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REVIEW ARTICLE

A systematic review of dreams and nightmares recall in patients with rapid eye movement sleep behaviour disorder

Elisabetta Fasiello[1] | Serena Scarpelli[1] | Maurizio Gorgoni[1,2] | Valentina Alfonsi[1] | Andrea Galbiati[3,4] | Luigi De Gennaro[1,2]

[1]Department of Psychology, Sapienza - University of Rome, Rome, Italy

[2]Body and Action Lab, IRCCS Fondazione Santa Lucia, Rome, Italy

[3]"Vita-Salute", San Raffaele University, Milan, Italy

[4]Department of Clinical Neuroscience, Neurology and Sleep Disorders Center, IRCCS San Raffaele Scientific Institute, Milan, Italy

Correspondence
Luigi De Gennaro, Department of Psychology, University of Rome 'Sapienza' Via dei Marsi, 78, 00185 Rome, Italy.
Email: luigi.degennaro@uniroma1.it

Summary

Rapid eye movement (REM) sleep behaviour disorder is a REM sleep parasomnia characterised by the loss of the physiological muscle atonia during REM sleep, resulting in dream enactment behaviours that may cause injuries to patients or their bed partners. The nocturnal motor episodes seem to respond to the dream contents, which are often vivid and violent. These behavioural and oneiric features make the REM sleep behaviour disorder a potential model to study dreams. This review aims to unify the literature about dream recall in REM sleep behaviour disorder as a privileged approach to study dreams, systematically reviewing studies that applied retrospective and prospective experimental designs to provide a comprehensive overview of qualitative and quantitative aspects of dream recall in this REM sleep parasomnia. The present work highlights that the study of dreaming in REM sleep behaviour disorder is useful to understand unique aspects of this pathology and to explore neurobiological, electrophysiological, and cognitive mechanisms of REM sleep and dreaming.

KEYWORDS
dream recall, dreaming, nightmares, REM sleep behaviour disorder, sleep

INTRODUCTION

Rapid eye movement (REM) sleep behaviour disorder (RBD) is a REM sleep parasomnia that may occur in two forms: (i) symptomatic (sRBD) when it is associated with other neurological diseases (i.e., α-synucleinopathies, narcolepsy) (Schenck & Mahowald, 2002) or secondary to the intake of antidepressants (Postuma, Gagnon, & Montplaisir, 2012); (ii) idiopathic or 'isolated' (iRBD) when it appears in the absence of other neurological or sleep disorders. In recent years, clinicians and researchers have observed that iRBD, in middle-aged and older adults, often foreruns the onset of α-synucleinopathies, especially Parkinson's disease (PD), dementia with Lewy bodies (DLB) and multiple system atrophy (MSA) (Galbiati, Verga, Giora, Zucconi, & Ferini-Strambi, 2019; Iranzo et al., 2013; Schenck, Boeve, & Mahowald, 2013).

The core feature of RBD, in both forms and essential for the diagnosis, is the loss of the physiological muscle atonia during REM sleep (Sateia, 2014), resulting in dream enactment behaviours that may cause injuries to patients or their bed partners (Schenck & Mahowald, 2002). These nocturnal behaviours, often accompanied by vocalisations, seem to correspond to the dream mentation and are consistent with dream contents (Postuma et al., 2012). Indeed, observations of RBD episodes showed behaviours in which patients attempted to escape or defend themselves or their bed partners against the attack of something or someone. Upon awakening, patients often recalled unpleasant, violent, action-filled dreams and nightmares, in which they were attacked by animals or unknown people, consistent with behaviours that were acted during the RBD episodes (Manni et al., 2011). These dream and behavioural features make this parasomnia a privileged access channel to the dream world. Actually, the main limitation of dream research is the impossibility of having direct access to oneiric content (Scarpelli, Gorgoni, D'Atri, Ferrara, & De Gennaro, 2019), mainly due to the temporal asynchrony

TABLE 1 Retrospective and prospective methods for the dream assessment

	Strengths	Weaknesses	Tools employed in the studies revised	Dream features extracted
Retrospective methods Retrospective procedures require an estimation of dreams recalled in the past, covering periods of different durations (i.e., weeks, months, years, or the entire life), and often using self-reported questionnaires. Responses required in these questionnaires may be binary, interval scales, ordinal or open-ended choice.	• Quick methods • Simple data collection • Large sample sizes • Minimal expenses	Underestimation of dream-recall frequency (memory biases)	Semi-structured interview and/or free recall (Fantini et al., 2005; Fernández-Arcos et al., 2016; Herlin et al., 2015; Lam et al., 2013; Lee et al., 2016; Uguccioni et al., 2013)	• Dreams- and nightmares-recall frequency • Dream content scored by the Hall and Van De Castle system to classify dreams according to their complexity and bizarreness
			Dream questionnaire (Godin et al., 2013; McCarter et al., 2014)	Dreams- and nightmares-recall frequency extracted by the 'Dream recall' subscale
			• RBDQ-HK (Lam et al., 2013; Li et al., 2010; Zhou et al., 2014; Zhou et al., 2015) • RBDQ-KR (Jun et al., 2019; Jun et al., 2020; Sunwoo et al., 2019; Sunwoo et al., 2020; You et al., 2017) • RBDQ-JP (Takeuchi et al., 2020) • RBDQ-3 M (Li et al., 2016) • RBDQ-Beijing (Chang et al., 2014)	• Dreams- and nightmares-recall frequency during the lifetime and the last year extracted by Items 1 and 2 • Dream features extracted by Factor 1 comprised of five questions that examine the dreams and nightmares frequency and the content (i.e., emotional, violent, aggressive, and frightening dreams) • Dream vividness extracted by Item 13 • Dream content extracted by Item 3, 4 and 5
			TDQ (Godin et al., 2015)	• Dreams- and nightmares-recall frequency • Dream content extracted by the 'Nightmare distress' and 'Belief in dream meaning' subscales
			RBDSQ (Haridi et al., 2017)	• Dreams- and nightmares-recall frequency extracted by item 8 • Dream vividness extracted by item 1 • Dream content extracted by item 2
Prospective methods Prospective procedures involve all methods that collect dreams immediately after awakening (spontaneous or provoked). Sleep logs are often used daily, completed by the subjects for different periods and may be in the form of a checklist or narrative-written log. When the dream collection is conducted in a sleep laboratory, prospective methods are often characterised by accurate questions asked by researchers or clinicians upon subject's awakening.	• Overcome the dream-recall bias and the underestimation of dream recall • Allow to conduct longitudinal studies to observe changes in oneiric activity over time	Require considerable time and resources	Daily logs (Cavallotti et al., 2022; D'Agostino et al., 2012)	• Presence of dreams with or without motor manifestation • Word count and length of dream report • Dream content scored by the Hall and Van De Castle system • Frequency of threats elements scored by TSS • Formal features of dream narratives assessed with the Dream Bizarreness scale
			Free recall (Oudiette et al., 2011; Uguccioni et al., 2013)	• Presence or absence of dream recall • Dreams- and nightmares-recall frequency • Presence of dreams with or without motor manifestation • Word count and length of dream report • Dream content scored by the Hall and Van De Castle system to classify dreams according to their complexity and bizarreness • Frequency of threats elements scored by TSS • Dream setting

Abbreviations: RBDQ-3M, modified RBD questionnaire; RBDQ-JP, RBD questionnaire–Japanese version; RBDQ-HK, RBD Questionnaire-Hong Kong version; RBDQ–KR, RBD Questionnaire–Korean version; RBDSQ, RBD Screening Questionnaire; TDQ, typical dreams questionnaire; TSS, threat simulation scale.

between the dream and mental activity during sleep and dream recall after awakening. Most studies in the dream field have as the object of study the oneiric memory through dream recall, which is an indirect cognitive outcome of the dream mentation experience (Cipolli, Ferrara, De Gennaro, & Plazzi, 2017). Importantly, observing RBD episodes in action in which individuals acted out their dreams, and assessing the dream contents through an immediate dream recall, allows researchers to study in vivo cognitive, emotional, and physiological mechanisms underlying oneiric processes.

Several studies in the iRBD population were conducted to assess dream mentation using standard methods. These approaches can be distinguished as retrospective and prospective, with different strengths and weaknesses reported and summarised in Table 1 (Robert & Zadra, 2008; Scarpelli, Gorgoni, et al., 2019; Schredl, 2002; Zadra & Robert, 2012).

The interest and the scientific relevance of studying dream activity in the RBD population has led to an increased number of scientific works on this topic in recent years. However, the framework is still fragmented. This paper aims to systematically review and analyse studies in the literature that investigated oneiric activity in patients with RBD. Studies with retrospective and prospective experimental designs were systematically reviewed to provide a comprehensive overview of qualitative and quantitative aspects of dream recall in this disorder.

METHODS

Search method

The systematic review was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Moher et al., 2009). One author systematically searched for literature up to November 2021 using the professional databases PubMed, PsyArticles, Scopus, and Web of Science.

Search terms in the abstract or title were: ((REM Sleep Behavior Disorder) OR (RBD) OR (dream enactment)) AND ((dreaming) OR (dream*) OR (dream recall) OR (dream report)) AND ((polysomnography) OR (video polysomnography) OR (EEG)).

The search was limited to studies written in English, primary studies (books, abstracts, comments, cases-reports, reviews, or meta-analyses were excluded), and human species, without age, gender, or ethnicity restrictions. After removing duplicates, the search returned 2,915 articles overall.

Studies selection

The articles screening was conducted through a two-step evaluation. The first assessment concerned how the title and the abstract were relevant to the review's aim. After the screening procedure, 2,865 papers were excluded, and 50 full-text articles were assessed for eligibility. Moreover, one recent article (Cavallotti, Stein, Savarese, Terzaghi, & D'Agostino, 2022), not found through the search, was retrospectively included. The qualitative inclusion criteria adopted to provide a more exhaustive evaluation of the selected articles were the presence of qualitative or quantitative dreams analyses in the studies and the attendance of the iRBD patient's sample. Studies that enrolled patients exclusively (without iRBD group as comparison-group) with RBD secondary to other pathology (i.e., PD) were excluded from the systematic review. Moreover, one study that performed only a descriptive dream assessment in RBD (Oudiette et al., 2009), and four studies that did not specify methods adopted for the evaluation of the dreams, were excluded from the systematic review (Bonakis, Howard, Ebrahim, Merritt, & Williams, 2009; Kunz & Bes, 1999; Olson, Boeve, & Silber, 2000; Pujol et al., 2017).

At the end of the eligibility stage, 24 articles published between 2005 and 2022 were included in this systematic review.

An outline of the selection procedure is illustrated via the PRISMA flowchart (Figure S1).

Qualitative assessment

The 24 studies that passed the eligibility step underwent a qualitative assessment using an adapted version of the Critical Appraisal Skills Programme (CASP) Checklist for Cohort Studies (CASP, 2018). This tool consists of 12 questions that ensure a qualitative evaluation of each study with a systematic method. We considered nine questions compatible with the aim of this review. The checklist assesses the potential risk of bias in the following aspects: clarity of the issue; selection of participants; measurement of bias; confounding factors taken into account in the design and/or analysis; completion and length of the follow-up (these questions have been applied exclusively at longitudinal studies) (Fernández-Arcos, Iranzo, Serradell, Gaig, & Santamaria, 2016; Jun et al., 2019; Li et al., 2016; Sunwoo et al., 2020); credibility of the results; fitting with other evidence; implication of the study for practice. For each item, the quality of the study was categorised as 'YES', 'NO', or 'Cannot TELL' (Figure S2).

Data collection

From each study, the following dimensions were extracted according to the PICOS approach (population, interventions, comparison, outcomes, and study design) (Liberati et al., 2009). Authors and publication year, the study design, and the sample features (i.e., sample size, gender and age, the RBD onset when available, the presence of comorbidity, and treatment in the RBD sample) are summarised in Table S1. Moreover, the methodological features extracted (i.e., the use of polysomnography [PSG], the immediate upon awakening dream reports practice, methods for dreams survey and the sleep, psychological, cognitive, and neurological assessment) are reported in Table S2.

Table 1 shows the studies' categorisation based on the methods applied for the dream assessment (i.e., retrospective and prospective) and on the specific tools (i.e., questionnaires, dream diaries, free recall) employed in the studies. This distinction will outline the results' description.

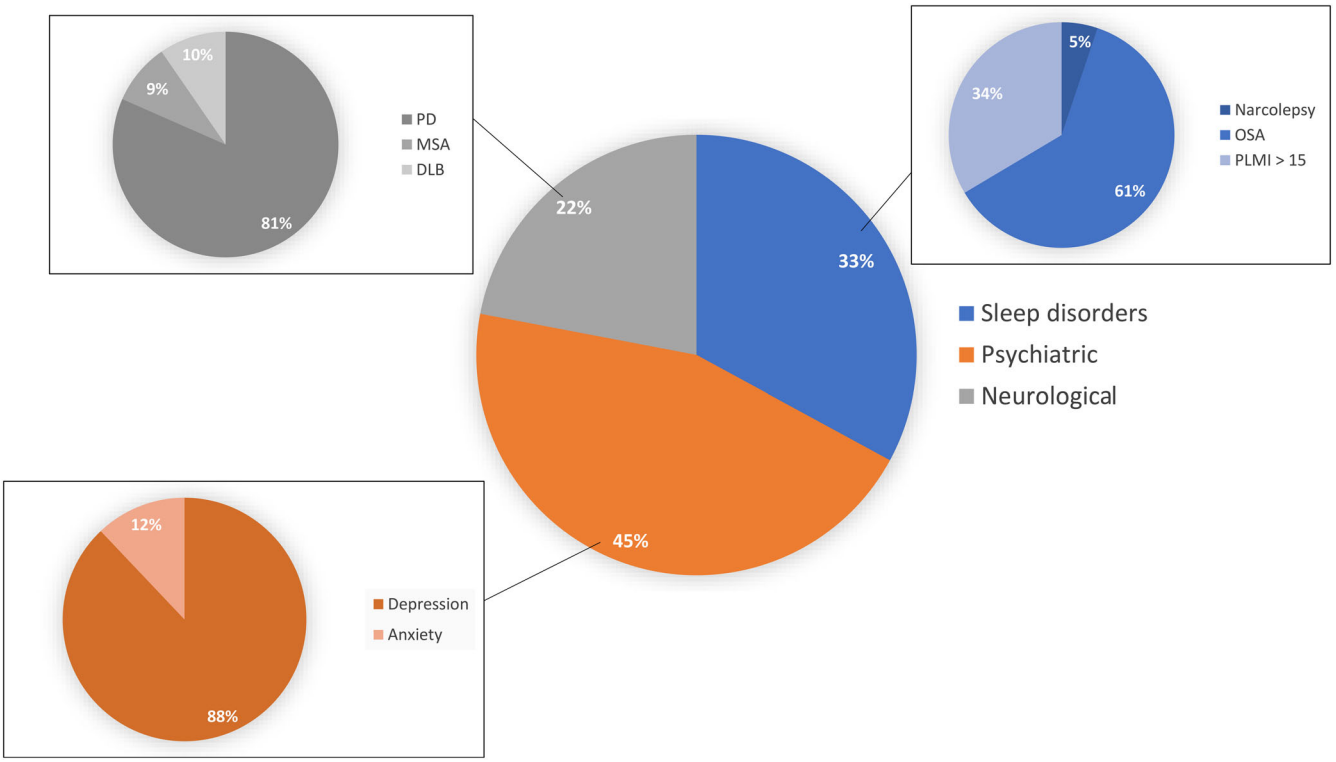

FIGURE 1 Other sleep, psychiatric and neurological disorders in patients with RBD. DLB, dementia with Lewy bodies; MSA, multiple system atrophy; OSA, obstructive sleep apnea; PD, Parkinson's disease; PLMI, periodic limb movements index

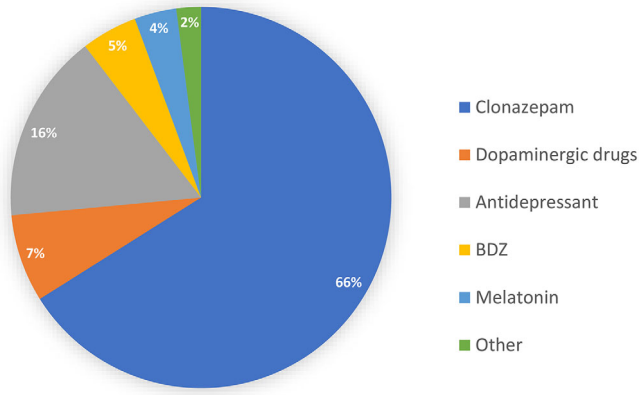

FIGURE 2 Pharmacological treatment in patients with RBD. BDZ, benzodiazepine

RESULTS

Demographic and clinical data

Overall, the reviewed studies evaluated dreams in 1,721 patients with RBD with a mean age of 65 years, and male patients represented 63% of the RBD sample.

In the literature, the mean age of RBD symptoms onset was 58.53 years, with a mean duration of 5.8 years. Despite these factors represent highly relevant clinical information in RBD, only 10 studies reported the age at disease onset (D'Agostino et al., 2012; Fantini, Corona, Clerici, & Ferini-Strambi, 2005; Fernández-Arcos et al., 2016; Jun et al., 2019; Lee, Choi, Lee, & Jeong, 2016; Li et al., 2016; McCarter et al., 2014; Uguccioni et al., 2013; Zhou et al., 2014; Zhou et al., 2015) and eight studies reported the symptoms duration (Fantini et al., 2005; Fernández-Arcos et al., 2016; Herlin, Leu-Semenescu, Chaumereuil, & Arnulf, 2015; Jun et al., 2020; McCarter et al., 2014; Sunwoo et al., 2019; Sunwoo et al., 2020; You et al., 2017; Zhou et al., 2014).

In all studies, among patients with RBD, 646 were isolated (i.e., iRBD) and 211 were secondary. In addition, one study (Li et al., 2010) enrolled patients with RBD-like disorder, referring to RBD symptoms confirmed by a video-PSG (vPSG) and often associated with psychotropic medication and psychiatric illness (Lam, Fong, Ho, Mandy, & Wing, 2008). Moreover, other sleep, neurological and psychiatric disorders were present in patients with RBD (Figure 1).

Finally, eight studies (Chang et al., 2014; Haridi et al., 2017; Jun et al., 2019; Jun et al., 2020; Lam et al., 2013; Sunwoo et al., 2019; Takeuchi, Sasai-Sakuma, & Inoue, 2020; Uguccioni et al., 2013) excluded patients under pharmacological treatment. In all, 66% of RBDs were treated with clonazepam and 4% with melatonin, the two main pharmacological treatment for RBD (St Louis & Boeve, 2017). Moreover, benzodiazepine was taken by 5% of patients among studies. In addition, 8% of patients were treated with dopaminergic drugs, the first-line treatment for PD (Marsden & Parkes, 1977). Finally, 17% of RBDs were treated with antidepressants (Figure 2). It should be

TABLE 2 Dreams- and nightmares-recall frequency results

Population	Study	Findings
RBD	Herlin et al., 2015	• Dream recall: • In 97.3% RBD in the previous 10 years • In 98.6% RBD during their entire life
	Zhou et al., 2014	Dream frequency: 91% RBD reported dreams >3 times/week
	Lee et al., 2016	Dream recall in 75.5%
	Godin et al., 2015	• Negative correlation between dream recall and tonic REM % • No significant correlation between dream recall and phasic REM • No significant correlation between nightmares recall and phasic nor tonic REM
	Jun et al., 2020	Negative correlation between frequent nightmares and CERQ adaptive score
RBD Pre- versus post-treatment	Fernández-Arcos et al., 2016	At the follow-up: < in the frequency and severity of unpleasant dream for RBD + OSAS treated with CPAP
	Li et al., 2016	Pre- versus post-clonazepam treatment • Dream frequency: no significant difference • Nightmare frequency: > before treatment ($p < 0.01$)
RBD Non-dreamers versus dreamers	Herlin et al., 2015	• Dream recall: • In childhood: > in dreamers ($p = 0.009$) • In the previous 10 years: > in dreamers ($p = 0.0005$) • In the previous years: > in dreamers ($p < 0.0001$) • Latency to previous dream recall: < in dreamers ($p = 0.0005$) • Frequency per week: > in dreamers ($p = 0.0004$)
RBD Injury versus no injury	McCarter et al., 2014	Dream recall: > in patients in which injury occurred ($p = 0.002$)
RBD Depressed versus not depressed	Lee et al., 2016	Dream recall: < in depressed RBD ($p = 0.008$)
RBD M versus F	Fernández-Arcos et al., 2016	Unpleasant dream recall: no significant differences
	Lee et al., 2016	Dream recall: no significant differences
RBD versus HC	Fantini et al., 2005	Dream recall: > in RBD ($p < 0.001$)
	Godin et al., 2013	Dream recall: no significant differences
	Godin et al., 2015	• Dream recall: ◦ > in RBD ($p < 0.01$) ◦ > in F RBD compared to F HC ($p = 0.040$) ◦ No significant differences between M RBD and M HC • Nightmares recall: ◦ > in RBD ($p < 0.00001$) ◦ > in F RBD compared to F HC ($p = 0.005$) ◦ > in M RBD compared to M HC ($p = 0.002$)
	Haridi et al., 2017	Dream recall: no significant differences
RBD versus SW and ST	Uguccioni et al., 2013	• Number of dreams during the lifetime: < in RBD compared to SW/ST ($p = 0.04$) • Number of words during the lifetime: > in RBD SW/ST ($p = 0.07$)
	Haridi et al., 2017	Dream recall: no significant differences

Abbreviations: CPAP, continuous positive airway pressure; F, female; HC, healthy controls; M, male; OSAS, obstructive sleep apnea syndrome; HC, healthy controls; REM, rapid eye movements; RBD, rapid eye movement sleep behaviour disorder; SW, sleepwalkers; ST, sleep terrors.

noted that antidepressant drugs are highly associated with REM sleep without atonia (RSWA) and there is a debate about the relationship between psychiatric illnesses themselves as aetiological factors in RBD (Teman, Tippmann-Peikert, Silber, Slocumb, & Auger, 2009).

Participants' sleep was assessed through objective and subjective methods. All studies performed a vPSG as required by the International Classification of Sleep Disorders, third edition (ICSD-3) criteria for the diagnosis (Sateia, 2014) (Table S2).

Moreover, selected studies collected also subjective sleep parameters (i.e., sleepiness, subjective sleep quality, and the arousal disorder severity), psychological dimensions (i.e., depression, aggressiveness, emotion regulation, alexithymia, and personality traits) and the participants' global cognitive functioning (Table S2).

Retrospective dreams assessment

As shown in Table 1, 21 studies performed a retrospective dream assessment. Several procedures for dreams' collection were used in studies to obtain quantitative and qualitative oneiric features. To

TABLE 3 Dreams related features (RBDQ – Factor 1) results

Population	Study	Findings
RBD	Sunwoo et al., 2019	No significant correlation between Factor 1 and power spectral density changes during phasic and tonic REM in RBD
RBD M versus F	Zhou et al., 2015	No significant differences
	Takeuchi et al., 2020	No significant differences
RBD Pre- versus post-treatment	Li et al., 2016	• > RBDQ – Factor 1 before clonazepam treatment ($p < 0.001$) • No significant difference between response and no-response group • Positive correlation between RBDQ – Factor 1 and PLMI
	Jun et al., 2019	No significant differences between pre- versus post-melatonin treatment
	Sunwoo et al., 2020	No significant differences between improvement versus no-response after clonazepam or melatonin treatment
iRBD versus sRBD versus RBD-like	Li et al., 2010	> RBDQ – Factor 1 in RBD-like compared to iRBD and sRBD ($p < 0.005$)
iRBD versus pRBD	Lam et al., 2013	< RBDQ – Factor 1 in iRBD compared to pRBD ($p < 0.01$)
Early- vs late-onset RBD	Zhou et al., 2014	No significant differences
RBD versus HC	Li et al., 2010	> RBDQ – Factor 1 in RBD compared to HC ($p < 0.001$)
	Lam et al., 2013	• > RBDQ – Factor 1 in pRBD compared to pHC ($p < 0.01$) • > RBDQ – Factor 1 in iRBD compared to pHC ($p < 0.01$)
	Zhou et al., 2014	No significant differences
	You et al., 2017	> RBDQ – Factor 1 in RBD compared to HC ($p < 0.001$)
	Sunwoo et al., 2019	> RBDQ – Factor 1 in RBD compared to HC ($p < 0.001$)
	Jun et al., 2020	> RBDQ – Factor 1 in RBD compared to HC ($p < 0.001$)
RBD versus OSA	Chang et al., 2014	> RBDQ – Factor 1 in RBD compared to OSA ($p < 0.001$)

Abbreviations: F, female; HC, healthy controls; iRBD, idiopathic rapid eye movement sleep behaviour disorder; M, male; OSA, obstructive sleep apnea syndrome; PLMI, Periodic Limb Movements Index; pHC, psychiatric healthy controls; pRBD, psychiatric rapid eye movement sleep behaviour disorder; REM, rapid eye movements; RBD, rapid eye movement sleep behaviour disorder; sRBD, symptomatic rapid eye movement sleep behaviour disorder.

describe results of the systematic review, the following paragraphs will be divided according to the type of dreams' assessment (i.e., quantitative and qualitative) and according to the tools employed (i.e., questionnaire and interviews).

Quantitative dreams features

All retrospective studies assessed quantitative dream features (i.e., dreams- and nightmares-recall frequency and dreams-related features). Results will be reported in the following sections according to the extracted quantitative oneiric features.

Dreams and nightmares recall frequency

Through heterogenous procedures reported in Table 1 (further details in the Supplementary Materials), dreams- and nightmares-recall frequency rates in RBDs were explored in the revised literature.

This section reports recall frequency results in patients with RBD (categorised by gender, clinical and sleep features), and differences in the recall rates between RBDs and healthy controls (HCs) or patients with other parasomnias (i.e., sleepwalkers [SWs]/sleep terrors [STs]) (Table 2).

The patients with RBD reported high rates of dream recall, as expected: 97.3% of RBDs reported dream recall in the previous 10 years, 98.6% during their entire life (Herlin et al., 2015) and 91% reported dreams >3 times/week (Zhou et al., 2014). However, lower dream-recall rates (75.5%) were reported by Lee et al. (2016).

Moreover, correlational studies showed a negative association between dream recall in RBDs and tonic REM sleep activity percentage (Godin, Montplaisir, & Nielsen, 2015), and between frequent nightmares and adaptive emotional strategies (Jun et al., 2020).

Two longitudinal studies (Fernández-Arcos et al., 2016; Li et al., 2016) aimed to assess changes in dream-recall frequency after treatment, which showed a decreased dreams- and nightmares-recall frequency after clonazepam assumption ($p < 0.01$) (Li et al., 2016), and after treatment with continuous positive airway pressure (CPAP), in studies on RBD with comorbid obstructive sleep apnea (OSA) (Fernández-Arcos et al., 2016).

Some studies divided the RBD samples based on specific characteristics (i.e., dream and sleep features, psychological traits, gender) to explore relations with recall-frequency rates. Among these, one study (Herlin et al., 2015) explored differences between 'dreamers' and 'non-dreamers' RBD patients in the dream-recall frequency rates during their entire life. The 'dreamers' were identified as patients that

TABLE 4 Dream bizarreness, vividness, and complexity results

Population	Study	Findings
RBD	Zhou et al., 2014	Disturbances associated to vivid dreams in 54% RBD
RBD M versus F	Zhou et al., 2015	No significant differences in vivid dreams
RBD versus SW versus ST	Uguccioni et al., 2013	• Complexity during the lifetime: > in RBD ($p = 0.006$) • Bizarreness during the lifetime: < in RBD, in the total score ($p = 0.03$) and in the type 4 ($p = 0.04$)
	Haridi et al., 2017	No significant differences in vivid dreams between yHC vs oHC vs SW vs RBD

Abbreviations: F, female; M, male; oHC, old healthy controls; RBD, rapid eye movement sleep behaviour disorder; SW, sleepwalkers; ST, sleep terrors; yHC, young healthy controls.

reported the presence of any awareness of feelings, thoughts or emotions that had occurred during sleep; whereas 'non-dreamers' were patients who reported a complete absence of any dream recall in the previous 6 months. Consistently, authors showed that 'dreamers' RBDs had higher dream-recall rates compared to 'non-dreamers' patients during childhood ($p = 0.009$) and the previous 10 years ($p = 0.0005$) (Herlin et al., 2015). Moreover, patients experiencing more injuries during RBD episodes also reported higher dream-recall frequency than patients with RBD who did not report a history of injuries ($p = 0.002$) (McCarter et al., 2014).

Considering gender differences, two studies reported the absence of significant differences between male and female patients with RBD in the dreams- and nightmares-frequency rate (Fernández-Arcos et al., 2016; Lee et al., 2016). On the other hand, Godin et al. (2015), comparing RBDs and HCs, found more dream ($p = 0.040$) and nightmare ($p = 0.005$) recall in female patients with RBD than in female HCs. However, male RBDs had more nightmares recall ($p = 0.002$) compared to male HCs (Godin et al., 2015).

Taking into account differences between RBDs and HCs without distinction for gender, no significant difference in dream recall was reported in most of investigations (Fantini et al., 2005; Godin, Montplaisir, Gagnon, & Nielsen, 2013; Haridi et al., 2017).

Lastly, studies that compared recall-frequency rates between patients with RBD and those with SW/ST (Haridi et al., 2017; Uguccioni et al., 2013) showed opposite findings. In the study conducted by Haridi et al. (2017) there was no difference in dream-recall frequency (Haridi et al., 2017). In contrast, Uguccioni et al. (2013) reported less dream-recall frequency during the lifetime in RBDs ($p = 0.04$), but a greater number of words in the dream recall during the lifetime ($p = 0.07$) (Table 2).

Dream-related features (RBD Questionnaire [RBDQ]-Factor 1)

Other studies assessed oneiric activity employing the RBDQ-Factor 1, which examines the dreams and nightmares frequency and contents (i.e., emotional, violent, aggressive and frightening dreams) (described in the Supplementary Materials) (Jun et al., 2019; Jun et al., 2020; Lam et al., 2013; Li et al., 2016; Sunwoo et al., 2019; Sunwoo et al., 2020; You et al., 2017; Zhou et al., 2015).

This section reports evidence suggesting higher dreams and nightmares frequency and higher emotional, violent, aggressive, and frightening dreams in RBDs compared to HCs and patients with OSA. Moreover, the literature findings indicate absence of impact of treatment to the RBDQ-Factor 1 score (Table 3).

In more detail, studies that compared male and female patients did not reveal significant gender-differences in dream-related features (Factor 1) (Takeuchi et al., 2020; Zhou et al., 2015).

Conflicting evidence are reported by follow-up studies aimed to evaluate dream-related features changes after treatment. Indeed, two studies showed no difference in the Factor 1 score in RBDs pre–post treatment with clonazepam or melatonin (Jun et al., 2019; Sunwoo et al., 2020). On the other hand, one study (Li et al., 2016) reported lower Factor 1 scores in RBDs after treatment with clonazepam ($p < 0.001$) (Li et al., 2016).

Moreover, literature evidence showed higher dreams- and nightmares-recall frequency and more emotional, violent, aggressive, and frightening dreams (Factor 1 scores) in RBD-like patients ($p < 0.005$) and in RBDs with comorbid psychiatric disorders (pRBDs; $p < 0.01$) than iRBDs (Lam et al., 2013; Li et al., 2010). The same finding (higher Factor 1 scores) was reported in patients with RBD compared to HCs ($p < 0.01$) (Jun et al., 2020; Lam et al., 2013; Li et al., 2010; Sunwoo et al., 2019; You et al., 2017) and patients with OSA (Chang et al., 2014). However, one study noted no significant differences between the two groups (Zhou et al., 2014).

In addition, Sunwoo et al. (2019) performed correlational analyses between quantitative dream characteristics (Factor 1) and power spectral density changes during REM sleep in RBDs compared to HCs. However, dream characteristics were not statistically correlated to the sigma- and beta-power decrease during REM sleep observed in RBDs (Sunwoo et al., 2019).

Qualitative dreams features

The 12 studies that performed retrospective dream assessment (Table 1) investigated different qualitative features that will be reported in the paragraphs below.

Bizarreness, vividness and complexity

Bizarreness, vividness and complexity were investigated in literature using free-recall methods and questionnaires described in Table 1 (more details are presented in the Supplementary Materials).

TABLE 5 Dream content results

Dream themes	Population	Study	Findings
Violence	RBD	Zhou et al., 2014	Violent dreams in 80% RBD
		Jun et al., 2020	No significant correlations between CERQ adaptive score and violent dreams
	RBD M versus F	Zhou et al., 2015	Violent dreams: no significant differences
	RBD Pre- versus post-treatment	Li et al., 2016	< violent content after clonazepam treatment ($p < 0.01$)
	RBD versus SW/ST	Uguccioni et al., 2013	> violent contents in RBD ($p = 0.04$)
Aggression	RBD	Fantini et al., 2005	• Positive correlation between PLMI and A/C ratio and % of dreams with aggression in RBD • Negative correlation between % of dreams with aggression and the Hostility AQ subscale
		Fernández-Arcos et al., 2016	Attacked by someone in 76.8% RBD
		Jun et al., 2020	No significant correlations between CERQ adaptive score and aggressive dreams
	RBD M versus F	Fernández-Arcos et al., 2016	Attacked by someone elements: > in M RBD ($p < 0.001$)
	iRBD versus sRBD	Fantini et al., 2005	No significant differences
	Injury versus non-injury RBD	McCarter et al., 2014	Fight theme: no significant differences
	RBD versus HC	Fantini et al., 2005	• Aggression/friendliness: > in RBD ($p = 0.00007$) • Dreamer as aggressor: > in RBD ($p = 0.002$; uncorrected) • Dreams with at least one aggression: > in RBD ($p = 0.00000$)
		Godin et al., 2015	• > physical attacks in RBD ($p = 0.001$) • > physical attacks in M RBD compared to M HC ($p = 0.006$)
		Haridi et al., 2017	> aggressive dreams in RBD compared to oHC ($p < 0.0001$)
	RBD versus SW/ST	Uguccioni et al., 2013	> aggressive contents in RBD ($p = 0.04$)
Animals	RBD	Fernández-Arcos et al., 2016	Attacked by an animal in 39.9% • Dogs in 33.3% • Snakes in 18.5% • Lion in 12.3% • Insects in 6.2% • Tiger in 6.7%
	RBD versus HC	Fantini et al., 2005	> in RBD compared to HC ($p = 0.00013$)
		Godin et al., 2015	• Snakes-insects: > in RBD ($p < 0.001$; uncorrected) • Beast: > in RBD ($p = 0.004$) • Snakes: > in F RBD compared to F HC ($p = 0.041$) • Wild, violent beasts: > in RBD ($p = 0.033$)

TABLE 5 (Continued)

Dream themes	Population	Study	Findings
Negative social interactions	RBD	Fernández-Arcos et al., 2016	• Chased by someone in 55.7% • Arguing with someone in 63.5% • Children in a life-threating situation in 12.8%
	RBD M versus F	Fernández-Arcos et al., 2016	• Arguing with someone: > in M RBD ($p = 0.003$) • Children in a life-threating situation: < in M RBD ($p < 0.001$)
		Godin et al., 2015	Failure: > in F RBD compared to M RBD ($p = 0.05$)
	Injury versus non-injury RBD	McCarter et al., 2014	Chase theme: no significant differences
	RBD versus HC	Godin et al., 2015	Loss of control: > in F RBD compared to F HC ($p = 0.036$)
Positive social interactions	RBD versus HC	Fantini et al., 2005	• Familiar characters: < in RBD ($p = 0.065$; uncorrected) • Dreams with at least one sexuality: < in RBD ($p = 0.00007$)
		Godin et al., 2015	• Sexual experiences: < in RBD ($p = 0.030$) • Sexual experiences: < in M RBD compared to M HC ($p = 0.001$)
Activities with negative contents	RBD	Fernández-Arcos et al., 2016	Falling from a cliff in 47.8%
	RBD M versus F	Fernández-Arcos et al., 2016	Falling from a cliff < in M RBD ($p = 0.032$)
	iRBD versus sRBD	Fantini et al., 2005	Striving: < in sRBD ($p < 0.00024$)
	RBD versus SW/ST	Uguccioni et al., 2013	Accidents and misfortunes: < in RBD ($p = 0.008$)
Activities with positive contents	RBD	Fernández-Arcos et al., 2016	Action-filled sports in 15.8%
	RBD M versus F	Fernández-Arcos et al., 2016	Action-filled sports: > in M RBD ($p = 0.002$)
Natural disasters	RBD	Godin et al., 2015	Positive correlations between disaster factor and phasic REM% in RBD
	RBD versus HC	Godin et al., 2015	• Disasters: > in RBD ($p < 0.001$; uncorrected) • Floods or tidal waves: > in RBD ($p = 0.050$) • Fire: > in F RBD compared to F HC ($p = 0.044$)

Abbreviations: A/C, aggression/characters ratio; AQ, aggression questionnaire; CERQ, Cognitive Emotion Regulation Questionnaire; F, female; iRBD, idiopathic rapid eye movement sleep behaviour disorder; M, male; oHC, old healthy controls; REM, rapid eye movement; RBD, rapid eye movement sleep behaviour disorder; SW, sleepwalkers; ST, sleep terrors; sRBD, symptomatic rapid eye movement sleep behaviour disorder.

TABLE 6 Emotional content results

Dream themes	Population	Study	Findings
Fright	RBD	Zhou et al., 2015	Frightening dreams in 80% RBD
		Jun et al., 2020	No significant correlations between CERQ adaptive score and violent dreams
	RBD M versus F	Zhou et al., 2015	Frightening dreams: significant differences
	RBD Pre- versus post-treatment	Li et al., 2016	< frightening contents after clonazepam treatment ($p < 0.01$)
	pRBD versus pHC	Lam et al., 2013	Scary theme > in pRBD compared to pHC ($p < 0.05$)
Sadness	RBD Pre- versus post-treatment	Li et al., 2016	No changes in the dreams with emotional or sorrowful content
	iRBD versus pRBD	Lam et al., 2013	Sad theme < in iRBD compared to pRBD ($p < 0.05$)
Anger	iRBD versus pRBD versus pHC	Lam et al., 2013	Angry/agitated theme > in iRBD and in pRBD compared to pHC ($p < 0.01$)
Negative emotions	RBD	Fantini et al., 2005	Negative correlation between % of Negative Emotion and the Physical Aggression AQ subscale
	RBD versus HC	Fantini et al., 2005	Negative emotion: > in RBD ($p = 0.003$; uncorrected)
Nightmare distress	RBD versus HC	Godin et al., 2013	• Nightmare distress: > in iRBD ($p < 0.01$) • Positive correlation between Nightmare Distress score and TAS-20 scores in RBD and HC • Positive correlation between Nightmare Distress score and DIF scores in RBD and HC

Abbreviations: AQ, aggression questionnaire; CERQ, Cognitive Emotion Regulation Questionnaire; DIF, difficulty identifying feelings; F, female; iRBD, idiopathic rapid eye movement sleep behaviour disorder; M, male; pHC, psychiatric healthy controls; pRBD, psychiatric rapid eye movement sleep behaviour disorder; RBD, rapid eye movement sleep behaviour disorder; TAS-20, Toronto Alexithymia Scale.

Zhou et al. (2014) reported that 54% of patients with RBD had sleep disturbances associated with vivid dreams (Zhou et al., 2014). However, no differences in dream vividness were found between male and female RBDs (Zhou et al., 2015), nor between RBDs and SWs or HCs (Haridi et al., 2017). Conversely, Uguccioni et al. (2013) demonstrated in RBDs more dreams complexity ($p = 0.006$) and less bizarreness ($p = 0.03$) comparing patients with RBD to SWs/STs during the lifetime (Table 4).

Dream content

All the qualitative studies focused on the dream content investigation using different procedures as free-recall methods, interviews, and questionnaires to retrospectively collect the dream contents (Supplementary Materials). Dream elements evaluated by these tools are many and different from each other, this results in high heterogeneity between studies (Table 5). To facilitate the insight on findings, we will report results according to specific contents extracted. Specifically, oneiric elements assessed by studies reviewed were: (a) violent and aggressive dreams, (b) dreams with animals, (c) negative or positive social interactions elements, (d) activities with negative or positive contents, (e) dreams with natural disasters.

Dream's themes most investigated were referring to violence (in five studies: Uguccioni et al., 2013; Zhou et al., 2014; Zhou et al., 2015; Li et al., 2016; Jun et al., 2020) and aggression (in seven studies: Fantini et al., 2005; Uguccioni et al., 2013; McCarter et al., 2014; Godin et al., 2015; Fernández-Arcos et al., 2016; Haridi et al., 2017; Jun et al., 2020).

TABLE 7 Quantitative dream results extracted by prospective studies

Population	Study	Findings
RBD	Uguccioni et al., 2013	Dream recall in 25% RBD
	Cavallotti et al., 2022	Dream recall • 100% in iRBD-T • 100% in iRBD-NT Dream recall associated to DEBs • 43% in iRBD-T • 64% in iRBD-NT Dream recall without DEBs • 56% in iRBD-T • 36% in iRBD-NT
RBD versus HC	Oudiette et al., 2011	Dream-recall frequency: no significant difference
	D'Agostino et al., 2012	Words number: no significant differences
RBD versus SW/ST	Oudiette et al., 2011	Dream recall frequency: no significant difference
	Uguccioni et al., 2013	• Number of dreams: no significant differences • Words number: < in RBD ($p = 0.03$)

Abbreviations: DEBs, dream enactment behaviours; HC, healthy controls; iRBD-NT, idiopathic rapid eye movement sleep behaviour disorder untreated; iRBD-T, idiopathic rapid eye movement sleep behaviour disorder clonazepam treated; RBD, rapid eye movement sleep behaviour disorder; ST, sleep terrors; SW, sleepwalkers.

TABLE 8 Qualitative dream results extracted by prospective studies

Population	Study	Findings
RBD Dream recall associated with DEBs versus Dream recall without DEBs	D'Agostino et al., 2012	• Dream content: no significant differences • Threat simulation dream content: no significant differences
	Cavallotti et al., 2022	• In iRBD-T • Threatening events: no significant differences • Frequency of aggressive dream contents: > in dream recall associated with DEBs ($p = 0.007$) • Frequency of familiar figures: > in dream recall associated with DEBs ($p = 0.014$) • In iRBD-NT • Threatening events: no significant differences • Frequency of aggressive dream contents: > in dream recall associated with DEBs ($p = 0.012$)
RBD versus HC	D'Agostino et al., 2012	• Dream content: no significant differences • Threat simulation dream content: no significant differences • Bizarreness Density Index: no significant differences
	Cavallotti et al., 2022	• Frequency of threatening dream contents: no significant differences • Frequency of aggressive dream contents: no significant differences • Frequency of Friendliness item • > in iRBD-T compared to HC ($p = 0.036$) • > in iRBD-NT compared to HC ($p = 0.036$)
RBD versus SW/ST	Uguccioni et al., 2013	• Complexity: < in RBD ($p = 0.05$) • Bizarreness: no significant differences • Dream content • Target of the threat: individuals important to subject < in RBD ($p = 0.06$) • No significant differences in all others categories of dream collection

Abbreviations: DEBs, dream enactment behaviours; HC, healthy controls; iRBD-NT, idiopathic rapid eye movement sleep behaviour disorder untreated; iRBD-T, idiopathic rapid eye movement sleep behaviour disorder clonazepam treated; RBD, rapid eye movement sleep behaviour disorder; ST, sleep terrors; SW, sleepwalkers.

Violent and aggressive dream elements were recurrent in RBDs dream recalls (80%) (Zhou et al., 2014) and were more present compared to SWs/STs ($p = 0.04$) (Uguccioni et al., 2013) and to HCs ($p = 0.00007$ [Fantini et al., 2005]; $p = 0.001$ [Godin et al., 2015]; $p < 0.0001$ [Haridi et al., 2017]). Moreover, dreams with violent contents decreased in patients with RBD after clonazepam treatment ($p < 0.01$) (Li et al., 2016).

Exploring gender differences, two studies demonstrated more dreams with physical attacks in male patients with RBD compared to male HCs ($p = 0.006$) (Godin et al., 2015) and attacks were more present in male compared to female RBDs ($p < 0.001$) (Fernández-Arcos et al., 2016). However, comparing aggression and fight themes in patients with RBD sub-grouped according to specific characteristics (iRBD versus sRBD [Fantini et al., 2005]; injury RBD versus non-injury RBD [McCarter et al., 2014]) no significant differences were found (Fantini et al., 2005; McCarter et al., 2014). Correlational analyses in the RBD population revealed that dreams with aggression negatively correlated with the 'Hostility' subscale on the Aggression Questionnaire (AQ) and positively correlated with the Periodic Limb Movements Index (Fantini et al., 2005).

In addition, Fernández-Arcos et al. (2016) reported dreams with animal attacks in 39% RBDs (Fernández-Arcos et al., 2016), which were more present in RBDs compared to HCs ($p = 0.00013$) (Fantini et al., 2005; Godin et al., 2015).

Moreover, social interactions (negative and positive) during dreams were also investigated.

Concerning negative social interactions two studies (Fernández-Arcos et al., 2016; McCarter et al., 2014) reported elements with 'chased by someone' in 55.7% of RBDs (Fernández-Arcos et al., 2016), but no difference in the chase theme between injury and non-injury RBDs (McCarter et al., 2014). Moreover, Fernández-Arcos et al. (2016) showed that in 63.5% of RBDs, dream recalls experiences were of arguing with someone, which were more present in male than female RBDs ($p = 0.003$); and in 12.8% of RBDs, dream reports with children in a life-threatening situation were more present in females than males RBDs ($p < 0.001$) (Fernández-Arcos et al., 2016).

On the other hand, Fantini et al. (2005) and Godin et al. (2015) reported positive social interactions in dream recalls. Both studies showed less sexual elements in RBDs dream reports compared to HCs ($p < 0.00001$ [Fantini et al., 2005]; $p = 0.030$ [Godin et al., 2015]), and specifically in male RBDs compared to male HCs ($p = 0.001$) (Godin et al., 2015).

A similar distinction in reporting results can be made between studies that investigate physical actions in dream reports with negative (Fantini et al., 2005; Fernández-Arcos et al., 2016; Uguccioni et al., 2013) and positive contents (Fernández-Arcos et al., 2016). Concerning activities with negative contents, striving elements were more frequent in iRBDs, than in RBDs with other neurological disorders ($p < 0.00024$) (Fantini et al., 2005). Moreover, in 47.8% of patients with RBD recurred oneiric experiences of falls from a cliff were more present in female RBDs ($p = 0.032$) (Fernández-Arcos et al., 2016). Lastly, Uguccioni et al. (2013) reported minor accidents

and misfortunes in RBDs compared to SWs/STs ($p = 0.008$) (Uguccioni et al., 2013). Regarding positive actions in dream reports, only one study reported sports actions in RBDs (15.5% of dream recalls), which were more recurrent in male than female patients with RBD ($p = 0.002$) (Fernández-Arcos et al., 2016).

Concluding, a single study (Godin et al., 2015) explored specific dream contents differences between RBDs and HCs. Authors showed that in RBDs more dreams were present containing elements of natural disasters ($p < 0.001$; uncorrected) and higher rates of 'Paralysis-presence in the room' factor ($p < 0.001$; uncorrected).

Moreover, in female patients with RBD compared to female HCs there were more recurrent fire elements ($p = 0.04$), half awake and paralysed experiences ($p = 0.037$), greater dream theme diversity index ($p = 0.053$), 'loss of control' ($p = 0.036$) and 'magic-myth' factors ($p = 0.010$). On the other hand, male RBDs showed more dreams of seeing themselves as dead than male HCs ($p = 0.002$) (Godin et al., 2015).

Emotional content

A large category explored by literature concerned the emotional content of dream recalls in RBDs, focusing on fright, sadness, anger, negative emotions in general, and nightmare distress (Table 6).

Evidence showed that male and female RBDs did not differ in frightening dreams (Zhou et al., 2015); however, after clonazepam treatment frightening elements in RBDs dreams decreased ($p < 0.01$) (Li et al., 2016). Emotional contents regarding sadness, anger and fear were explored by Lam et al. (2013), comparing patients with iRBD with pRBDs and HCs with comorbid psychiatric disorders (pHCs). Results indicated fewer sadness contents in iRBDs compared to pRBDs ($p < 0.05$), as expected. Furthermore, in RBDs (both iRBDs and pRBDs), authors showed more anger elements compared to pHCs ($p < 0.01$). On the other hand, dreams with fear content were more recurrent in patients with pRBD compared to pHCs ($p < 0.05$) (Lam et al., 2013). Lastly, Fantini et al. (2005) showed more negative emotions during dream recalls in RBDs compared to HCs ($p = 0.003$; uncorrected), which negatively correlated with the 'Physical Aggression' AQ subscale (Fantini et al., 2005).

Furthermore, Godin et al. (2013) assessed specifically relations between dream contents and alexithymia traits (by using the Toronto Alexithymia Scale [Taylor, Bagby, & Parker, 2003]). Results showed more nightmare distress in the RBD sample than HCs ($p < 0.01$), which positively correlated with higher alexithymia traits and with the 'Difficulty Identifying Feelings' subscale (Godin et al., 2013).

Prospective dreams assessment

Prospective dream assessment was conducted in four studies (Oudiette et al., 2011; D'Agostino et al., 2012; Uguccioni et al., 2013; Cavallotti et al., 2022), employing free-dream recall or dream diaries performed the morning immediately after awakening (Table 1). As for the 'Retrospective dreams assessment' paragraph, results from studies will be discussed below according to the study's dream features (i.e., quantitative and qualitative).

Quantitative dreams features

All prospective reviewed studies performed quantitative dreams assessment. Employing methods reported in the Supplementary Materials.

Different frequency rates of dream recall in RBDs are reported among studies. Indeed, using the immediate free recall the morning after the night spent in the sleep laboratory, dream recall was reported in 25% RBDs (Uguccioni et al., 2013). However, in the study conducted by Cavallotti et al. (2022) requiring patients to keep a 3-week daily dream diary, the frequency of dream reports was 100% in RBDs. Of these dream recalls, 43% were associated with motor manifestations in medicated RBDs and 64% in drug-free RBDs (Cavallotti et al., 2022). However, comparing the RBD to HC and SW/ST groups, no difference arose in the immediate dream-recall frequency (Oudiette et al., 2011; Uguccioni et al., 2013) and in the word count analysis on the dream report (D'Agostino et al., 2012). However, Uguccioni et al. (2013) observed fewer words number in RBDs dreams reports compared to patients with SW/ST ($p = 0.03$) (Table 7).

Qualitative dreams features

Qualitative assessment in dream features was performed by three of four prospective studies (Cavallotti et al., 2022; D'Agostino et al., 2012; Uguccioni et al., 2013) (Table 8). Procedures and methods employed are reported in the Supplementary Materials.

Comparing dream content and bizarreness between RBD and HC or SW/ST participants, studies did not show any statistically significant difference (D'Agostino et al., 2012; Uguccioni et al., 2013). However, RBDs differed from SWs/STs in dream complexity and in the target of the threat showing lower values (respectively: $p = 0.05$; $p = 0.06$) (Uguccioni et al., 2013).

Moreover, the studies by D'Agostino et al. (2012) and Cavallotti et al. (2022) were the only ones specifically assessing dream-recall contents associated with motor manifestations. Both studies showed that the presence of threatening events did not differ between dream recalls associated with dream enactment behaviours and dream recall without motor manifestation. Conversely, dream recalls associated with enactment behaviours exhibited more aggressive ($p = 0.007$ in treated RBD; $p = 0.012$ in untreated RBD) and familiar elements ($p = 0.014$ in treated RBD) than dream recall not accompanied by enactment behaviours. Concluding, the authors showed the absence of significant differences between clonazepam-treated RBDs and drug-free RBDs in the frequency of aggressive and threatening elements. However, friendliness elements were more frequent in RBDs (treated and untreated) than in HCs (Cavallotti et al., 2022).

DISCUSSION

The research on dreaming in RBD is helpful to understand particular aspects of this REM sleep parasomnia and to explore neurobiological, electrophysiological, and cognitive mechanisms of REM sleep and dreaming. We will discuss the results from our systematic review addressing these two topics.

RBD as a recall-bias syndrome?

The recall bias can be briefly explained as the tendency of patients with RBD to remember vivid and bizarre dreams with violent content and in which they hurt themselves or their bed partners. In other words, oneiric activity associated with violent body movements that caused injury or awakening is more likely to be recalled. This tendency, resulting in higher dream-recall frequency in the RBD population compared to HCs and other clinical populations, is magnified by a retrospective dream collection. The evidence reviewed in this paper are in line with this assumption. Indeed, retrospective studies reported in the RBD population high rates of dreams- (Herlin et al., 2015; Lee et al., 2016; Zhou et al., 2014) and nightmares-recall frequency (Fernández-Arcos et al., 2016) compared to prospective studies that collect dreams immediately upon morning awakening (Uguccioni et al., 2013).

Moreover, in line with the above mentioned recall bias, studies that compared RBDs with HCs supported the hypothesis that patients with RBD do not have more dreams with violent content (Cavallotti et al., 2022; D'Agostino et al., 2012; Fantini et al., 2005; Godin et al., 2013; Haridi et al., 2017; Uguccioni et al., 2013). In addition, some findings point out that dream-enacted episodes that may cause physical damage facilitate dream recall (Cavallotti et al., 2022; McCarter et al., 2014). However, it must be taken into account that four of these investigations (Cavallotti et al., 2022; D'Agostino et al., 2012; Fantini et al., 2005; Godin et al., 2013) enrolled patients treated with clonazepam, known as a drug that reduces the dream-recall frequency and, especially, reduces the negative and aggressive dream content. This point represents a severe limitation in the interpretation of these results.

As the recall bias could confound the potential association between RBD syndrome and violent dream characteristics, future studies should implement experimental designs foreseeing higher supervision. A solution is to schedule a week of dream diary monitoring in order to consider a short period, asking subjects to report any type of mental activity recalled. In the literature, only three studies that reported recall frequency rate in RBD performed a prospective dream recall (Cavallotti et al., 2022; Oudiette et al., 2011; Uguccioni et al., 2013), and only two studies (Cavallotti et al., 2022; D'Agostino et al., 2012) investigated the recall-frequency rate related to dreams with and without dream enactment behaviours. Future studies should further explore the association between dream enactment and dream-recall frequency in a prospective design to confirm the hypothesis that dream recall is facilitated after its enactment.

Moreover, future studies should assess the brain dynamics associated with oneiric activity through EEG to clarify dream-recall mechanisms in RBD. Indeed, dream recall seems to be facilitated by specific brain states (i.e., fast EEG frequencies, intra-sleep wakefulness, decreased slow oscillation) that can only be observed via electrophysiological methods (Scarpelli et al., 2020).

Gender differences in RBD

Clinical evidence in the literature suggests a male predominance in RBD disease (Iranzo et al., 2006; Olson et al., 2000; Postuma et al., 2009) with a male–female ratio of 9:1 (Schenck, 1990) and displaying a more severe symptomatic pattern in male patients compared to females. Indeed, males with RBD report more vigorous and aggressive behaviours during RBD episodes (Bodkin & Schenck, 2009; Oksenberg, Radwan, Arons, Hoffenbach, & Behroozi, 2002) with higher rates of phenoconversion in α-synucleinopathies compared to females with RBD (Galbiati et al., 2019). On the other hand, a relevant and recent study aimed to determine the prevalence of RBD in the general population, reported an absence of a clear male predominance and gender-difference in RBD (Haba-Rubio et al., 2018). According to Haba-Rubio et al. (2018), our literature analysis reported a rate of 63% of male patients among the studies, far below that of previous evidence (Galbiati et al., 2019; Schenck, 1990). In this vein, the male predominance reported by clinical studies may be partially explained by the more violent episodes during sleep leading more often to male RBDs coming to clinical attention (Bodkin & Schenck, 2009). According to this last hypothesis, evidence from the reviewed studies is consistent and points to an absence of differences between male and female RBD in the dream-recall frequency and features (Fernández-Arcos et al., 2016; Lee et al., 2016; Takeuchi et al., 2020; Zhou et al., 2015). However, male patients with RBD exhibited more dreams with attacks and fights contents (Fernández-Arcos et al., 2016; You et al., 2017), while female patients with RBD reported more dreams with unpleasant social interactions (Fernández-Arcos et al., 2016; Godin et al., 2015). These findings are in agreement with studies that showed in male RBDs more violent and aggressive dream enactment episodes (Bjørnarå, Dietrichs, & Toft, 2013; Bodkin & Schenck, 2009; Oksenberg et al., 2002) and with the evolutionistic hypothesis suggesting that in most mammalian species males show more aggressive behaviours than females, and this difference might arise from biological differences (Bjørnarå et al., 2013). Also in the general population, males appear to report more aggressive and violent dream content than do females (Nielsen et al., 2003; Schredl, Ciric, Götz, & Wittmann, 2004). However, the available data are insufficient to ascertain whether male and female patients with RBD differ in dream features effectively. Considering the methodological soundness of prospective methods to collect dream recall, no analysed study adopted a prospective experimental design aimed to assess gender differences in dream features in the RBD population.

A focus on emotional symptoms in RBD through dreaming

A specific research line in RBD explores emotional symptoms claimed by patients (i.e., anxiety, apathy, depression) (Barber et al., 2017;

Barber et al., 2018; Molano et al., 2008) and the relationship with oneiric activity. Although the association between emotional processes and dreaming is well understood in the general population (Scarpelli, Bartolacci, D'Atri, Gorgoni, & De Gennaro, 2019), there are few works exploring emotional symptoms and oneiric activity in RBD. Findings from our systematic review indicate that depressed patients with RBD had less dream-recall frequency (Lee et al., 2016), consistent with previous studies showing an association between depression and reduced ability to recall dreams (Armitage, Rochlen, Fitch, Trivedi, & Rush, 1995). Moreover, as depression is common in neurodegenerative conditions, authors explained the reduction in dream recall as a memory impairment reported by depressed patients with RBD, which may have more neurodegenerative changes than RBDs without depression (Lee et al., 2016). However, this explanation remains speculative as this study did not perform a neuropsychological assessment to determine differences between the two groups in memory performance.

Additionally, pRBDs (i.e., major depressive disorder, bipolar affective disorder, psychosis, anxiety disorder and post-traumatic stress disorder) reported higher rates of RBDQ-Factor 1 than RBD without psychiatry comorbidities, more sadness content in the dream reports, higher prevalence of nightmares and associated symptoms. Moreover, dream-related features were accompanied by higher tonic electromyography (EMG) activity during REM sleep (Lam et al., 2013). These findings were interpreted by the authors in terms of a higher probability of pRBDs to convert into PD, as the elevated prevalence of depression in patients with PD (Nilsson, Kessing, & Bolwig, 2001; Remy, Doder, Lees, Turjanski, & Brooks, 2005) and the RSWA characteristics as probable biomarkers to predict the phenoconversion (Galbiati et al., 2019). However, this explanation needs to be tested, and follow-up studies are needed to assess the long-term outcome of pRBD relative to neurodegeneration.

Interestingly, higher levels of alexithymia (Godin et al., 2013) and emotional regulation deficit were found in the RBD population (Jun et al., 2020). Alexithymia is described as difficulty recognising and identifying emotions and discriminating between feelings and bodily sensations, accompanied by a concrete style of thinking (Taylor, Bagby, & Parker, 1999). On the other hand, emotion regulation is a construct concerning the adjustment of subjects' emotional responses to manage difficult situations (Gross, 2015). These two aspects seem to be associated with changes in dream activity (De Gennaro et al., 2003; Levin & Nielsen, 2009). Interesting, findings in RBDs showed emotional dysregulation features associated with dream-related symptoms, mainly the frequency of the nightmares, in addition to depressive traits and cognitive decline (Jun et al., 2020).

Moreover, higher rates of nightmare distress reported by patients with RBD were related to higher alexithymia traits and difficulties identifying feelings (Godin et al., 2013). Both these findings are in line with the neurocognitive model of dreaming proposed by Levin and Nielsen, (2009), suggesting that nightmares stem from impairment in the fear-extinction function, reflecting failures in emotions expression and regulation during the daytime (Levin & Nielsen, 2009). However, the affect distress explanation reflected by this finding showed an opposite picture of results compared to what was illustrated by Fantini et al. (2005). The RBDs who recalled more dreams with aggression were characterised conversely by fewer aggressiveness levels during the daytime (Fantini et al., 2005) and by a generalised style of passivity and non-aggressiveness (Fantini et al., 2005; Uguccioni et al., 2013). Nevertheless, the emotional dysregulation and the presence of alexithymia traits in RBD seem to explain some sleep symptoms reported by patients, such as excessive and unexpected emotional bursts during REM sleep. This interpretation is supported by the crucial role played by dreams and REM sleep features in the overnight regulation of negative emotions, also reported in other disorders such as insomnia (Galbiati et al., 2020) and depression (Palagini, Baglioni, Ciapparelli, Gemignani, & Riemann, 2013). Indeed, REM sleep has a crucial role in emotional memory processing during the night, reducing the neural, cognitive, and behavioural load in response to the daytime emotional experiences (Van der Helm et al., 2011). Also, neuroimaging measures may explain the association between emotional symptoms and dream features in RBD. Indeed, dysfunctions in the prefrontal cortex, identified in RBD as an early sign of neurodegeneration (Kim et al., 2021; Wu et al., 2014) and implicated in the emotional regulation through the limbic network, may be associated with the emotional symptoms during the daytime related to the dreams content in RBD (Nielsen & Levin, 2007).

However, to understand the mechanisms underlying the emotional symptoms in RBD, further studies will be helpful to determine the role of REM sleep in the emotional regulation of this disorder and the potential role of such impairments as potential markers of neurodegeneration.

Concluding, a critical point that cannot be neglected is the strict relation between RBD symptoms and psychotropic drugs among patients with psychiatric illnesses (Nofzinger & Reynolds, 1994; Onofrj, Luciano, Thomas, Iacono, & D'Andreamatteo, 2003). This aspect involves broader issues that will be discussed in the next paragraph.

Dreaming and pharmacological issues in RBD

Part of the literature suggests that given the high prevalence of psychiatric comorbidities in RBDs (Arnulf, 2012) and the close association between the intake of antidepressants and RBD symptoms (Nofzinger & Reynolds, 1994; Onofrj et al., 2003), RBD features can be triggered by psychotropic medication (Lam et al., 2010). A study by Lam et al., 2013, comparing pRBDs and pHCs with no differences in the usage of antidepressants, showed that the first group reported more prevalence of nightmares, dream enactments episodes and sleep-related injuries. Moreover, pRBD had more severe RSWA characterised by a predominant phasic EMG activity during REM sleep. Thus, given these differences between pRBDs and pHCs, RBD symptoms could not be limited to the side-effects of antidepressants. Still, further specific susceptibility factors could be related to the enhanced risk of developing RBD (Lam et al., 2013). These results suggest that in psychiatric conditions, the aetiology of RBD could be more complex and not merely due to pharmacological therapies.

Another research line in the RBD field explores the dream-related symptoms changes associated with clonazepam and melatonin consumption, the two main pharmacological treatments for RBD (St Louis & Boeve, 2017). Notably, this association is controversial. Indeed, longitudinal studies showed on one hand absence of effects on dream-related features (explored by RBDQ-Factor 1) (Jun et al., 2019; Sunwoo et al., 2020) and in dream-recall frequency (Li et al., 2016) after clonazepam and melatonin treatment. In the same direction, the unique study in the literature that compared clonazepam-treated and untreated RBDs (Cavallotti et al., 2022) indicated no difference in the dream contents (i.e., violent, threatening, and aggressive elements) between groups. On the other hand, clonazepam-treated RBDs recalled more frequently acted dreams that presented familiar figures. This evidence is interpreted by the authors as an anxiolytic effect of clonazepam on dream contents (Cavallotti et al., 2022), also supported by Li et al. (2016) showing that clonazepam reduced the dream-related features, nightmare frequency, and dreams with violent and frightening contents (Li et al., 2016).

In light of these findings, it can be assumed that clonazepam has a specific effect on the dream affect and content, suggesting further comprehension into modes of actions of clonazepam in RBD.

Moreover, clonazepam affects the activation of limbic and paralimbic brain structures, acting on dream generation mechanisms (Hobson, Pace-Schott, & Stickgold, 2000). Conversely, melatonin seems to be ineffective for the dream-related symptoms in RBD. However, the absence of effects may be due to methodological aspects of the investigations. Indeed, the dosage of melatonin used by the studies reviewed (2–6 mg [Jun et al., 2019] and 2 mg [Sunwoo et al., 2019]) is far below the recommended dosage (12 mg; McGrane, Leung, Louis, & Boeve, 2015). Further controlled trial studies that explore the treatment effects on dream-related symptoms are needed to get insights into the RBD pathophysiology on one side and to explore neurobiological mechanisms underlying dreaming on the other.

RBD as a model to study dreaming

As dreaming is an inaccessible behavioural and neurobiological phenomenon, researchers are interested in parasomnias such as RBD to study dreaming processes from an appealing point of view (Alfonsi, D'Atri, Scarpelli, Mangiaruga, & De Gennaro, 2019). Indeed, by observing behaviours and verbal expressions during sleep, researchers have easy access to events likely related to dreaming aspects. For this purpose, Uguccioni et al. (2013) have compared patients with RBD and SW/ST, providing the most significant contribution to the novel advancement in dream research. As for RBD, SW/ST are characterised by abnormal related complex behaviours during sleep that may lead to sleep injuries and sleep disruption (Sateia, 2014).

The contents of dream mentation associated with the episodes and behaviours of the dream enactment may differ between RBDs and SWs/STs, providing insight into the cognitive processes that occur during oneiric activity. The primary evidence underlined by the authors showed that, although the two groups differed in response to the attacks reported in the dream recall, during dreams the fight-or-flight response is partially active to threats described in wakefulness (Cannon, 1929). Specifically, patients with RBD tended to defend themselves or others when dream's content was a physical attack, whereas the SWs/STs tended to wake up. On the other hand, the response modalities reversed when the dream content was a natural disaster (i.e., the SWs/STs fled, whereas the RBDs woke up). However, no dreamers reported being frozen facing these threats (Uguccioni et al., 2013). By contrast, during the wakefulness humans and animals, when the threats are predators or natural disasters that cannot be combated and that may lead to an imminent risk of death, a typical response is freezing (Hilton, 1982).

As patients with RBD and SW/ST reported a high frequency of aggressions and natural disasters (Uguccioni et al., 2013), some authors hypothesised that the dream mentation occurring in these two parasomnias might be a 'threat simulation', consistent with the Revonsuo hypothesis (Revonsuo, 2000). This theory suggests the evolutionary function of dreaming: during dreams, the life-threatening dangers are simulated to train subjects to face such dangers and the repetitive rehearsal of threat perception seems to dissipate the resulting emotional arousal (Revonsuo, 2000).

Uguccioni et al. (2013) showed that dream reports often recalled by SW patients were set in the room where the subjects slept. In contrast, only one patient with RBD reported a dream that occurred in the sleeping room (Uguccioni et al., 2013). The behavioural observations during nocturnal episodes demonstrated different features between the two parasomnias: RBDs had their eyes closed and they did not get out of their bed during the dream enactment (Oudiette et al., 2012). Conversely, SW patients had their eyes open and seemed to be able to avoid obstacles in the room when they walked (Derry, Harvey, Walker, Duncan, & Berkovic, 2009). According to evidence that sleep is a local phenomenon (Siclari & Tononi, 2017), Uguccioni et al. (2013) showed for the first time that in the SW/ST the dreaming process could integrate internal and external cues (Uguccioni et al., 2013).

LIMITATIONS AND CONCLUSIONS

The literature regarding the oneiric activity in the RBD has interested sleep researchers in recent years. However, our literature review has allowed us to highlight some methodological limits, which affect the interpretation of the results. In our opinion, these limitations can be divided into constraints that concern clinical aspects of RBD and the experimental designs employed to study dreams.

When we consider clinical points, we refer first of all to the selection procedures for enrolled RBD participants. Indeed, most studies included unselected patients, with different aetiology and neurological or psychiatric comorbidities. Strictly connected with this issue, no study explored the relationship between cognitive impairments and dreaming, although some studies evaluated patients' neuropsychological profile (Herlin et al., 2015; Jun et al., 2019; Jun et al., 2020;

Sunwoo et al., 2019; Sunwoo et al., 2020; Takeuchi et al., 2020) (Table S2). Indeed, several cognitive abilities have been found to co-vary with the dream-recall frequency (Ruby, 2011), particularly memory abilities (Butler & Watson, 1985). It could be argued that patients with RBD and cognitive decline have impaired recall of dream reports compared to patients with iRBD with preserved cognitive functioning. This issue severely limits the interpretation of dream-recall findings in RBD and future studies on dreaming in this parasomnia should consider neuropsychological performances. Moreover, it is important to bear in mind that 64% of patients who participated in the studies included in this systematic review were treated with clonazepam (Figure 2 and Table S2), which may influence the dream-experience and dream-recall mechanisms (Hobson et al., 2000).

In conclusion, we have to consider that the studies conducted in patients with RBD enrolled hospitalised subjects who may represent the most violent portion of this parasomnia who came to clinical attention but may not be representative of the features of RBD in the general population.

Concerning the experimental designs applied to study dreaming, the first limitation of the literature regards the retrospective (Chang et al., 2014; Fantini et al., 2005; Fernández-Arcos et al., 2016; Godin et al., 2013; Godin et al., 2015; Haridi et al., 2017; Herlin et al., 2015; Jun et al., 2019; Jun et al., 2020; Lam et al., 2013; Lee et al., 2016; Li et al., 2010; Li et al., 2016; McCarter et al., 2014; Sunwoo et al., 2019; Sunwoo et al., 2020; Takeuchi et al., 2020; Uguccioni et al., 2013; You et al., 2017; Zhou et al., 2014; Zhou et al., 2015) and cross-sectional (D'Agostino et al., 2012; Fantini et al., 2005; Godin et al., 2013; Godin et al., 2015; Haridi et al., 2017; Herlin et al., 2015; Jun et al., 2020; Lam et al., 2013; Lee et al., 2016; McCarter et al., 2014; Sunwoo et al., 2019; Takeuchi et al., 2020; Zhou et al., 2014; Zhou et al., 2015) nature of most studies. These methodological weaknesses do not permit the identification of casual relations between dream activity and RBD characteristics. Retrospective methods to collect dreams render the recall less sensitive to changes that occur over time and less representative of the salience and emotional dream features, which may be exacerbated or neglected over time (Robert & Zadra, 2008).

Moreover, the main limitation concerns the lack of an appropriate objective sleep assessment during the night in prospective studies. Indeed, no study monitored the sleep stage in which dreams likely occur. This represents a fundamental methodological limitation in dreaming research, as dream recall improves after awakenings during REM sleep (82%) compared with after an awakening during non-REM sleep (43%–67%) (Montangero, 2018; Nielsen, 2000). In addition, no prospective study considered intra-sleep wakefulness and the number of awakenings during the recording night, which can affect the ability to remember dreams (Scarpelli et al., 2020; Vallat, Chatard, Blagrove, & Ruby, 2017). Specifically, the dream-recall frequency is enhanced by more awakenings (Ruby, 2011) and a higher duration of wakefulness (Koulack & Goodenough, 1977; Vallat et al., 2017) during the night. Moreover, as previously discussed, also dream enactment may enhance the dream recall. However, only three studies (Cavallotti et al., 2022; D'Agostino et al., 2012; Uguccioni et al., 2013) assessed the motor behaviour associated with the dream recall and none of the studies systematically investigated reports soon after RBD episodes.

Our systematic review allowed us to collect considerable quantitative and qualitative features of dreaming in RBD that could guide future research. Overcoming clinical and methodological limitations identified and discussed in this review, future studies might be able to clarify the relationship between RBD pathophysiology and oneiric activity offering unique insights for the understanding of cognitive and electrophysiological processes of dreaming.

AUTHORS CONTRIBUTION

Elisabetta Fasiello is the primary author. She developed the topic and wrote the paper in collaboration with Serena Scarpelli and Luigi De Gennaro. Maurizio Gorgoni, Valentina Alfonsi and Andrea Galbiati also contributed to the development of this paper and were very active in providing feedback during the writing process.

All authors approved the final version of the manuscript for submission.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

ORCID

Elisabetta Fasiello https://orcid.org/0000-0003-2342-7587
Serena Scarpelli https://orcid.org/0000-0002-9260-7111
Maurizio Gorgoni https://orcid.org/0000-0002-5544-5483
Valentina Alfonsi https://orcid.org/0000-0002-9929-0399
Andrea Galbiati https://orcid.org/0000-0001-8132-1399
Luigi De Gennaro https://orcid.org/0000-0003-3613-6631

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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