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REVIEW

Exploring therapeutic interventions for functional neurological disorders: a comprehensive scoping review

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Abstract

Functional Neurological Disorders (FNDs) are characterized by the symptoms experienced by the individuals but also by how they express personal experiences and concerns related to the clinical condition. Access to care programs for functional neurological symptoms appears challenging and may entail circular, self-perpetuating healthcare pathways. Given the challenging and misleading interpretations around FND, in advocating for care pathways beyond medical therapies, we designed a scoping review to map recently suggested practices and interventions. We identified 31 relevant papers published between January 2018 and December 2022. Most of the literature was gathered from the US and UK healthcare experiences, with documented interventions provided by multi-professional teams or stand-alone psychotherapists. We found different care pathways addressing either motor or non-motor manifestations. Persons with Functional Motor Disorder are more likely to be referred to physical therapy first, while Persons suffering from Non-Epileptic Seizures are to mental health services. A narrow focus was given to minor components of multimodal approaches (e.g. social workers, and occupational therapists). High heterogeneity was found between assessment instruments as well, reflecting different perspectives in selecting treatment outcomes (e.g., reduction of non-epileptic events, psychological functioning, motor symptoms). Among healthcare professionals, neurologists and (neuro)psychiatrists are typically engaged in formulating and delivering diagnoses, while treatment is often administered by physiotherapists and/or psychologists. In the context of FNDs, the complex etiopathological nature of the condition, including comorbidities, suggests the recommendation of multidisciplinary treatments adopting a stepped care model progressing from standard to higher level individualized modules may better suit individual complexities.

Keywords Functional neurological disorders · Intervention · Care pathways · Multi-professional · Non-medical

Introduction

Functional Neurological Disorders (FNDs) are characterized by the symptoms experienced by the individuals and how they express personal experiences and concerns related to the clinical condition. So far, FNDs are much more represented by motor abnormalities (Functional Motor Disorder, FMD) and Functional Seizures (FS). Understanding the disorder's origin has transitioned from 'emotion-centric' psychological models to multifaceted perspectives, encompassing cognitive and neurobiological explanations [1]. Both the Diagnostic and Statistical Manual of Mental Disorders (DSM) [2] and the International Classification of Diseases (ICD) [3] adopt a symptom-based approach, enabling clinicians to diagnose by specifying signs and symptoms. The underlying cause triggering the onset of functional neurological symptoms remains unconfirmed. Either comorbid neurological conditions or abrupt psychological/physical stressful events may trigger central nervous system dysfunction [4]. Despite the genuine nature of the symptoms, persons with an FND (PwFND) often grapple with the stigma of being labeled as "deliberate feigners" [5, 6], particularly as routine medical investigations fail to reveal any structural or organic alterations. It is noteworthy that from 55 to 95% of adult PwFND are estimated to have at least one psychiatric comorbidity [7]. The hypothesis of a causal relationship between stressful or traumatic life events and the onset of symptoms seems unlikely [8]. Importantly, although psychological distress is no longer a prerequisite for diagnosis

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[9, 10] but rather a predisposing factor, people experiencing these symptoms encounter significant challenges, both in terms of recognition and the potential misclassification of their condition.

Etiopathogenetic formulations of the functional neurological condition are currently interpreted within an integrated biopsychosocial framework [9, 11]. The biopsychosocial model acknowledges genetic, neurobiological, affective, social, and environmental contributions to the clinical condition's onset, precipitation, and maintenance mechanisms. The neurophysiopathological factors underlying the manifestation of symptoms are still under investigation. More consistent findings are related to the motor phenotype (FMD), where abnormal neural activity at cortical (i.e., dorsolateral prefrontal cortex, supplementary motor area) and limbic (i.e., hippocampus, amygdala, cingulate) circuits has been hypothesized to affect PwFMD's sense of agency [9, 11, 12]. Neural abnormalities have also been found in response to aversive emotional stimuli [13] associated with poor selection and suppression of activated motor responses [14]. On the other hand, patients suffering functional seizures have shown increased cortical activity in those areas involved in emotion regulation (insula), executive control (frontal gyrus, parietal cortex), and movement (precentral sulcus) [15, 16].

Unfortunately, accessing care programs for functional neurological symptoms appears challenging. It may entail circular, self-perpetuating healthcare pathways, including specialist consultations, admissions to healthcare facilities, e.g., emergency departments, and diagnostic investigations [17, 18]. Gatekeepers responsible for providing first aid, mainly general practitioners, neurologists, and internists, have acknowledged a need for more expertise in managing FND [19], so misdiagnosis and inappropriate interventions may slow recovery. Without evidence-based care plans, a comprehensive overview of different domains of functioning could guide appropriate and personalized care. Some authors [20, 21] point out how distressing it is for PwFND to deal with the *unknown,* including a lack of endorsement towards an integrated and unambiguous epistemology of their condition.

Given the challenging and misleading interpretations around FND, in advocating for care pathways beyond medical therapies, we sought to leverage a biopsychosocial model of the disease [22] that helps understand the interplay of psychological, social, and neurobiological factors. Following the recent debate about FND management according to a multidisciplinary approach [23, 24], we designed a scoping review to map recently suggested practices and interventions.

The inception of this scoping review was formulated as an extension of preceding endeavors promoting an interdisciplinary, integrated strategy for addressing FNDs, especially given the absence of evidence from randomized clinical trials, with the review's scope commencing from 2018 onwards. Notably, a 2018 review in JAMA Neurology underscored the imperative for additional research to appraise the efficacy of amalgamating diverse therapies and embracing multidisciplinary approaches, notwithstanding the augmentation of supporting evidence for specific interventions [9]. In the realm of neurological expertise, the role of practicing neurologists in the sole management of FNDs has been subject to questioning. A commentary from 2018 posited that while there is potential for neurologists to contribute to the diagnosis and coordination of interdisciplinary care for FNDs, the optimal practice involves their collaboration with a range of professionals, including psychiatrists, psychotherapists, physical and occupational therapists, and other allied clinicians, rather than functioning in isolation [25]. In this context, it has been observed that although neurologists may exhibit more excellent proficiency in diagnosing patients with FND, there remains a necessity for additional guidance regarding the conduct of follow-up outpatient visits and suggested treatments [26].

Additionally, O'Neal and Baslet highlighted in 2018 the importance of adopting a comprehensive, multidisciplinary approach to FND treatment from a psychiatric standpoint. They emphasized the necessity for close collaboration among the diagnosing clinicians, physical therapists, and mental health clinicians [27].

Methods

To map the therapeutic "non-medical" interventions for PwFND, we opted for the scoping review methodology described by Arksey and O'Malley [28–30]. We define *non-medical* as a therapeutic intervention that fits within the individual's biopsychosocial framework and moves beyond conventional medical solutions (e.g., drugs). Such an approach may encompass (psycho)education, psychotherapy, physiotherapy, occupational therapy, or other treatments that address symptoms by integrating the individual and the environment. From this perspective, the psychological dimension of the person, i.e., emotion, cognition, behavior, life experiences, and the social environment, are pivotal, as external factors may interact and shape internal ones.

A scoping review, also known as a scoping study or mapping review, is effective when a body of literature exhibits a complex and heterogeneous nature and needs to be comprehensively reviewed. It aims to scope the knowledge landscape to identify existing knowledge and significant areas of interest, determine whether a systematic review is valuable, and suggest potential future research directions [31].

In contrast to a systematic review, a scoping review does not yield definitive answers to a particular clinical question. Instead, it encapsulates essential concepts and maps out

existing studies, irrespective of their quality. Our approach involved an exhaustive exploration of the empirical literature, prioritizing breadth and including diverse study designs. This method aimed to delineate the scope, diversity, and characteristics of the literature related to our topic, with the primary objective of identifying crucial findings and discerning any existing gaps.

Identifying relevant studies

MCB defined a search strategy, shown in Table 1, using the PPC mnemonic tool (Population, Context, and Concept) [31, 32]. The authors agreed on proposing terms for the population (PwFND) and the concept (non-medical interventions). As to context, the terms invoked themselves for neurological care settings. Given the broad spectrum of the FND clinical phenomena, we opted for search terms that refer to the current terminology of functional neurological symptom disorders classification and are, therefore, likely to inform on the most common phenotypes and symptom constellations. Records needed to be based on empirical studies to be included in the scoping review.

Consequently, we excluded reviews, viewpoints, position papers, or other non-empirical investigations. We also excluded studies involving pediatric patients. No language restriction was applied.

We searched five electronic databases (MEDLINE, Embase, Cinahl, PsychINFO, Scopus) to cover the empirical scientific literature from January 2018 to December 2022. The choice to initiate the review in 2018 was influenced by the ongoing discourse surrounding the management of FNDs through a multidisciplinary approach, as evidenced by recent discussions [9, 22, 23, 25–27]. This decision was undertaken with particular attention to the precise classification of FNDs per the ICD-11, the deliberations of which originated around the timeframe mentioned above [9, 33, 34]. We also reviewed the references of the relevant articles to identify additional information.

Study selection

At least two reviewers independently assessed eligibility and extracted the data. The initial search produced 1602 articles. The title reading to the full-text access stage was selected using the Rayyan web tool (https://www.rayyan.ai/). We uploaded the reference list of the articles identified by the electronic bibliographic search into Rayyan and conducted the preliminary screening process. The screening process was performed double-blind by two authors with separate access to the same shared database. Each author decided whether or not to include each record by reading the title and/or abstract according to eligibility criteria. The platform allowed them to keep track of the selection process via dedicated EXCLUDE/INCLUDE buttons and to add notes. A subset of 1298 leftover studies was collected after duplicate removal. All titles/abstracts were screened for relevance, and 48 articles were selected for the full-text screening. Full texts of selected works were accessed on electronic digital libraries. CM, FS, LG, and FR later assessed the remaining articles for eligibility. In case of doubts, discussion among CM, FR, and FS was planned to reach a consensus on the final decision.

We included all studies targeting individuals struggling with FND and empirically investigated therapeutic interventions beyond medications for PwFND. Systematic and literature reviews, conference abstracts, posters, and commentaries were excluded. No language restriction was applied.

A final set of 31 relevant papers was collected. Seven more studies were included by checking the reference section of previously collected studies and additional handsearch. The PRISMA flowchart is reported below (Fig. 1). Once the screening stage was completed and agreed upon, the final database was exported in Excel to proceed with data extraction.

Charting the data

CM and FR extracted data using a data extraction table that includes the following information: author(s), year and study location, the aim of the study, study design, sample size, age range (mean and standard deviation if available), recruitment strategies, intervention setting, professional who delivered the treatment, comorbidities, assessment instruments, and time points. Please see the data extraction table in the Supplementary Materials (Table S1).

Table 1 Search strategy

Domains	Key terms
Population and context	Functional neurological disorders OR neurological functional disorders OR functional neurologic* disorders
AND	
Concept	Social OR health literacy OR education OR psychotherapy* OR intervention* OR help OR psychosocial OR quality of life OR wellbeing

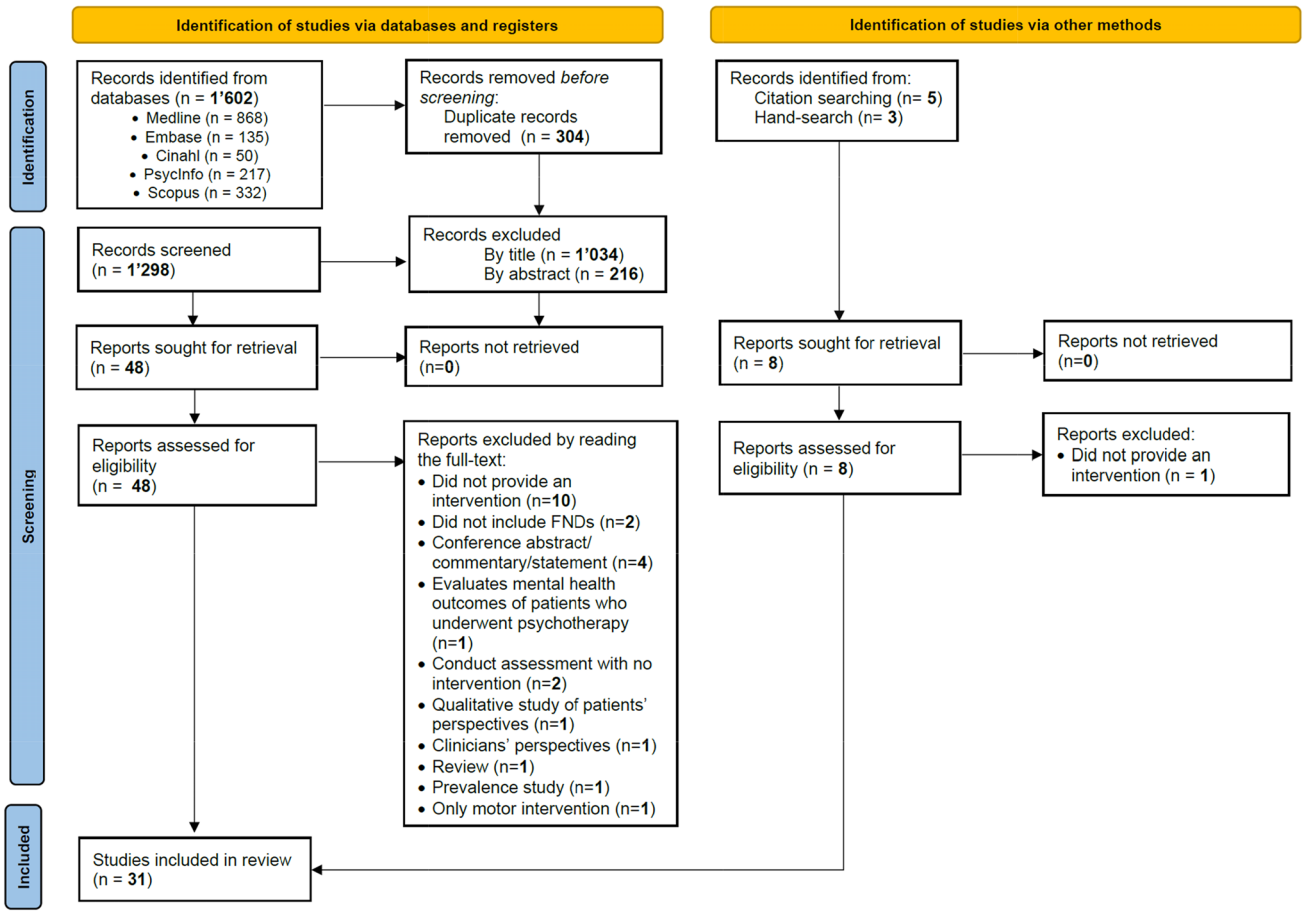

Fig. 1 PRISMA flowchart

Collating, summarizing, and reporting results

The review results are presented in three ways: firstly, we provided a tabulation and description of information for research. Secondly, we opted for a visual presentation of the included sources to improve their interpretability. Thirdly, we offered interpretative narratives from the reviewed studies. Given the nature of our research inquiry, we considered a scoping review as the most appropriate way for (i) mapping the existing practices targeting PwFNDs' needs and (ii) exploring potential common characteristics within intervention approaches. Furthermore, we have identified critical issues that warrant further discussion. These include the objectives of the intervention, healthcare providers participating in the treatment (with a focus on a monistic or pluralistic framework), and the selection of the outcome of interest with related assessment instruments.

Results

Characteristics of the included studies

The database search and subsequent screening yielded 29 studies published in English, 1 in French, and 1 in Danish.

The collected literature spans various countries globally, with 15 studies conducted in Europe (specifically, England [35–43]; Denmark [44]; Finland [45]; Netherlands [46]; France [47]; Germany [48]; Italy [49]), 12 in North America (including the United States [50–61]; 1 in South America (Argentina [62]), 1 in Asia (Israel [63]), and 2 in Oceania (Australia [64]; New Zealand [65]). A visual examination of the world map (Fig. 2) indicated that most literature originates from the US and UK.

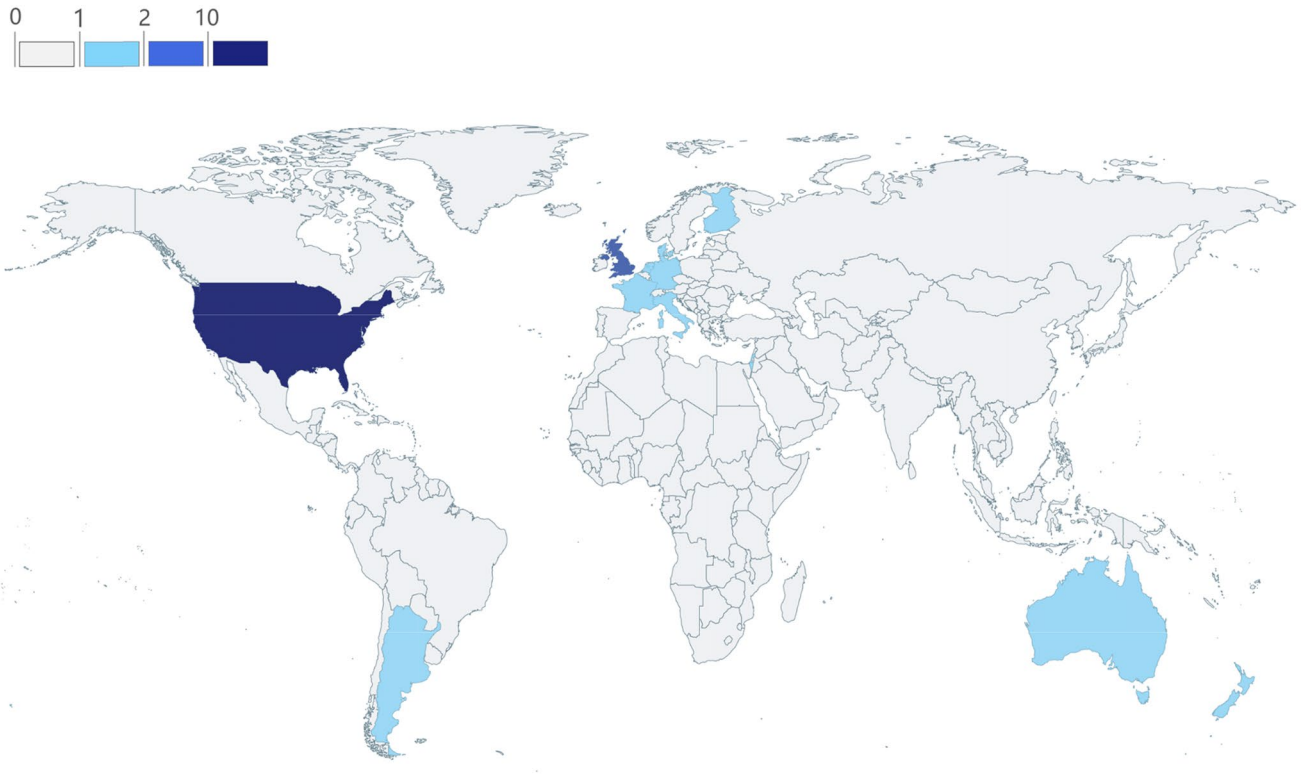

Fig. 2 Number of studies included by country

The study design exhibited heterogeneity across the selected papers. Twelve papers engage in open clinical trials, with 1 presenting follow-up results of a previously published search and 2 examining retrospective data. Eleven papers were case reports, one of which was detailed in a book chapter. Additionally, four papers adopted randomized controlled trial designs (including two multicenter trials, one non-blinded, and one retrospective). One paper employed a cross-sectional comparative approach; three reported case series (including one retrospective series), and one was a retrospective observational study. Ultimately, a routine rehabilitation protocol tailored for inpatients with FND was outlined.

"Functional neurological disorder": what is the clinical definition?

The collected literature needed to be more consistent in reporting the nomenclature of Functional Neurological Disorders (FNDs). Within FNDs, functional movement disorders and Psychogenic non-epileptic seizures also referred to as non-epileptic seizures, functional seizures, or dissociative seizures, were the most represented clinical subtypes.

Five [44, 50, 51, 56, 58] out of 31 works did not formally define FND, FMDs, or FS. Ten [36, 41, 42, 47, 48, 54, 59, 60, 62, 63] mentioned the DSM or ICD classifications. Most papers [35, 38–40, 43, 45, 46, 49, 52, 55, 57, 61, 64, 65] referred to a definition supplied by previous research or country-specific guidelines.

Interventions

The most common care practices included education, psychoeducation, and psychotherapy, eventually integrated with motor rehabilitation programs (Table 2). Occupational therapy, speech therapy, and social clinical assistance were mentioned as minor components of multidisciplinary approaches.

… by targeting population

1275 persons with a clinical diagnosis of Functional Neurological (symptoms) Disorder were included. Follow-up study samples [51] were excluded from the calculation. Demographics documented an average age range of 30–50 years with a prevalence of 73.3% females, which aligns with current epidemiological evidence [66]. The female-to-male ratio in case reports and case series was 2:1. Severe acute psychopathology at baseline (e.g., psychosis, current self-harm/suicidality) was an exclusion criterion in

Table 2 Characteristics of the interventions. Studies have been grouped by 'multimodal interventions', 'psychotherapies', and 'education and psychoeducation'

Clinical population	Source	Functional symptoms experienced	Intervention†	Timing	Setting	Time-points	Favorable outcome*
Multimodal interventions							
FMD	Jacob et al. [28]	Movement symptoms (gait abnormalities, hyperkinesis—e.g., tremor, chorea, myoclonus, dystonia—limb weakness) 56.3% comorbid speech disturbances	*Mayo Clinic's* FMD motor-reprogramming protocol	1-week, daily sessions	In-person	Baseline post 6-months f/u	Yes
	Arlien-Søborg et al. [44]	Leg tremor with muscle spasms	Physiotherapy and psychological intervention	≥ 3 weeks	In-person	Baseline post 3-months f/u	Yes
	Hsieh and Deshpande [38]	Functional fixed dystonia and leg weakness	CBT, physiotherapy, and physical exercise	3 days for 8-week	In-person	Baseline post 2-, 6-months f/u	Yes
	Hebert et al. [57]	Movement symptoms (tremor, gait disorder, limb weakness, myoclonus, dystonia, hemiparesis, freezing) 18% comorbid speech disorder	*Mayo Clinic's* FMD motor-reprogramming protocol	1-week, daily sessions	In-person	Baseline post	Partial
	Gandolfi et al. [49]	Movement symptoms (weakness, tremor, dystonia, myoclonus, gait disorder, facial/voice disorder, swallowing)	Motor rehabilitation with adjuvant home-based education and psychoeducation on illness-related anxiety and depression symptoms	5 days	In-person home-based	Baseline post 3-months f/u	Yes
FS	Heru [58]	Functional seizures	Individual and family therapy, medication, psychoeducational group therapy, and psychodynamic group therapy	6-month	In-person	Baseline post	Yes

Table 2 (continued)

Clinical population	Source	Functional symptoms experienced	Intervention†	Timing	Setting	Time-points	Favorable outcome*
Other *(e.g. grouped motor-non motor populations or phenotypes)*	Richardson et al. [65]	Weakness/reduced mobility Tremor Functional seizures Mixed motor-non motor	Routine psychoeducation, psychotherapy, physiotherapy, and occupational therapy	5 days 2–4hs a day	In-person	Baseline post 12-, 26-months f/u	Yes
	Petrochilos et al. [42]	50% movement symptoms 41% functional seizures 9% sensory or cognitive symptoms	*nx1* group education session, *nx9* individual CBT, *nx9* physiotherapy, *nx9* occupational therapy sessions, *nx3* neuropsychiatric consultations, *nx1* family session	5-weeks, twice a week	In-person	Baseline post 6-months f/u	Yes
	Maggio et al. [56]	84% movement symptoms (gait disorder, tremor, dystonia, limb weakness, mixed motor) 6% functional seizures	Physiotherapy, education, psychoeducation, occupational therapy, and CBT elements	once a week for 6–12 weeks	In-person	Baseline post	Yes
	Jimenez et al. [54]	40% functional seizures 10% functional movement disorder 50% unspecified	Interdisciplinary Cronic pain rehabilitation program (iCPRP) including detoxification from opioids and benzodiazepines, individual or group psychotherapy, education, biofeedback or relaxation, and physical or occupational therapy	3–4 weeks, daily sessions	In-person	Baseline post	Yes
Psychotherapy							

Table 2 (continued)

Clinical population	Source	Functional symptoms experienced	Intervention†	Timing	Setting	Time-points	Favorable outcome*
FMD	Graham et al. [37]	Movement symptoms (tremor, leg, weakness/paralysis, myoclonus, paresthesia)	Acceptance and Commitment Therapy	6 to 10 weekly sessions (1 h)	In-person	Baseline post	Yes
	Papadopoulos and Röhricht [41]	Movement symptoms (arm paralysis, gait impairment)	Body Oriented Psychological Therapy	50 weekly sessions	In-person	Baseline post	Yes
	Mack and La France Jr. [60]	Movement symptoms (abnormal jerking movements, gait disturbance)	CBT-informed psychotherapy (or NBT)	12 weekly sessions	In-person	Baseline post	Yes
FS	Myers and Zandberg [59]	Functional seizures	Prolonged Exposure	14 sessions delivered in 5 weeks	In-person	Baseline post	Yes
	Kamil et al. [55]	Functional seizures	CBT	Once a week for 10 weeks	In-person	N/A	Yes
	Ben-Naim et al. [63]	Functional seizures 41% comorbid epilepsy	Psychotherapy *Transtheoretical*	4 to 48 months	In-person	Baseline post 24-month f/u	Yes
	Tolchin et al. [61]	Functional seizures	Motivational Interview + MBT	Single MI session + 12 MBT weekly sessions	In-person	–	N/A
	Baslet et al. [50]	Functional seizures 6% history of epilepsy	MBT	12 weekly sessions	In-person	Baseline post	Yes
	Baslet et al. [51]	See Baslet et al. [37]	See Baslet et al. [37]	See Baslet et al. [37]	See Baslet et al. [37]	3-, 6-months f/u	Yes
	Goldstein et al. [36]	Functional seizures 24% history of epilepsy	CBT + TAU	Weekly CBT	In-person	Baseline mid 6-, 12-months f/u	Partial
	Jones et al. [39]	Functional seizures 28% comorbid epilepsy	Group CBT	6 sessions once a week + 1-month f/u	Online	Mid post	N/A
	Malda-Castillo et al. [40]	Functional seizures	Intensive Short-Term Dynamic Psychotherapy (ISTDP)	3 sessions	In-person	Baseline post 1-month f/u	Yes

Table 2 (continued)

Clinical population	Source	Functional symptoms experienced	Intervention†	Timing	Setting	Time-points	Favorable outcome*
Other *(e.g. grouped motor-non motor populations or phenotypes)*	Joos [48]	Unspecified	Group Psychotherapy (psychoeducation, CBT, and emotion regulation)	Once a week	In-person	-	N/A
	Gutkin et al. [64]	83% functional movement disorders 17% functional seizures 17% sensory symptoms 7% cognitive symptoms	Shared Individual Formulation Therapy (SIFT)	4 monthly sessions	In-person	Baseline post 6-, 12-months f/u	Yes
	Bullock et al. [52]	Motor symptoms Sensory symptoms	Virtual Reality – Mirror Visual Feedback + Virtual Reality – Prolonged Exposure (pilot study)	8 sessions once a week	In-person	Baseline once a week for 8 weeks	N/A
	Leandertz et al. [45]	Dissociative amnesia Functional seizures	Vibroacoustic Psychotherapy (pilot study)	7 sessions twice a week for 10 weeks + 1-month washout + 13 sessions + 1-month washout	In-person	Baseline post	Yes
	Bottemanne et al. [47]	Movement symptoms (tetraparesis, tremor) Functional seizures	Psychotherapy with Biofeedback and repetitive Transcranial Magnetic Stimulation (rTMS)	N/A	In-person	Baseline mid post 24-months f/u	Yes
Education and psychoeducation							
FMD	Zarotti et al. [43]	Movement symptoms (limb weakness, gait disorder)	Psychoeducation + CFT inputs	12 weekly sessions	In-person	Baseline post	Yes
	Gelauff et al. [46]	Functional motor symptom (limb weakness or other movement disorder)	Self-help education website vs TAU	N/A	Online in-person	Baseline 3-, 6- months f/u	No
FS	Sarudiansky et al. [62]	Functional seizures 2% comorbid epilepsy	Psychoeducation	One session every 2 months (2 h each)	In-person	Baseline post 6-months f/u	Yes

Table 2 (continued)

Clinical population	Source	Functional symptoms experienced	Intervention†	Timing	Setting	Time-points	Favorable outcome*
Other (*e.g. grouped motor-non motor populations or phenotypes*)	Cope et al. [35]	Movement symptoms (muscle spasms, gait impairment, weakness) Fits or seizures Sensory symptoms (tingling or numbness) Memory complaints Other	Education	Single 1h45 session	In-person	Baseline post	Yes

Each intervention is broken down by FND subtype (FS, FMD, other)

N/A = missing information

CBT cognitive-behavioral therapy, *CFT* compassion focused therapy, *FNSD* functional neurological symptoms disorder, *FMD(s)* functional motor disorder(s), *MBT* mindfulness-based therapy, *FS* functional seizures, *TAU* treatment as usual

*Overall reported benefit. *Yes, No or Partial* statements are irrespective of the endpoint of interest (e.g., seizure frequency, psychosocial benefits, etc.)

†For randomized-controlled trials, only the intervention arm has been reported

all studies except one [40]. Neuropsychiatric comorbidities, i.e., depression, anxiety, Post-traumatic Stress Disorder, Complex Post-traumatic stress disorder, (early) trauma history, previous self-harm/suicide attempts, or behaviors, were common among PwFND. Significant medical comorbidities included headache, chronic pain, and cardiovascular disease. Only one study [63] included people with neurodevelopmental disorders (autism and intellectual disability).

FND conditions could include both motor and non-motor symptoms. Ten [28, 37, 38, 41, 43, 44, 46, 49, 57, 60] treated only PwFMD, [11, 37, 40, 41, 51, 59, 60, 63, 64, 67] PwFS, and 10 [35, 42, 45, 47, 48, 52, 54, 56, 64, 65] targeted multiple clinical subtypes.

… by professionals delivering the treatment

The professionals responsible for delivering the intervention were diverse. A multi-professional team managed most of the interventions (Fig. 3), except for eight studies that reported stand-alone psychological interventions [38, 40, 43, 45, 48, 59, 62, 64].

Our data suggest that a dual liaison between neurologists and psychiatrists/neuropsychiatrists [36, 55, 63] is the pivotal component of most routine care protocols tailored to people experiencing functional seizures. Psychologists, nurses, and social workers' participation in care pathways were infrequent. On the other hand, physiotherapists often played a role in managing movement complaints in PwFND and supporting neurological consultations. At the same time, the role of psychiatrists, occupational therapists, speech therapists, social workers, and psychologists was unclear, spanning from primary (e.g., [37]) to minor (e.g., [49]). Studies that encompassed clinically heterogeneous populations ranged from multimodal interventions (e.g., [36, 54, 65]) to stand-alone mental health care typically provided by psychologists or psychotherapists (e.g., [48, 64]).

… by settings and intervention modalities

Intervention modality has been identified as twofold, both in-person and remote.

Most in-person interventions ($k = 28$) were delivered in healthcare facilities, i.e., hospitals, university clinics, and outpatient medical centers, while one took place in a conference room. Two were online self-help interventions (one of which also provided face-to-face usual care).

Aims of the interventions

Overall, the main objectives of the intervention included (i) education about FND, (ii) psychoeducational elements on cognitive and emotional issues related to the condition, and (iii) symptom improvement.

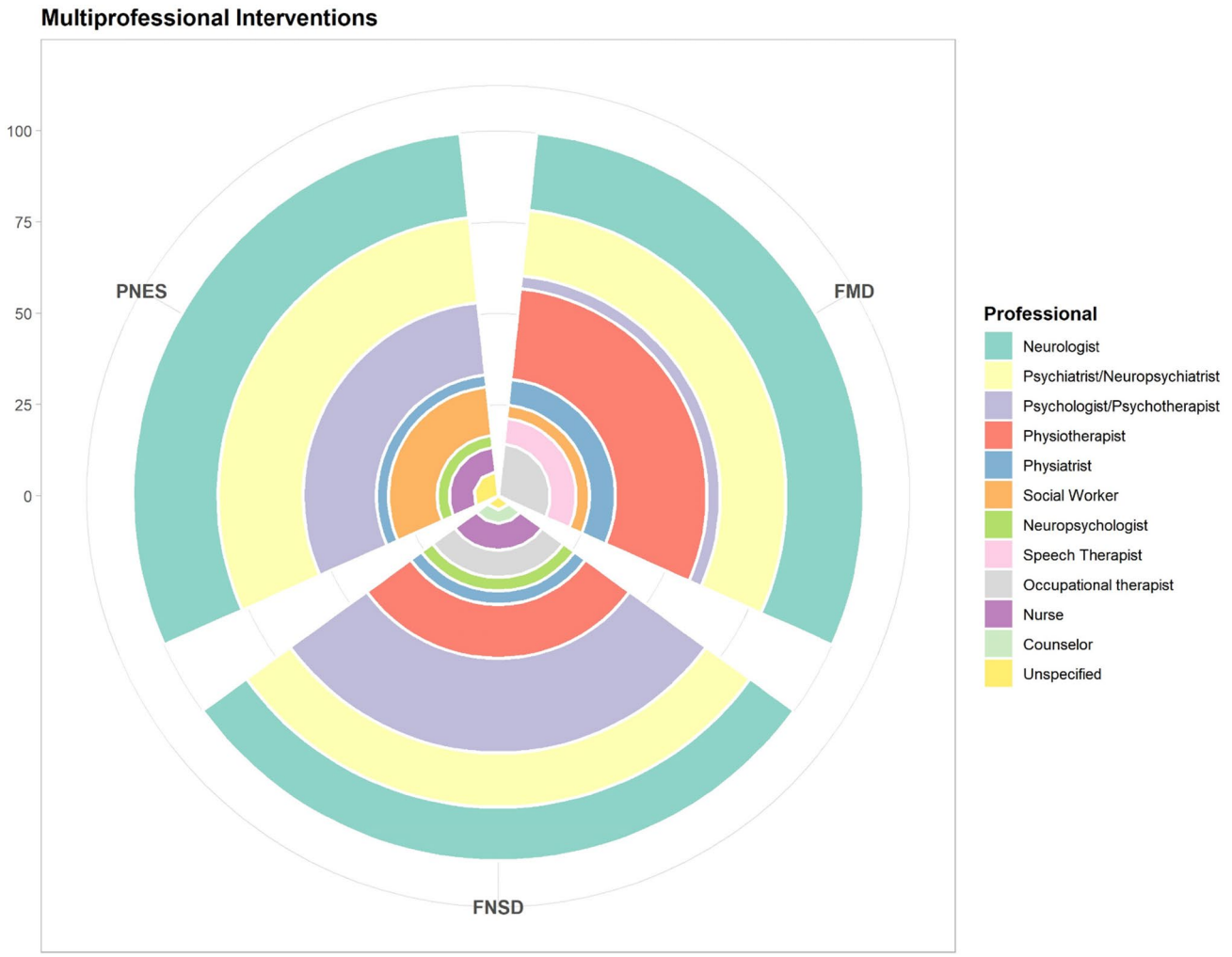

Fig. 3 Visual representation of the healthcare professionals engaged in multidisciplinary interventions, categorized by type of functional neurological condition. The thickness of each colored area corresponds to the frequency rate associated with the participation of each professional in the respective treatments

Education and psychoeducation

Education includes information about the condition, such as symptoms' characteristics, severity, and impact on managing daily activities. On the other hand, psychoeducation refers to the role of cognitive, behavioral, and emotional processes that can either facilitate or disadvantage adaptive coping strategies of newly diagnosed individuals. Both education and psychoeducation may ultimately influence the medical and psychological outcomes of persons with chronic diseases [67, 68] while improving family members' literacy about the illness and coping skills [69]. In our case, education was usually provided by the professional overseeing the communication of the diagnosis, whereas psychoeducation oversaw other healthcare professionals involved in the recovery program.

Gandolfi et al. [49] supplied people experiencing functional motor symptoms with a rehabilitation program that included in-person physiotherapy and a self-help website providing education about the illness and facilitating group-sharing experiences. Post-treatment assessments were conducted for both symptom severity and perceived mental health conditions. Gelauff et al. [46] evaluated the effectiveness of an internet-based self-help tool in a sample of people with functional movement symptoms compared to usual care. The website consultation provided general information on FND, motor symptoms, and related impacts on daily life functioning (work, family, and friends) while advising on available treatment options and home-based physical exercises. Psychoeducational approaches, incorporating medical and psychosocial input, were offered to PwFS by Sarudiansky et al. [62] and Ben-Naim et al. [63]. The former set up a

group-based multidisciplinary treatment protocol to promote understanding of the disease. At the same time, the latter proposed a tailored intervention to help persons cope with past and present stressors.

Psychotherapy

For ease of reading, psychoeducation and psychotherapy are discussed separately here. However, it is worth mentioning that elements of psychoeducation are steadily included in psychotherapy to build and sustain therapeutic alliances, especially in the early stages. In the clinical setting, we came across various therapeutic approaches. These included psychodynamic psychotherapy, Cognitive-Behavioral Therapy (CBT), 'third wave' CBT interventions, and transtheoretical therapeutic techniques.

Psychodynamic psychotherapy

The psychodynamic model posits that traumatic experiences may trigger somatization, conversion, or dissociative symptoms [70, 71]. This assumption led to the old terms "*Conversion Disorder*" and "*Hysteria*" [72], as the condition was historically attributed to women. According to this model, functional symptoms should be treated via trauma processing.

Heru et al. [58] evaluated a psychodynamic intervention to improve problem-solving and reduce family conflict in a sample of PwFS and their relatives. Malda-Castillo et al. [40] also implemented a shorter three-session protocol of intensive dynamic psychotherapy. Gutkin et al. [64] investigated 'Shared Individual Formulation Therapy' (SIFT), which integrates psychoeducation with psychodynamic principles to assess the feasibility and safety of a newly developed treatment for functional neurological symptoms.

Cognitive-behavioral therapy

Cognitive-behavioral therapy (CBT) suggests that dysfunctional core beliefs underlie automatic thoughts that affect both behavior and emotional experiences. CBT aims to alleviate symptoms by eliciting more adaptive thoughts, thereby fostering a sense of control over the symptoms [73]. Kamil [55] and Goldstein [36] provided 10–12 weekly individual face-to-face CBT sessions, while Jones et al. [39] opted for 6 weekly sessions of group-based online CBT, with a specific focus on treatment adherence. Petrochilos et al. [42] outlined a comprehensive multidisciplinary treatment approach, incorporating a single session of education, individual CBT, physiotherapy, occupational therapy, neuropsychiatric consultation, and one family therapy session. CBT plus physiotherapy and medication were also offered to PwFMD by Hebert et al. [57]. Bottemanne et al. [47] sought to strengthen awareness of motor symptoms and metacognitive skills by integrating CBT with biofeedback techniques. Myers and Zandberg [59] employed a specific CBT protocol called 'Prolonged Exposure' to achieve symptom remission by addressing trauma processing. Cope et al. [35] proposed a single education session illustrating the benefits of CBT for both PwFND and their family members.

'Third-wave' CBT approaches

The so-called 'third wave' cognitive-behavioral therapies [74] are said to target psychological flexibility through mindfulness, acceptance, and metacognitive practices [75]. Unlike standard CBT, these practices do not aim to modify the content of thoughts or negative beliefs but to act on processes. That is, how the individual relates to his thoughts without changing them. Within this framework, Baslet et al. [50, 51] implemented a mindfulness-based intervention (MBI) to facilitate emotion regulation strategies and illness acceptance. Effectiveness was assessed as changes in seizure frequency, intensity, and duration after the intervention [50] and over the long term [51]. Tolchin et al. [61] implemented MBI incorporating Motivational Interviews to enhance psychotherapy adherence as the primary endpoint. Acceptance principles guided Graham et al.'s [50] Acceptance and Commitment Therapy (ACT) intervention, which was offered to outpatients with functional symptoms by targeting specific facets of psychological flexibility (commitment, openness, awareness). Finally, Zarotti et al. [43] offered 12 sessions of Compassion Focused Therapy (CFT; [76]) to address functional motor symptoms by improving emotion regulation.

Transtheoretical approaches

The literature documented transtheoretical personalized treatment approaches not grounded on a specific theoretical model but merging elements from different methods.

As an example, Neurobehavioral Therapy (NBT) or CBT-informed psychotherapy (CBT-ip) represents one such personalized multimodal psychotherapy intervention that incorporates diverse theoretical models [60]. In the early stages of treatment, psychoeducation about the illness and goal setting is provided. Integration of elements drawn from different treatment approaches (e.g., Interpersonal Therapy, Dialectal Behavioral Therapy, Acceptance and Commitment Therapy, etc.) followed. The main goal was to offer an intervention tailored to the individuals' uniqueness. Similarly, Ben-Naim et al. [63] evaluated the benefits of an integrated, tailored treatment approach based on the personal and medical history of PwFS. Richardson et al. [65] assessed the effectiveness of the Nocebo Hypothesis Cognitive Behavioural Therapy (NH-CBT), which combines CBT principles with movement retraining using real-time

feedback on motor performance. The idea is that personal assumptions about the illness can induce a bodily 'nocebo response' [77]. A body-oriented psychological therapy was also evaluated by Papadopoulos and Röhricht [41] to address functional neurological symptoms and depression together. Finally, the impact of Vibroacoustic psychotherapy on symptom improvement was assessed by Leandertz et al. [45] using music exposure to facilitate mind–body connection and therapeutic interpersonal bonding.

Evaluation of effectiveness

Assessment measures

Different assessment measures were used according to the purpose of each intervention. After removal of assessment-free studies [44, 48, 55, 60, 61], 25 papers remained. The Beck Depression Inventory-II (BDI-II), the Clinical Global Impression Scale—Self-report version (CGI-SR), the Primary Health Questionnaire 15-items (PHQ-15), and a self-compiled seizure calendar were the most common assessment instruments (i.e., occurred in five or more papers). The PHQ-15 and the self-compiled seizure calendar were frequently used together, as were the BDI-II and the CGI-SR. For a detailed description of the assessment instruments categorized into clinician-rated and self-report instruments, please refer to the Supplementary Material (Table S2).

Outcomes

We found poor inter-study agreement in selecting endpoints, even within the same clinical population. High variability between studies in primary and secondary outcomes made comparisons of effectiveness unfeasible. Most studies included as primary endpoints either global health status, illness-related psychological processes (e.g., [58]), psychopathological comorbid conditions [59], or symptom improvement (e.g., [38, 64]). In post-treatment evaluations of both functional symptoms and (mental) health status (e.g., [37, 58]), reported benefits in coping with negative thoughts and emotions associated with the clinical condition did not necessarily match symptom improvement.

Multimodal interventions appear as the treatment of choice to target FMD, followed by psychotherapy and [psycho]education. Stand-alone psychotherapy is in the first line as the treatment of choice to address FS. In the end, when dealing with grouped phenotypes or constellations of symptoms, the range of documented treatments often overlaps with those provided for "pure" FMD cases. This finding is consistent with that most mixed phenotypes mainly exhibited motor manifestations.

Treatment format

Interventions were delivered over a wide range of time frames, from 5 days [59, 65] to 48 months [63]. The timing of sessions was mainly once a week [36, 37, 39, 41, 43, 48, 52, 55, 56, 60, 61] or 2–3 times a week [38, 42, 45, 59] or daily [28, 57, 59, 65]. It is worth noting that frequency plays a role in assessing effectiveness and subsequent intervention design. However, we observed that both time frame and frequency were very heterogeneous and often tailored to individual cases, even within the same study group (e.g., [56, 63]).

Follow-up

A large proportion of the studies included ($k = 16$) did not conduct any long-term follow-up evaluations after the intervention was completed. Fourteen [28, 36, 38, 40, 42, 44, 46, 47, 49, 51, 62–65] conducted at least 1 follow-up assessment (T1), of which 6 [36, 38, 46, 51, 64, 65] also conducted a second evaluation later point (T2). The median follow-up assessment period at T1 was 6 months. Further details can be found in Table 3.

Table 3 Two-way table reporting time points at first and second follow-up (months)

	1st follow-up						Total
	1 month	2 months	3 months	6 months	12 months	24 months	
2nd follow-up							
Absent	1	–	2	3	–	2	8
1 month	–	–	–	–	–	–	0
2 months	–	–	–	–	–	–	0
3 months	–	–	–	–	–	–	0
6 months	–	1	2	–	–	–	3
12 months	–	–	–	2	–	–	2
26 months	–	–	–	–	1	–	1
Total	1	1	4	5	1	2	**14**

The number of studies proving long-term evaluations is reported

Discussion

Monistic and pluralistic approach: which is the ultimate option of care?

The diagnosis and management of functional neurological symptoms can be challenging due to poor etiological understanding and precipitating and amplifying mechanisms of symptoms [4]. Different care pathways addressing motor or non-motor manifestations have been documented [8, 19, 78]. PwFND complaining of motor problems are more likely to be referred to physical therapy first, while people experiencing functional seizures go to mental health services. Persons with functional motor disruptions usually receive multimodal treatment from the outset, including physiotherapy, psychological support, occupational therapy, and, where appropriate, speech therapy. Rehabilitation is crucial in addressing motor impairments affecting personal autonomy beyond physical limitation. A few years ago, a consensus recommendation on physiotherapy interventions beyond motor rehabilitation [79] promoted a biopsychosocial model of care that includes other stakeholders, such as occupational therapists and psychologists. Among psychosocial approaches, the effectiveness of psychotherapy in the recovery of functional motor symptoms is controversial [80]. Some authors [81] documented that PwFMD referred to a psychologist or psychiatrist for psychotherapy did not reach a more favorable outcome than those not referred. Somatization severity predicted the overall clinical outcome more than access to psychotherapy.

Conversely, the idea that functional seizures likely correlate with psychological stressors, such as past traumatic experiences [82] and current maladaptive emotion regulation [83], suggests why psychotherapy is the next option of care after the communication of the diagnosis. In fact, in the case of FS, psychotherapy has proven more beneficial than medications. Still, systematic randomized trial synthesis [84] advises poor evidence to support the use of any intervention in the treatment of non-epileptic seizures. Indeed, no medications are approved by international regulatory authorities, specifically as a treatment.

In terms of mental health, cognitive and affective domains should be examined to help identify the risk of suicidal behaviors as well. Case–control studies [85] have documented a significantly higher risk of suicide in people suffering from functional seizures compared to epilepsy patients and healthy controls (60% vs 19% vs 11%). Comorbid psychiatric conditions may partially explain such findings. Retrospective cohort studies [86] documented higher suicidal ideation or self-harm behaviors in patients with prevalent functional motor symptoms and comorbid depression and trauma-related conditions. In addition, up to 20% of deaths within PwFND happened due to suicide [87, 88]. These findings suggest a strong interplay between psychiatric complaints and functional neurological disorders and prompt us to identify professionals who oversee such complex populations and facilitate access to appropriate care solutions. Mental health professionals such as psychiatrists and psychotherapists oversee conducting suicide risk assessment, which often requires information gathered through both clinical interviews and standardized rating scales. While these professionals bring invaluable expertise on the topic, the complexity of comorbid mental health issues demands a multidisciplinary approach. Specialization proves advantageous in clinical practice. It allows professionals to stay abreast of the latest field research and developments while navigating clinical complexity. Indeed, in the modern landscape of biomedical epistemological approaches [89] outsourcing care to single disciplines may not be effective in providing successful care due to the high complexity of biological systems. The complexity of biological systems, including humans, requires a collaborative effort from various specialties to foster a culture of interdisciplinary collaboration. By embracing a multidisciplinary approach, a pure modular care approach is not expected to be the ultimate solution for achieving a favorable clinical outcome but rather the genesis of a more integrated and personalized model of care.

How to evaluate clinical improvement?

The literature suggests high heterogeneity between assessment instruments, reflecting different perspectives in selecting treatment outcomes (e.g., reduction of functional seizures, psychological functioning, and motor symptoms). We found high variability among primary and secondary outcomes studies, making effective comparisons unfeasible. When evaluating the benefits of an intervention, different conclusions must be drawn on whether illness-related psychological experiences and/or functional symptom modification are addressed. If the primary endpoint is observing changes in seizures/motor/sensory-motor manifestation over time, we assume the treatment aims to modify the symptom(s). Conversely, primary psychological endpoints (e.g., emotion regulation, trauma processing) reflect the purpose of improving *how* the patient deals with those symptoms without necessarily modifying them. In this case, the effect of the intervention on symptoms could be an unforeseen and indirect outcome. The various assessment tools may reflect different epistemological positions [21]. Recent literature reviews [90, 91] supported by the FND-COM (Functional Neurological Disorders-Core Outcome Measure) group confirmed a broad spectrum of domains

being investigated in PwFND. Still, only a few validated FND-specific outcome measures [90]. A long-term assessment strategy integrating self-report and clinician-rated (or performance-based) instruments should be recommended to address core symptoms, comorbidities, and psychosocial domains [91].

Therefore, most of the studies reflected a high level of complexity, including six or more self-reported or clinician-rated instruments, while the statistical properties of the included instruments (e.g., validity, reliability) sometimes needed improvement.

Selecting valid and reliable clinical outcome measure(s) is essential to spot and quantify treatment effect(s) within the constellation of functional neurological features. Basic units of symptom severity (e.g., seizure frequency) are not considered exhaustive for evaluating improvement [91]. Additional clinical indices are required to provide information on the extent to which the person feels (i) able to cope with their condition, (ii) adequately informed about available care services, and (iii) supported by a favorable psychosocial environment.

For instance, non-pharmacological interventions for FS proved beneficial in clinical outcomes beyond seizure frequency [92]. Within the realm of psychological constructs, anxiety and depression symptoms evaluation was prioritized, employing several assessment solutions. People experiencing functional neurological symptoms often suffer from comorbid anxiety and depression, either because of misdiagnosis, struggling with the symptoms, or previous adverse life experiences [93]. Since people experiencing functional symptoms are the ultimate addressee of the intervention, their perspectives and personal experiences should inform the selection of outcome measures. Indeed, involving patients as active participants in their care can help improve treatment adherence.

Ethnographic paradigms of functional neurological symptoms

The etiology of functional neurological symptoms passed through various conceptualizations over time, including demonic possession and reproductive organ dysfunction, causing intrapsychic conflict (*hysteria*), thus leading to different, still quaint, therapeutic interventions [94]. Some authors [20] posit that socio-cultural backgrounds may shape physiological experience, i.e., how people describe, interpret, and experience bodily sensations. Interoceptive dysfunction has been described in PwFMD and PwFS [95], suggesting disruptions in physical experience, physiological state recognition, and self-modulation [96]. Indeed, culturally based explanations of mental health conditions may foster internalized stigma [97, 98], which calls for international collaboration between experts targeting discrimination issues [99]. Functional neurological persons themselves feel uncomfortable with the idea of having psychological complaints and may perceive potential discrimination related to them [94].

When conceptualizing FNDs, it is crucial to examine sociocultural domains to understand how these factors may influence symptom onset, impact outcomes, and ultimately inform treatment planning [100]. Indeed, healthcare professionals' unbiased communication approaches are essential in medical consultations. Physicians' communication strategies have recently been examined [21, 101], and some core skills, such as active listening, support, and validation, may help build a collaborative physician–patient relationship [101].

We found that most of the scientific evidence on current practices for PwFND originates from Western countries, such as England and the United States, where the literature on the topic is more prolific than in other parts of the globe. Otherwise, cross-cultural differences in care provision may stem from different ethnographic conceptualizations of the condition [94].

Limitations and future directions

The present review is subject to certain limitations. Firstly, conducting a thorough synthesis of current treatment options beyond conventional medical solutions proved challenging due to poor between-treatment similarities and the need for more convergence in assessment strategies, particularly in outcome measures. Secondly, our data predominantly reflect the Western cultural perspective regarding current best practices for managing functional neurological symptoms. Consequently, relevant evidence may have to be considered, potentially attributable to a monoculture viewpoint on the disease. Thirdly, minor components of multimodal interventions, such as clinical social workers and occupational therapists, needed to be more adequately described, stemming from a need for more comprehensive insight into these fields of intervention within the included works. Lastly, minor FND phenotypes were not included in the present review, resulting in an incomplete overview of the current therapeutic strategies.

As mentioned in the introduction section, the absence of a unified inter-professional terminology for describing functional neurological conditions might slow down the development of a comprehensive and solid body of scientific knowledge on the topic, therefore, enacting effective treatment pathways. This could lead to epidemiological biases regarding other phenotypes, which appear less documented in the literature at first glance and thus underestimate their impact on health services. Functional cognitive disorders are an example of how various terms have been employed to describe the same clinical condition [102].

Current knowledge of recovery perspectives of functional neurological symptoms remains scarce, and longitudinal results on treatment outcomes are outdated (e.g., [103–105]). Updating the evidence base is essential to support the ongoing monitoring of newly developed intervention strategies and assessing their long-term effectiveness. Optimal and appropriate timing for follow-up assessments is tricky to determine since it may depend on many factors such as (i) the target of the intervention (e.g., functional symptoms, emotion processing, cognitive-behavioral changes), (ii) session frequency (e.g., daily, weekly or monthly), (iii) outcome measures (clinician-rated or self-report instruments, or other relevant indicators/markers), (iv) and available resources.

Despite the recognized importance of incorporating the social environment, including family and community members, throughout the care pathway to endorse treatment adherence and prevent relapses, we did not identify any interventions specifically targeting PwFNDs' relatives. Challenges and conflicts related to the illness may emerge in nearly any chronic disease undergoing intricate diagnostic and therapeutic pathways. Consequently, it would be valuable to develop care services to assist family members in coping with the disease and averting caregiver burden.

Conclusion

In the context of FNDs, the complex etiopathophysiological nature of the condition suggests the recommendation of multidisciplinary treatments. Among healthcare professionals, neurologists and (neuro)psychiatrists are typically engaged in formulating and delivering diagnoses, while physiotherapists and/or psychologists often administer treatment. In multimodal approaches, individual intervention components tend to have a narrow focus, with only a subset of the involved professionals receiving attention. The prevalence of comorbid conditions, whether medical or psychopathological, varies among FND populations. This variation suggests that a stepped care model progressing from standard to higher level individualized modules better suits the individual complexities of PwFND. Disparities in intervention strategies, timing, duration, and outcome measurements, including follow-up assessments, may arise from the need to address a broad spectrum of symptoms.

Considering the potential for internalized stigma associated with the clinical condition, gatekeepers need to consider patients' beliefs, motivations, and socio-cultural context when communicating the diagnosis. This approach aims to establish appropriate and, ideally, satisfactory care pathways for individuals dealing with FNDs.

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