure) [1]. Medical imaging reveals lesions of the white matter, which appear as hypodensity on computed tomography scan and as hyperintensity in T2 on magnetic resonance imaging. These lesions, frequently located in subcortical (especially in the frontal horns) and periventricular areas, consist in demyelination of subcortical-frontal

fibers associated with astrocytic gliosis, mainly caused by ischemic damage [1]. These morphological alterations are correlated with the symptoms present in PDS. Indeed, the postural and motor disorders are mostly related to subcortical atrophy, whereas dysexecutive disorders are more likely to be related to the severity of periventricular damage [1].

1.4. DIFFERENTIAL DIAGNOSIS OF PSYCHOMOTOR DISADAPTATION SYNDROME

The main differential diagnoses of PDS are as follows:

- Parkinson's disease, whose clinical picture includes freezing, a walking with small slipped steps with increased bipodal support, akinesia, hypertonia, bradyphrenia and sometimes backward disequilibrium, as in the PDS [9]. However, in PDS, akinesia is mainly axial, whereas it is generalized in Parkinson's disease. Hypertonia is oppositional in the PDS and does not affect the facial muscles while it is plastic and "lead pipe" in Parkinson's disease and also affects the muscles of the face, giving Parkinsonian patients the typical blank stare. In addition, the Parkinson's disease triad includes resting tremor, which is not present in PDS when it is not secondary to a Parkinsonian syndrome [3,9].
- Major neurocognitive disorder with subcortical involvement. Differential diagnosis may be difficult, especially in the early phase of PDS and in certain acute situations, like the beginning of hospitalization, when acute factors leading to PDS may also favor the onset of a delirium, which, in turn, will not facilitate the cognitive evaluation. Moreover, differential diagnosis is even more difficult considering that a major neurocognitive disorder may be associated with PDS as a predisposing factor. In addition, the bradyphrenia observed in the chronic form of PDS may also interfere with a cognitive evaluation. Hence the importance of regularly repeating the cognitive tests, such as the Mini-Mental State Examination (MMSE) and the Montreal Cognitive Assessment (MoCA), which assess attention, concentration, executive functions, memory, language, visual-constructive abilities, abstraction, calculation and orientation [1,9].
- Normal pressure hydrocephalus, which includes, as in PDS, gait disorders, bradyphrenia, motor slowing, indifference and disinterest. The difference between the

two pictures is based on sphincter disorders and enlargement of the sustentation polygon, typically present in normal pressure hydrocephalus but not in PDS [5,9].

- Depression, which, like the PDS, can present with psychomotor bradypsychia and motor slowing down. However, a crucial difference consists in the absence of moral suffering, main sign of depression but not found in PDS. Moreover, contrary to the depression, patients suffering from PDS are detached and indifferent from their loss of independence [5,9].

1.5. Course, management follow-up and prognosis of psychomotor disadaptation syndrome

Psychomotor disadaptation syndrome represents a geriatric emergency, due to a major risk of cascading decompensation, which could lead to serious functional or even vital consequences. Thus, older people with PDS are more exposed to the risk of falling, having physical and psychological complications and losing autonomy, with a major hazard of institutionalization [4].

The care program should be multidisciplinary and introduced as early as possible, involving various health care professionals including physicians, physiotherapists, occupational therapists, psychologists, nurses and caregivers.

The care objectives consist in the investigation and management of chronic and acute factors involved in the PDS pathophysiology, and the correction of the symptoms [4,5].

The physician must be able to identify and evaluate the chronic diseases exposing to subcortical-frontal dysfunctions, as well as the acute predisposing factors, mainly those causing cerebral hypoperfusion such as hypotension, dehydration and ionic disturbances, to enable their rapid correction [4].

The physiotherapist should provide a global motor rehabilitation involving the relearning of basic motor acts and the rehabilitation of balance and walking. Moreover, the correction of backward disequilibrium is fundamental, such as teaching strategies to get up from the ground.

The MMT is an essential tool for initial assessment and follow-up of patients suffering from PDS [9,10].

The occupational therapist's tasks are requested to maintain and recover postural and motor patterns (if necessary, with environment modifications) and teaching the use of adapted technical devices.
The psychologist contributes for management of the fear of falling, standing and walking, as well as bradyphrenia and demotivation.
Nurses and caregivers act daily through habitual and specific care, especially through frequent physical and motor stimulation of the patients.
However, high-quality care does not guarantee a functional recovery in all cases. This also depends on the type and severity of comorbidities and on the patient's motivation.
Finally, it is essential to follow up these patients by maintaining the multidisciplinary dynamics initiated in the initial phase [4,5].

1.6. PREVENTION OF PSYCHOMOTOR DISADAPTATION SYNDROME

Primary prevention of PDS is mainly achieved by identifying subcortical-frontal fragility elements.
Patients suffering from PDS should have regular medical and motor follow-up, with the aim of better stabilizing chronic conditions that predispose to PDS.
In addition, the role of motor physiotherapy, dedicated to older adults living at home as well as to those hospitalized, is crucial [4,9].

2. OBJECTIVES OF THE REVIEW

In 2019, the share of very old people (≥ 85 years) in European population was 2.8 %, and France, with Portugal, Spain, Greece and Italy, had the highest shares of very old people [11]. The population aged ≥ 65 years will not stop growing in Europe, and will increase significantly, rising from 90.5 million at the start of 2019 to reach 129.8 million by 2050 [11]. In face with this considerable and continuous growth of the older population, health professionals will be increasingly confronted with the PDS. For this reason, it is essential for physicians and paramedical staff to know how to recognize and manage this syndrome, in order to avoid any loss of opportunity for the patients.
In this context, the aim of this study was to assess the knowledge of PDS among health professionals. The main purpose of this study was to assess whether PDS is known

and taken into account in clinical practice by health professionals worldwide, now that more than 35 years have passed since its original description in France. The second aim was to assess if all the PDS clinical signs are recognized as part of this syndrome, or whether as a multitude of symptoms without connection. The third objective was to assess whether epidemiological studies on the topic have been conducted.

3. MATERIALS AND METHODS

3.1. DATA SOURCES

The present literature review includes several papers and studies of several designs (journal articles, case reports, reviews and short reviews, randomized control trials, observational and retrospective and case control studies), so it can be classified as a mixed-methods review. The studies assessed were searched on PubMed, Science Direct and Google Scholar. The keywords used were: “psychomotor disadaptation syndrome”, “psychomotor regression syndrome”, “frontal sub cortical dysfunction syndrome”, “backward disequilibrium”, “retropulsion”, “post-fall syndrome”, “reactional hypertonia”, “axial akinesia”, “older” AND “elderly”.

To be included, articles had to be original dealing with the psychomotor disadaptation syndrome or even assessing at least one aspect of the syndrome, whatever of the language, the country and the year of publication. Indeed, there was no restriction with regard these last criteria.

Duplicate articles, articles in which there was not match with the background of this review, and articles not available in full text, were not included.

3.2. SELECTION OF STUDIES

The identification of the studies was initially conducted by screening the titles and the abstracts, then duplicate items were removed. Finally, additional records, identified through reference lists, were selected.

Thereafter, full texts of the papers were reviewed for further confirmation.

3.3. DATA EXTRACTION

The following data from included studies were extracted: author(s), objective(s), design, sample characteristics, results and conclusion of the article, in addition to year, country and language of publication.

4. RESULTS

The flow chart of the review search process is presented in Figure 1.

A total of 456 papers was initially found as a result of research from the three databases, PubMed, Google Scholar and Science Direct.

After removing duplicate items and after a first reading of the abstracts, 404 articles were excluded. In addition, five papers were identified from the reference lists of these retrieved studies, increasing the number of the articles to 57. After an exhaustive reading, 8 studies were excluded for not match with the review background and 7 because not available in full text. Finally, 42 studied were included in this review. Among these 42 articles, 28 were carried out in France. For the remaining part, two studies were conducted in Belgium, two in Japan, two in Spain, two in United Kingdom, one in Australia, one in Brazil, one in Korea, one in Switzerland, one in Tunisia and one in USA. Among the retrieved studies, 26 articles were in English, 15 in French and one in Spanish.

Among the included studies, nine analyzed the PDS in all its aspects, describing its pathophysiology, clinical signs, diagnosis, prevention and management. The remaining studies focused on specific individual aspects of the syndrome.

No epidemiological studies have been found.

Data of included studies are summarized in the Table 2.

Figure 1: The review flow chart.

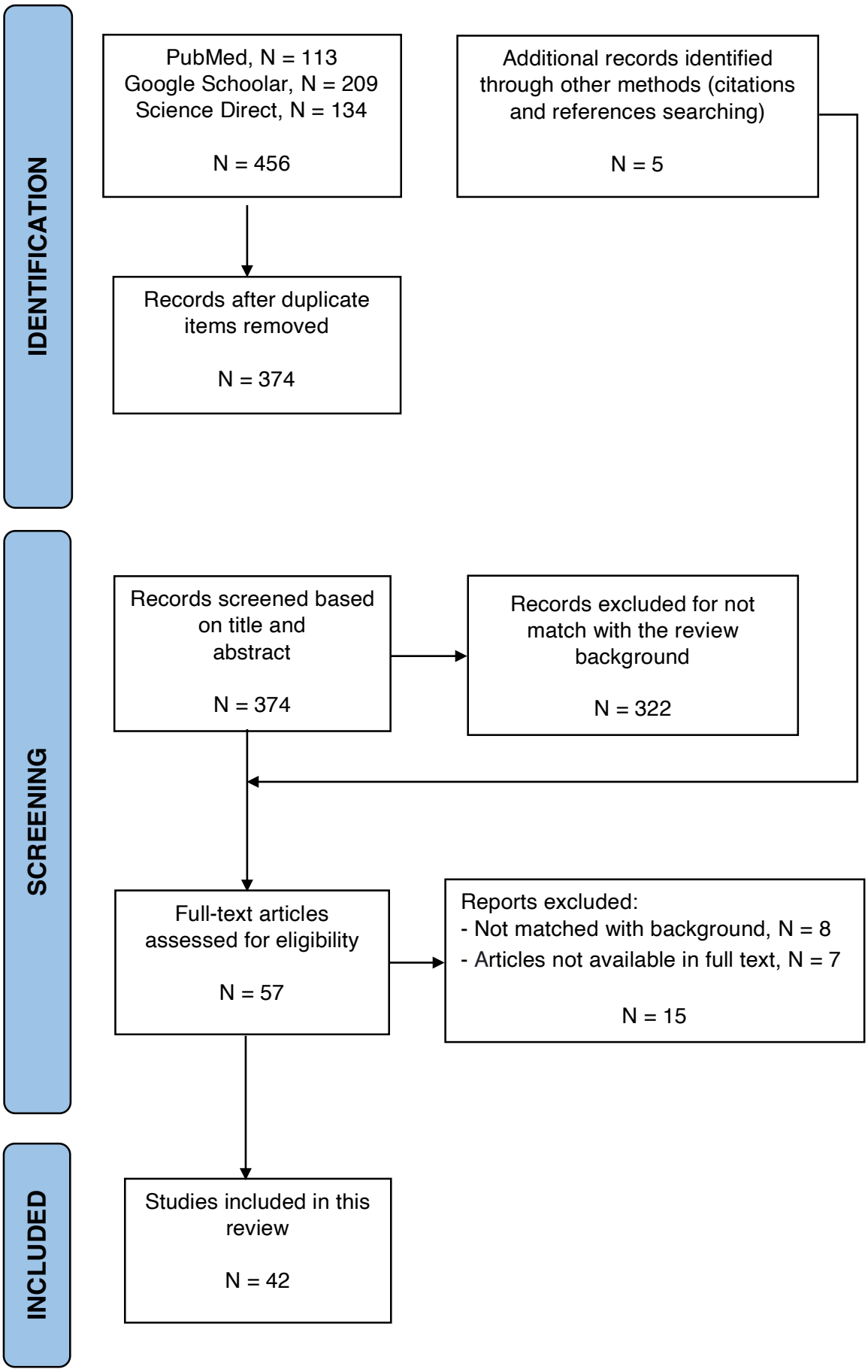

Table 2: basic characteristics of the included studies.

AUTHOR (YEAR) COUNTRY	OBJECTIVE	STUDY DESIGN - SAMPLE CHARACTERISTICS	MAIN RESULTS AND CONCLUSIONS
Lepage et al. [1] (2012) BELGIUM	Description of pathophysiology, clinical features, diagnostic process, prevention and treatment of PDS.	Review Article.	PDS is frequent in geriatric medicine and it should be systematically investigated in older patients who had a fall. Prompt and adapted rehabilitation must be performed in order to avoid risk of functional decline and dependence.
Mourey et al. [3] (2004) FRANCE	Description of pathophysiology, clinical features, diagnostic process, prevention and treatment of PDS.	Review Article.	PDS is characterized by postural and motor impairments, associated with neurologic disorders, potentially triggered by many factors, such as cardiovascular and metabolic diseases, falls, and bed rest. Early management and specific rehabilitation approaches are decisive factors for prognosis.
Manckoundia et al. [4] (2020) FRANCE	Description of pathophysiology, clinical features, diagnostic process, prevention and treatment of PDS.	Review Article.	PDS needs to be well known by health professionals in order to avoid any misdiagnosis and to assure an adapted multi-professional management of these patients.
Manckoundia et al. [5] (2021) FRANCE	Description of pathophysiology, clinical features, diagnostic process, prevention and treatment of PDS.	Review Article.	PDS, as an emergent geriatric syndrome, needs to be well known by physicians, particularly geriatricians and general practitioners.
Manckoundia et al. [6] (2019) FRANCE	Description of pathophysiology, clinical features, diagnostic process, prevention and treatment of PDS.	Review Article.	Multidisciplinary management, including medical, psychological and motor physiotherapy strategies, is essential for PDS patients.
Manckoundia et al. [9] (2007) FRANCE	Description of pathophysiology, clinical features, diagnostic process, prevention and treatment of PDS.	Review Article.	PDS, as an emergent geriatric syndrome, imposes an adaptation of management schemes. Large populations prevalence studies and further research on PDS are needed to evaluate benefit of its treatment and management.
Pfitzenmeyer et al. [12] (1999) FRANCE	Description of PDS.	Review Article.	PDS is considered as a functional disorder of which clinicians should identify etiological and predisposing factors. PDS is a reversible syndrome which can benefit of medical and rehabilitation treatment with specific multidisciplinary approaches.
Pfitzenmeyer et al. [13] (2003) FRANCE	Description of pathophysiology, clinical features, diagnostic process, prevention and treatment of PDS.	Review Article.	Since PDS is an emergent geriatric syndrome, it is necessary to boost the scientific research on physiopathology and diagnostic aspects in order to evaluate the benefit of its management.
Manckoundia et al. [14] (2014) FRANCE	Description of pathophysiology, clinical features, diagnostic process, prevention and treatment of PDS.	Review Article.	PDS patients need multidisciplinary management, including medical, physiotherapy and psychological strategies.
Pfitzenmeyer et al. [15] (2004) FRANCE	Report of the institutionalization risks and death in PDS patients.	Prospective observational study: follow-up over a 4-year period by comparing PDS hospitalized patients with Alzheimer hospitalized patients.	Follow-up of 41 PDS patients compared to 35 Alzheimer patients. Institutionalization and mortality rates were higher ($p < 0.05$) in the PDS subjects compared to Alzheimer subjects. The high risk of disability and death in PDS patients indicates the need of specific care programs including daily living activities for these patients.

N: number**, PDS**: psychomotor disadaptation syndrome, **PFS**: post-fall syndrome, **ANS**: autonomic nervous system, **WMC**: white matter changes, **FoF**: fear of falling, **BD**: backward disequilibrium, **APA**: anticipatory postural adjustment, **MMSE**: mini-mental state examination **RCT**: randomized control trial, **PTSD:** post-traumatic stress disorder, **VRET**: virtual reality training, **MMT**: mini-motor test, **STAI**: state-trait anxiety inventory.

AUTHOR (YEAR) COUNTRY	OBJECTIVE	STUDY DESIGN - SAMPLE CHARACTERISTICS	MAIN RESULTS AND CONCLUSIONS
Morisod et al. [16] (2007) SWITZERLAND	Discussion on clinical presentation and management of PFS.	Two case reports: - First case of an 86-year-old patient presenting a typical picture of PFS with complete recovery thanks to an early and adapted physiotherapy. - Second case of an 80-year-old obese patient who had fallen with 3-days stasis on the ground, presenting a typical picture of PDS; the patient had not recovered to his previous condition and was placed in a nursing home.	PFS is frequent in geriatric medicine and it is considered as the acute form of PDS. Early diagnosis and prompt care are required.
Pfitzenmeyer et al. [17] (2002) FRANCE	Improvement of the knowledge on PDS, integrating cardiovascular risk factors and cerebral CT-scan findings of these patients.	Prospective observational study that included PDS hospitalized patients. General characteristics, neurological and cardiovascular data were collected. WMC were detected using CT scan.	73 hospitalized patients with PDS were included: 90% of patients had reaction hypertonia (no patient showed normal reactive postural responses), 49% had prior history of hypertension, 13% had ongoing antihypertensive treatment, 44 presented orthostatic hypotension. On CT scan, 67% of patients had severe o moderate periventricular lucencies and 50.5% had sever ventricular enlargement. PDS might be associated with WMC, hypotension being a possible etiologic factor of WMC.
Mourey et al. [18] (2009) FRANCE	Evaluation of effort adaptation possibilities during rehabilitation programs of PDS patients by exploring their cardiac ANS activity.	Prospective observational study that assessed cardiac ANS activity in PDS hospitalized patients comparing to control frail hospitalized subjects, by 24-hour electrocardiogram recordings from three leads holter.	14 PDS patients (mean age: 84.5 ± 6.9 years) compared to 13 frail control subjects (80.6 ± 6.7 year). The decrease in cardiac ANS activity observed in PDS subjects was greater than control group ($p < 0.05$). ANS abnormalities ar seen as type of physical deconditioning and could be correlated to the restricte usual physical activity level of PDS patients, and also underlying the typical orthostatic hypotension of these subjects. These patients could benefit from specific physical training.
Manckoundia et al. [19] (2007) FRANCE	Review of causes, consequences and management of BD. Proposition of a semi-quantitative BD score.	Review Article	BD consisting in a multitude of several pathological situations either somatic (i.e. degenerative, ischemic and traumatic brain lesions), psychosomatic (i.e. PDS and extended bed confining) or psychological (i.e. depression). Falls and loss of autonomy are the main consequences of BD. A simple and fast-realizin semi-quantitative scale for BD has been proposed based on five everyday livir activity items, each rated from 0 to 3 (total score on 15).
Manckoundia et al. [20] (2008) FRANCE	Review of BD in older subjects focusing on its causes, consequences, assessment and management.	Review Article	BD has serious physical, psychological and social consequences. BD causes are often a mix of somatic and psychological conditions such as PFS. BD management should include interdisciplinary cares and early motor physiotherapy. Further studies are needed on the prevalence and incidence of BD.
Scheets et al. [21] (2015) USA	Description of a patient suffering from BD and proposition of a specific physical rehabilitation program.	A case report of an 83-year old white woman presenting a fall with displaced right femoral neck fracture and subsequent hemiarthroplasty. Patient presented sensory detection and force production deficits with BD and PDS.	Thanks to a specific physical rehabilitation program the patient decreased her dependence on caregivers, improved in short physical performance battery an performance-oriented mobility assessment, reaching the patient primary goal o staying in her own housing. Knowledge and recognition of BD could benefit of an appropriate management.
Matheron et al. [22] (2010) FRANCE	Analysis of postural control in the upright stance in PDS patients.	Prospective observational study including PDS hospitalized patients compared with control hospitalized subjects in order to asses postural control differences using the Sway Star TM system.	10 patients suffering from PDS (age 87.3 ± 4.9 years) compared with 10 contr subjects (age 85.4 +/- 7.9 years): PDS group showed greater body sway amplitude than controls with eyes opened ($p = 0.026$) and with eyes closed (p 0.013). PDS has a negative effect on postural control and this should be considered during the rehabilitation programs.
Brondel et al. [23] (2005) FRANCE	Verification of the hypothesis that postural impairments might increase energy cost during a clinical functional test.	Prospective observational study including PDS hospitalized patients compared with control hospitalized subjects in order to check energy expenditure before, during and after the ‘‘up and go test’’. Following parameters were recorded: O_2 uptake, CO_2 output, expiratory minute ventilation, breathing frequency, heart rate, and alveolar ventilation.	24 PDS women compared with 24 control frail women: PDS group had significant increase in O_2 uptake during exercise and recovery periods. PDS may be related to an increase in energy expenditure. Low tolerance even for moderate exercise should be considered in setting of PDS specific rehabilitatic programs.

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AUTHOR (YEAR) COUNTRY	OBJECTIVE	STUDY DESIGN - SAMPLE CHARACTERISTICS	MAIN RESULTS AND CONCLUSIONS
Murphy et al. [8] **(1982) UNITED KINGDOM**	First description of PFS.	Prospective observational study including patients aged ≥ 65 years, hospitalized after a fall and followed during 4 months.	Of the 36 included patients, 10 developed tendency to grab and clutch and were unabl walk without support, 16 showed similar signs but they were able to walk independentl had no features of PFS. The nature and significance of PFS was unclear, but it was important to focus attention on its clinical relevance and potential severe prognosis in c to prevent or reverse this condition.
Alarcón et al. [24] **(2009) SPAIN**	Analysis of different FoF assessing methods in order to evaluate if they change the risk factors for developing it, and its consequences.	Systematic review from 5 electronic databases.	24 articles selected. The choice of FoF assessing method depended on the study population, the objective and the time available, but the risk factors and the consequen of FoF were similar in the different studies.
Wu S. Y. F. et al. [25] **(2020) AUSTRALIA**	Identification of the interventions that occupational therapists can use to treat FoF.	Scoping review from 13 online databases.	22 included studies. Cognitive behavioral therapy, guided imagery, and tai-chi were us interventions in order to reduce the risks for future falls and to improve mental health quality of life.
Jung et al. [26] **(2008) KOREA**	Definition of FoF by clarifying its measurement and describing its risk factors.	Literature Review.	FoF measurements involve use of a fall efficacy scale. Nurses who work closely with o adults should encourage them to maximize their basic health status and improving thei physical activity to decrease FoF.
Uemura et al. [27] **(2012) JAPAN**	Evaluation of the FoF effect on APA during walking initiation under dual-task situations in older subjects.	Prospective observational study that included non-hospitalized patients with FoF compared to control subjects. The subjects performed walking initiation in single-task and dual-task situations, a 10-m walking test, a timed up & go test and a functional reach test while center of pressure and APA data were collected.	57 included patients were categorized into FoF (N =24) or No-FoF (N =33) groups. Under the dual-task situation the FoF group had significantly longer APA phases, howe no significant differences were found under the single-task situation or in any clinical measurements.
Legters et al. [28] **(2002) UNITED KINGDOM**	Improvement of FoF knowledge in the UK Scientific Community by describing its prevalence, measurement tools, relationships to other conditions, and the potential management interventions.	Review Article.	The FoF prevalence was 30% in older adults with no history of fall, and 60% in older ad who have fallen. The factors contributing to FoF are various. Multiple interventions hav been recommended with cognitive behavioral positive effects and increased self-confidence to perform daily activities.
Mourey et al. [29] **(2009) FRANCE**	Description of FoF and its consequences.	Literature Review.	FoF must be assessed with accuracy in order to prevent its consequences such as restriction of activity and social withdrawal.
Gaxatte et al. [30] **(2011) FRANCE**	Evaluation of FoF prevalence and its associated factors among older fallers, with attention to the FoF impact on the ''getting out of the house'' activity.	Prospective study that included fallers and subjects at high risk for falls, in order to evaluate their FoF. Subjects were questioned at baseline and 6 months later by a multidisciplinary team (including a geriatrician, a neurologist and a rehabilitation physician). FoF was assessed by following yes/no question: ''are you afraid of falling?''.	635 included patients had a mean age of 80.6 years, and 78% of them (N = 502) expressed a FoF. Patients with FoF were mostly women ($p < 0.001$) who had a higher number of falls in the 6 months preceding the consultation ($p = 0.01$), a longer time spe on the floor after a fall ($p < 0.001$), had more balance disorders ($p = 0.002$), and a more frequent use of a walking technical aid ($p = 0.02$). These findings suggest the need of systematic screening for fallers or high fall risk subjects.
Suzuki et al. [31] **(2004) JAPAN**	Investigation of the benefits in combined long-term and home-based fall prevention programs for older Japanese women.	RCT that consisted in a 6-month program of fall-prevention exercise classes and home-based exercise program for the intervention group, while the control group received only a brochure and advice on fall prevention. The follow up was realized at 8 and 20 months.	52 women aged ≥ 73 years were randomized in the intervention group (N: 28) and in th control group (N: 24). At 20 months, 54.5% of subjects in the control group presented a versus the 13.6% of subjects in the intervention group. Combination of exercise classes and home-based program significantly decrease the incidence of falls.

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AUTHOR (YEAR) COUNTRY	OBJECTIVE	STUDY DESIGN - SAMPLE CHARACTERISTICS	MAIN RESULTS AND CONCLUSIONS
Kechaou et al. [32] **(2019) TUNISIA**	Evaluation of the traumatic circumstances and psychosocial consequences of falls in older patients.	Retrospective study that included inpatients and outpatients aged ≥ 65 years presenting with a history of at least one fall in the previous year.	40 subjects were included with a mean age of 75.7 years. Correction of the extrinsic an intrinsic precipitating factors of falls and application of "getting-up technique" educationa programs can prevent the risk of falls and their serious consequences.
Fromage et al. [33] **(2005) FRANCE**	Comparison of the self-concept (defined as perception of a subject about himself), in older adults in presence and absence of falls.	Prospective observational study that included patients hospitalized in a geriatric short-stay unit, waiting for admission to nursing home. Experimental group included patients who had fallen at least once in the past year. Control group included patients without fall.	Two groups of eight older patients (MMSE score ≥ 23) were included. Faller patients showed a less important words production associated to a negative and depreciatory s description, loss of confidence, and feeling of impotence in everyday life and future. Th kind of self-representation can be incorporated in the clinical picture of PFS. Psychological aspects of falls could benefit of specific management.
Bloch et al. [34] **(2015) FRANCE**	Description of psychological non-traumatic complications of falls, such as PFS, PDS, FoF which are too often neglected.	Review Article.	It is necessary to focus the attention on psychological consequences of a fall, too often neglected, which can have a significant negative impact in terms of medical consequences, loss of autonomy, quality of life, institutionalization risk and mortality.
Gonthier R. [35] **(2014) FRANCE**	Description of epidemiology, morbidity, mortality, cost to society, causes and consequences of falls.	Review Article.	Falls are the main cause of accidental death among older adults (about 12000 deaths/year). Risk factors for falls are various, including age. Severe traumatic consequences are observed in 10% of falls, even without physical repercussions. Psychological effects of falls (anxiety while walking, FoF) can be complicated by PDS with severe impact on routine daily life in 30% of cases. With the increasing number of older people, preventive approach in order to reduce healthcare costs is mandatory.
Meyer et al. [36] **(2020) FRANCE**	Investigation of the PFS risk factors.	Prospective observational monocentric case-control study which included patients hospitalized after a fall and followed at 1 year. General physicians collected data about new falls, functional mobility, hospitalization and mortality.	70 patients were included (age ≥ 70 years, 41% with PFS). Patients with PFS showed body functions/structure disorders and activity limitations prior to the fall suggesting the existence of a pre-fall syndrome (i.e. a PDS existing prior to the fall). Among the analyz risk factors, FoF, vision impairment and muscle strength could be targeted for improvement. PFS could be considered as a marker of functional movement loss of at year.
Miró et al. [37] **(2019) SPAIN**	Assessment of functional modifications and factors affecting 180-day functional prognosis among older subjects attending a hospital emergency department due to a fall.	Retrospective study that included subjects aged ≥ 65 years attending four Spanish emergency departments after a fall.	Of the 452 included patients, 29.6% (N = 133) had a clinically significant functional decline at 180 days. Age ≥ 85 years, fall-related fracture, hospitalization and PFS were independently associated with 180-day clinically significant functional decline.
Pfitzenmeyer et al. [38] **(2001) FRANCE**	Evaluation of the benefits of a specific rehabilitation program in patients with PFS.	Prospective observational study that included patients with PFS aged ≥ 70 years and hospitalized after a fall. Get-up and go test, timed get-up and go test, and assessment of functional activities and postural abilities were evaluated at hospital admission, then at discharge from hospital. Subjects underwent to specific rehabilitation program consisting in motor patterns training, balance exercises, and gait training.	13 female patients were included and they showed an improvement in physical mobility following the rehabilitation program. These findings suggested that faller older patients must benefit from specific multidisciplinary rehabilitation programs in order to avoid a lo of functional capacities and disability.
Manckoundia et al. [39] **(2007) FRANCE**	Evaluation of the impact of medical, psychological, and physiotherapeutic management on motor abilities, psychological status and independence of older fallers with PDS.	Prevention study that included subjects aged ≥ 70 years who were admitted to geriatric day-hospital and who suffered from a fall in the past 6 months with subsequent PDS. Patients were assessed at the inclusion and at the end of the intervention. Follow-up was realized at 6 and 9 months.	Of the 28 enrolled patients (mean age 81.4 years), only 14 subjects took part in the tota multidisciplinary 6-weeks program. The intervention had a global positive impact on mo abilities as shown by the raise in the MMT scores, the positive results in rising from the floor and reduction of time for the dual-task. Reduction in the FoF and decrease in the rate of fallers were also observed. These positive effects were sustained in the follow-u

N: number**, PDS**: psychomotor disadaptation syndrome, **PFS**: post-fall syndrome, **ANS**: autonomic nervous system, **WMC**: white matter changes, **FoF**: fear of falling, **BD**: backward disequilibrium, **APA**: anticipatory postural adjustment, **MMSE**: mini-mental state examination **RCT**: randomized control trial, **PTSD:** post-traumatic stress disorder, **VRET**: virtual reality training, **MMT**: mini-motor test, **STAI**: state-trait anxiety inventory.

AUTHOR (YEAR) COUNTRY	OBJECTIVE	STUDY DESIGN - SAMPLE CHARACTERISTICS	MAIN RESULTS AND CONCLUSIONS
Bloch et al. [40] (2013) FRANCE	Assessment of the articles investigating the VRET in the treatment of PTSD and anxiety disorders, in order to evaluate the potential VRET role in patients with PFS.	Literature review.	23 studies were assessed. Psychological symptoms of post-fall syndrome could be related to a post-traumatic stress disorder and they could benefit from VRET, but it usefulness should be tested in specific studies
Marivan et al. [41] (2016) FRANCE	Evaluation of the feasibility and acceptability of VRET in rehabilitation of patients suffering from post-fall syndrome.	Prospective monocentric cohort study which included patients (age ≥ 75 years and MMSE > 18/30) hospitalized in geriatric acute or subacute care units with loss of motor or functional autonomy. Subjects performed VRET sessions and answered a questionnaire on its feasibility and acceptability.	Eight patients were recruited, and VRET consisted in an avatar walking through vir environment. VRET could aid rehabilitation by developing new memory structures could replace the fearful memories of these patients. Due to the limited number of included patients, no significant differences in terms of improvement in FoF were observed, however VRET proven to be an acceptable and feasible technique for ol subjects. Efficacy for PFS management should be tested in further studies.
Rmadi et al. [42] (2020) FRANCE	Evaluation of the acceptability and tolerance of VRET among older subjects with PDS.	Prospective monocentric cohort study which consisted in three VRET sessions offered to older hospitalized patients with PDS. Acceptability was assessed by the patient's consent to participate to other sessions after the first one. Tolerance was assessed by heart rate and blood pressure increases during, and after the sessions, and by STAI scores administered before and after the sessions.	VRET seemed to have good acceptability and tolerability in the rehabilitation of patients suffering from PDS. Additional studies should be realized to support these findings.
Piau et al. [43] (2019) FRANCE	Evaluation of the acceptability and feasibility of a robotic walking aid to support physiotherapists in reducing FoF during the rehabilitation of older patients suffering from PDS.	RCT included patients (age ≥ 70 years) with FoF and PDS after a fall who were admitted to a rehabilitation department. During 10 days, interventional group received SafeWalker® robotic walking aid while control group received standard care only.	20 PDS patients were included (mean age 85.2 years) and they were randomized an interventional group (N: 10) and in a control group (N: 10). Patients in the intervention group found the robotic procedure easier ($p = 0.048$). No robotic rehabilitation session had to be replaced by standard rehabilitation and no differen in the ratings of acceptability were observed between the two groups.
Mourey et al. [10] (2005) FRANCE	Evaluation of feasibility and reliability of MMT to establish rehabilitation goals in PDS patients.	Diagnostic observational accuracy study. MMT was performed by two independent investigators (physiotherapist and physician) in four geriatric centers.	101 subjects were included (mean age 84.9 ± 6 years). MMT was an easy direct-observation test, useful in subject presenting severe postural and gait disorders. It could be used in clinical practice in order to establish an interdisciplinary approach a common rehabilitation goal in subjects with PDS.
Cremer et al. [44] (2012) BELGIUM	Description of the steps implicated in the development of the “get-up early test”, an easy screening test for PDS, applicable in non-geriatric services.	Diagnostic observational accuracy study.	Initially elaborated through consensus of nine experts, the first 5-item version show poor reproducibility. New 4-item version had substantial concordance and good diagnostic performance compared to the MMT as gold standard (sensibility: 0.73 a specificity 0.88, area under curve: 0.823). It may be suggested as a screening tool paramedical professionals in order to identify the PDS before a more complete geriatric evaluation to early adapt the care plan.
Santos-Pontelli et al. [45] (2011) BRAZIL	Description of the case report published in 2010 by Cardoen and Santens.	Journal Article. Authors described the case report of two subjects with a severe disorder of body orientation in the sagittal plane with backward disequilibrium, posterior tilt and an active resistance to forward pulling or pushing, identified by Cardoen and Santens as “posterior pusher syndrome”.	Two main hypotheses advanced by the authors: “Posterior pusher syndrome” as a new neurological behavior or a severe reactive/protective postural reaction due to already described PDS

N: number**, PDS**: psychomotor disadaptation syndrome, **PFS**: post-fall syndrome, **ANS**: autonomic nervous system, **WMC**: white matter changes, **FoF**: fear of falling, **BD**: backward disequilibrium, **APA**: anticipatory postural adjustment, **MMSE**: mini-mental state examination **RCT**: randomized control trial, **PTSD:** post-traumatic stress disorder, **VRET**: virtual reality training, **MMT**: mini-motor test, **STAI**: state-trait anxiety inventory.

5. DISCUSSION

This literature review analyzed the studies on PDS on all or only some of its aspects, with the aim of assessing the level of knowledge on the PDS in the French and international literature. The secondary objectives were to evaluate whether or not the PDS is known in all its aspects, and to investigate the existence of epidemiological studies on the subject.

A total of nine articles, among them eight realized in France and one in Belgium, gave a complete description of PDS, including its physiopathology, clinical features, diagnostic process, prevention and management [1,3-6,9,12-14]. All the articles stressed the necessity for the health professionals to know this syndrome, in front of the exponential increase of very frail older individuals and consequently of the PDS as well.

Only one study, realized in France, evaluated the risks of institutionalization and death during a follow-up of 4 years (1998–2002), in hospitalized patients suffering from PDS, compared to hospitalized subjects with Alzheimer disease [15]. In this study, both institutionalization and mortality rates were significantly higher ($p < 0.05$) in the PDS group compared to Alzheimer group, suggesting the priority of specific care programs, in order to reduce the risk of institutionalization and to improve the quality of life of these patients.

In a Swiss study, Morisod et al. accentuated the need to recognize and distinguish the acute form (post-fall syndrome) of the chronic form of PDS by describing two clinical cases [16]. One case reported an 86-year-old patient with a typical picture of post-fall syndrome after several falls at home. This subject recovered all his physical aptitudes, thanks to an early and adapted physiotherapy. The second case was an 80-year-old obese woman, with a typical picture of PDS after a fall with stasis on the ground for 3 days. Despite intensive physiotherapy, the patient could not recover her basic psychomotor state, and she was placed in a nursing home. Thus, it is necessary to diagnose and distinguish the acute from the chronic form, in order to quickly take appropriate measures to enable recovery of previous abilities.

Only two articles realized in France had studied the pathophysiology of PDS. Pfitzenmeyer et al. analyzed the cerebral computed tomography scan of 73 patients suffering from PDS. They found an important association between this syndrome and

moderate to severe periventricular white matter injuries (leukoaraiosis) in 67% of cases, and severe ventricular enlargement in 50.5% of cases. In addition, the prevalence of orthostatic hypotension was 44%, suggesting its possible involvement in the occurrence of subcortical lesions, due to the reduction of the cerebral blood flow in subcortical areas [17]. Mourey et al. explored the cardiac autonomic nervous system activity in 14 patients suffering from PDS, assessing heart rate variability in 24-hour holter recordings, then compared these 14 patients to 13 frail control subjects. It was observed a greater decrease in cardiac autonomic nervous system activity in subjects suffering from PDS than control group ($p < 0.05$). This autonomic dysfunction could underlie orthostatic hypotension, which in turn could be an important etiologic factor of periventricular lesions in PDS, causing reduced cerebral blood flow in subcortical areas [18].

Three articles, two French and one American, focused on backward disequilibrium, the main sign of PDS [19-21]. The two French studies reviewed causes, consequences and management of backward disequilibrium, describing among its main psycho-somatic causes the PDS [19,20]. Besides, Manckoundia et al. proposed a semi-quantitative backward disequilibrium scale, composed of five situations, including sitting position, standing position with eyes open, standing position with eyes closed, sit-to-stand transition and back-to-sit, each rated from 0 to 3, with the total score varying from 0 to 15 [19]. Nevertheless, this scale has not yet been validated. The American study, carried out by Scheets et al., described the case study of an 83-year-old woman who fell and sustained a displaced right femoral neck fracture with subsequent hemiarthroplasty, and presenting a clinical picture of backward disequilibrium and PDS [21]. Authors proposed a therapy management program, including 44 visits of physiotherapists over 15 weeks. It consisted in five primary components (standing with the back against the wall with heels touching the wall, practicing moving from sit-to-stand, practicing moving from stand-to-sit, walking with continuous stepping, and stepping backward), allowing important improvements in dependence and gait impairments, achieving the patient primary goal of staying in her own housing [21].

Matheron et al., examined postural control in the upright position in older patients suffering from PDS compared with a control group of older subjects [22]. Authors showed that postural control in upright position with eyes open or closed decrease in

subjects suffering from PDS compared with the control subjects, emphasizing the negative impact of PDS on postural control [22].

Brondel et al. investigated the hypothesis that postural impairments in PDS might increase energy expenditure during a clinical functional test in frail older individuals [23]. A significant increase in oxygen uptake during exercise and recovery periods was showed in women suffering from PDS, compared with a control group. The latter, suggests an increased energy expenditure, due to the postural disorders of PDS, which must be considered in specific rehabilitation programs for PDS patients [23].

Most of the studies dealt with the post-fall syndrome, i.e. the acute form of PDS, and fear of falling.

Murphy and Isaacs described for the first time the post-fall syndrome in 1982, analyzing 36 patients aged 65 and over, hospitalized after a fall and followed for 4 months [8].

Seven studies, two French, one Australian, one English, one Japanese, one Korean and one Spanish, analyzed fear of falling and its different aspects [24-30]. Basically, all the studies recognized fear of falling as a key symptom of the post-fall syndrome, but only the French studies mentioned PDS [29, 30].

Five studies, three French, one Japanese and one Tunisian, focused on various features of falls, analyzing causes, prevention, and consequences. All these studies recognized the post-fall syndrome as one of the most serious complications of falls due to the significant loss of autonomy it can cause [31-35]. However, only two French studies, mentioned PDS among the consequences of falls [34, 35].

The French study carried out by Meyer et al. aimed to identify the risk factors for post-fall syndrome, by evaluating patients older than 70 years who were hospitalized after a fall and 1-year follow-up [36]. This study showed the existence of body functions/structure impairments and activity limitations prior to the fall, among patients suffering from post-fall syndrome. It suggests the existence of a pre-fall syndrome, i.e. a PDS, confirming that post-fall syndrome can be considered an acute form of PDS.

The Spanish study carried out by Miró et al. aimed to determine functional modifications and factors affecting 180-day functional prognosis among older subjects attending four Spanish emergency departments after a fall [37]. Among the 452 patients included (age ≥ 65 years), 29.6% had a clinically significant functional decline at 180 days. Age ≥ 85 years, fall-related fracture, hospitalization and post-fall syndrome were independently associated with 180-day clinically significant functional decline. Thus, post-fall syndrome is identified in this study, as a risk factor that may help to

identify among patients attending hospital emergency departments after a fall, those at increased risk of functional impairment [37].

Several studies evaluated rehabilitation and prevention programs for PDS. Pfitzenmeyer et al. showed the benefit of a specific rehabilitation program, including basic motor patterns training, practice of balance exercises and gait training in patients with post-fall syndrome [38]. Manckoundia et al. studied the effectiveness of a multidisciplinary program including medical, psychological, and physiotherapeutic interventions, in 14 older subjects with post-fall syndrome followed during 6 and 9 months [39]. It was showed a global positive impact of the multidisciplinary intervention on motor abilities, reduction of fear of falling and decrease of falls. These positive effects were sustained until 9 months after the beginning of the multidisciplinary program [39].

Three French studies assessed the virtual reality exposure training (VRET) in older adults [40-42]. The study carried out by Bloch et al. in 2013, reviewed the articles investigating the VRET in the treatment of post-traumatic stress disorder and anxiety disorders [40]. According to the authors, psychological symptoms of post-fall syndrome could be related to a post-traumatic stress disorder and they could benefit from VRET, but its usefulness should be tested in specific studies [40]. In 2016, Marivan et al. aimed to determine the feasibility and acceptability of VRET in rehabilitation of patients suffering from post-fall syndrome [41]. Eight patients aged over 75 years were recruited, and VRET consisted in an avatar walking through virtual environment. VRET could aid rehabilitation by developing new memory structures that could replace the fearful memories of these patients. Because of the limited number of included patients, no significant differences in terms of improvement in fear of falling were observed, however VRET proven to be an acceptable and feasible technique for old subjects [41]. The study performed by Rmadi et al. in 2020 aimed to evaluate the acceptability and tolerance of VRET among patients suffering from PDS [42]. Ten hospitalized patients suffering from PDS were included. Acceptability was assessed by patient consent to participate in additional sessions after the first one. Tolerance was evaluated by any increase in blood pressure and heart rate before, during, and after the sessions, and by the State-Trait Anxiety Inventory score (scores out of 80, the higher the score, the worse the anxiety) dispensed before and after the sessions. A good acceptability and tolerability was demonstrated in hospitalized subjects with PDS,

and further studies are necessary to evaluate the efficacy of VRET in these patients [42].

The study performed by Piau et al. assessed, with encouraging results, the acceptability and feasibility of the use of a robotic walking aid to assist physiotherapists work in rehabilitation programs, to reduce fear of falling in patients suffering from PDS [43].

Two studies, one realized in France and the other in Belgium, described the steps involved in developing screening tests for PDS. The French study performed by Mourey et al. developed the MMT in order to determinate rehabilitation objectives in patients suffering from PDS and to follow them [10]. Nowadays, MMT represents the gold standard in the follow-up and also for the early identification of PDS patients. Cremer et al. presented the development procedure of the "get-up early test". It consisted of 4 items, including 1) inability to sit up independently at the edge of the bed, 2) difficulty handling: the person opposes, weighs down, clutches, 3) trunk staggering backwards, sliding off the edge of the bed, and 4) apprehension: screams, frightened look, frozen body, for a score ranged from 0 to 4. A score ≥ 1/4 indicates a high risk of functional decline [44]. It may be suggested as a screening tool for paramedical professionals in order to identify the PDS before a more exhaustively and complete geriatric evaluation.

Finally, Santos-Pontelli et al. commented a case report published in 2010 by Cardoen and Santens on the “posterior pusher syndrome” [45]. These last authors reported two subjects with a serious disorder of body orientation in the sagittal plane, associated with backward disequilibrium, posterior tilt and an active resistance to forward pulling or pushing, identified by Cardoen and Santens as “posterior pusher syndrome”, a newly described neurological behavior. Santos-Pontelli et al., on the basis of all the patient characteristics described on the case report, suggested instead, a severe reactive/protective postural reaction due to the already described PDS [45].

Our literature review found that the vast majority of studies on PDS come from teams in France, the country of initial description of this syndrome. The latter deserves to be better known in other countries given the public health and care issues. In our paper, we found no epidemiological studies on PDS in the literature. Teams working on PDS should perform epidemiological studies to show and confirm its high prevalence and incidence, although empirical observations and cross-sections support this.

Our literature review may have some limitations, especially in terms of completeness.

First, the literature search was performed through three databases (PubMed, Google Scholar, Science Direct), while it could be completed through other scientific search engines and databases.
Finally, the main limitation of this paper is the restricted number of studies included (N = 42), while the PDS must be known by a maximum of health professionals, because of its frequency based on experience and its severity, requiring early management.

6. CONCLUSION

Based on the findings of this literature review, PDS is still poorly known. The country with the largest number of studies on PDS remains France, in which this syndrome was first described, while in other countries, it still remains poorly known and studied. In these other countries, post-fall syndrome is the most well-known and studied aspect of PDS, although in most cases it is still not considered as the acute form of PDS. In addition, no epidemiological studies have been realized so far.
In face with the continuous growth of the older population, the number of patients suffering from PDS will consequently increase. Thus, the need of increasing knowledge about the PDS, and to develop epidemiological studies; with the aim to obtain a broad knowledge of PDS among health professionals.

CONCLUSION EN FRANÇAIS

D'après les résultats de cette revue de la littérature, le SDPM reste encore très peu connu dans la littérature internationale. Le pays ayant le plus grand nombre d'études sur le SPDM reste la France, où le syndrome a été décrit pour la première fois. À l'étranger, seuls certains aspects sont décrits, sans pour autant être systématiquement regroupés en syndrome, notamment en SDPM. Le syndrome post-chute est l'aspect le plus connu et le plus étudié du SDPM, bien que dans la plupart des cas, il ne soit toujours pas reconnu comme la forme aiguë de ce dernier. De plus, jusqu'à présent aucune étude épidémiologique n'a été réalisée sur le SDPM.
Avec l'augmentation de la population âgée, le nombre de patients souffrant du syndrome de désadaptation psychomotrice va également croître. Il est donc

nécessaire d'approfondir les connaissances sur le SDPM chez les professionnels de santé et développer des études épidémiologiques.

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THESE SOUTENUE PAR MME MERENDINO Antonella

CONCLUSIONS

Le syndrome de désadaptation psychomotrice (SDPM) est une pathologie gériatrique qui se manifeste par des troubles de la posture, des troubles de la marche, des signes neurologiques et des troubles psycho-comportementaux. Il consiste en une décompensation de la fonction posturale et des automatismes psychomoteurs, entraînant des chutes. Le SDPM a été initialement décrit en 1986 par le Pr GAUDET et son équipe, à Dijon (France) sous la dénomination syndrome de régression psychomotrice. En raison des progrès réalisés sur sa physiopathologie, il fut rebaptisé SDPM dans les années 1990. Depuis les années 2000, il est également appelé syndrome de dysfonctionnement sous-cortico-frontal, en raison du rôle déterminant des lésions sous-cortico-frontales dans sa genèse. Face à la croissance continue de la population âgée, le nombre de malades atteints du SDPM augmentera. Il est donc indispensable qu'il soit connu du personnel médical et paramédical et bien pris en soin. D'où Cette revue de la littérature dont l'objectif principal était de faire le point sur le niveau de connaissance du SDPM, dans la littérature aussi bien française, qu'internationale, 35 ans après sa description initiale. Les objectifs secondaires étaient d'une part d'évaluer si le SDPM est connu ou non dans tous ses aspects et d'autre part de rechercher l'existence d'études épidémiologiques sur le sujet.

D'après les résultats de cette revue de la littérature, le SDPM reste encore très peu connu dans la littérature internationale. Le pays ayant le plus grand nombre d'études sur le SPDM reste la France, où le syndrome a été décrit pour la première fois. À l'étranger, seuls certains aspects sont décrits, sans pour autant être systématiquement être regroupés en syndrome, notamment en SDPM. Le syndrome post-chute est l'aspect le plus connu et le plus étudié du SDPM, bien que dans la plupart des cas, il ne soit toujours pas reconnu comme étant la forme aiguë du de ce dernier. De plus, jusqu'alors aucune étude épidémiologique n'a été réalisée sur le SDPM.

Avec l'augmentation de la population âgée, le nombre de patients souffrant du syndrome de désadaptation psychomotrice va également croître. Il est donc nécessaire d'approfondir les connaissances sur le SDPM chez les professionnels de santé et développer des études épidémiologiques.

Le Président du jury,

Pr. P. MANCKOUNDIA

Vu et permis
d'imprimer Dijon, le 9 MARS 2023
Le Doyen

Pr. M. MAYNADIÉ

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TITRE DE LA THESE :

PSYCHOMOTOR DISADAPTATION SYNDROME : LITERATURE REVIEW

LE SYNDROME DE DESADAPTATION PSYCHOMOTRICE : REVUE DE LA LITTERATURE

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RESUME :

INTRODUCTION : Le syndrome de désadaptation psychomotrice est une pathologie gériatrique qui comprend des troubles posturaux, de la marche et psycho-comportementaux, ainsi que des signes neurologiques. Il comporte une décompensation des fonctions posturales et des automatismes psychomoteurs, responsables de chutes. Il a été initialement décrit en 1986 à Dijon (France) sous la dénomination syndrome de régression psychomotrice. Suite aux progrès réalisés sur sa physiopathologie, il fut renommé syndrome de désadaptation psychomotrice dans les années 1990. Depuis les années 2000, il est aussi appelé "syndrome de dysfonctionnement sous-cortico-frontal", en raison du rôle crucial des lésions sous-cortico-frontales dans sa physiopathologie. Face à la croissance continue de la population âgée, le nombre de patients atteints du syndrome de désadaptation psychomotrice augmentera, d'où la nécessité pour le personnel médical et paramédical de savoir le reconnaître et prendre en soin.

OBJECTIF : Cette revue de la littérature a principalement fait le point sur le niveau de connaissance du syndrome de désadaptation psychomotrice, dans la littérature tant française, qu'internationale, 35 ans après sa description. Les objectifs secondaires étaient d'une part d'évaluer si le syndrome de désadaptation psychomotrice est connu ou non dans tous ses aspects et d'autre part de rechercher l'existence d'études épidémiologiques sur le sujet.

METHODE : Les études ont été extraites de trois bases de données électroniques, PubMed, Science Direct et Google Scholar, en utilisant les termes "Psychomotor disadaptation syndrome", "Psychomotor regression syndrome", "Frontal sub cortical dysfunction syndrome", "Backward disequilibrium", "Retropulsion", "Post-fall syndrome", "Reactional hypertonia", "Axial akinesia" et "elderly".

RESULTATS : seuls 42 articles sur 456 présélectionnés répondaient aux critères d'inclusion. Cette revue de la littérature a montré que le syndrome de désadaptation psychomotrice est encore très peu connu, notamment en dehors de la France, pays comptant le plus grand nombre d'études sur ce syndrome. A l'étranger, seuls 3 aspects sont décrits (syndrome post-chute, rétropulsion, peur de tomber) mais bien souvent, ils ne sont pas reconnus comme appartenant à un véritable syndrome, mais plus une association de signes. Le syndrome post-chute est l'aspect le plus connu et le plus étudié du syndrome de désadaptation psychomotrice (14 études sur 42 sélectionnés), bien que dans la plupart des cas il ne soit pas encore considéré comme sa forme aiguë. Aucune étude épidémiologique n'a été réalisée jusqu'à présent.

CONCLUSION : Avec l'augmentation de la population âgée, le nombre de patients souffrant du syndrome de désadaptation psychomotrice croîtra aussi. Il est donc nécessaire d'approfondir les connaissances sur ce dernier chez les professionnels de santé et développer des études épidémiologiques.

MOTS-CLES : syndrome de désadaptation psychomotrice, syndrome de régression psychomotrice, syndrome de dysfonctionnement sous-cortico-frontal, personne âgée, rétropulsion, chutes