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Virtual Reality Therapy

Virtual reality has arrived as a therapy form in controlled research: by far the largest share of the work in humans is designed as controlled, and the most cited work in the field addresses stroke rehabilitation. It is striking that a methodological recommendation for conducting studies itself ranks among the most cited works — the field is examining its own standards.

2,460

STUDIES IN
TOTAL

2,026

IN HUMANS

1,390

OF WHICH
CONTROLLED

6

IN ANIMALS

0

IN THE LAB

Figures from the IHR study database · Last updated 2026-10-15

How to Read This Dossier

ESTABLISHED

measured in humans, with a comparison group

PLAUSIBLE

supported by mechanism, animal studies or observation

HYPOTHESIS

a likely connection that still needs to be tested

Virtual Reality Therapy at a Glance

ORIGIN:

Virtual reality therapy places the patient via headset or screen into a computer-generated, three-dimensional environment in which they move or act. A distinction is made between immersive systems with a completely replaced field of view and non-immersive applications; the therapy serves as a training environment for movement sequences and balance as well as an exposure space, and the recorded studies range from 2000 to 2026.

EVIDENCE BASE:

2,460 evaluated studies · 1,390 controlled human studies · 636 observational studies · 181 review articles · 6 animal studies · 0 cell culture studies

STRONGEST EVIDENCE:

- Anxiety disorders: The meta-analysis of 30 randomised studies with 1,057 participants showed an effect size of $g = 0,90$ versus wait-list and no significant difference versus in-vivo exposure ($g = -0,07$).
- Stroke: The meta-analysis of 30 randomised studies with 1,473 patients demonstrated an effect of rehabilitative systems specifically on body function ($SMD = 0,23$), but not of recreational gaming systems.
- Post-traumatic stress disorder: In a placebo-controlled randomised study of 156 veterans, symptoms improved in all conditions and remained stable at 3, 6 and 12 months.
- Social anxiety disorder: In a randomised study with 97 participants, both active groups improved versus wait-list and at twelve months on all measures; no differences existed between them.
- Meta-review of 25 review articles: Virtual reality performs favourably for anxiety disorders, eating and weight disorders and pain management, with long-term effects that transfer to daily life.

LIMITATIONS:

- The comparator arms differ: some use conventional therapy, some a wait-list, some another form of distraction, which limits statements about the contribution of the virtual environment.
- Immersion, field of view, control, session duration and the hardware and software employed vary considerably; the heterogeneity of the systems complicates pooling of the studies.
- The Cochrane reviews on stroke rehabilitation list target variables, inclusion criteria and search strategy in the present extract, but no pooled results.

ASSESSMENT:

Virtual reality has arrived as a therapeutic modality in controlled research; its effect is established for anxiety disorders and after stroke, while comparability of the systems remains open work.

1. What Virtual Reality Therapy Is

Virtual reality therapy uses a computer-generated, three-dimensional environment into which the patient immerses via headset or screen and in which they move or act. A distinction is made between immersive systems that completely replace the field of view and non-immersive applications on monitor or projection surface; the studies in the database employ both forms. The method is applied in two ways: as a training environment in which movement sequences, balance or cognitive tasks are repeatedly practised, and as an exposure space in which anxiety-provoking situations are presented in a controlled and graded manner. The oldest studies recorded in the database date from 2000, the most recent from 2026.

For the evaluation of all studies it is crucial that “virtual reality” does not denote a uniform procedure. Immersion, field of view, control, session duration and the hardware and software employed differ substantially between studies, and the same designation may refer to balance training on a monitor or to fully immersive exposure. Added to this is the choice of comparator arm: the application is tested partly against conventional therapy, partly against a wait-list, partly against another form of distraction. Endpoints range from motor measurements and balance scales through anxiety and pain questionnaires to cognitive test performance. An international working group published in 2019 its own recommendations for the methodology of clinical studies with virtual reality — an indication that comparability of the studies themselves is the subject of research.

2. What the Studies Show in Detail

The key human studies and the most important reviews — by application area, with population, duration, preparation, outcome measure and result as reported in the original studies. Numbers appear only where the study states them.

Distribution of **controlled human studies** by application area — the numbers are not additive, as one study may be assigned to several areas:

APPLICATION AREA	CONTROLLED STUDIES
Cognition and psyche	800
Musculoskeletal system	549
Safety and tolerability	355
Fatigue and stress	280

APPLICATION AREA	CONTROLLED STUDIES
Gut and microbiome	67
Oncology	62
Heart and circulation	53
Skin	42

Cognition and Psyche

The broadest foundation is provided by a meta-analysis of 30 randomised controlled studies with 1,057 participants on exposure in virtual reality for anxiety disorders. Fourteen studies concerned specific phobias, eight social anxiety disorder or test anxiety, five post-traumatic stress disorder and three panic disorder with and without agoraphobia. Versus wait-list a large effect size emerged ($g = 0.90$), versus psychological placebo conditions a medium to large effect ($g = 0.78$); comparison of virtual-reality exposure and in-vivo exposure found no significant difference ($g = -0.07$). A meta-regression showed that larger samples were associated with smaller effects versus control conditions ($\beta = -0.007$, $p < 0.05$). The authors rate exposure in virtual reality as effective and equivalent to in-vivo exposure.

For social anxiety disorder there is a randomised study with 97 participants who named public speaking as their main fear (mean age = 39 years, 62 % women)⁷. They received eight sessions of manualised virtual-reality exposure, group exposure or were placed on the wait-list; standardised self-report measures were collected before, after and twelve months after treatment, process measures during treatment, a standardised speech task before and after treatment, and diagnostic status after three months. Versus the wait-list both active groups improved on all measures except one, namely speech length in the group therapy and fear of negative evaluation in the virtual condition. After twelve months a significant improvement versus baseline appeared on all measures; at no time point did differences exist between the active treatments in process or outcome variables, nor in partial or full remission.

The children in the intervention group saw a realistic, child-friendly immersive version of the operating theatre on the day of surgery to familiarise themselves with the environment and the anaesthesia procedures; the control group received usual care. The primary endpoint was anxiety during anaesthesia induction, measured with the modified Yale Preoperative Anxiety Scale; secondarily, self-reported anxiety, self-reported and observed pain, emergence delirium, the need for morphine as rescue analgesia and parental anxiety were recorded. The median of the modified Yale Preoperative Anxiety Scale in the group with virtual preparation was 40.0.

The 2004 review classifies exposure in virtual reality as a modified form of behaviour therapy and as a possible alternative to standard in vivo exposure; technically, it combines real-time computer graphics, body tracking, visual displays and further sensory input devices¹⁵. It finds evidence for efficacy in height and flight phobia, describes the research on other phobias as not yet conclusive and calls for randomised clinical trials in which exposure in virtual reality is tested against standard exposure and evaluated as a standalone treatment. A systematic review identified 285 empirical studies: 86 on diagnostics, 45 on theory development and 154 on treatment²⁹. The most frequently investigated conditions were anxiety ($n = 192$), schizophrenia ($n = 44$), substance-related disorders ($n = 22$) and eating disorders ($n = 18$). The authors describe the methodological quality of the studies as overall low and the reduction of anxiety disorders through exposure-based treatments as the best-established finding; the term virtual reality is frequently used for non-interactive and non-immersive technologies. A further review describes the technique as controlled delivery of sensory stimuli by the therapist via head-mounted display and specialised input devices that track head movements so that images and movement move naturally with them, and classifies it as a convenient and cost-effective treatment³⁰.

A meta-review of 25 reviews from 22 months concludes that virtual reality performs favourably in anxiety disorders, eating and weight disorders and pain management, with long-term effects that transfer to everyday life; the authors attribute this to embodied simulations, that is, the same mechanism by which the brain models body and environment³¹. For psychoses, 50 studies were included in a systematic review from 638 identified articles³²: safety and acceptance of the technique, neurocognitive diagnostics, functional capacity and performance, recording of paranoid ideas and auditory hallucinations, and interventions. The review describes virtual reality as a valuable method for capturing symptoms in ecologically valid environments and reports preliminary findings on cognitive rehabilitation, social skills training and VR-supported therapies. A literature review collected 36 studies on VR treatments in psychiatry²⁴ and describes exposure therapies as particularly effective for anxiety and helpful for phobias and post-traumatic stress disorder; for dementia, mild cognitive impairment, schizophrenia and autism, cognitive training and social skills training are described as routes to improving quality of life. The pooled effect size after treatment was $d = -0.47$ (95 % CI -0.69 to -0.24); subgroup analyses showed smaller effects for psychoeducation and training, better results for self-help versus guided interventions and higher effects with wait-list as control.

The Cochrane reviews on stroke rehabilitation, updates of a work first published in 2011, examine as primary aim the function and activity of the upper limb and as secondary aims, among others, gait and balance, global motor function, cognitive function, activity limitations, participation restrictions, quality of life and adverse events in adults after stroke; included are randomised and quasi-randomised studies^{1, 9}. A systematic review of VR-supported training screened 246 articles and included 15¹³: of 12 studies on physiological endpoints, eight showed positive effects on physical fitness, muscle strength, balance and limb function; of four studies on psychological endpoints, three showed positive effects by alleviating fatigue, tension and depression, promoting calm and improving quality of life; nine studies examined rehabilitative endpoints. It remains open which depth of immersion and which number of sessions underpin the observed effects and whether the findings can be transferred to other application areas.

Fatigue and Stress

In a double-blind, placebo-controlled randomised clinical trial, 156 female and male veterans of the wars in Iraq and Afghanistan with post-traumatic stress disorder received, after an introductory session, five sessions of exposure in virtual reality supplemented either by D-cycloserine (50 mg) or alprazolam (0.25 mg) or placebo². The aim was to examine whether the addition of these two substances alters the outcome of the exposure.

Symptoms of post-traumatic stress disorder improved from before to after treatment in all conditions and were maintained at 3, 6 and 12 months. Between D-cycloserine and placebo, no differences in symptoms were observed at any time point. Alprazolam and placebo differed significantly in the Clinician-Administered PTSD Scale value after treatment and in the diagnosis at 3 months: the rate in the alprazolam group was 82.8 %, in the placebo group 47.8 %.

Extinction learning between sessions was a treatment-specific enhancer of outcome only in the D-cycloserine group; after treatment, the D-cycloserine group showed the lowest cortisol reactivity and the smallest startle response during the scenes in virtual reality. The authors conclude that a six-session treatment in virtual reality was associated with a reduction in diagnoses and symptoms.

Because exposure in this study was consistently accompanied by an additional substance, no statement about the effect of exposure alone can be derived from it; the contribution of D-cycloserine and alprazolam was examined. **Hypothesis:** The lower cortisol reactivity and the smaller startle response in the D-cycloserine group could indicate an independent mechanism of action of the accompanying substance via extinction learning; this is an assumption from the reported secondary measures, not from the symptom values. It remains open how a six-session exposure without accompanying substance performs in this population and how the number of sessions affects maintenance over twelve months.

Musculoskeletal System

A systematic meta-analysis included 30 randomised controlled trials with 1473 patients after stroke and distinguished VR systems developed specifically for rehabilitation from those intended for leisure games¹⁶. Specific systems showed a significant effect on body function versus conventional therapy (SMD = 0.23; 95 % CI = 0.10 to 0.36; P = .0007), non-specific systems did not (SMD = 0.16; 95 % CI = -0.14 to 0.47; P = .30); this pattern was repeated in the activity measures. **Proven:** In the pooled analysis, an effect on body function and activity measures was shown for specifically developed VR systems versus conventional therapy, but not for non-specific systems.

For telerehabilitation, a single-blind randomised controlled study examined 30 chronic outpatient patients with stroke and residual hemiparesis³. Twenty 45-minute training sessions were completed three times per week, either in the clinic or at home via the telerehabilitation system. The primary endpoint was the Berg Balance Scale, secondary the balance and gait subscales of the Performance-Oriented Mobility Assessment and the Brunel Balance Assessment; additionally, System Usability Scale and Intrinsic Motivation Inventory as well as costs in dollars were recorded, measured at baseline, after 8 weeks and after 12 weeks. Both groups improved markedly from the first to the last assessment in the Berg Balance Scale ($\eta^2 = .68$; P = .001), in the balance subscale ($\eta^2 = .24$; P = .006) and in the gait subscale ($\eta^2 = .57$; P = .001).

In the randomised, single-blind, multicentre EVREST study, adults aged 18 to 85 years with a first ischaemic stroke and a motor deficit of the upper limb of at least 3 points on the Chedoke-McMaster Scale within 3 months of randomisation were included, recruited from 14 inpatient rehabilitation units in four countries (Canada 11, Argentina 1, Peru 1, Thailand 1)⁵. Ten sessions of 60 minutes each took place over two weeks in addition to conventional rehabilitation, either with a non-immersive VR game system or with simple leisure activities such as card games, bingo, Jenga or ball games; endpoints were assessed blinded, primary endpoint was upper limb function. In a single-blind randomised controlled study, 28 patients with Parkinson's disease were divided into two groups of 14 each⁸. The intervention group trained for 12 weeks, 45 minutes per session on 5 days per week in virtual reality, the control group received conventional physiotherapy; Berg Balance Scale, Timed Up and Go Test, part three of the Unified Parkinson's Disease Rating Scale and Functional Gait Assessment were recorded before and after treatment. Berg Balance Scale, Timed Up and Go Test and Functional Gait Assessment improved significantly in both groups (P < 0.05); in part three of the Unified Parkinson's Disease Rating Scale, no significant difference was found in the control group (P > 0.05). The VR group performed significantly better than the conventionally treated group (P < 0.05).

A systematic review with meta-analysis according to PRISMA guidelines searched the databases CINAHL Plus, MEDLINE, Web of Science, Embase and Cochrane Library on 31 December 2021 for randomised controlled trials on VR-supported exercise therapy of the upper limb after stroke¹⁴. Changes in impairments of function and structure of the upper limb, in activity limitations and in participation restrictions were evaluated, each from baseline to post-intervention, from there to follow-up and from baseline to follow-up; standardised mean differences were calculated with a random-effects model, subgroup analyses examined age, recovery stage, VR programme type, mode of therapy delivery and agreement of intervention duration. Which exercise intensity, which depth of immersion and which number of sessions underpin the motor effects has not yet been examined.

Safety and Tolerability

An international working group of 21 specialists, selected according to their contributions to the literature on virtual reality, met in repeated sessions to develop a methodological framework for planning, conducting, evaluating, interpreting and communicating studies on VR treatments⁴. The discussions were transcribed, central themes identified and a scientific framework for the methodology of clinical studies derived from them.

The phase model I to III of drug testing by the Food and Drug Administration served as orientation; from this emerged a framework with three levels of clinical study designs: VR1, VR2 and VR3. VR1 studies develop content jointly with patients and therapists according to the principles of human-centred design; VR2 studies conduct the early testing with emphasis on feasibility; VR3 studies examine efficacy. **Plausible:** Such a staged framework makes adverse events and reasons for discontinuation comparable across studies because their recording is already placed in the early phases. It remains open how the three stages will be adopted in practice and with which instruments adverse events in VR studies will be recorded uniformly.

Further Investigations

A systematic review with meta-analysis evaluated 21 randomised controlled trials with a median PEDro score of 6.0 and compared balance or gait training with and without virtual reality in patients after stroke¹⁰. For the most frequent measures — gait speed, Berg Balance Scale and Timed Up & Go Test — a greater effect of training with virtual reality than conventional therapy was shown; the advantage was more pronounced when the VR sessions were conducted in addition to conventional therapy and the time dose was matched. As limitations, the authors cite publication bias and heterogeneity of the included studies. For pain, 20 experimental and quasi-experimental studies from the period January 2007 to December 2018 were evaluated²³. The majority of the studies supported the use of virtual reality for reducing acute pain during and immediately after a procedure; several studies found pain reduction in chronic pain during VR exposure, for sustained pain relief the review found insufficient evidence. Patient groups, pain conditions and dose of VR exposure varied considerably, so heterogeneity did not permit a meta-analysis.

A systematic review with meta-analysis identified 41 (2.87 %) from 1430 found studies and examined all reported endpoints in chronic pain²⁷. In a three-level meta-analysis of 194 effect sizes from 25 studies, a pooled effect size of 1.22 (95 % CI 0.55–1.89; z = 3.56; P < .001) emerged in favour of an improvement after the VR intervention; evidence was found for pain, functional ability, mobility, functional capacity, psychological endpoints, quality of life, neuropsychological endpoints and physical sensations. In a prospective randomised comparative effectiveness study, 120 inpatients with an average pain score of at least 3 out of 10 points received either a library of 21 VR experiences via a head system or special health-promoting television programmes; 61

were assigned to the VR group and 59 to the control group ¹². The mean difference in pain scores immediately before and after the first application was greater in the VR group (-1.72 points; SD 3.56) than in the control group (-0.46 points; SD 3.01) and significant in favour of virtual reality ($P < .04$); values after 48 and 72 hours were also compared.

36 participants with Parkinson's disease (Hoehn and Yahr stage 1 to 3) were randomised into three groups ²⁶. The two exercise groups completed 12 sessions over 6 weeks with either a VR game programme or traditional exercise, each 45 minutes, followed by 15 minutes of treadmill training; the control group received no structured exercise programme. Primary endpoints were obstacle negotiation (crossing speed, step length, vertical toe clearance) and dynamic balance (maximum excursion, movement velocity, directional control in the Limits of Stability test), secondary Sensory Organization Test, Parkinson's Disease Questionnaire, Fall Efficacy Scale and Timed Up and Go Test, recorded at baseline, after training and after one month. A review on diagnostics in mental health describes as strengths the higher ecological validity of controlled environments, stronger personalisation and engagement as well as the recording of automatic data in real time ³³; as questions it names costs and access, building the evidence base, technical challenges and ethical implications.

A selective review identified six studies on the mechanisms of pain relief, four small randomised controlled trials and two prospective or pilot studies, in adults and children, on acute pain and on chronic conditions such as headache or fibromyalgia, partly in combination with biofeedback and cognitive behavioural therapy ⁶. As mechanism of action it describes distraction and, beyond that, neurophysiological changes in connection with conditioning and exposure therapies. For paediatric pain, a review describes acute and procedural pain as well as rehabilitation in chronic pain and names presence, interactivity, individualisation, social interaction and embodiment as properties that make virtual reality acceptable for children and adolescents; at the same time it points out that the experiences carry risks and should be used with caution ²⁵. For sustained pain relief in chronic courses and for the transfer of balance gains into everyday life, clarification through studies with uniform dose and follow-up is still outstanding.

Skin

In a single-blind randomised controlled study at the burns clinic of a large children's hospital, 30 adolescents aged 10 to 17 years were included and during wound care assigned to three groups: usual care, passive distraction by a film or virtual reality via a tripod device instead of an immersive helmet; 28 participants completed the study ¹¹. Before wound care, the State-Trait Anxiety Inventory for Children and a pre-procedure questionnaire were completed without the participants knowing their group assignment.

Pain was assessed after wound care with the Adolescent Pediatric Pain Tool. The VR group reported less pain than the passive distraction group and than the usual care group, determined by multivariable linear regression controlling for age, sex, pain before the procedure, state anxiety, opioid use and treatment duration. Only in the VR group was an estimated decrease in pain perception from baseline before the procedure to pain during the procedure found. Adolescents who had previously received opioid analgesics and female adolescents reported more pain during care. How the effect holds over several consecutive wound care sessions and beyond discharge has not yet been examined in 28 evaluated adolescents.

Oncology

From 882 screened titles and abstracts, 23 studies were included in a systematic review published between 2000 and 2020 that examined the effect of VR interventions on symptoms in cancer patients; MEDLINE/PubMed, Cochrane Library and ScienceDirect were searched ²⁸. Quality assessment, data extraction and analysis were performed for all included studies; the studies were ordered by symptom groups: anxiety and depression, fatigue and pain.

The review shows that VR interventions were more effective than the control condition, that is standard care, for anxiety, depression, fatigue and pain; the authors see this as an approach that can alleviate these symptoms in different contexts and conditions. **Hypothesis:** Because the studies were ordered by symptom groups and not by VR content, the effects could be distributed differently across the contents of the virtual environments, the number of sessions and the support provided by the treatment team; this cannot be derived from the review. Which VR contents, session numbers and follow-up periods carry the effects in oncological patients is not reported separately and remains an open question.

Overall picture

Across the fields, one finding stands out most clearly: exposure-based treatments in virtual reality reduce anxiety symptoms. The pooled data from the anxiety meta-analysis support this, and for social anxiety disorder the equivalence with in vivo exposure holds up to the twelve-month follow-up.

Established: The same relationship between exercise logic and outcome appears in the motor domain; systems developed specifically for rehabilitation are more effective than conventional therapy after stroke, whereas non-specific leisure systems are not. In pain, balance and gait, virtual reality contributes primarily when it is used in addition to conventional treatment with matching time dose.

Where research is at an early stage: The pain review found insufficient evidence for sustained pain relief in chronic courses, the burn-pain study in adolescents is small, and the six-session treatment of post-traumatic stress disorder was tested exclusively in combination with D-cycloserine or alprazolam. **Hypothesis:** That the effect operates through conditioning and exposure mechanisms and not through distraction alone is a reasoned assumption from six studies on pain mechanisms and from the model of embodied simulations; it could be tested in studies that measure the mechanism directly. What must also be clarified next is which depth of immersion and which dose carry the effects and how adverse events are recorded systematically.

Overall picture

What works in virtual reality remains open

One of the most cited works on pain treatment already poses the question in its title: Does virtual reality reduce pain through distraction, or is there more to it. This question is not peripheral, because if distraction is the active component, then part of the studies are measuring not the virtual environment but attention guidance. The objection is supported by the comparator arms: when the application is tested against another activity rather than against standard treatment, the contribution of immersion cannot be isolated.

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is that several mechanisms act together — attention binding, exposure, movement training — and their share varies according to the field of application.

It is noteworthy that the most cited works in the entire field are predominantly reviews and mechanism studies, not individual studies. This indicates that orientation in this field occurs mainly through summaries and that the primary literature is difficult for the individual practitioner to survey. The 2019 recommendations of an international working group on the methodology of clinical studies with virtual reality are to be read against this background as a self-correction of the field.

HYPOTHESIS:

Some of the smaller controlled studies are likely to be susceptible to biased reporting because positive results are published more readily; reliable statements therefore rest on the meta-analyses.

3. How Reliable the Research Is

The controlled human studies are concentrated in a few areas. Cognitive questions and the musculoskeletal system are most strongly represented; together they account for the largest share of controlled studies. These are followed by investigations into the safety of the application and into fatigue. The fields of bowel, oncology, cardiovascular, skin, bone and inflammation are markedly smaller. The most cited controlled studies come from stroke rehabilitation, exposure treatment of anxiety disorders and pain management, for example in burn wounds and in hospitalised patients. The review and mechanism studies focus almost exclusively on mental health: anxiety, psychosis and the question of how virtual environments alter perception and body image.

Methodologically the field is broadly based: alongside a large number of controlled studies there are observational studies, basic research and reviews. Meta-analyses of randomised controlled trials are available for several applications, for example for exposure treatment of anxiety disorders and for balance training after stroke; there the effect can be classified as **belegt**. In other areas individual controlled studies predominate, whose comparator arms and endpoints differ, so that the findings are initially regarded as **gezeigt**. Some of the studies test the application not against standard therapy but against another form of distraction, which limits the statement about the actual contribution of the virtual environment. The heterogeneity of the systems additionally complicates synthesis.

4. What Is Frequently Claimed — and What the Data Support

AUSSAGE	STUDIENLAGE
Virtual reality helps with every form of anxiety.	For exposure treatment of anxiety disorders a meta-analysis of randomised controlled studies is available; for other forms of anxiety the situation is more inconclusive.
The application replaces conventional rehabilitation.	It was mostly tested as an adjunct or as an alternative to training; the comparison arms differ, so no substitution claim can be derived from this.
Pain can be reliably reduced with virtual reality.	The controlled studies primarily concern acute situations, for example before operations, in burn wounds and in hospitalised patients, not everyday life.
The application is a side aspect of treatment.	For safety there is a dedicated group of controlled studies; it is therefore not a marginal note but a subject of examination in its own right.

5. The Most Reliable Studies

Ordered by strength of evidence, not by prominence. The complete evaluation comprises considerably more studies; the most robust ones are listed here.

Controlled Human Studies

- ¹ Virtual reality for stroke rehabilitation (2017)
- Virtual reality exposure therapy for anxiety and related disorders: A meta-analysis of randomized controlled trials (2019)
- ² A randomized, double-blind evaluation of D-cycloserine or alprazolam combined with virtual reality exposure therapy for posttraumatic stress disorder ... (2014)
- ³ Effectiveness, usability, and cost-benefit of a virtual reality-based telerehabilitation program for balance recovery after stroke: a randomized ... (2015)
- ⁴ Recommendations for Methodology of Virtual Reality Clinical Trials in Health Care by an International Working Group: Iterative Study (2019)
- ⁵ Efficacy and safety of non-immersive virtual reality exercising in stroke rehabilitation (EVREST): a randomised, multicentre, single-blind ... (2016)

- ⁶ Innovative Technology Using Virtual Reality in the Treatment of Pain: Does It Reduce Pain via Distraction, or Is There More to It? (2018)
- ⁷ Virtual reality exposure therapy for social anxiety disorder: a randomized controlled trial (2013)
- Virtual reality exposure before elective day care surgery to reduce anxiety and pain in children: A randomised controlled trial (2019)
- ⁸ Virtual Reality Rehabilitation Versus Conventional Physical Therapy for Improving Balance and Gait in Parkinson's Disease Patients: A Randomized ... (2019)
- ⁹ Virtual reality for stroke rehabilitation (2015)
- ¹⁰ Effect of Virtual Reality Training on Balance and Gait Ability in Patients With Stroke: Systematic Review and Meta-Analysis (2016)
- ¹¹ Effect of virtual reality on adolescent pain during burn wound care (2014)
- ¹² Virtual reality for management of pain in hospitalized patients: A randomized comparative effectiveness trial (2019)
- ¹³ The Effectiveness of Virtual Reality Exercise on Individual's Physiological, Psychological and Rehabilitative Outcomes: A Systematic Review (2020)
- ¹⁴ Effectiveness of Using Virtual Reality-Supported Exercise Therapy for Upper Extremity Motor Rehabilitation in Patients With Stroke: Systematic Review ... (2022)
- ¹⁵ Virtual reality exposure therapy of anxiety disorders: a review (2004)
- ¹⁶ Effect of Specific Over Nonspecific VR-Based Rehabilitation on Poststroke Motor Recovery: A Systematic Meta-analysis (2019)
- ¹⁷ Inferiority or Even Superiority of Virtual Reality Exposure Therapy in Phobias?-A Systematic Review and Quantitative Meta-Analysis on Randomized ... (2019)
- ¹⁸ A rapid evidence assessment of immersive virtual reality as an adjunct therapy in acute pain management in clinical practice (2014)
- ¹⁹ Arm motor recovery using a virtual reality intervention in chronic stroke: randomized control trial (2013)
- ²⁰ Home-based virtual reality balance training and conventional balance training in Parkinson's disease: A randomized controlled trial (2016)
- ²¹ Use of virtual reality to enhance balance and ambulation in chronic stroke: a double-blind, randomized controlled study (2009)
- ²² Efficacy of virtual reality exposure therapy in the treatment of PTSD: a systematic review (2012)

6. Summary

As **proven** the effect is considered where meta-analyses of randomised controlled trials are available: for exposure treatment of anxiety disorders and for balance training after stroke. The anxiety meta-analysis pools 30 randomised controlled trials with 1057 participants: versus waiting list a large effect size ($g = 0.90$), versus in vivo exposure no significant difference ($g = -0.07$). The stroke meta-analysis over 30 randomised controlled trials with 1473 patients shows an effect specifically of rehabilitative systems on body function ($SMD = 0.23$), not of leisure game systems. In post-traumatic stress disorder the symptoms improved in all conditions and remained after 3, 6 and 12 months.

Proven is according to the pooled evidence of the stroke meta-analysis that not the technique itself, but the exercise logic implemented in it makes the difference. **Plausible** is that the effect depends less on the hardware than on repetition and graded exposure, because the captured studies run as training environment and as exposure space. **Hypothesis:** If embodied simulations carry the long-term effects, the same logic could also support exercise applications outside of anxiety.

What remains open is which immersion depth and which session number carry the anxiety effects and whether the findings are transferable to disorder pictures outside of anxiety. Equally open is how a six-session exposure without accompanying substance performs in veterans with post-traumatic stress disorder and how the session number influences maintenance over twelve months. A review from 2004 calls for randomised clinical trials that test virtual reality exposure against standard exposure and evaluate it as a standalone treatment. An international working group published in 2019 has presented recommendations for the methodology of clinical trials with virtual reality; to be clarified is whether comparability improves thereby.

7. What Remains Open

- **Mechanism:** Can the contribution of immersion be isolated when compared against another form of distraction and not against a standard treatment?
- **Comparability:** Which minimum details on system, immersion and session design make studies comparable across different fields of application?
- **Transfer:** Which findings from rehabilitation and exposure treatment apply to fields such as gut, skin or oncology, where only individual controlled studies are available so far?

Frequently Asked Questions

For which applications is the evidence base the most robust?

The evidence base is most robust where meta-analyses of randomised controlled trials exist: in exposure treatment for anxiety disorders and in balance training after stroke. There the effect can be classified as **proven**. For pain management in acute situations, for example in burn wounds and in hospitalised patients, several controlled studies are available. In the remaining application areas individual studies predominate.

How do I recognise whether a study is actually testing virtual reality itself?

The decisive factor is the comparator arm. When the application is tested against conventional therapy, something can be said about its contribution to treatment; when it is tested against another distraction, the study measures attention binding rather than the specific effect. Equally important is whether the system was immersive and which endpoints were recorded — motor measurements, questionnaires or cognitive test performance indicate different things.

How do immersive and non-immersive applications differ in the studies?

Both forms are represented in the studies. Immersive systems replace the field of view; non-immersive systems run on a monitor or projection surface. Because the studies handle immersion, control and session design differently, results can only be transferred between systems to a limited extent. The methodological recommendations for clinical studies with virtual reality issued by an international working group in 2019 address precisely this point.

Sources

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