TECHNICAL COMMENTARY

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Exercise therapy

Introduction

Individuals with serious mental illnesses are more likely to be sedentary than the general population and are consequently at high risk for chronic medical conditions associated with inactivity. Physical activity reduces the risk of these medical conditions, and positive psychological effects have also been reported, including improved quality of life. Exercise also has the potential to alleviate secondary symptoms including depression, low self-esteem and social withdrawal.

Method

We have included only systematic reviews (systematic literature search, detailed methodology with inclusion/exclusion criteria) published in full text, in English, from the year 2000 that report results separately for people with a diagnosis of schizophrenia, schizoaffective disorder, schizophreniform disorder or first episode schizophrenia. Reviews were identified by searching the databases MEDLINE, EMBASE, CINAHL, Current Contents, PsycINFO and the Cochrane library. Hand searching reference lists of identified reviews was also conducted. When multiple copies of reviews were found, only the most recent version was included. Reviews with pooled data are given priority for inclusion.

Review reporting assessment was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist that describes a preferred way to present a meta-analysis[1]. Reviews rated as having less than 50% of items checked have been excluded from the library. The PRISMA flow diagram is a suggested way of providing information about studies included and excluded with reasons for exclusion. Where no flow diagram has been presented by individual reviews, but identified studies have been described in the text, reviews have been checked for this item. Note that early reviews may have been guided by less stringent reporting checklists than the PRISMA, and that some reviews may have been limited by journal guidelines.

Evidence was graded using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) Working Group approach where high quality evidence such as that gained from randomised controlled trials (RCTs) may be downgraded to moderate or low if review and study quality is limited, if there is inconsistency in results, indirect comparisons, imprecise or sparse data and high probability of reporting bias. It may also be downgraded if risks associated with the intervention or other matter under review are high. Conversely, low quality evidence such as that gained from observational studies may be upgraded if effect sizes are large or if there is a dose dependent response. We have also taken into account sample size and whether results are consistent, precise and direct with low associated risks (see end of table for an explanation of these terms)[2]. The resulting table represents an objective summary of the available evidence, although the conclusions are solely the opinion of staff of NeuRA (Neuroscience Research Australia).

Results

We found 19 reviews that met our inclusion criteria[3-21].

- Moderate quality evidence suggests exercise therapy can improve symptoms, particularly negative symptoms, as well as improving quality of life and functioning. Moderate to low quality evidence suggests exercise therapy can also improve depression, anxiety, weight, and cardiometabolic factors.
- Moderate to high quality evidence suggests exercise therapy can improve cognition, particularly working memory, attention, and social cognition. More minutes per week of

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exercise supervised by a physical activity professional is associated with the greatest benefit.

- Moderate quality evidence finds no significant differences between mindfulness exercise (yoga or tai chi) and non-mindfulness exercise for mental health or social functioning.
- Moderate to high quality evidence finds a reduced risk of developing schizophrenia in people who exercise regularly, although this association was not apparent after controlling for other variables (SES, family structure, gender, age, BMI, physical activity intensity, birth weight, non-preterm birth, mother's mental disorders).

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Broderick J, Crumlish N, Waugh A, Vancampfort D

Yoga versus non-standard care for schizophrenia

Cochrane Database of Systematic Reviews 2017; 9: CD012052

View review abstract online

Comparison	**Yoga for people with schizophrenia vs. other exercise programs.**
Summary of evidence	**Moderate quality evidence (small to medium-sized samples, consistent where appropriate, precise, indirect) suggests a small effect of fewer people leaving the study early in the yoga groups, with no differences in mental health, quality of life, social functioning or physical health.**

Leaving the study early

A significant, small effect of fewer people in the yoga group leaving the study early;

6 studies, N = 586, RR = 0.64, 95%CI 0.49 to 0.83, $p = 0.0016$, $I^2 = 16\%$, $p = 0.31$

Mental health

Positive and Negative Syndrome Scale (PANSS)

There were no differences between groups;

1 RCT, N = 84, RR = 0.81, 95%CI 0.62 to 1.07, $p > 0.05$

Quality of life and social functioning

Short Form Survey (SF-36) quality of life sub-scale, Social and Occupational Functioning Scale (SOFS)

There were no differences between groups;

Quality of life: 1 RCT, N = 69, MD = -5.30, 95%CI -17.78 to 7.18, $p > 0.05$

Social functioning: 1 RCT, N = 84, RR = 0.90, 95%CI 0.78 to 1.04, $p > 0.05$

Physical health

World Health Organization Quality of Life BREF Version (WHOQOL-BREF) physical-health sub-scale

There were no differences between groups;

1 RCT, N = 69, MD = 9.22, 95%CI -0.42 to 18.86, $p > 0.05$

Risks	No differences in adverse effects.
Consistency in results‡	Consistent where appropriate (> 1 RCT).
Precision in results§	Precise
Directness of results‖	Indirect; mixed control conditions.

Broderick J, Vancampfort D

Yoga as part of a package of care versus standard care for schizophrenia

Cochrane Database of Systematic Reviews 2017; 9: CD012145

View review abstract online

Comparison	**Yoga package for people with schizophrenia vs. standard care.** **Yoga package was yoga combined with drama, music, motivational and feedback session, or counselling.**
Summary of evidence	**Low quality evidence (small samples, inconsistent where appropriate, unable to assess precision, indirect) is unable to determine any benefits of yoga packages over standard care.**
Leaving the study early	
There were no differences between groups; 3 RCTs, N = 193, RD = 0.06, CI -0.01 to 0.13, $p = 0.084$, $I^2 = 70\%$, $p = 0.4$	
Quality of life **Short Form Survey (SF-36) quality of life sub-scale**	
A significant effect of greater improvement in quality of life with yoga; 1 RCT, N = 80, MD = 22.93, 95%CI 19.74 to 26.12, $p < 0.00001$	
Consistency in results	Inconsistent where appropriate (> 1 RCT).
Precision in results	Unable to assess; standardised measures are not reported.
Directness of results	Indirect; mixed yoga package conditions.

Brokmeier LL, Firth J, Vancampfort D, Smith L, Deenik J, Rosenbaum S, Stubbs B, Schuch FB

Does physical activity reduce the risk of psychosis? A systematic review and meta-analysis of prospective studies

Psychiatry Research 2019; 284: 112675

View review abstract online

Comparison	**Development of schizophrenia in people with high physical activity vs. low physical activity.**
Summary of evidence	**Moderate to high quality evidence (large samples, consistent precise, indirect) suggests a reduced risk of developing schizophrenia in people who exercise regularly, although this association may be explained by other variables (SES, family structure, gender, age, BMI, physical activity intensity, birth weight, non-preterm birth, mother's mental disorders).**
Schizophrenia	
A significant, small effect of fewer people developing schizophrenia in the high exercise group; 4 studies, N = 30,025, OR = 0.73, 95%CI 0.52 to 0.99, p = 0.04, I^2 = 37%, p = 0.17 *The association was not significant in the analysis of adjusted data;* 2 studies, N = 15,971, OR = 0.59, 95%CI 0.25 to 1.38, p = 0.226, I^2 = 56%, p = 0.13	
Risks	Not reported
Consistency in results	Consistent
Precision in results	Precise for the unadjusted analysis, imprecise for the adjusted analysis.
Directness of results	Indirect; mixed exercise and control conditions

Cramer H, Lauche R, Klose P, Langhorst J, Dobos G

Yoga for schizophrenia: a systematic review and meta-analysis

BMC Psychiatry 2013; 13: 32

Exercise therapy

View review abstract online	
Comparison 1	**Up to 4 months of yoga plus standard care vs. standard care.**
Summary of evidence	**Moderate to low quality evidence (small samples, inconsistent, imprecise, direct) suggests a large effect for improved quality of life after up to 4 months of yoga compared to standard care. There were no differences in symptoms or social functioning.**
Mental health **Positive and Negative Syndrome Scale (PANSS)**	
No significant differences in positive symptoms in patients receiving yoga vs. standard care; 2 RCTs, N = 91, *d* = -0.58, 95%CI -1.52 to 0.37, *p* = 0.23, I^2 = 66%, *p* = 0.08 *No significant differences in negative symptoms in patients receiving yoga vs. standard care;* 2 RCTs, N = 91, *d*= -0.59, 95%CI -1.87 to 0.69, *p* = 0.36, I^2 = 80%, *p* = 0.02	
Quality of life and social functioning **World Health Organization Quality of Life BREF Version (WHOQOL-BREF) quality of life assessment, General Quality of Life Inventory-74, Subjective Exercise Experiences Scale, Social and Occupational Functioning Scale (SOFS)**	
A significant, large improvement in quality of life in patients receiving yoga vs. standard care; 2 RCTs, N = 98, *d* = 2.28, 95%CI 0.42 to 4.14, *p* = 0.02, I^2 = 89%, *p* < 0.01 *No significant differences in social functioning in patients receiving yoga vs. standard care;* 3 RCTs, N = 171, *d* = 1.20, 95%CI -0.78 to 3.18, *p* = 0.23, I^2 = 96%, *p* < 0.01	
Risks	No differences in extrapyramidal symptoms.
Consistency in results	Inconsistent
Precision in results	Imprecise
Directness of results	Direct
Comparison 2	**4 months of yoga plus standard care vs. exercise therapy plus standard care**
Summary of evidence	**Moderate quality evidence (small samples, inconsistent, mostly precise, direct) suggests no differences in symptoms, social functioning or quality of life after 4 months of yoga compared to exercise.**
Mental health **Positive and Negative Syndrome Scale (PANSS)**	

No significant differences in positive symptoms in patients receiving yoga vs. exercise; 2 RCTs, N = 102, *d* = -0.35, 95% CI -0.75 to 0.05, *p* = 0.09, I^2 = 0%, *p* = 0.85 *No significant differences in negative symptoms in patients receiving yoga vs. exercise;* 2 RCTs, N = 102, *d* = -0.28, 95%CI -1.42 to 0.86, *p* = 0.63, I^2 = 87%, *p* < 0.01
Quality of Life and social functioning **World Health Organization Quality of Life BREF Version (WHOQOL-BREF) general functioning assessment, Social and Occupational Functioning Scale (SOFS)**
No significant differences in quality of life in patients receiving yoga vs. exercise; 1 RCT, N = 61, *d* = 0.17; 95% CI −0.27 to 0.61 *No significant differences in social functioning in patients receiving yoga vs. exercise;* 2 RCTs, N = 102, *d* = 0.20; 95%CI −0.27 to 0.67, *p* = 0.41, I^2= 27%, *p* = 0.24

Risks	No differences in extrapyramidal symptoms.
Consistency in results	Consistent, apart from negative symptoms.
Precision in results	Precise
Directness of results	Direct

Dauwan M, Begemann MJH, Heringa SM, Sommer IE

Exercise improves clinical symptoms, quality of life, global functioning, and depression in schizophrenia: A systematic review and meta-analysis

Schizophrenia Bulletin 2016; 42(3): 588-99

View review abstract online

Comparison	**Exercise therapy plus standard care vs. control conditions.**
Summary of evidence	**Moderate quality evidence (large samples, inconsistent, precise, indirect) suggests exercise therapy can improve symptoms, quality of life and functioning in people with schizophrenia. Yoga may show some benefit for long-term memory.**
Mental health **Positive and Negative Syndrome Scale (PANSS), Brief Psychiatric Rating Scale (BPRS), Scale for the Assessment of Positive Symptoms (SAPS) or the Scale for the Assessment of Negative Symptoms (SANS)**	

Exercise therapy

Small to medium-sized effects of improved symptoms with exercise therapy; Total symptoms: 14 studies, N = 659, *g* = 0.39, 95%CI 0.19 to 0.58, *p* < 0.001, I^2 = 61% Subgroup analysis of total symptoms showed the effect size was larger in the passive control studies than in the active control studies (*g* = 0.25, vs. *g* = 0.75), although both remained significant. Positive symptoms: 15 studies, N = 641, *g* = 0.32, 95%CI 0.14 to 0.50, *p* < 0.01, I^2 = 50% Subgroup analysis of positive symptoms showed the effect size was larger in the passive control studies than in the active control studies (*g* = 0.27, vs. *g* = 0.70), although both remained significant. Negative symptoms: 18 studies, N = 765, *g* = 0.49, 95%CI 0.31 to 0.67, *p* < 0.01, I^2 = 60% Subgroup analysis of negative symptoms showed the effect size was larger in the passive control studies than in the active control studies (*g* = 0.33, vs. *g* = 0.89), although both remained significant. General symptoms: 10 studies, N = 436, *g* = 0.27, 95%CI 0.04 to 0.50, *p* < 0.05, I^2 = 58% Subgroup analysis of general symptoms showed the effect size was larger in the passive control studies than in the active control studies (*g* = 0.16, vs. *g* = 0.64), with only the passive control analysis remaining significant. Depressive symptoms: 7 studies, N = 316, *g* = 0.71, 95%CI 0.33 to 1.09, *p* < 0.01, I^2 = 79% Authors report no publication bias.
Quality of life and functioning **Global Assessment of Functioning scale (GAF), and Social and Occupational Functioning Assessment Scale (SOFAS/SOFS)**
Small to medium-sized effects of improved quality of life and functioning with exercise therapy; Quality of life: 11 studies, N = 277, *g* = 0.55, 95%CI 0.35 to 0.76, *p* < 0.001, I^2 = 49% Functioning: 5 studies, N = 276, *g* = 0.32, 95%CI 0.11 to 0.53, *p* < 0.01, I^2 = 0%
Cognition
No differences between groups for cognition; Working memory: 6 studies, N = 262, *g* = 0.23, 95%CI -0.04 to 0.50, *p* > 0.05, I^2 = 49% Long-term memory: 6 studies, N = 262, *g* = 0.14, 95%CI -0.07 to 0.35, *p* > 0.05, I^2 = 14% Processing speed: 4 studies, N = 201, *g* = 0.15, 95%CI -0.10 to 0.40, *p* > 0.05, I^2 = 24% Attention/executive functioning: 4 studies, N = 209, *g* = 0.07, 95%CI -0.17 to 0.32, *p* > 0.05, I^2 = 59% *Moderator analyses revealed a significant effect of improving long-term memory with yoga;* 2 studies, N = 184, *g* = 0.32, 95%CI 0.04 to 0.61, *p* < 0.01

Risks	Not reported
Consistency in results	Inconsistent, apart from functioning.

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Precision in results	Precise
Directness of results	Indirect; mixed control conditions.

Firth J, Cotter J, Elliott R, French P, Yung AR

A systematic review and meta-analysis of exercise interventions in schizophrenia patients

Psychological Medicine 2015; 45: 1343-61

View review abstract online

Comparison	**Exercise therapy vs. control conditions.**
Summary of evidence	**Moderate quality evidence (small samples, consistent, precise, indirect) suggests exercise therapy can improve symptoms. Moderate to low quality evidence (imprecise) suggests no differences in BMI.**

Mental health

A large, significant effect of improved total symptom scores following exercise was found in the subgroup analysis that excluded four trials implementing low-intensity exercise (e.g. walking, stretching) in comparison with yoga;

4 RCTs, N = 95, SMD = -0.72, 95%CI -1.14 to -0.29, $p = 0.0009$, $I^2 = 0\%$, $p = 0.72$

Medium-sized, significant effects of improved positive and negative symptoms following moderate to vigorous exercise;

Positive: 4 RCTs, N = 97, SMD = -0.54, 95%CI -0.95 to -0.13, $p = 0.009$, $I^2 = 0\%$, $p = 0.94$

Negative: 5 RCTs, N = 140, SMD = -0.44, 95%CI -0.78 to -0.09, $p = 0.01$, $I^2 = 0\%$, $p = 0.84$

BMI

No significant differences in BMI;

4 RCTs, N = 80, MD = -0.98, 95%CI -3.17 to 1.22, $p = 0.38$, $I^2 = 0\%$, $p = 0.85$

Risks	Not reported
Consistency in results	Consistent
Precision in results	Precise for symptoms, unable to assess BMI (not SMD)
Directness of results	Indirect; mixed control conditions.

Firth J, Stubbs B, Rosenbaum S, Vancampfort D, Malchow B, Schuch F, Elliott R, Nuechterlein KH, Yung AR

Aerobic Exercise Improves Cognitive Functioning in People With Schizophrenia: A Systematic Review and Meta-Analysis

Schizophrenia Bulletin 2017; 43(3): 546-56

View review abstract online

Comparison	**Exercise therapy plus standard care vs. control conditions; mostly treatment as usual.** **Average 2.9 sessions per week of 20–60 minutes over 12.2 weeks, primarily focused on aerobic exercise.**
Summary of evidence	**Moderate to high quality evidence (small to medium-sized samples, consistent, precise, direct) suggests exercise therapy can improve cognition, particularly working memory, attention and social cognition, with more minutes per week supervised by a physical activity professional being most beneficial.**

Cognition

Medium-sized effects of improved global cognition, working memory, attention and social cognition with exercise therapy;

Global cognition: 10 studies, N = 383, g = 0.33, 95%CI 0.13 to 0.53, p = 0.001, I^2 = 0%

Working memory: 7 studies, N = 282, g = 0.39, 95%CI 0.05 to 0.73, p = 0.024, I^2 = 45.1%

Attention/vigilance: 3 studies, N = 104, g = 0.66, 95%CI 0.20 to 1.12, p = 0.005, I^2 = 20.3%

Social cognition: 3 studies, N = 81, g = 0.71, 95%CI 0.27 to 1.15, p = 0.002, I^2 = 0%

There were no significant differences for processing speed, verbal or visual learning and memory, and reasoning and problem solving;

Processing speed: 6 studies, N = 195, g = 0.13, 95%CI -0.15 to 0.40, p = 0.38, I^2 = 0%

Verbal learning/memory: 6 studies, N = 166, g = 0.28, 95%CI -0.09 to 0.64, p = 0.14, I^2 = 35.6%

Visual learning/memory: 3 studies, N = 61, g = 0.004, 95%CI -0.45 to 0.52, p = 0.889, I^2 = 0%

Reasoning/problem solving: 4 studies, N = 146, g = -0.10, 95%CI -0.42 to 0.22, p = 0.53, I^2 = 0%

There were no significant differences between exercise plus cognitive remediation therapy and cognitive remediation therapy alone;

3 studies, N = 76, g = 0.21, 95%CI -0.33 to 0.75, p = 0.45, I^2 = 26.8%

Moderator analysis on the global cognition effect showed exercise interventions supervised by

physical activity professionals showed a non-significant, but larger effect than those supervised by other professionals (g = 0.47 vs. g = 0.20, Q_B p = 0.19). A trend effect was also found for more minutes per week of exercise being associated with greater improvement in global cognition (B = 0.0054, p = 0.065), although there was no effect when exercise duration was measured in weeks or in the number of sessions per week. There were also no significant differences in the effect size for global cognition according to study design (RCT vs. non-randomised), study quality, patient age, sex or duration of illness. Authors report no evidence of publication bias	
Risks	Not reported
Consistency in results	Consistent
Precision in results	Precise
Directness of results	Direct

Gorczynski P, Faulkner G

Exercise therapy for schizophrenia

Cochrane Database of Systematic Reviews 2010; Issue 5. Art. No.: CD004412.

View review abstract online

Comparison	**Exercise therapy plus standard care vs. standard care.**
Summary of evidence	**Low quality evidence (very small samples, unable to assess consistency or precision, direct) is uncertain of the benefit for exercise therapy over standard care.**

Mental health

Mental Health Inventory (MHI), Positive and Negative Syndrome Scale (PANSS)

1 RCT compared 12 weeks of aerobic and strength training for 1 hour twice a week to standard care

No difference between groups in MHI total scores;

N = 10, MD = 7.40, 95%CI -2.46 to 17.26, p = 0.14

Significantly improved MHI depression ratings for the exercise group;

N = 10, MD = 17.50, 95%CI 6.70 to 28.30, p = 0.0015

Significantly improved MHI anxiety ratings for the exercise group;

N = 10, MD = 8.00, 95%CI 0.80 to 15.20, p = 0.029

No difference between groups in MHI positive affect scores;

N = 10, MD = 3.30, 95%CI -23.66 to 30.66, *p* = 0.81 *No difference between groups in MHI behavioural scores;* N = 10, MD = -5.40, 95%CI -21.28 to 10.48, *p* = 0.51 1 RCT compared 16 weeks of walking for 30 minutes, 3 times a week to standard care *Significantly improved PANSS negative ratings for the exercise group;* N = 10, MD = -8.50, 95%CI -11.11 to -5.89, *p* < 0.00001 *Significantly improved PANSS positive ratings for the exercise group;* N = 10, MD = -2.50, 95%CI -4.73 to -0.27, *p* = 0.028
Physical health
1 RCT compared 12 weeks of aerobic and strength training for 1 hour twice a week to standard care *Significantly improved physical fitness for the exercise group;* N = 13, MD = 79.50, 95%CI 33.82 to 125.18, *p* = 0.00065 *Significantly improved maximal strength for the exercise group;* N = 13, MD = 2.00, 95%CI 0.55 to 3.45, *p* = 0.0069 *No difference between groups in blood pressure;* N = 13, MD = -1.00, 95%CI -8.05 to 6.05, *p* = 0.78 *No difference between groups in body mass index;* N = 13, MD = -1.20, 95%CI -2.92 to 0.52, *p* = 0.17 *No difference between groups in waist and hip ratio;* N = 13, MD = 0.01, 95%CI -0.02 to 0.04, *p* = 0.49 *No difference between groups in final weight;* N = 13, MD = 1.30, 95%CI -3.64 to 6.24, *p* = 0.61
Leaving the study early
2 RCTs compared aerobic and strength training or walking vs. standard care *No difference between groups;* N = 25, RR = 5.00, 95%CI 0.29 to 86.43, *p* = 0.27, I^2 = 0, *p* = 1.00

Risks	Not reported
Consistency in results	Consistent where applicable (leaving the study early).
Precision in results	Imprecise for leaving the study early, unable to assess other outcomes (not standardised).
Directness of results	Direct

Exercise therapy

Comparison 2	**Exercise therapy (16 weeks light walking, jogging, stretching, and relaxation techniques for 1 hour, 5 times a week) plus standard care vs. yoga (1 hour, five times a week) plus standard care.**
Summary of evidence	**Low quality evidence (small samples, unable to assess precision, direct) is uncertain of the benefit for exercise therapy over yoga.**
Mental health **Positive and Negative Syndrome Scale (PANSS)**	
1 RCT compared exercise vs. yoga *Significantly improved PANSS total ratings for the yoga group vs. the exercise group;* N = 41, MD = 14.95, 95%CI 2.60 to 27.30, *p* = 0.018 *Significantly improved PANSS depression ratings for the yoga group;* N = 41, MD = 2.89, 95%CI 0.86 to 4.92, *p* = 0.0052 *Significantly improved PANSS anergia ratings for the yoga group;* N = 41, MD = 2.40, 95%CI 0.47 to 4.33, *p* = 0.015 *Significant improvement in PANSS negative score in yoga group;* N = 41, MD = 5.56, 95%CI 1.69 to 9.43, *p* = 0.0049 *No difference between groups in PANSS positive score;* N = 41, MD = 2.41, 95%CI -1.20 to 6.02, *p* = 0.19	
General functioning **Social and Occupational Functioning Scale (SOFS)**	
1 RCT compared exercise vs. yoga *No differences between groups in SOFS ratings;* N = 41, MD = 4.35, -1.18 to 9.88, *p* = 0.12	
Quality of Life **World Health Organization Quality of Life BREF Version (WHOQOL-BREF)**	
1 RCT compared exercise vs. yoga *No differences between groups in WHOQOL psychological ratings;* N = 41, MD = -9.22, -18.86 to 0.42, *p* = 0.061 *Significantly improved WHOQOL social ratings for the yoga group vs. the exercise group;* N = 41, MD = -20.75, -34.08 to -7.42, *p* = 0.0023 *Significantly improved WHOQOL environmental ratings for the yoga group vs. the exercise group;*	

N = 41, MD = -18.09, -28.52 to -7.66, *p* = 0.00067	
Leaving the study early	
High attrition in both groups, no significant difference between groups; N = 61, RR = 0.90, 0.47 to 1.88, *p* = 0.86	
Risks	No differences between groups in Parkinsonism (Simpson Angus Scale, Abnormal Involuntary Movements Scale).
Consistency in results	Not applicable (1 RCT).
Precision in results	Unable to assess (not standardised).
Directness of results	Direct

Holley J, Crone D, Tyson P, Lovell G

The effects of physical activity on psychological well-being for those with schizophrenia: A systematic review

British Journal of Clinical Psychology 2011; 50: 84-105

View review abstract online

Comparison	**Exercise therapy in a variety of experimental settings vs. control conditions.**
Summary of evidence	**Moderate to low quality evidence (small samples, unable to assess consistency or precision, direct) suggests exercise therapy may improve anxiety, competence, quality of life and functioning levels, but not positive or negative symptoms, motivation, confidence or self-esteem.** **Low quality evidence (small samples, direct, unable to assess consistency or precision) is unsure of the benefit of exercise therapy on perceived physical self-efficacy and body image.**
Mental health	
3 of 4 studies reported a significant improvement in anxiety; 1 quasi-experimental (not randomised), N = 40, with chronic schizophrenia – all on chlorpromazine. Patients participated in both high and low physical activity (swimming, work therapy, gardening, occupational therapy), 2 x per week, reported that patients showed decreased tension (*p* = 0.0004) and irritability (*p* value not reported).	

1 quasi-experimental, N = 80 with chronic schizophrenia. Patients participated in an aerobic exercise conditioning program (jogging), 3 x 40 min per week for 10 weeks and reported decreased scores on Profile of Mood States scale ($p \leq 0.05$).

1 single case study, N = 1 with chronic schizophrenia and on neuroleptic medication, participated in an exercise program in a community gym, 4 x 20-50 min/week for 12 weeks, and reported decreased tension ($p < 0.05$).

The remaining 1 study reported no difference between groups in anxiety levels and 3 of 3 studies reported no difference in positive and negative symptoms;

1 case study, 1 RCT, 1 experimental study (no control), 1 structured interview (no control), N = 76. Patients took part in various exercise activities (yoga vs. physical training and bicycle ergometer). Results were non-significant, however authors reported beneficial outcomes after exercise.

Functioning and quality of life

1 of 1 study reported significant improvement in perceived general competence;

1 quasi-experimental (cross-over) study, N = 15, aged 16 to 21 years on 500mg largactil, some cases lithium. Patients participated in a physical activity program (warm up, Frisbee, skipping) in groups and individually as part of an educational program, 5 x 45 min/week (for 3 weeks of study then a week of wash out then swapped intervention) for 7 weeks, $p = 0.28$.

4 of 8 studies reported significant increase in social competence, quality of life and functioning;

1 RCT, N = 61, aged 18 to 55 years, all on chlorpromazine. Patients participated in yoga therapy vs. physical training such as walking or jogging, 5 x 60 min/week for 3 weeks. The yoga therapy group showed a significant improvement on Quality of Life (QOL) and Social and Occupational Functioning Scale (SOFS).

1 quasi-experimental study, N = 40, aged 20 to 77 years with chronic schizophrenia– all on chlorpromazine. Patients participated in both high and low physical activity (high-swimming, work therapy, gardening, occupational therapy) 2 x per week.

1 single case study, N = 1 male, with chronic schizophrenia on neuroleptic medication, participated in an exercise program in a community gym, 4 X 20 to 50 min/week for 12 weeks.

1 quasi-experimental, N = 30 on antipsychotic medication. Patients took part in an aerobic exercise program 3 x per week for the first 2 weeks 25 minutes then increased to 40 minutes for 10 weeks. Participants significantly improved on all psychological measured except alogia (poverty of speech).

The 4 remaining studies reported no significant difference in social competence;

2 experimental (no control), 1 observational, 1 qualitative study, N = 34 schizophrenia patients (16 on antipsychotics). Patients took part in various exercise programs (hallway walking (whenever they had a hallucinatory episode), kinesiotherapy program, walking and swimming, football program), the findings were not significant although authors reported that patients showed increased competence and social activity.

2 of 2 studies reported no difference in motivation;

1 experimental study (no control), 1 observational study, N = 14. Patients took part in various physical activities (walking, swimming in local park and leisure center, bike ergometer, muscle toning/strengthening exercises) which varied from 8 to 10 weeks, authors reported non-significant

results however exercise led to increased motivation towards other components of the rehabilitation program. *3 of 3 studies reported no significant difference in patients' confidence and self-esteem;* 3 studies (1 narrative life history, 1 observational, 1 qualitative) study, N = 17 schizophrenia on antipsychotics. Patients participated in various exercise programs (walking, swimming, football) which varied from 10 weeks to ongoing participation. Results were not significant, however authors reported increased confidence, self-esteem, and sense of self with added structure to their lives.
Physical health and body image
1 of 1 study reported a significant increase in perceived physical self-efficacy; 1 quasi-experimental (cross-over) study, N = 15, aged 16 to 21 years on 500mg largactil, some cases lithium. Patients participated in a physical activity program (warm up, frisbee, skipping) in groups and individually as part of an educational program, 5 x 45 min/week (for 3 weeks of study then a week of wash out then swapped intervention) for 7 weeks. The study reported improvement in psychomotor characteristics. *1 of 3 studies reported a significant improvement in patients' perceived body image;* 1 experimental study (no control), N = 9, chronic schizophrenia patients participated in movement exercises followed by relaxation exercises, 1 x 30min/ week for 10 weeks. *2 of 3 studies reported no significant difference in patients' perceived body image;* 2 studies (1 qualitative, 1 quasi-experimental), N = 93, with chronic schizophrenia (13 on antipsychotic medication). Patients took part in various activities (aerobic exercise conditioning program [jogging], football program) which varied from 10 weeks to 9 months.

Risks	Not reported
Consistency in results	No measure of consistency is reported, although anxiety, positive and negative symptoms, motivation, confidence and self-esteem outcomes appear reasonably consistent across studies.
Precision in results	No measure of precision is reported.
Directness of results	Direct

Li J, Shen J, Wu G, Tan Y, Sun Y, Keller E, Jiang Y, Wu J

Mindful exercise versus non-mindful exercise for schizophrenia: A systematic review and meta-analysis of randomized controlled trials

Complementary Therapies in Clinical Practice 32: 17-24

View review abstract online

Comparison	**Mindfulness exercise (yoga or tai chi) vs. non-mindfulness exercise (physical training, aerobic exercise).**
Summary of evidence	**Moderate quality evidence (small to medium-sized samples, inconsistent, precise, direct) finds no significant differences between mindfulness exercise (yoga or tai chi) and non-mindfulness exercise for mental health or social functioning.**
Mental health **Positive and Negative Syndrome Scale (PANSS)**	
No significant differences between groups; 3 RCTs, N = 234, MD = -6.24, 95%CI -12.76 to 0.28, $p > 0.05$, $I^2 = 60\%$ This effect became significant with one study removed.	
Social functioning **Social and Occupational Functioning Scale (SOFS)**	
No significant differences between groups; 2 RCTs, N = 126, RR = 0.90, 95%CI 0.78 to 1.04, $p > 0.05$, $I^2 = 80\%$	
Risks	There were no adverse events.
Consistency in results	Inconsistent
Precision in results	Precise for social functioning, unable to assess mental health (not standardised).
Directness of results	Direct

Pearsall R, Smith DJ, Pelosi A, Geddes J

Exercise therapy in adults with serious mental illness: A systematic review and meta-analysis

BMC Psychiatry 2014; 14

View review abstract online

Comparison	**Exercise therapy (2-4 times a week over 10-24 weeks) plus standard care vs. standard care.** **Two of eight studies also included people with mood disorders.**

Exercise therapy

Summary of evidence	**Low quality evidence (small samples, mostly consistent and imprecise, direct) is uncertain of the benefit for exercise therapy over standard care.**
BMI and weight	
No significant differences in body mass index; 4 RCTs, N = 151, SMD = -0.24, 95%CI -0.56 to 0.08, p = 0.14, I^2 = 0%, p = 0.69 *No significant differences in weight;* 2 RCTS, N = 77, SMD = 0.13, 95%CI -0.32 to 0.58, p = 0.57, I^2 = 0%, p = 0.79	
Mental health	
No significant differences in negative symptoms; 2 RCTs, N = 84, SMD = -0.54, 95%CI -1.79 to 0.71, p = 0.40, I^2 not reported *No significant differences in positive symptoms;* 2 RCTs, N = 84, SMD = -1.66, 95%CI -3.78 to 0.45, p = 0.12, I^2 not reported *No significant differences in anxiety/depression symptoms;* 2 RCTs, N = 94, SMD = -0.26, CI -0.91 to 0.39, p = 0.43, I^2 = 49%, p = 0.49	
Quality of life	
No significant differences in quality of life (physical); 2 RCTs, N = 30, SMD = 0.45, CI -0.27 to 1.18, p > 0.05, I^2 not reported *No significant differences in quality of life (mental);* 2 RCTs, N = 30, SMD = 0.65, CI -0.09 to 1.39, p > 0.05, I^2 not reported	
Risks	Not reported.
Consistency in results	Consistent where reported.
Precision in results	Precise for BMI and weight only.
Directness of results	Direct

Roine E, Roine RP, Rasanen P, Vuori I, Sintonen H, Saarto T

Cost-effectiveness of interventions based on physical exercise in the treatment of various diseases: A systematic literature review

International Journal of Technology Assessment in Health Care 2009; 25:4: 427-454

View review abstract online

Comparison	**Exercise therapy (mean 4.1 years, 30 min per week of coordination, cooperation, speed, agility, balance, plus a 30-min soccer game) plus standard care vs. standard care.**
Summary of evidence	**Low quality evidence (very small samples, unable to assess consistency or precision, direct) is uncertain of the benefit for exercise therapy over standard care.**
Relapse rates	
No data reported, but authors state there was significantly higher reduction in relapse rates in the exercise group of 1 quasi-experimental study, N = 40.	
Hospitalisation cost	
No data reported, but authors state enrolment in an exercise program considered a more effective and efficient treatment than standard care for reducing healthcare costs.	
Risks	Not reported
Consistency in results	Not applicable – 1 study
Precision in results	Unable to assess, no data reported.
Directness of results	Direct

Rosenbaum S, Tiedemann A, Sherrington C, Curtis J, Ward PB

Physical Activity Interventions for People with Mental Illness: A Systematic Review and Meta-Analysis

Journal of Clinical Psychiatry 2014; 75(9): 964-974

View review abstract online

Comparison	**Movement-based physical activity interventions (duration ranged from 5 to 12 weeks, frequency 1-12 times per week) vs. standard care.**
Summary of evidence	**Moderate to low quality evidence (medium-sized sample, inconsistent, imprecise, direct) finds a large effect of improved symptoms with physical activity.**
Mental health	
A large effect of improved symptoms with physical activity; 8 RCTs, N = 453, *g* = 1.00, 95%CI 0.37 to 1.64, $p < 0.01$, I^2 88%, $p < 0.00001$ Authors report that 7 trials were rated as being of low quality.	
Risks	Not reported
Consistency in results	Inconsistent
Precision in results	Imprecise
Directness of results	Direct

Sabe M, Kaiser S, Sentissi O

Physical exercise for negative symptoms of schizophrenia: Systematic review of randomized controlled trials and meta-analysis

General Hospital Psychiatry 2020; 62: 13-20

View review abstract online

Comparison	**Physical exercise for negative symptoms vs. control conditions.**
Summary of evidence	**Moderate quality evidence (large sample, inconsistent, precise, indirect) finds a small effect of improved negative symptoms with physical activity.**
Negative symptoms	
A small, significant effect of improved negative symptoms with physical exercise: 17 RCTs, N = 954, SMD = -0.24, 95%CI -0.43 to -0.06, $p = 0.01$, $I^2 = 45\%$, $p = 0.02$ Subgroup analysis showed the effect was significant only for aerobic exercise.	
Risks	Not reported

Consistency in results	Inconsistent
Precision in results	Precise
Directness of results	Indirect; mixed control conditions

Sabe M, Sentissi O, Kaiser S

Meditation-based mind-body therapies for negative symptoms of schizophrenia: Systematic review of randomized controlled trials and meta-analysis

Schizophrenia Research 2019; 212: 15-25

View review abstract online

Comparison	**Meditation-based mind-body therapies (yoga, tai chi, qi-gong, mindfulness) vs. mixed control conditions (waitlist, treatment as usual, rehabilitation).**
Summary of evidence	**Moderate quality evidence (large samples, inconsistent, precise, indirect) finds a small effect of improved negative symptoms with meditation-based mind-body therapies.**

Mental health

A small effect of meditation-based mind-body therapies for improved negative symptoms;

15 studies, N = 1,081, SMD = -0.36, 95%CI -0.58 to -0.15, $p = 0.0009$, $I^2 = 62\%$, $p = 0.0008$

Subgroup analysis of type of therapy showed yoga and mindfulness studies showed a significant effect, with no significant effect of tai chi. There was no moderating effect of time spent on yoga, or the severity of baseline negative symptoms.

There was no effect of meditation-based mind-body therapies on positive symptoms;

14 studies, N = 1,051, SMD = -0.19, 95%CI -0.39 to 0.00, $p = 0.05$, $I^2 = 54\%$, $p = 0.008$

Subgroup analysis of type of therapy showed yoga studies showed a significant, small effect, with no significant effect of tai chi or mindfulness. The effect for yoga became non-significant with the removal of one outlier.

There was no effect of meditation-based mind-body therapies on general symptoms;

7 studies N = 355, SMD = -0.38, 95%CI -0.82 to 0.06, $p = 0.09$, $I^2 = 75\%$, $p < 0.05$

This effect became significant with the removal of an outlier (SMD = -0.63).

Risks	Not reported

Consistency in results	Inconsistent
Precision in results	Precise
Directness of results	Indirect; mixed control conditions

Vancampfort D, Knapen J, De Hert M, van Winkel R, Deckx S, Maurissen K, Peuskens J, Simons J, Probst M

Cardiometabolic effects of physical activity interventions for people with schizophrenia

Physical Therapy Reviews 2009; 14(6): 388-398

View review abstract online

Comparison	**Physical activity interventions (duration ranged from 10 sessions to 52 weeks, frequency 1-7 times per week), with or without diet counselling, for reducing weight and improving cardiometabolic outcomes.**
Summary of evidence	**Moderate to low quality evidence (small to medium-sized samples, unable to assess consistency or precision, direct) suggests that physical activity showed some benefits for weight loss and preventing weight gain, and when combined with diet counselling may also have cardiometabolic benefits.**

Physical activity

13 studies (one case study, six quasi-experimental, six RCTs) examined the effectiveness of physical activity interventions;

Interventions largely included aerobic exercise; five studies also included additional resistance training. The intensity of the interventions varied widely.

All studies found moderate levels of weight loss, ranging from 2-7%. One study also reported effective prevention of weight gain. 5-10% improvements were reported in cardiovascular fitness.

Without clinical maintenance, program attendances rates were poor, with dropout rates as high as 90% in one study (N = 10). Poor motivation and medication side-effects were the most commonly cited reason for non-attendance.

Greater adherence correlated with reduced depressive symptoms (1 study, N = 13). Greater attendance was also related to levels of weight loss (4 studies, N = 265).

Cardiometabolic outcomes

Two quasi-experimental studies (N = 24) found reductions in both systolic and diastolic blood pressure over 12-24 weeks, most notably in hypertensive participants. Two studies (N = 70) found non-significant reductions of hyperglycaemia (fasting glucose concentration) and one study reported significant blood glucose reductions (N = 128). Physical activity combined with diet counselling was found to reduce insulin resistance (1 study, N = 128) and fasting blood insulin concentrations (2 studies, N = 181). 2 studies found no significant differences in levels of total serum cholesterol (N = 65), but some reductions were found in triglyceride levels in 2 studies (N = 65) but not in a third (N = 6). Reduced ratio of low density to high density lipoproteins was also reported in 1 study (N = 48).	
Risks	Not reported
Consistency in results	Unable to assess; no measure of consistency is reported.
Precision in results	Unable to assess; no measure of precision is reported.
Directness of results	Direct

Vancampfort D, Vansteelandt K, Scheewe T, Probst M, Knapen J, DeHerdt A, De Hert M

Yoga in schizophrenia: a systematic review of randomised controlled trials

Acta Psychiatrica Scandinavica 2012; 126: 12-20

View review abstract online

Comparison	**Yoga plus standard care, compared to other exercise plus standard care, or standard care alone in people with schizophrenia (treatment duration 2-4 months, 2-5 sessions per week).**
Summary of evidence	**Moderate to low quality evidence (small to medium-sized samples, unable to assess consistency or precision, direct) suggests yoga may improve symptoms and quality of life compared to exercise or standard care.**
Mental health	
3 RCTs (N = 125) reported improvements in symptoms (PANSS scores) and quality of life after 2 to 4 months of yoga compared to exercise or standard care.	
Risks	No serious adverse effects were reported.

Consistency in results	Unable to assess; no measure of consistency is reported.
Precision in results	Unable to assess; no measure of precision is reported.
Directness of results	Direct

Vancampfort D, Probst M,Skjaerven LH, Catalan-Matamoros D, Lundvik-Gyllensten A, Gomez-Conesa A, Ijntema R, De Hert M

Systematic Review of the Benefits of Physical Therapy Within a Multidisciplinary Care Approach for People With Schizophrenia

Physical Therapy 2012; 92(1): 11-23

View review abstract online

Comparison	**Physical therapy (including aerobic or strength exercises, relaxation, or body awareness training) plus standard care vs. standard care.**
Summary of evidence	**Low quality evidence (very small sample, unable to assess consistency or precision, direct) is unable to determine the effects of physical therapy.**

Mental health

1 RCT (N = 41) reported significant improvements in symptoms with physical therapy (aerobic or strength exercise), but 2 RCTs (N = 76) reported better outcomes for the comparison group (yoga).

1 RCT (N = 40) reported significant improvements in anxiety and psychological distress and improvements in subjective well-being after single sessions of aerobic exercise and yoga. 3 RCT (N = 106) also reported improvements in anxiety after progressive muscle relaxation, but 1 RCT (N = 30) reported no improvements.

Risks	No adverse effects were reported.
Consistency in results	Unable to assess; no measure of consistency is reported.
Precision in results	Unable to assess; no measure of precision is reported.
Directness of results	Direct

Vogel JS, van der Gaag M, Slofstra C, Knegtering H, Bruins J, Castelein S

Exercise therapy

The effect of mind-body and aerobic exercise on negative symptoms in schizophrenia: A meta-analysis

Psychiatry Research 2019; 279: 295-305

View review abstract online

Comparison	**Mind-body exercise, aerobic exercise, and resistance training for negative symptoms vs. active control or treatment as usual.**
Summary of evidence	**Moderate quality evidence (large sample, inconsistent, precise, indirect) finds a medium-sized effect of improved negative symptoms with physical activity.**
Mental health	
A medium-sized effect in favor of physical exercise; 22 studies, N > 1,000, *g* = 0.434, 95%CI 0.196 to 0.671, I^2 = 76% Subgroup analysis showed similar effects across exercise types, although there was no difference when compared with an active control group.	
Risks	Not reported
Consistency in results	Inconsistent
Precision in results	Precise
Directness of results	Indirect; mixed control conditions – direct for subgroup analyses of individual control conditions.

Explanation of acronyms

BPRS = Brief Psychiatric Rating Scale, CI = Confidence Interval, *g* = Hedges' *g*, standardised mean difference, GAF = Global Assessment of Functioning scale, I^2 = the percentage of the variability in effect estimates that is due to heterogeneity rather than sampling error (chance), MD = mean difference, MHI = Mental Health Inventory, N = number of participants, *p* = statistical probability of obtaining that result ($p < 0.05$ generally regarded as significant), PANSS = Positive and Negative Syndrome Scale, Q_B = between study group analysis, QOL = Quality of Life, RCT = randomised controlled trial, RR = relative risk, SANS = Scale for the Assessment of Negative Symptoms, SAPS = Scale for the Assessment of Positive Symptoms , SOFS = Social and Occupational Functioning Scale, SMD = standardised mean difference, vs. = versus, WHOQOL-BREF = World Health Organization Quality of Life BREF Version

Explanation of technical terms

* Bias has the potential to affect reviews of both RCT and observational studies. Forms of bias include; reporting bias – selective reporting of results; publication bias - trials that are not formally published tend to show less effect than published trials, further if there are statistically significant differences between groups in a trial, these trial results tend to get published before those of trials without significant differences; language bias – only including English language reports; funding bias - source of funding for the primary research with selective reporting of results within primary studies; outcome variable selection bias; database bias - including reports from some databases and not others; citation bias - preferential citation of authors. Trials can also be subject to bias when evaluators are not blind to treatment condition and selection bias of participants if trial samples are small[22].

† Different effect measures are reported by different reviews.

Prevalence refers to how many existing cases there are at a particular point in time. Incidence refers to how many new cases there are per population in a specified time period. Incidence is usually reported as the number of new cases per 100,000 people per year. Alternatively some studies present the number of new cases that have accumulated over several years against a person-years denominator. This denominator is the sum of individual units of time that the persons in the population are at risk of becoming a case. It takes into account the size of the underlying population sample and its age structure over the duration of observation.

Reliability and validity refers to how accurate the instrument is. Sensitivity is the proportion of actual positives that are correctly identified (100% sensitivity = correct identification of all actual positives) and specificity is the proportion of negatives that are correctly identified (100% specificity = not identifying anyone as positive if they are truly not).

Weighted mean difference scores refer to mean differences between treatment and comparison groups after treatment (or occasionally pre to post treatment) and in a randomised trial there is an assumption that both groups are comparable on this measure prior to treatment. Standardised mean differences are divided by the pooled standard deviation (or the standard deviation of one group when groups are homogenous) that allows results from different scales to be combined and compared. Each study's mean difference is then given a weighting depending on the size of the sample and the variability in the data. Less than 0.4 represents a small effect, around 0.5 a medium effect, and over 0.8 represents a large effect[22].

Odds ratio (OR) or relative risk (RR) refers to the probability of a reduction (< 1) or an increase (> 1) in a particular outcome in a treatment group, or a group exposed to a risk factor, relative to the comparison group. For example, a RR of 0.75 translates to a reduction in risk of an outcome of 25% relative to those not receiving the treatment or not exposed to the risk factor. Conversely, a RR of 1.25 translates to an increased risk of 25% relative to those not receiving treatment or not having been exposed to a risk factor. A RR or OR of 1.00 means there is no difference between groups. A medium effect is considered if RR > 2 or < 0.5 and a large effect if RR > 5 or < 0.2[23]. lnOR stands for logarithmic OR where a lnOR of 0 shows no difference between groups. Hazard ratios measure the effect of an explanatory variable on the hazard or risk of an event.

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Correlation coefficients (eg, r) indicate the strength of association or relationship between variables. They can provide an indirect indication of prediction, but do not confirm causality due to possible and often unforseen confounding variables. An r of 0.10 represents a weak association, 0.25 a medium association and 0.40 and over represents a strong association. Unstandardised (*b*) regression coefficients indicate the average change in the dependent variable associated with a 1 unit change in the independent variable, statistically controlling for the other independent variables. Standardised regression coefficients represent the change being in units of standard deviations to allow comparison across different scales.

‡ Inconsistency refers to differing estimates of effect across studies (i.e. heterogeneity or variability in results) that is not explained by subgroup analyses and therefore reduces confidence in the effect estimate. I^2 is the percentage of the variability in effect estimates that is due to heterogeneity rather than sampling error (chance) - 0% to 40%: heterogeneity might not be important, 30% to 60%: may represent moderate heterogeneity, 50% to 90%: may represent considerable heterogeneity and over this is considerable heterogeneity. I^2 can be calculated from Q (chi-square) for the test of heterogeneity with the following formula[22];

$$I^2 = \left(\frac{Q - df}{Q}\right) \times 100\%$$

§ Imprecision refers to wide confidence intervals indicating a lack of confidence in the effect estimate. Based on GRADE recommendations, a result for continuous data (standardised mean differences, not weighted mean differences) is considered imprecise if the upper or lower confidence limit crosses an effect size of 0.5 in either direction, and for binary and correlation data, an effect size of 0.25. GRADE also recommends downgrading the evidence when sample size is smaller than 300 (for binary data) and 400 (for continuous data), although for some topics, these criteria should be relaxed[24].

‖ Indirectness of comparison occurs when a comparison of intervention A versus B is not available but A was compared with C and B was compared with C that allows indirect comparisons of the magnitude of effect of A versus B. Indirectness of population, comparator and/or outcome can also occur when the available evidence regarding a particular population, intervention, comparator, or outcome is not available and is therefore inferred from available evidence. These inferred treatment effect sizes are of lower quality than those gained from head-to-head comparisons of A and B.

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