Neuropsychology Review (2019) 29:166–180
https://doi.org/10.1007/s11065-019-09409-4

REVIEW

(Neuro)Psychological Interventions for Non-Motor Symptoms in the Treatment of Patients with Parkinson's Disease: a Systematic Umbrella Review

Hanna Kampling[1] · Lisa K. Brendel[1] · Oskar Mittag[1]

Received: 28 March 2018 / Accepted: 29 April 2019 / Published online: 5 June 2019

Abstract

Conducted in a multidisciplinary and multimodal setting, the main objectives of neuropsychological treatment are to improve cognition, alleviate affective disorders, and to promote activities and participation. This article reviews the evidence on therapeutic or educative interventions based on psychological principles for patients with Parkinson's disease. The electronic bibliographic databases MEDLINE, PsycINFO, PSYNDEX, and CINAHL were systematically searched for meta-analyses on psychological interventions for patients with Parkinson's disease, published from January 2000 to June 2018. We extracted psychological interventions, non-motor outcomes, effect sizes, confidence intervals, and I^2 heterogeneity statistics. In addition, we rated the level of evidence on an intervention's effectiveness regarding a specific outcome. We identified 15 meta-analyses out of 1084 search results and identified a broad variety of psychological interventions for non-motor symptoms in patients with Parkinson's disease. In total, 48 outcome-intervention-pairs were extracted. Psychotherapy, mind and body interventions, and cognitive training are promising treatment approaches when addressing cognition, depression, and QoL in patients with Parkinson's disease. The available evidence on the effectiveness of psychological interventions in the treatment of symptoms in patients with Parkinson's disease is very heterogeneous. Still, our review reveals that some interventions are appropriate and effective for a variety of symptoms. Primary studies are not considered in this review, resulting in the omission of potentially relevant findings. Further high-quality research is needed to confirm the existing evidence and to explore the potential of psychological interventions for patients with Parkinson's disease.

Keywords Parkinson's disease · Neuropsychology · Non-motor outcomes · Psychological interventions · Alternative and complementary therapy · Systematic review · Umbrella review

Abbreviations

ADL	activities of daily living
CBT	cognitive-behavioral therapy
CI	confidence interval
MCIC	minimally clinically important changes
MD	mean difference
PD	Parkinson's disease
PDQ	Parkinson's Disease Questionnaire
pts.	points
QoL	quality of life
RCT	randomized controlled trials
SMD	standardized mean difference
UPDRS	Unified Parkinson's Disease Rating Scale

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s11065-019-09409-4) contains supplementary material, which is available to authorized users.

✉ Hanna Kampling
hanna.kampling@psycho.med.uni-giessen.de

[1] Section of Health Care Research and Rehabilitation Research, Faculty of Medicine, Medical Center – University of Freiburg, Hugstetter Str. 49, 79106 Freiburg, Germany

Introduction

Parkinson's disease (PD) is a progressive neurodegenerative disorder affecting a broad spectrum of motor and non-motor abilities. With an estimated prevalence of 1 to 2% in people older than 65 years (Pringsheim, Jette, Frolkis, & Steeves, 2014), PD is the second most frequent neurodegenerative disorder after Alzheimer's disease (Chen, 2010; de Lau & Breteler, 2006; Tanner & Goldman, 1996).

The therapy of PD includes ambulatory medication closely matched to expressed symptoms (Mochizuki, 2010), as well as a large variety of alternate interventions addressing motor and non-motor symptoms more holistically (Heisters, 2011). Integrative treatment of patients with PD consists of specialized drug therapy, physiotherapy, speech therapy, occupational therapy, as well as psychological and neuropsychological approaches. Due to this variety of therapies, high treatment efficacy is achievable (Müller et al., 2004; Trend, Kaye, Gage, Owen, & Wade, 2002; Wade et al., 2003). This is supported by recent research on psychological interventions for patients with PD. For example, randomized controlled trials (RCT) report the appropriateness of psychological interventions on non-motor symptoms directly affecting quality of life in patients with PD (Dobkin et al., 2011; Edwards et al., 2013). In particular, psychological interventions may help patients and their relatives to deal with dysfunctional emotions, cognitions, and behaviors, in learning new coping strategies for daily life, and in regaining impaired cognitive abilities. Despite the importance of psychological interventions, there are still no differentiated guidelines or practical recommendations summarizing psychological approaches in the treatment of patients with PD (see for example refs. (Deutsche Gesellschaft für Neurologie (DGN), 2016; National Institute for Health and Care Excellence (NICE), 2006; Scottish Intercollegiate Guidelines Network (SIGN), 2010)). At the same time, the growing awareness of the importance of conducting high quality research has resulted in an increasing number of RCTs addressing a great variety of research questions in patients with PD. Typically RCTs focus on specific research questions including only particular outcome-treatment-pairs while using various control designs and measurements. In addition, even RCTs addressing the same – or at least similar – research questions often report heterogeneous results. The different types of psychological interventions combined with these circumstances challenge clinicians and researchers alike to manage the vast number of studies, deal with the inconsistency of effects, and to identify high quality evidence. Systematic reviews with and without meta-analyses address this problem by summarizing the evidence, pooling the effects of certain research questions, and assessing the quality of studies. However, corresponding to the increasing number of RCTs, managing the number of systematic reviews has become challenging as well. In order to help clinicians make well founded and evidence based decisions, and to inform researchers on current research gaps or the absence of high quality studies, umbrella reviews offer an easily accessible overview of the current available literature. For that purpose all available evidence of review-level is gathered and assessed (Fragkos, 2016). An umbrella review is characterized by its ability to present the best available evidence from different systematic reviews on a specific field of research (Grant & Booth, 2009; Ioannidis, 2009). Instead of being limited to one outcome-treatment-pair, an umbrella review "can provide a broader picture of many treatments" (Aromataris et al., 2015, p. 133). Thereby, clinicians and researchers obtain a comprehensive picture of psychological interventions by consulting only one review.

This umbrella review provides an overview of high-quality evidence of psychological interventions applied in the therapy of non-motor symptoms of patients with PD. Psychological interventions are defined as all planned and systematically applied therapeutic or educational procedures based on psychological principles to prevent an impairment, to eliminate it, or to avoid the disease's negative consequences. Hence, they include certain forms of psychotherapy, as well as relaxation techniques, mind-body interventions, or cueing approaches.

By collecting and summarizing prior systematic reviews (both meta-analyses and narrative reviews) on specific psychological interventions, we reviewed the variety of interventions and evidence on the effectiveness of psychological interventions in treating patients with PD. Our review aims to help practitioners make well-founded decisions about the therapy of PD, and the researcher to identify areas of need for high quality research.

Methods

Eligibility Criteria

Our study population comprises patients with primary (idiopathic) PD; other types of PD such as secondary forms, or atypical syndromes were excluded. Included types of publications were systematic reviews with meta-analyses. We also included the effects for interventions based on single RCTs reported in a systematic review with meta-analyses. We included all psychologically founded interventions as defined above applied in the treatment or rehabilitation of patients with PD. Other interventions such as medication, neurosurgery, transcranial magnetic stimulation, or pure physical exercises were excluded. We also excluded descriptive overviews of symptomatology without treatment approaches. The publications assessed dated from January 2000 to June 2018, and were written in English or German.

Search Methods for Identification of Publications

The online databases PSYNDEX, PsycINFO and CINAHL (all accessed via EBSCO) and MEDLINE (accessed via Ovid) were systematically searched. Therefore, the search strategy included systematically designed sensitive filters for MeSH-terms and text words for the included population (patients with PD), the intervention (all interventions based on psychological principles as defined in the introduction), and the publication type (meta-analyses). The complete search strategy is provided as

supplements 1 and 2. The electronic search was complemented by hand-searching the references of all retrieved full texts to identify potentially relevant publications.

Selection of Publications

After having removed duplicates, three reviewers (HK, LKB, OM) independently assessed the search results to obtain more specific results. Irrelevant search results were removed by screening titles, and subsequently, abstracts and full texts. Any disagreement between the two researchers on the inclusion or exclusion of search results was resolved by discussion or by referral to an additional researcher. If necessary, additional information was to be requested from primary authors.

Data Extraction and Analysis

We extracted non-motor outcomes as well as corresponding psychological interventions dealing with these outcomes: problem-intervention pairs. To provide information on the relevance and benefit of these interventions for patients with PD, available data on mean differences (MDs), effect sizes (SMDs) and the 95% confidence interval (CI) were extracted. Interpretation of SMDs is defined as follows: .01 = very small, .2 = small, .5 = medium, .8 = large, 1.2 = very large, and 2.0 = huge (Sawilowsky, 2009).

To obtain additional information for MDs about the potential clinical relevance of the findings, we also extracted, if possible, information on the minimally clinically important change (MCIC). The MCIC offers information on the minimal necessary increase/decrease of a score of a specific instrument to be meaningful for patients. For example, even a statistically significant increase of two points might be clinically negligible if the scale ranges from one to 100. In addition, whenever possible, measuring units were adjusted to enable better comparison (e.g., cm into m).

The I^2 heterogeneity statistics are reported to allow for a quantification of inconsistency across studies and to assess the impact of heterogeneity. Following the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins & Green, 2011), we categorized heterogeneity into three groups: < 35% no considerable heterogeneity, 35% to 60% moderate heterogeneity, and > 60% substantial heterogeneity.

For each intervention the grade of evidence was rated following the classification used in the practice guidelines by the National Guideline Clearinghouse (Shekelle, Woolf, Eccles, & Grimshaw, 1999). Table 1 offers an overview of the respective grades of evidence as well as the number/type of study necessary to attain a particular grading (see Table 1). For example, for evidence to be graded 1a a meta-analysis had to be conducted, and for a 1b grading the evidence must be based on at least one RCT.

For easier interpretation of the results in the summary of findings tables (Table 5) we used a traffic-light-color-scheme with red indicating no statistically significant results/substantial heterogeneity, yellow indicating mixed results (also with regard to inconsistencies between statistical significance, or clinical (ir)relevant/moderate heterogeneity), and green indicating statistically (and clinically) significant results/no considerable heterogeneity.

Results

Literature Search and Inclusion of Publications

Our database search identified 1084 references. The PRISMA flow diagram (Moher, Liberati, Tetzlaff, Altman, & PRISMA Group, 2010) shown in Fig. 1 summarizes the search and selection process. Inter-rater-reliability after abstract-screening was high (14 differences; $\kappa = .75$). No additional information from primary authors was required. In total, 15 meta-analyses were eligible for inclusion. Table 2 offers an overview of the respective meta-analyses as well as the outcomes and interventions reported in this umbrella review. Information on excluded publications is listed in supplement 3.

Table 1 Levels of evidence

Grade of evidence	Description
Ia	evidence from meta-analysis of randomized controlled trials
Ib	evidence from at least one randomized controlled trial
IIa	evidence from at least one controlled study without randomization
IIb	evidence from at least one other type of quasi-experimental study
III	evidence from non-experimental descriptive studies, such as comparative studies, correlation studies, and case-control studies
IV	evidence from expert committee reports or opinions or clinical experience of respected authorities, or both

Grading of evidence used by the National Guideline Clearinghouse, Agency for Healthcare Research and Quality, U.S. Department of Health & Human Services. Adapted from (Shekelle et al., 1999)

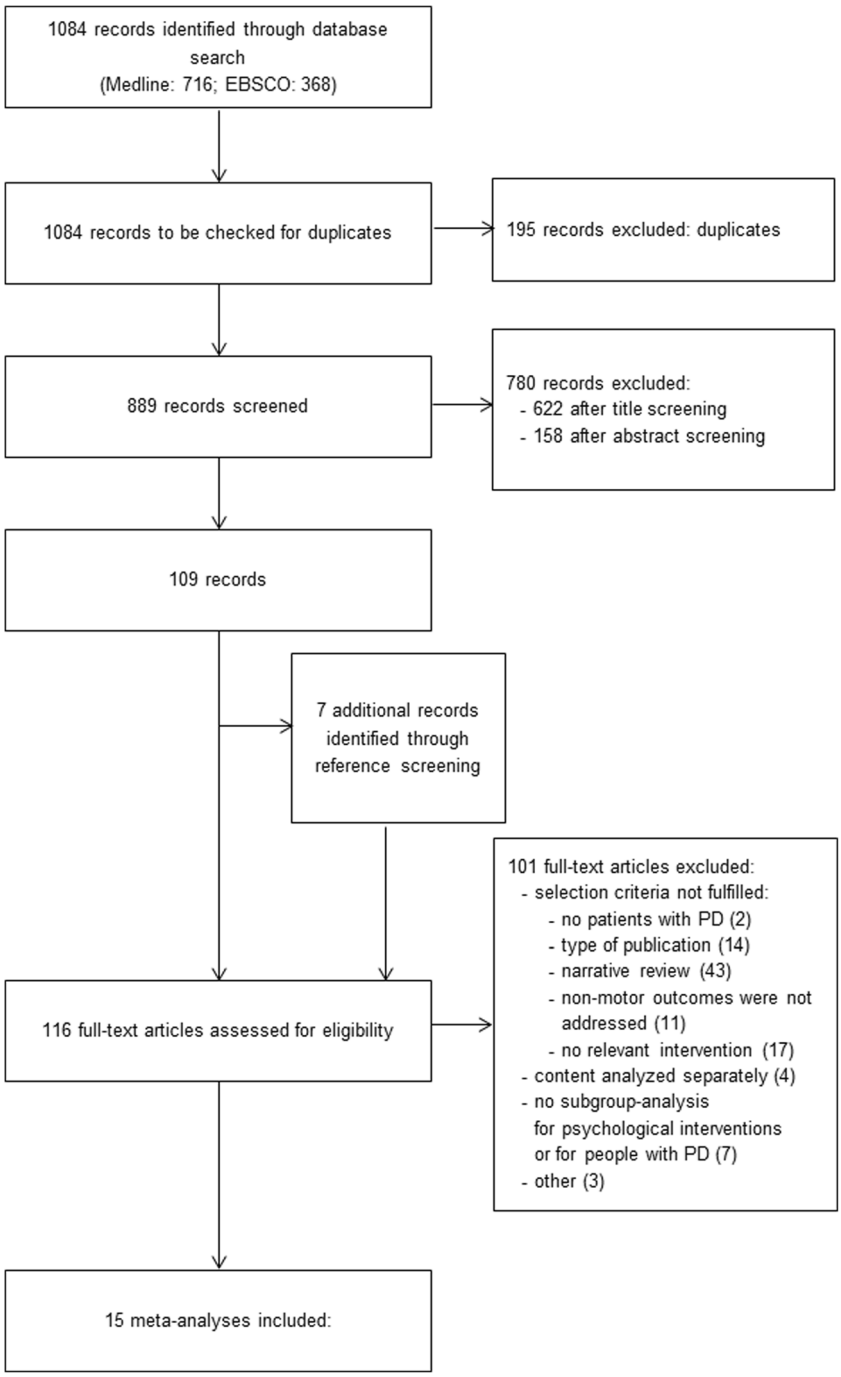

Fig. 1 PRISMA flow diagram of the database search. *Note.* Adapted from (Moher et al., 2010)

Summary of the Evidence on Psychological Interventions for Patients with PD

The observed outcomes and outcome measures are listed in Table 3. Table 4 provides an overview and short description of the included psychological interventions.

In total, we extracted 48 problem-intervention-pairs. The following paragraphs are sorted according to outcomes, naming each corresponding psychological intervention used to treat or address them in patients with PD. To provide information on the relevance and benefit for patients with PD, MDs or SMDs respectively, CI, MCIC (when available), and assigned grade of evidence are reported. Following Aromataris et al. (2015) on how to present data in umbrella reviews, we included Table 5 to present the summary of findings table on non-motor outcomes and corresponding interventions, numbers of included studies/participants as well as heterogeneity of studies the evidence is based upon, MDs or SMDs respectively, CI, the grading of the evidence, and finally the colored highlighting of the results and heterogeneity in a traffic-light-color-scheme.

Table 2 Overview of included meta-analyses and narrative reviews as well as corresponding outcomes/intervention

Reference	Type of reporting	Included outcome(s)	Included interventions
(Bomasang-Layno et al., 2015)	Narrative	Anxiety	Psychodrama
	Narrative	Depression	CBT – for depression
	Narrative	Depression	CBT – for impulse control disorders
	Narrative	Depression	CBT – telephone administered
	Narrative	Depression	Psychodrama
(Dockx et al., 2016)	Narrative	ADL	Virtual reality
	Narrative	Global cognition	Virtual reality
	Meta-analysis	QoL	Virtual reality
(Dos Santos Delabary et al., 2018)	Meta-analysis	QoL	Dance
(Franssen et al., 2014)	Narrative	Fatigue	CBT
(Kwok et al., 2016)	Narrative	Depression	Mind body interventions
(Lawrence, De Silva, & Henley, 2010)	Meta-analysis	Attention/working Memory	Cognitive training – standard and individualized
	Meta-analysis	Executive function	Cognitive training – standard and individualized
	Meta-analysis & Narrative	Global cognition	Cognitive training – standard and individualized
	Meta-analysis	Memory	Cognitive training – standard and individualized
	Meta-analysis & Narrative	Visuospatial skills	Cognitive training – standard and individualized
(Lee et al., 2017)	Meta-analysis	QoL	CBT
	Meta-analysis	QoL	Self-management program
(Leung et al., 2015)	Meta-analysis	Attention/working Memory	Cognitive training
	Meta-analysis	Depression	Cognitive training
	Meta-analysis	Executive function	Cognitive training
	Meta-analysis	Global cognition	Cognitive training
	Meta-analysis	Memory	Cognitive training
	Meta-analysis	Overall	Cognitive training
	Meta-analysis	Processing speed	Cognitive training
	Meta-analysis	Visuospatial skills	Cognitive training
(Lötzke et al., 2015)	Narrative	Depression	Dance
	narrative	Fatigue	Dance
(Ni et al., 2014)	Meta-analysis	QoL	Mind body interventions – plus medication
	narrative	QoL	Mind body interventions – without medication
(Sharp & Hewitt, 2014)	Meta-analysis	QoL	Dance
(Song et al., 2017)	Meta-analysis	Depression	Mind body interventions
	Meta-analysis	Global cognition	Mind body interventions
	Meta-analysis	QoL	Mind body interventions
(Tomlinson et al., 2013)	Narrative	ADL	Dance
	Narrative	QoL	Cueing
(Troeung et al., 2013)	Narrative	Anxiety	CBT
	Narrative	Depression	CBT
(Xie et al., 2015)	Meta-analysis	Global cognition Depression	Brief psychotherapy
	Meta-analysis	Depression	Brief CBT
	Meta-analysis	QoL	Brief psychodynamic Psychotherapy
	Meta-analysis		Brief psychotherapy

Activities of Daily Living (ADL)

Dance [Grade of Evidence: Ib]

One systematic review addressed ADL narratively (Tomlinson et al., 2013). Comparing tango to no exercise, there was no significant improvement of ADL measured by the Unified Parkinson's Disease Rating Scale (UPDRS-II) (MD: -2.50; 95% CI: -6.83 to 1.83).

Virtual Reality [Grade of Evidence: Ib]

One systematic review reported on the effects of virtual reality on ADL narratively and found mixed results (Dockx et al., 2016). While a comparison of virtual reality to active controls yielded no significant improvement (measured by the UPDRS II), a comparison to passive controls showed a beneficial effect (measured by the modified Barthel Index), (MD: -0.30; 95% CI: -1.91 to 1.31 and MD: 2.40; 95% CI: 0.29 to 4.51, respectively).

Anxiety

CBT [Grade of Evidence: Ib]

One meta-analysis reported evidence on the reduction of anxiety by a CBT intervention for depression. Compared to clinical monitoring, a significant and large effect was observed (SMD: 1.03; 95% CI: 0.57 to 1.50), (Troeung, Egan, & Gasson, 2013).

Psychodrama [Grade of Evidence: Ib]

One systematic review reported narratively on the significant improvement of anxiety by psychodrama compared to no intervention measured by the State Trait Anxiety Inventory (Bomasang-Layno, Fadlon, Murray, & Himelhoch, 2015).

Table 3 Observed non-motor outcomes and outcome measures

Outcome	Outcome measures
Activities of daily living (ADL)	Barthel Index (modified)
	UPDRS-II
Anxiety	Beck Anxiety Inventory (BAI)
	Hamilton Anxiety Rating Scale (HAMA)
Cognitive symptoms – domain specific	Various tests of domain specific cognitive functions:
Attention/working memory	Computerized CT program (RehaCom)
	Group-based multidomain training (NEUROvitalis)
	Multidomain training combining paper-pencil with computerized exercises (SmartBrain Tool)
Executive function	Computerized CT program (RehaCom)
	Group-based multidomain training (NEUROvitalis)
	Multidomain training combining paper-pencil with computerized exercises (SmartBrain Tool)
	Structured paper-pencil tasks that target multiple domains (REHACOP)
Memory	Computerized CT program (RehaCom)
	Group-based multidomain training (NEUROvitalis)
	Multidomain training combining paper-pencil with computerized exercises (SmartBrain Tool)
	Structured paper-pencil tasks that target multiple domains (REHACOP)
Overall	Computerized CT program (RehaCom)
	Computerized CT (InSight)
	Group-based multidomain training (NEUROvitalis)
	Multidomain training combining paper-pencil with computerized exercises (SmartBrain Tool)
	Multidomain training with an integrative computerized CT program combining motor training with attention and working memory
	Structured paper-pencil tasks that target multiple domains (REHACOP)
Processing speed	Computerized CT program (RehaCom)
	Computerized CT (InSight)
	Multidomain training combining paper-pencil with computerized exercises (SmartBrain Tool)
	Structured paper-pencil tasks that target multiple domains (REHACOP)
Visuospatial skills	Computerized CT program (RehaCom)
	Group-based multidomain training (NEUROvitalis)
	Multidomain training combining paper-pencil with computerized exercises (SmartBrain Tool)
Cognitive symptoms – global cognition	Computerized CT program (RehaCom) multidomain training combining paper-pencil with computerized exercises (SmartBrain Tool)
	Group-based multidomain training (NEUROvitalis)
	Montreal Cognitive Assessment Scale (MOCA)
	Multidomain training with an integrative computerized CT program combining motor Training with attention and working memory
	UPDRS I and trail making tests
Depression	Beck Depression Inventory (BDI)
	Geriatric Depression Scale
	Hamilton Depression Rating Scale (HAMD) and HAMD-17
	Inventory of Depressive Symptomatology- Clinician (IDS-C)
	Montgomery–Åsberg Depression Rating Scale (MADRS)
	Patient Health Questionnaire 9 (PHQ-9)
	Self-rating Depression Scale (SDS)
	Zung Self-Rating Depression Scale
Fatigue	Fatigue Impact Scale
	Fatigue Severity Scale
	Multidimensional Fatigue Inventory
	Parkinson Fatigue Scale
	Profile of Mood Status (Fatigue subscale)
Quality of life (QoL)	PDQ-8
	PDQ-39

Adapted from refs. (Bomasang-Layno et al., 2015; Dockx et al., 2016; Dos Santos Delabary et al., 2018; Franssen et al., 2014; Kwok et al., 2016; Lawrence et al., 2017; Lee et al., 2017; Leung et al., 2015; Lötzke et al., 2015; Ni et al., 2014; Sharp & Hewitt, 2014; Song et al., 2017; Tomlinson et al., 2013; Troeung et al., 2013; Xie et al., 2015)

Cognitive Symptoms – Domains

Cognitive Training [Grade of Evidence: Ia]

Two meta-analyses examined the effects of cognitive training compared to active and passive controls on different cognitive domains (Lawrence, Gasson, Bucks, Troeung, & Loftus, 2017; Leung et al., 2015). While cognitive training yielded no effects for visuospatial skills, it statistically significantly improved attention/working memory (SMD: 0.23; 95% CI: 0.02 to 0.44), executive function (SMD: 0.42; 95% CI: 0.15 to 0.68), memory (SMD: 0.33; 95% CI: 0.06 to 0.59), overall symptoms (SMD: 0.23; 95% CI: 0.01 to 0.44), processing speed (SMD: 0.31; 95% CI: 0.01 to 0.61), and working memory (SMD: 0.74; 95% CI: 0.32 to 1.17). However, comparing standard cognitive training and individualized approaches, there was no statistically significant effect for individualized approaches for attention/working memory, executive functions, or memory.

Table 4 Observed psychological interventions

Intervention	Description
Brief psychotherapy	Brief cognitive-behavioral or psychodynamic psychotherapy where the therapist is more active and focuses on a particular problem, rather than difficulties affecting the whole personality
Cognitive training	Teaching strategies or guided practice on tasks that address different cognitive abilities
CBT	An approach of psychotherapy that is skill-based and that targets thoughts and behaviors contributing to an individual's distress and symptoms
Cueing	Technique to facilitate movement initiation and continuation through external temporal or spatial stimuli; studied extensively in PD, particularly with respect to gait
Dance	Dance is a sequence of movements that is choreographed and mostly performed to music. In the treatment of PD dance has attracted interest as it is a multi-dimensional activity involving auditory, visual and sensory stimulation, social interaction, emotional perception, interaction and expression, as well as memory and motor learning
Mind body interventions	Interventions combining body movements and cognitive processes that can address motor and non-motor symptoms in PD. Tai Chi and Qigong are of special interest in PD: • Tai Chi: Traditional Chinese martial art that includes exercises of deep breathing and relaxation with slow, gentle movements • Qigong: Predecessor of Tai Chi, through the practice of meditation and focused movement an internal movement of energy is tried to be reached • yoga: yoga is a traditional mindfulness-based exercise and is another form of exercise which combines multiple physical elements with relaxation and breathing
Psychodrama	Psychological approach which uses dramatic action to explore problems, concerns, desires and interactions of individuals and groups
Psychodynamic psychotherapy	Psychotherapy based on psychodynamic principles
Self-management programs	Interventions which aim at providing individuals with skills and information to manage their health condition more effectively
Virtual reality	Virtual reality offers opportunities to learn new motor strategies and to relearn motor abilities that were lost as a result of injury or disease by offering augmented feedback about performance, enabling individualized repetitive practice of motor function and stimulating both motor and cognitive processes simultaneously

Adapted from refs. (Armento et al., 2012; Bega, Gonzalez-Latapi, Zadikoff, & Simuni, 2014; Dockx et al., 2016; Hui, Chui, & Woo, 2009; Kattenstroth, Kolankowska, Kalisch, & Dinse, 2010; Leung et al., 2015; Li, Dong, Cheng, & Le, 2016; Nieuwboer et al., 2007; Pappa, Doty, Taff, Kniepmann, & Foster, 2017; Sproesser, Viana, Quagliato, & de Souza, 2010; Xie et al., 2015)

Cognitive Symptoms – Global Cognition

Brief Psychotherapy [Grade of Evidence: Ia]

Using the Montreal cognitive assessment scale, one meta-analysis reported evidence on the significant improvement of cognition outcomes by a brief psychotherapy intervention (CBT or psychodynamic psychotherapy) addressing depression (SMD: 0.52; 95% CI: 0.15 to 0.88), (Xie et al., 2015).

Cognitive Training [Grade of Evidence: Ia]

Comparing cognitive training to active and passive controls, two meta-analysis reported showed no statistically significant effect on global cognition, neither delivered as standard cognitive training, nor as individualized cognitive training (Lawrence et al., 2017; Leung et al., 2015).

Mind Body Interventions [Grade of Evidence: Ia]

One meta-analysis offered information on the effects of mind and body interventions on global cognition (Song et al., 2017). Measured by the UPDRS-I and Trail Making Tests, there was no statistically significant improvement of global cognition by interventions consisting of either Tai Chi or Qigong compared to controls.

Virtual Reality [Grade of Evidence: Ib]

One systematic review reported narratively on the effect of virtual reality on global cognition measured by the Montreal Cognitive Assessment (Dockx et al., 2016). Comparing virtual reality to an active control group resulted in a statistically significant improvement of global cognition (MD: 0.20; 95% CI: -1.42 to 1.82).

Depression

Brief Psychotherapy [Grade of Evidence: Ia]

One meta-analysis analyzed the effect of brief psychotherapy compared to mixed control conditions on depression measured by the Hamilton Depression Rating

Table 5 Summary of findings for non-motor outcomes

outcome	ontervention	number of studies/ participants	observed effect(s)	grade of evidence	source(s)	hetero-geneity
activities of daily living	dance	1/52 participants	no statistically significant improvement by tango (MD: -2.50; 95% CI: -6.83 to 1.83)	Ib	(Tomlinson et al., 2013)	N/A
	virtual reality	1/32 participants	no statistically significant improvement by virtual reality compared to active controls (MD: -0.30; 95% CI: -1.91 to 1.31)	Ib	(Dockx et al., 2016)	N/A
		1/20 participants	statistically significant improvement by virtual reality compared to passive controls (MD: 2.40; 95% CI: 0.29 to 4.51)			
anxiety	CBT	1/80 participants	statistically significant improvement by CBT for depression (SMD: 1.03; 95% CI: 0.57 to 1.50)	Ib	(Troeung et al., 2013)	N/A
	psychodrama	1/16 participants	statistically significant improvement by psychodrama	Ib	(Bomasang-Layno et al., 2015)	N/A
cognitive symptoms – domains						
attention/working memory	cognitive training	9/338 participants	statistically significant improvement by cognitive training (SMD: 0.23; 95% CI: 0.02 to 0.44)	Ia	(Lawrence et al., 2017; Leung et al., 2015)[a]	I^2=0%
	specifically:		specifically:			
	standard	6/247 participants	significant improvement by standard cognitive training (SMD: 0.29; 95% CI: 0.04 to 0.53)			I^2=0%
	individualized	3/93 participants	no significant improvement by individualized cognitive training (SMD: 0.08; 95% CI: -0.32 to 0.48)			I^2=0%
executive function	cognitive training	7/337 participants	statistically significant improvement by cognitive training (SMD: 0.42; 95% CI: 0.15 to 0.68)	Ia	(Lawrence et al., 2017; Leung et al., 2015)[a]	I^2=0%
	specifically:		specifically:			
	standard	4/146 participants	significant improvement by standard cognitive training (SMD: 0.51; 95% CI: 0.16 to 0.85)			I^2=0%
	individualized	3/91 participants	no significant improvement by individualized cognitive training (SMD: 0.30; 95% CI: -0.16 to 0.76)			I^2=15%
memory	cognitive training	5/202 participants	statistically significant improvement by cognitive training (SMD: 0.33; 95% CI: 0.06 to 0.59)	Ia	(Lawrence et al., 2017; Leung et al., 2015)[a]	I^2=0%
	specifically:		specifically:			
	standard	3/137 participants	significant improvement by standard cognitive training (SMD: 0.35; 95% CI: 0.03 to 0.66)			I^2=0%
	individualized	2/65 participants	no significant improvement by individualized cognitive training (SMD: 0.28; 95% CI: -0.20 to 0.76)			I^2=0%
overall	cognitive training	7/272 participants	statistically significant improvement by cognitive training (SMD: 0.23; 95% CI: 0.01 to 0.44)	Ia	(Leung et al., 2015)	I^2=0%
processing speed	cognitive training	4/158 participants	statistically significant improvement by cognitive training (SMD: 0.31; 95% CI: 0.01 to 0.61)	Ia	(Leung et al., 2015)	I^2=0%
visuospatial skills	cognitive training	3/108 participants	no statistically significant improvement by cognitive training (SMD: 0.25; 95% CI: -0.13 to 0.63)	Ia	(Lawrence et al., 2017; Leung et al., 2015)[a]	I^2=0%
	specifically:		specifically:			
	standard	2/93 participants	no significant improvement by standard cognitive training (SMD: 0.32; 95% CI: -0.12 to 0.76)	Ia		I^2=10%
	individualized	1/15 participants	no significant improvement by individualized cognitive training (SMD: -0.15; 95% CI: -1.10 to 0.81)	Ib		N/A
cognitive symptoms – global cognition	brief psychotherapy	2/ 120 participants	statistically significant improvement by brief psychotherapy (CBT/psychodynamic psychotherapy) for depression (SMD: 0.52; 95% CI: 0.15 to 0.88)	Ia	(Xie et al., 2015)	I^2=0%
	cognitive training	4/140 participants	no statistically significant improvement by cognitive training (SMD: 0.32; 95% CI: -0.01 to 0.64)	Ia	(Lawrence et al., 2017; Leung et al., 2015)[a]	I^2=0%
	specifically:		specifically:			
	standard	3/125 participants	no significant improvement by standard cognitive training (SMD: 0.32; 95% CI: -0.02 to 0.67)	Ia		I^2=0%
	individualized	1/15 participants	no significant improvement by individualized cognitive training (SMD: 0.28; 95% CI: -0.68 to 1.24)	Ib		N/A
	mind body interventions	2/43 participants	no statistically significant improvement by Tai Chi or Qigong (SMD: -0.23; 95% CI: -0.85 to 0.40)	Ia	(Song et al., 2017a)	I^2=0%
	Virtual Reality	1/32 participants	statistically significant improvement by virtual reality (MD: 0.20; 95% CI: -1.42 to 1.82)	Ib	(Dockx et al., 2016)	N/A
depression	brief psychotherapy			Ia	(Xie et al., 2015)	
	brief CBT	4/298 participants	statistically significant improvement by brief CBT (SMD: -0.90; 95% CI: -1.30 to -0.49)			I^2=64%
	brief psychodynamic psychotherapy	6/684 participants	statistically significant improvement by brief psychodynamic psychotherapy (SMD: -2.02; 95% CI: -2.99 to -1.06)			I^2=93%
	CBT		statistically significant results for the improvement of depression by CBT	Ib	(Bomasang-Layno et al.,	

Table 5 (continued)

		1/80 participants	statistically significant improvement by CBT for depression (SMD: 1.24; 95% CI: 0.76 to 1.72)		2015; Troeung et al., 2013)[b]	N/A
		1/45 participants	statistically significant improvement by nurse-led CBT for impulse control disorders (SMD: 1.22; 95% CI: 0.566 to 1.87)			N/A
		1/10 participants	statistically significant improvement by telephone administered CBT (SMD: 0.55; 95% CI: -0.72 to 1.81)			N/A
	cognitive training	5/201 participants	no statistically significant improvement by cognitive training (SMD: 0.20; 95% CI: -0.28 to 1.28)	Ia	(Leung et al., 2015)	I^2=86%
	dance	1/33 participants	no statistically significant improvement by Argentine tango	Ib	(Lötzke et al., 2015)	N/A
	mind body interventions	4/148 participants	statistically significant improvement by Tai Chi or Qigong (SMD: -0.46; 95% CI: -0.80 to -0.12)	Ia	(Song et al., 2017a)	I^2=0%
		2/69	mixed results by yoga: RCT 1: beneficial effects RCT 2: no effect	Ib	(Kwok et al., 2016)[c]	N/A
	psychodrama	1/16 participants	statistically significant improvement by psychodrama	Ib	(Bomasang-Layno et al., 2015)	N/A
fatigue	CBT	1/18 participants	no statistically significant improvement by CBT (ES: -0.08; 95% CI: -1.21 to 1.06)	Ib	Franssen et al., 2014	N/A
	dance	1/33 participants	statistically significant improvement by Argentine tango	Ib	(Lötzke et al., 2015)	N/A
quality of life	brief psychotherapy	3/180 participants	no statistically significant improvement by brief psychotherapy (CBT/psychodynamic psychotherapy) (SMD: -0.87; 95% CI: -2.55 to 0.80)	Ia	(Xie et al., 2015)	I^2=93%
	CBT	3/639 participants	no statistically significant improvement by CBT (MD: -1.27; 95% CI: -3.33 to 0.79)	Ia	(Lee et al., 2017)	I^2=0%
	cueing	1/153 participants	no statistically significant improvement by cueing (MD:-1.58; 95% CI: 5.45 to 2.29)	Ib	(Tomlinson et al., 2013)	N/A
	dance	2/68 participants	statistically significant but clinically irrelevant improvement by dance (Tango or Irish set Dancing) (MD: 4.00pts; 95% CI: −7.13 to −0.87)	Ia	(Sharp & Hewitt, 2014)[d]	I^2=0%
		2/57 participants	no statistically significant improvement by (Tango and Irish set Dancing) (MD: -2.03pts; 95% CI: −8.33 to 4.26)	Ia	(Dos Santos Delabary et al., 2018)[d]	I^2=0%
	mind body interventions	4/263 participants	statistically significant improvement by Tai Chi plus medication (SMD: -1.10; 95% CI: -1.81 to -0.39)	Ia	(Ni et al., 2014)[e]	I^2=82%
		1/17 participants	no statistically significant improvement by Tai Chi without medication (SMD: 0.09; 95% CI: -0.86 to 1.04)	Ib	(Ni et al., 2014)[e]	N/A
		6/386 participants	statistically significant improvement by Tai Chi or Qigong (SMD: -0.39; 95% CI: -0.61 to -0.17)	Ia	(Song et al., 2017a)[c]	I^2=0%
	self-management programs	5/344 participants	no statistically significant improvement by self-management programs (MD: -3.57pts.; 95% CI: -12.23 to 5.09)	Ia	(Lee et al., 2017)	I^2=95%
	virtual reality	4/106 participants	no statistically significant improvement by virtual reality compared to active controls (MD: 3.73pts; 95% CI: -2.16 to 9.61)	Ia	(Dockx et al., 2016)	I^2=46%
		1/20 participants	statistically significant improvement by virtual reality compared to passive controls (MD: 15.00; 95% CI: 4.51 to 25.49)	Ib		N/A

The traffic-light-color-scheme indicate statistically (and clinically) significant results/no considerable heterogeneity (= green), mixed results (also with regard to inconsistencies between statistical significance and clinical (ir)relevane)/moderate heterogeneity (= yellow), and no statistically significant results/substantial heterogeneity (= red)

[a] Note: The RCTs included in (Leung et al., 2015) are also included in (Lawrence et al., 2017). One exception was the study by (Zimmermann et al., 2014) which was excluded by (Lawrence et al., 2017). Lawrence and colleagues justified this by declaring to include only controlled comparisons in pooled effects

[b] Note: The two RCTs included in (Troeung et al., 2013) were also referred to by (Bomasang-Layno et al., 2015)

[c] Note: Narrative report on two RCTs yielding contradicting results

[d] Note: One RCT was included in both analyses

[e] Note: Three of the included RTCs are the same in both analyses, with (Ni et al., 2014) conducting separate analyses for Tai Chi with and without medication, and (Song et al., 2017) including Qigong as well as Tai Chi

Scale (Xie et al., 2015). While psychodynamic psychotherapy (SMD: -2.02; 95% CI: -2.99 to −1.06) was superior to CBT, CBT still significantly reduced depressive symptoms also according to the Hamilton Depression Rating Scale (SMD: -0.90; 95% CI: -1.30 to −0.49).

CBT [Grade of Evidence: Ib]

Two meta-analyses addressed the treatment of depression by CBT but results were reported narratively (Bomasang-Layno et al., 2015; Troeung et al., 2013):

CBT compared to clinical monitoring [Grade of Evidence: Ib]

Measured by the Hamilton Rating Scale for Depression a comparison of CBT and clinical monitoring favored CBT (SMD: 1.24; 95% CI: 0.76 to 1.72). Comparing the effects of different antidepressant treatments (e.g., medication, transcranial magnetic stimulation, and alternate methods) CBT showed the highest effect size.

CBT (nurse-led) for impulse control disorders compared to standard medical care [Grade of Evidence: Ib]

Comparing a nurse-led CBT intervention for impulse control disorders to standard medical care measured by the Beck Depression Inventory CBT improved depression significantly (SMD: 1.22; 95% CI: 0.566 to 1.87).

Telephone administered CBT compared to supportive treatment [Grade of Evidence: Ib]

Based on results of the Patient Health Questionnaire-9 a comparison of telephone administered CBT and supportive treatment yielded significant results in improving depression in favor of CBT (SMD: 0.55; 95% CI: -0.72 to 1.81).

Cognitive Training [Grade of Evidence: Ia]

One meta-analysis yielded no statistically significant effect of cognitive training compared to active and passive controls on depression (Leung et al., 2015).

Dance [Grade of Evidence: Ib]

One systematic review reported narratively on the effects of Argentine tango on depression (Lötzke, Ostermann, & Büssing, 2015). Measured by the Beck Depression Inventory, Argentine tango compared to self-directed exercise yielded no statistically significant improvement of depression scores.

Mind Body Interventions [Grade of Evidence: Ia-Ib]

Two systematic reviews offer information on the effects of mind and body interventions on depression (Kwok, Choi, & Chan, 2016; Song et al., 2017).

One meta-analysis examines the effects Tai Chi and Qigong on depression (Song et al., 2017). Comparing Tai Chi or Qigong to controls revealed a statistically significant improvement of depression measured by Geriatric Depression Scale and Montgomery-Asperg Depression Rating Scale (SMD: -0.46; 95% CI: -0.80 to −0.12). Further, one systematic review summarized the effects for yoga on depression narratively, and found mixed results (Kwok et al., 2016). While one of the two included RCTs yielded beneficial effects for yoga on depression (measured by the Geriatric Depression Scale), the second RCT reported insignificant findings (measured by the Montgomery-Asperg Depression Rating Scale).

Psychodrama [Grade of Evidence: Ib]

One systematic review reported narratively on the significant improvement of depression by psychodrama compared to no intervention measured by the Beck Depression Inventory (Bomasang-Layno et al., 2015).

Fatigue

CBT [Grade of Evidence: Ib]

One review reported narratively of the nonsignificant effect of CBT on the reduction of fatigue (Franssen, Winward, Collett, Wade, & Dawes, 2014).

Dance [Grade of Evidence: Ib]

One systematic review reported narratively on the effects of Argentine tango on fatigue (Lötzke et al., 2015). Comparing Argentine tango to self-directed exercise showed a statistically significant improvement of fatigue measured by the Krupp Fatigue severity scale.

Quality of Life (QoL)

All assessments on QoL were conducted using the Parkinson's Disease Questionnaire (PDQ). The MCIC of the PDQ-39 is 5pts (Sumec, Filip, Sheardova, & Bares, 2015).

Brief Psychotherapy [Grade of Evidence: Ia]

One meta-analysis found no evidence for a significant improvement of QoL by brief psychotherapy, neither for brief CBT, nor brief psychodynamic psychotherapy (SMD: -0.87; 95% CI: -2.55 to 0.80) (Xie et al., 2015).

CBT [Grade of Evidence: Ia]

One meta-analysis found no statistically significant effects of CBT compared to controls on QoL (MD: -1.27; 95% CI: -3.33 to 0.79) (Lee, Choi, & Yoo, 2017).

Cueing [Grade of Evidence: Ia]

One systematic review reported narratively on the effects of cueing on QoL, and found no significant improvement (Tomlinson et al., 2013).

Dance [Grade of Evidence: Ia]

Two meta-analyses reported mixed results on the effects of dance (both including studies on tango and Irish set Dancing) on QoL (Dos Santos Delabary, Komeroski, Monteiro, Costa, & Haas, 2018; Sharp & Hewitt, 2014). Comparing standard exercise/no intervention to dance resulted in a significant but clinically irrelevant (MCIC: 5pts) improvement in QoL (MD: 4.00pts; 95% CI: −7.13 to −0.87). Comparing self-directed exercise/physiotherapy exercises to dance yielded no statistically significant results (MD: −2.03pts; 95% CI: −8.33 to 4.26).

Mind Body Intervention [Grade of Evidence: Ia-Ib]

Two meta-analyses reported mixed results on the effects of Tai Chi or Qigong as well as Tai Chi alone or in combination with medication on QoL (Ni, Liu, Lu, Shi, & Guo, 2014; Song et al., 2017). While Tai Chi alone showed no significant improvement of QoL, a mixed sample of Tai Chi and Qigong as well as a sample of both Tai Chi and medication yielded beneficial and significant effects:

Mind Body Interventions [Grade of Evidence: Ia]

Compared to controls, Tai Chi or Qigong significantly improved QoL (SMD: -0.39; 95% CI: -0.61 to −0.17).

Tai Chi plus medication [Grade of Evidence: Ia]

Compared to other exercise plus medication or medication alone, Tai Chi plus medication significantly improved health-related QoL (SMD: -1.10; 95% CI: -1.81 to −0.39).

Tai Chi without medication [Grade of Evidence: Ib]

Compared to other exercise, Tai Chi without medication could not improve health-related QoL significantly (SMD: 0.09; 95% CI: -0.86 to 1.04).

Self-Management Programs [Grade of Evidence: Ia]

One meta-analysis reported no statistically significant effects of self-management programs compared to controls on QoL (MD: −3.57pts.; 95% CI: -12.23 to 5.09) (Lee et al., 2017).

Virtual Reality [Grade of Evidence: Ia-Ib]

Using the PDQ-39, one meta-analysis compared virtual reality to active and passive controls (Dockx et al., 2016). While meta-analytical data comparing virtual reality to active controls yielded no beneficial effects on QoL, a narrative report of one RCT comparing virtual reality to passive controls showed a significant and clinically relevant improvement (MD: 3.73pts; 95% CI: -2.16 to 9.61 and MD: 15.00; 95% CI: 4.51 to 25.49, respectively).

Discussion

The major aim of this umbrella review was the disclosure of high quality evidence in the treatment of non-motor symptoms in patients with PD. An extensive literature search was conducted to identify meta-analyses addressing the broad spectrum and efficacy associated with psychological interventions in treating non-motor symptoms of patients with PD. While we identified 69 (systematic) reviews, only 15 were meta-analyses addressing non-motor outcomes, and therefore were, included in this umbrella review.

We extracted seven major types of outcomes, and eight major types of interventions. Outcomes comprised ADL, anxiety, cognitive symptoms – domains (attention/working memory, executive function, memory, overall, processing speed, and visuospatial skills), cognitive symptoms – global cognition, depression, fatigue, and QoL. Interventions included cueing, cognitive training (individualizes and standard, specific and global), dance (e.g., tango), mind body interventions (Tai Chi, Qigong, yoga), psychodrama, psychotherapy (CBT, psychodynamic psychotherapy), self-management programs, and virtual reality. In total, $N = 48$ problem-intervention pairs were addressed.

As we intended to give an overview of only high-quality research, we only included meta-analyses (= grade of evidence Ia). However, no pooled effects were available for little less than half ($n = 19$) of the extracted problem-intervention pairs, and therefore, were assigned an Ib grading only. This implies the need for future research on various topics already showing promising results to improve non-motor symptoms. For example, one RCT reported a high effect size for the improvement of anxiety by CBT for depression (SMD: 1.03). This knowledge might inspire research to replicate this positive result in order to validate the effectiveness of CBT for depression in the treatment of anxiety in patients with PD.

We identified three major groups of interventions yielding beneficial effects and a grade of evidence of Ia: psychotherapy, mind and body interventions, and cognitive training. Following, we will give an overview of the extracted outcomes, and whenever possible, recommendations on how to treat or not to treat them:

ADL: No recommendations on improving ADL can yet be made. High quality evidence is not available, and results are, at best, contradicting.

Anxiety: While psychodrama and CBT appear promising in reducing anxiety, high quality research has to confirm the beneficial effects of both interventions.

Cognitive symptoms – domains & global cognition: Various forms of standard cognitive training (an overall cognitive training irrespective of possible individual needs) yielded small effects for the improvement of attention/working memory (SMD: 0.29), memory (SMD: 0.35), overall (SMD: 0.23), and processing speed (SMD: 0.31), as well as a medium effect for the improvement of executive function (SMD: 0.51). While standard cognitive training improved various cognitive domains, patients receiving individualized cognitive training were not significantly better than those in control groups (attention/working memory, executive function, or memory). A positive effect of cognitive training on visuospatial skills could not be found either. The administration of cognitive training should be considered carefully with regard to cognitive domains impaired. Standard training appears to be superior to individualized and tailored approaches. Especially for executive functions but also for attention/working, memory and processing speed standard cognitive training can be recommended. When addressing global cognition on the other hand, cognitive training achieved no advancement. This is surprising and rises the questions whether cognitive training might just be an ineffective means to improve global cognition, or rather, if applied instruments fail to measure global cognition adequately, and therefore, do not represent achieved improvements in global cognition due to cognitive training. Future research should consider these results and address the issues of appropriate measures. With a medium effect, brief psychotherapy should be considered when dealing with impaired global cognition.

Depression: With approximately 40%, the prevalence of depression in patients with PD is very high (DGN, 2016). Therefore, clinicians are often confronted with singular depressive symptoms or an actual depressive episode. When treating these symptoms, clinicians might consider psychotherapy, or mind and body interventions. Including great numbers of patients across several studies, a brief psychotherapeutic intervention showed significant improvements with a high effect size for CBT (SMD: 0.90), and even a huge effect size for psychodynamic psychotherapy (SMD: 2.02). Additionally, a small effect was found for Tai Chi/Qigong, and hence, might also be offered (SMD: 0.46). Cognitive training, however, cannot be recommended in the treatment of depression.

Fatigue: High quality evidence on addressing fatigue in patients with PD is yet not available. Dance might prove to be beneficial but further research is necessary to confirm this.

QoL: QoL is an outcome in the majority of reviews for patients with PD. Various primary studies include QoL measures in hope that interventions intended to improve non-motor, or even motor outcomes might also be beneficial for QoL. Still, enhanced QoL could not be achieved by the majority of interventions applied. Neither brief psychotherapy or full CBT, nor virtual reality or self-management programs resulted in improvements. Results on a dance intervention were contradictory and even the statistically significant effect was of no clinical relevance (MD: 4pts < MCIC: 5pts). Only mind and body interventions showed beneficial results. A large effect was observed by an intervention combining Tai Chi and medication (e.g., levodopa; SMD: 1.10). A mixed sample of interventions comprising either Tai Chi or Qigong resulted in an at least small effect of improving QoL (SMD: 0.39). Further attempts should be made to find specific solutions on how to address reduced QoL in patients with PD. Until then, Tai Chi and Qigong might be considered to enhance QoL.

Considering the structure of this umbrella review, we discussed thoroughly in what order the results should be presented. Should the results be ordered by outcome or intervention? An order by intervention will allow for an easy check up on a certain intervention and their benefits or weaknesses. A clinician of a certain profession might prefer this order as he or she can simply look at his or her own toolbox of available interventions and quickly check if they are feasible for patients with PD. This approach certainly has its benefits. However, we decided to order the results by outcome in hopes to promote interdisciplinary teamwork, and a patient centered treatment. Patients with PD have complex symptom profiles with various motor and non-motor symptoms as well as disturbances in participation. By ordering the results by outcome we intend to shift the perspective back to individual problems. The question should not be: Who should receive for instance CBT? But rather: The patient has comorbid depression, could he or she profit from CBT and what other founded options are available? Instead of declaring depression to be the concern of

psychotherapists only, other qualified health professionals could be included in the treatment (e.g., psychologists), and all people involved in the treatment of people with PD should know who to refer their clients to. As our results demonstrated, mind and body interventions could also be offered to a person with depression with the positive side effect to improve QoL as well (which could not be achieved by psychotherapy alone). Grouping the results by outcome also allows clinicians to consider other or complementary therapy options. For example, even in the absence of a psychiatric disorder, patients with global cognitive impairments could be advised to seek psychotherapy. However, a clinician unaware of this therapy option might not even consider looking up the benefits of psychotherapy for cognition if ordered by intervention, despite the beneficial effects of psychotherapy in the treatment of global cognition. Ordering the results by outcome allows clinicians to face patients with certain problems, to look up beneficial or unfit interventions for this problem, and to offer, within and outside his or her profession, the best available therapy options.

We aim to help practitioners make well-founded decisions on the therapy of patients with PD. This overview offers information on a variety of non-motor outcomes and corresponding psychological interventions and their effectiveness. Effects with a grade of evidence of Ia are still rare resulting in a variety of treatments not founded on high-quality evidence. Nevertheless, there is high-quality evidence regarding some psychological interventions' efficacy in treating patients with PD. Psychotherapy, mind and body interventions, and cognitive training are promising treatment approaches when addressing cognition, depression, and QoL in patients with PD. However, especially psychotherapy for depression and Tai Chi plus medication for QoL showed very heterogeneous evidence and should be approached with caution. Here, different types were often pooled resulting in considerable heterogeneity. On the contrary, for cognitive training heterogeneity was consistently low.

Our review is just an initial step in developing systematic recommendations for the use of psychological interventions in the PD therapy. We need (practice) guidelines that consider both the effects revealed in systematic reviews as well as clinical expertise.

Limitations

There are several limitations to consider when interpreting this review's results. Firstly, we limited our search strategy and the subsequent umbrella review to meta-analysis, published in either English or German. By design, this excludes potentially clinically relevant findings reported in primary RCTs or in other languages. Secondly, only a few high-quality research articles are addressed in our review due to a paucity of available literature. If possible, we included an interpretation of the findings' clinical relevance but that was often not possible due to the use of different measures.

Directions for Future Research

There is still a need for more high-quality evidence on the effectiveness of psychological interventions in the context of modern multidisciplinary treatment programs for patients with PD. More RCTs and subsequent meta-analyses are necessary, including RCTs with larger samples of homogeneous patient groups with PD, clearly defined treatments, and extended follow-up evaluations. Still, current research provides worthwhile information for the development of guidelines or practice recommendations on psychological interventions in the treatment of patients with PD.

We excluded several publications on psychological interventions for patients with neurological disorders that did not supply subgroup-analyses for patients with PD (e.g., ref. (Fernie, Kollmann, & Brown, 2015)). Still, these publications report on overlapping symptoms and the effects of psychological interventions in different neurological disorders. Further research should examine the efficacy of psychological interventions in patients with neurological disorders in general.

Author's Contribution HK and OM contributed significantly to the conception, organization and execution of the research project. All authors contributed significantly to the analysis and interpretation of data. HK and LKB drafted the article. OM significantly contributed to the writing. All authors revised it critically for important intellectual content, and approved the final version.

Funding This work was supported by the German Statutory Pension Insurance (Deutsche Rentenversicherung Bund) under Grant 0423/00–40–64-50-18. The founding source was not involved in data collection, analysis, or interpretation of the data, in writing the manuscript, or in the decision to submit this article for publication.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflicts of interest.

References

Armento, M. E. A., Stanley, M. A., Marsh, L., Kunik, M. E., York, M. K., Bush, A. L., & Calleo, J. S. (2012). Cognitive behavioral therapy for depression and anxiety in Parkinson's disease: A clinical review. *Journal of Parkinson's Disease, 2*(2), 135–151. https://doi.org/10.3233/JPD-2012-12080

Aromataris, E., Fernandez, R., Godfrey, C. M., Holly, C., Khalil, H., & Tungpunkom, P. (2015). Summarizing systematic reviews: Methodological development, conduct and reporting of an umbrella review approach. *International Journal of Evidence-Based Healthcare, 13*(3), 132–140. https://doi.org/10.1097/XEB.0000000000000055

Bega, D., Gonzalez-Latapi, P., Zadikoff, C., & Simuni, T. (2014). A review of the clinical evidence for complementary and alternative

therapies in Parkinson's disease. *Current Treatment Options in Neurology, 16*(10), 314. https://doi.org/10.1007/s11940-014-0314-5

Bomasang-Layno, E., Fadlon, I., Murray, A. N., & Himelhoch, S. (2015). Antidepressive treatments for Parkinson's disease: A systematic review and meta-analysis. *Parkinsonism & Related Disorders, 21*(8), 833–842; discussion 833. https://doi.org/10.1016/j.parkreldis.2015.04.018

Chen, J. J. (2010). Parkinson's disease: Health-related quality of life, economic cost, and implications of early treatment. *The American Journal of Managed Care, 16*(*Suppl Implications*), S87–S93.

de Lau, L. M. L., & Breteler, M. M. B. (2006). Epidemiology of Parkinson's disease. *The Lancet. Neurology, 5*(6), 525–535. https://doi.org/10.1016/S1474-4422(06)70471-9

Deutsche Gesellschaft für Neurologie (DGN). (2016). S3-Leitlinie Idiopathisches Parkinson-Syndrom. Retrieved from http://www.dgn.org/images/red_leitlinien/LL_2016/PDFs_Download/030010_LL_langfassung_ips_2016.pdf. Accessed Jan 2018

Dobkin, R. D., Menza, M., Allen, L. A., Gara, M. A., Mark, M. H., Tiu, J., … Friedman, J. (2011). Cognitive-behavioral therapy for depression in Parkinson's disease: A randomized, controlled trial. *The American Journal of Psychiatry, 168*(10), 1066–1074. https://doi.org/10.1176/appi.ajp.2011.10111669

Dockx, K., Bekkers, E. M., Van den Bergh, V., Ginis, P., Rochester, L., Hausdorff, J. M., … Nieuwboer, A. (2016). Virtual reality for rehabilitation in Parkinson's disease. *The Cochrane Database of Systematic Reviews, 12*(100909747), CD010760. https://doi.org/10.1002/14651858.CD010760.pub2

Dos Santos Delabary, M., Komeroski, I. G., Monteiro, E. P., Costa, R. R., & Haas, A. N. (2018). Effects of dance practice on functional mobility, motor symptoms and quality of life in people with Parkinson's disease: A systematic review with meta-analysis. *Aging Clinical and Experimental Research, 30*(7), 727–735. https://doi.org/10.1007/s40520-017-0836-2

Edwards, J. D., Hauser, R. A., O'Connor, M. L., Valdés, E. G., Zesiewicz, T. A., & Uc, E. Y. (2013). Randomized trial of cognitive speed of processing training in Parkinson disease. *Neurology, 81*(15), 1284–1290. https://doi.org/10.1212/WNL.0b013e3182a823ba

Fernie, B. A., Kollmann, J., & Brown, R. G. (2015). Cognitive behavioural interventions for depression in chronic neurological conditions: A systematic review. *Journal of Psychosomatic Research, 78*(5), 411–419. https://doi.org/10.1016/j.jpsychores.2015.02.012

Fragkos, K. C. (2016). Reflective practice in healthcare education: An umbrella review. *Education Sciences, 6*(3), 27. https://doi.org/10.3390/educsci6030027

Franssen, M., Winward, C., Collett, J., Wade, D., & Dawes, H. (2014). Interventions for fatigue in Parkinson's disease: A systematic review and meta-analysis. *Movement Disorders: Official Journal of the Movement Disorder Society, 29*(13), 1675–1678. https://doi.org/10.1002/mds.26030

Grant, M. J., & Booth, A. (2009). A typology of reviews: An analysis of 14 review types and associated methodologies. *Health Information and Libraries Journal, 26*(2), 91–108. https://doi.org/10.1111/j.1471-1842.2009.00848.x

Heisters, D. (2011). Parkinson's: Symptoms, treatments and research. *British Journal of Nursing (Mark Allen Publishing), 20*(9), 548–554. https://doi.org/10.12968/bjon.2011.20.9.548

Higgins, J., & Green, S. (2011). *Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011].* The Cochrane collaboration. Retrieved from www.cochrane-handbook.org. Accessed Jan 2018

Hui, E., Chui, B. T., & Woo, J. (2009). Effects of dance on physical and psychological well-being in older persons. *Archives of Gerontology and Geriatrics, 49*(1), e45–e50. https://doi.org/10.1016/j.archger.2008.08.006

Ioannidis, J. P. A. (2009). Integration of evidence from multiple meta-analyses: A primer on umbrella reviews, treatment networks and multiple treatments meta-analyses. *CMAJ: Canadian Medical Association Journal = Journal de l'Association Medicale Canadienne, 181*(8), 488–493. https://doi.org/10.1503/cmaj.081086

Kattenstroth, J.-C., Kolankowska, I., Kalisch, T., & Dinse, H. R. (2010). Superior sensory, motor, and cognitive performance in elderly individuals with multi-year dancing activities. *Frontiers in Aging Neuroscience, 2*. https://doi.org/10.3389/fnagi.2010.00031

Kwok, J. Y. Y., Choi, K. C., & Chan, H. Y. L. (2016). Effects of mind-body exercises on the physiological and psychosocial well-being of individuals with Parkinson's disease: A systematic review and meta-analysis. *Complementary Therapies in Medicine, 29*(9308777, c6k), 121–131. https://doi.org/10.1016/j.ctim.2016.09.016

Lawrence, B. J., Gasson, N., Bucks, R. S., Troeung, L., & Loftus, A. M. (2017). Cognitive training and noninvasive brain stimulation for cognition in Parkinson's disease: A meta-analysis. *Neurorehabilitation and Neural Repair, 31*(7), 597–608. https://doi.org/10.1177/1545968317712468

Lawrence, S., De Silva, M., & Henley, R. (2010). Sports and games for post-traumatic stress disorder (PTSD). *Cochrane Database of Systematic Reviews*. https://doi.org/10.1002/14651858.CD007171.pub2

Lee, J., Choi, M., & Yoo, Y. (2017). A meta-analysis of nonpharmacological interventions for people with Parkinson's disease. *Clinical Nursing Research, 26*(5), 608–631. https://doi.org/10.1177/1054773816655091

Leung, I. H. K., Walton, C. C., Hallock, H., Lewis, S. J. G., Valenzuela, M., & Lampit, A. (2015). Cognitive training in Parkinson disease: A systematic review and meta-analysis. *Neurology, 85*(21), 1843–1851. https://doi.org/10.1212/WNL.0000000000002145

Li, S., Dong, J., Cheng, C., & Le, W. (2016). Therapies for Parkinson's diseases: Alternatives to current pharmacological interventions. *Journal of Neural Transmission (Vienna, Austria: 1996), 123*(11), 1279–1299. https://doi.org/10.1007/s00702-016-1603-9

Lötzke, D., Ostermann, T., & Büssing, A. (2015). Argentine tango in Parkinson disease–a systematic review and meta-analysis. *BMC Neurology, 15*(226), 226. https://doi.org/10.1186/s12883-015-0484-0

Mochizuki, H. (2010). [Treatment and pathogenesis of Parkinson's disease). Treatment and pathogenesis of Parkinson's disease. *Rinsho Shinkeigaku = Clinical Neurology, 50*(9), 623–627.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & PRISMA Group. (2010). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *International Journal of Surgery (London, England), 8*(5), 336–341. https://doi.org/10.1016/j.ijsu.2010.02.007

Müller, T., Voss, B., Hellwig, K., Josef Stein, F., Schulte, T., & Przuntek, H. (2004). Treatment benefit and daily drug costs associated with treating Parkinson's disease in a Parkinson's disease clinic. *CNS Drugs, 18*(2), 105–111.

National Institute for Health and Care Excellence (NICE). (2006). Parkinson's disease in over 20s: Diagnosis and management. Retrieved from https://www.nice.org.uk/guidance/cg35/resources/parkinsons-disease-in-over-20s-diagnosis-and-management-975388237765 Accessed Jan 2018

Ni, X., Liu, S., Lu, F., Shi, X., & Guo, X. (2014). Efficacy and safety of tai chi for Parkinson's disease: A systematic review and meta-analysis of randomized controlled trials. *PLoS One, 9*(6), e99377. https://doi.org/10.1371/journal.pone.0099377

Nieuwboer, A., Kwakkel, G., Rochester, L., Jones, D., van Wegen, E., Willems, A. M., … Lim, I. (2007). Cueing training in the home improves gait-related mobility in Parkinson's disease: The RESCUE trial. *Journal of Neurology, Neurosurgery, and Psychiatry, 78*(2), 134–140. https://doi.org/10.1136/jnnp.200X.097923

Pappa, K., Doty, T., Taff, S. D., Kniepmann, K., & Foster, E. R. (2017). Self-management program participation and social support in

Parkinson's disease: Mixed methods evaluation. *Physical & Occupational Therapy in Geriatrics, 35*(2), 81–98. https://doi.org/10.1080/02703181.2017.1288673

Pringsheim, T., Jette, N., Frolkis, A., & Steeves, T. D. L. (2014). The prevalence of Parkinson's disease: A systematic review and meta-analysis. *Movement Disorders: Official Journal of the Movement Disorder Society, 29*(13), 1583–1590. https://doi.org/10.1002/mds.25945

Sawilowsky, S. (2009). New effect size rules of thumb. *Theoretical and Behavioral Foundations of Education Faculty Publications*. Retrieved from https://digitalcommons.wayne.edu/coe_tbf/4 Accessed Jan 2018

Scottish Intercollegiate Guidelines Network (SIGN). (2010). Diagnosis and pharmacological management of Parkinson's disease. Retrieved from http://www.sign.ac.uk/pdf/sign113.pdf. Accessed Jan 2018

Sharp, K., & Hewitt, J. (2014). Dance as an intervention for people with Parkinson's disease: A systematic review and meta-analysis. *Neuroscience and Biobehavioral Reviews, 47*, 445–456. https://doi.org/10.1016/j.neubiorev.2014.09.009

Shekelle, P. G., Woolf, S. H., Eccles, M., & Grimshaw, J. (1999). Developing clinical guidelines. *The Western Journal of Medicine, 170*(6), 348–351.

Song, R., Grabowska, W., Park, M., Osypiuk, K., Vergara-Diaz, G. P., Bonato, P., … Wayne, P. M. (2017). The impact of tai chi and Qigong mind-body exercises on motor and non-motor function and quality of life in Parkinson's disease: A systematic review and meta-analysis. *Parkinsonism & Related Disorders, 41*(9513583), 3–13. https://doi.org/10.1016/j.parkreldis.2017.05.019

Sproesser, E., Viana, M. A., Quagliato, E. M. A. B., & de Souza, E. A. P. (2010). The effect of psychotherapy in patients with PD: A controlled study. *Parkinsonism & Related Disorders, 16*(4), 298–300. https://doi.org/10.1016/j.parkreldis.2009.08.008

Sumec, R., Filip, P., Sheardova, K., & Bares, M. (2015). Psychological benefits of nonpharmacological methods aimed for improving balance in Parkinson's disease: A systematic review. *Behavioural Neurology, 2015*(8914585), 620674–620616. https://doi.org/10.1155/2015/620674

Tanner, C. M., & Goldman, S. M. (1996). Epidemiology of Parkinson's disease. *Neurologic Clinics, 14*(2), 317–335.

Tomlinson, C. L., Patel, S., Meek, C., Herd, C. P., Clarke, C. E., Stowe, R., … Ives, N. (2013). Physiotherapy versus placebo or no intervention in Parkinson's disease. *The Cochrane Database of Systematic Reviews*, (9), CD002817. https://doi.org/10.1002/14651858.CD002817.pub4

Trend, P., Kaye, J., Gage, H., Owen, C., & Wade, D. (2002). Short-term effectiveness of intensive multidisciplinary rehabilitation for people with Parkinson's disease and their carers. *Clinical Rehabilitation, 16*(7), 717–725. https://doi.org/10.1191/0269215502cr545oa

Troeung, L., Egan, S. J., & Gasson, N. (2013). A meta-analysis of randomised placebo-controlled treatment trials for depression and anxiety in Parkinson's disease. *PLoS One, 8*(11), e79510. https://doi.org/10.1371/journal.pone.0079510

Wade, D. T., Gage, H., Owen, C., Trend, P., Grossmith, C., & Kaye, J. (2003). Multidisciplinary rehabilitation for people with Parkinson's disease: A randomised controlled study. *Journal of Neurology, Neurosurgery, and Psychiatry, 74*(2), 158–162.

Xie, C.-L., Wang, X.-D., Chen, J., Lin, H.-Z., Chen, Y.-H., Pan, J.-L., & Wang, W.-W. (2015). A systematic review and meta-analysis of cognitive behavioral and psychodynamic therapy for depression in Parkinson's disease patients. *Neurological Sciences: Official Journal of the Italian Neurological Society and of the Italian Society of Clinical Neurophysiology, 36*(6), 833–843. https://doi.org/10.1007/s10072-015-2118-0

Zimmermann, R., Gschwandtner, U., Benz, N., Hatz, F., Schindler, C., Taub, E., & Fuhr, P. (2014). Cognitive training in Parkinson disease: Cognition-specific vs nonspecific computer training. *Neurology, 82*(14), 1219–1226. https://doi.org/10.1212/WNL.0000000000000287