

Effectiveness of Exercise Training on Mental Health, Physical Activity Level and Social Participation in People Living with HIV/AIDS: A Systematic Review and Meta-Analysis

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Abstract

Background: Exercise training may increase physical activity (PA) level, improve social participation and mental health in people living with HIV/AIDS (PLWHA). Thus, a systematic review was conducted to answer the review question: what is the effectiveness of physical exercise training on mental health, physical activity level and social participation in PLWHA?

Method: Eight databases namely: PubMed, Emtree, Cochrane Library, Embase, CINAHL, AMED, PsycINFO and MEDLINE – were systematically searched from 1990 till August 2019. This review includes only studies published in English language, on adults (>18years) and are either on HAART/HAART-naïve; only RCTs that gave exercise intervention and assessed mental health, physical activity level and social participation on HIV/AIDS patients. The primary outcomes were mental health, PA level and social participation, while the secondary outcomes included psychological disorders.

Results: Meta-analysis of the five (out of seven) included studies for depression that met the inclusion criteria (n=346 participants) comprising males/females aged ≥ 18 years, show a significant overall effect (SMD=-0.89, [95%CI: -1.77, -0.01], Z=1.97, p=0.05) of exercise compared to the control group at post-intervention. However, statistical heterogeneity was high (I²=91%, X²=53.14, df=5, p<0.00001). The removal of two papers during sensitivity analysis for missing data/baseline differences showed a large significant effect (SMD=-1.01, [95%CI: -1.45, -0.57], Z=4.48, p=<0.00001). The statistical heterogeneity was low (I²=39%, X²=4.94, df=3, p=0.18). The results demonstrate a significant trend towards a decrease in depressive symptoms for participants in the exercise compared to no exercise group; aerobic exercise compared to normal routine activity group; aerobic and resistance exercise compared to other control groups. Narrative synthesis demonstrates the beneficial effects of exercise training on outcome measures: anxiety and cognitive function, apart from other psychological benefits. There was limited and no RCTs on the effects of exercise on physical activity level and social participation, respectively.

Conclusion: Combined exercise (Aerobic exercise+Strength training; 80mins/session; 3X/week for 12weeks.) + routine counselling OR Aerobic exercise training+counselling 40mins per session; 3X/week for 6weeks OR Combined exercise: Aerobic and Resistance exercise training 50mins/session; 2X/week for 6weeks OR Combined exercise: Aerobic and Resistance exercise training 60mins/session; 3X/week for 24weeks OR Aerobic exercise training 60mins per session; 3X per week for 12weeks may improve mood disorders while therapeutic exercise (2X per week for 6weeks) may improve psychological wellbeing.

Background

People living with the human immune deficiency virus (HIV)/Acquired immune deficiency syndrome (AIDS) (PLWHA) have a variety of psychological and physiological symptoms directly related to either the virus, antiretroviral therapy or a combination of both [1]. The common adverse physical side effects of highly antiretroviral therapy (HAART) include disorders of the nervous system (headache, pain, and fatigue), gastrointestinal tract (nausea, and diarrhoea), integumentary system (rash), metabolic processes (lipid alterations) and morphology (lipodystrophy, lipoatrophy) [2]. Lipodystrophy, and lipoatrophy, which arises from adipose tissue alterations, have no known effective treatment but may negatively affect self-image, self-esteem, and social functioning [3, 4].

Adipose tissue alterations have been linked to the experience of anxiety, depression and decrease in medication adherence [5, 6]. Therefore, the side effects of HAART may trigger negative psychological responses likely to reinforce existing adverse neuropsychiatric effects of HIV. The higher prevalence of depression, anxiety, agitation, confusion, nightmares, hallucinations, panic disorder, dysthymia and even mania in PLWHA [7–9] supports this view. All these may translate to poor mental health, lower functional quality of life, and lack of self-confidence which limit the activity of daily of living and participation in social/physical activities [10, 11]. Since regular exercise is beneficial to the psychological functioning in PLWHA, and have been used to treat psychological disorders, it may translate to improved mental health, physical activity level, and social participation in PLWHA [12–14]. Therefore, relevant literature was appraised in this review to synthesise the required evidence that will guide practice.

Changes associated with degeneration in HIV conditions are characterized as disability, involving physical, cognitive, mental and emotional symptoms [15] and they are worsened by lack of physical exercises and participation restriction [16, 17]. Social participation is the involvement of individuals in community activities or programmes. Therefore, any interventions that could prevent, ameliorate or reverse the adverse effects of HIV and HAART should be of clinical and public health interest. In this regard, physical exercise which has been associated with improvements in the adverse physiological and psychological effects of HIV/long-term antiretroviral therapy (ART) use in PLWHA [1] could be integrated into the routine care of PLWHA if there is any evidence of its effectiveness, hence this study.

Caspersen, Powell [18] defined exercise as physical activity that is planned, structured and repetitive and has a final or an intermediate objective of improving or maintaining physical fitness. In essence, exercise is a subset of physical activity and a component of most activities of daily living, which is individually determined. Meanwhile, physical activity refers to any bodily movement produced by the contraction of skeletal muscle that increases energy expenditure above a basal level at rest [17]. To experience the benefits of physical activity, the U.S. Department of Health and Human Services [19] has recommended 150 minutes of moderate-intensity aerobic physical activity per week or 75 min of vigorous-intensity aerobic physical activity or an equivalent combination of moderate and vigorous-intensity activity for adults (18–64 years). Similarly, 10,000 steps per day have been recommended for improved health outcomes and physical fitness in apparently healthy individuals [20, 21]. Physical exercises have been recommended to improve disability and optimize mental, physical, social and even economic outcomes for PLWHA [22]. Dianatinasab, Fararouei [23] reported that physical exercise training significantly improved mental health, particularly severe depression, and social dysfunction. An earlier epidemiological study reported a negative association between regular physical activity and depressive/anxiety disorders in adults [24]. However, the study design is a cross-sectional survey that cannot determine causal relationships; thus, the findings should be interpreted with caution. Besides, the question used to assess the level of physical activity does not define the word “regularly”. Also, no information was provided on the type of physical activity, practice frequency, intensity and duration. Hence, it is difficult to relate its findings to any specific types of physical activity and whether they are beneficial to mental health. Meanwhile, despite all the health benefits often attributed to physical activity/exercises in PLWHA; it is unclear how much physical activity they engage in [22] or may require to improve their mental health.

Mental health is not only the absence of psychopathology but the emotional, psychological and social well-being of an individual or group [25–27], and maybe boosted by interventions that improve any of these aspects of which physical exercises have been recommended. Invariably, physical exercise could be considered as a self-management strategy that may be deployed as a rehabilitation intervention to address disability in patients with HIV and improve or sustain the (mental) health of PLWHA [28] but requires evidence of efficacy to guide practice. Therefore, this review aimed to determine the effectiveness of physical exercise training on mental health, physical activity level and social participation in PLWHA. The review question is - What is the effectiveness of physical exercise training on mental health, physical activity level and social participation in PLWHA? To answer the review question, specific review objectives sought to determine the effectiveness of physical exercises in improving psychological disorders, physical activity and social participation.

Methods

This systematic review was registered according to the International platform of registered systematic review and meta-analysis protocols (INPLASY register) on 9 April 2020 (registration number: INPLASY202040048).

Eligibility Criteria

Eligibility criteria considered for selecting studies in the review include:

Inclusion criteria:

- **Type of studies:** This review includes only original studies published in the English language, in peer-review journals and conferences proceedings. Only studies based on randomised control trials (RCTs) design were included in the review when the following objectives were evaluated effects of exercise training on mental health, physical activity level and social participation in PLWH.
- **Participants:** This review included only RCTs of the effectiveness of physical exercise training in PLWHA, who are adults (>18 years) and are either on HAART or HAART-naïve. Though no specific limitation on the setting of the studies was considered, nevertheless, the included studies were mainly carried out in clinics, health centres, hospitals or community care settings.
- **Intervention:** RCTs of physical exercise intervention for PLWHA were included in the review, which was not restricted to specified dosage, form, intensity, frequency and duration of intervention or follow-up period after the intervention. The exercise intervention may be hospital-based, community-based or home-based, and the exercise type may be aerobic, resistance exercise or a combination of both. Similarly, RCTs of resistance exercise intervention were not limited to weight training, isometric and isotonic strengthening exercise in PLWHA.
- **Control:** This review includes studies that compared the effectiveness of physical exercise training on mental health, physical activity level and social participation to any other treatment options, such as usual prophylactic care, counselling or no treatment, in PLWHA.
- **Outcomes:** The outcomes of interest in this review include mental health, physical activity level and social participation as primary outcomes and psychological disorders as a secondary outcome. Studies were included regardless of whether an outcome of interest was accounted for as a primary or secondary outcome in the first article, so far as a clear analysis was carried out for each outcome. All outcome variables were collated as they were accounted for in individual studies, and the original description in those individual studies was not modified. Clinical results, detailed by individual studies were analysed and graded.

Exclusion criteria:

- Studies without an exercise or physical activity intervention component.
- Narratives review synthesis, systematic reviews, opinion papers, letters and any publication without primary data and/or explicit description of the methods.
- Duplicate publications from the same study, the most recent or most comprehensive publication were used.

Information sources and search strategy

An extensive search strategy to identify eligible studies was done in two stages including; (i) the search of the bibliographic database and grey literature, and (ii) the selection of studies for inclusion based on eligibility criteria. Searches involved several combinations of search terms from medical subject headings (MeSH) and keywords with a combination of Boolean logic in the title, abstract and text for the population, intervention, control and outcomes, first in a pilot search to establish the sensitivity of search strategy. This strategy was used differently for the three selected study outcomes. PubMed search strategy is shown in Appendix I. This strategy was modified to the syntax and subject heading of other databases. Studies were searched in PubMed, Emcare, Cochrane Library, Embase, CINAHL, AMED, PsycINFO and MEDLINE. Additional searches were made from the reference list of identified studies. This procedure was by the guidelines of the Cochrane Handbook for Systematic Reviews [29], and advice for Health Care Review by the Centre for Reviews and Dissemination [30].

Study record and Data management

The literature search result was exported into RefWorks™ to check for duplication of studies. Bibliographic records were exported from RefWorks™ into Microsoft Excel 2007 to facilitate the management and selection of articles for inclusion into the study based on specific eligibility criteria.

Selection Process

The screening was performed in two phases. The initial screening was conducted based on the title and abstract by V.U. (reviewer 1) to identify articles that met the eligibility criteria. I.F.O (reviewer 2) independently cross-checked the initial screening results. The two reviewers then read through the full text of selected studies for further screening, using the eligibility criteria. Differences in opinions at any stage regarding inclusion or exclusion were resolved by discussion and reflection or in consultation with D.I.S (reviewer 3) when needed to remove assessor bias. The reasons for excluding studies were adequately documented, and details of the study selection process are presented in Figure 1.

Data collection Processes

Quality appraisal of included studies: The PEDro scale for quality appraisal of clinical trials was used to appraise the quality and the risk of bias in the included studies. The PEDro scale is based on the Delphi list developed by Verhagen and colleagues at the Department of Epidemiology, the University of Maastricht [31]. The scale consists of a checklist of 10 items/questions, scored “yes” or “no” on the internal validity and statistical information provided in the study. The quality of the study was classified into – poor (≤ 3), fair/moderate quality (4-5), and high quality (6-10). Poor quality study means that the study has a high risk of bias, while high-quality study means the study has a low risk of bias. Two reviewers made judgments regarding the risk of bias independent of each other. Areas of differences were resolved by discussion and reflection, or in consultation with the third reviewer. Appraisal of the quality of the included studies was carried out after study selection was completed and during data extraction and synthesis. The strength of evidence for this review was further reported.

Data Item: The variables for which data from selected studies were collected include – authors reference, participants’ characteristics (including age range, gender, sample size), study sample size (also groups sample size where available), components of the intervention, the intervention setting, who delivered the intervention, duration of intervention and follow-up (where available), control, attrition rate, outcome(s) assessed, the outcome(s) measurement methods/techniques and summary of results, conclusions and funding sources.

Data synthesis and assessment of heterogeneity

The review question of the effectiveness of physical exercise training on mental health, physical activity level and social participation in PLWHA was answered. In doing this, all quantitative study outcomes which analyzed the effectiveness of these interventions were presented, considered and combined in a proof table. The appropriate statistical techniques were used for each study outcome. For continuous variables, weighted mean differences were applied when outcomes are uniform or standardised mean difference (SMD) when different outcomes are used with a 95% confidence interval. SMDs were calculated using means, standard differences, and sample sizes post-intervention (post-treatment effect sizes) according to the standard analysis procedure in the Cochrane meta-analyses.

A pre-post analysis was conducted for the main outcomes, by subtracting the post-intervention means from the pre-intervention means between all groups to determine the differences (a new mean). SMD ranges were interpreted as follows: small = 0.00–0.39, moderate = 0.40–0.70, and large = >0.70 [32]. Alpha was set at $p < 0.05$. For dichotomous variables, the risk ratio was applied with 95% CI. Characteristics of the retained studies were sorted by year of publication and presented in a tabular form providing information relating to authors’ references, sample size, age, setting, data collection format, outcomes, components of the intervention, component of the control, format and provider of the intervention, intervention and follow-up periods, and results. This review also includes a meta-analysis to find pooled effect sizes across studies, using a random-effects model relying on the level of heterogeneity of intervention effects. Heterogeneity was assessed using the Cochrane’s χ^2 test (10% significance level) and Higgins I^2 for which values of 25%, >25 – 75%, and >75% shows low, medium and high heterogeneity respectively as stipulated by the guidance in the Cochrane Handbook for Systemic Reviews of Interventions [30]. Investigation and presentation of outcomes were made using the primary outcome. Studies with homogenous characteristics in terms of design, intervention, and comparator(s) were pooled together for meta-analysis using a random-effects model. Heterogeneous studies were interpreted using narrative synthesis following the recommendation of the Centre for Reviews and Dissemination to explore the relationship and findings between and within the included studies [29]. Sensitivity analysis was done to decide the impacts of studies with a high risk of bias on the general outcomes with and without these studies.

Rating quality of evidence and strength of recommendation

The quality of evidence of the studies was evaluated using the Grading of Recommendations Assessment Development and Evaluation (GRADE) approach [33]. The GRADE approach evaluates consistency, design, directness, precision, publication bias and studies limitations. The studies in this review were graded as having a high risk of bias or low risk of bias, and then again individual evidence statement was graded from ‘High Quality’ to ‘Very Low Quality’ according to the criteria.

Result

Search result

Searches were carried out sequentially using the three primary outcomes (namely mental health, physical activity and social participation) in the search strategy. The initial search yielded 795 potential citations of which seven publications were considered eligible to be included in the review. Using the primary outcome measured in each study, mental health included seven publications [23, 34–38] while physical activity included only one publication [34]. However, no study reported the effect of exercise intervention on social participation.

Reasons for exclusion

Reasons for exclusion of studies following full-text screening included: studies had a control group that was exercising (n= 1), pre-test - post-test study design with no control group (n =1), Non-Randomized control trials (n=3), studies with missing data (n=2), studies with a non-human population (n=1), studies that did not have outcome measure of interest (n=1) (Figure 2).

Included studies

Table 1 provides the study characteristics of the seven included studies in this review, and further details are provided below -

Author, (Year) Location of Study	Characteristics of participants Age range(years) Gender Sample size. Retention (attrition)	Intervention.	Duration of intervention	Control	Outcome Parameter	Measurement tool for outcome	Summary of result
Dianatinasab et al, (2018) Iran	Asymptomatic HIV patients 20-40 Women N=40 75% (25%)	G ₀ : Combinational exercise (Aerobic exercise: 40-45% MHR for 45mins) + (Strengthening exercise: 3 sets of 8 repetitions on 50-55% RM for 15mins) 3x per week G ₀ = behavioural disease counselling (VCT's routine services). n= 20 (14) NR	12 weeks	VCT's routine services n= 20 (16)	Anxiety depression	GHQ-28	Aerobic and resistance exercises had a positive effect on mental health of HIV positive female patients(p=0.01)
Daniels & Van Niekerk, (2018) South Africa	Asymptomatic HIV patients 20-60 years Women (60) 100% (0%)	G ₀ : Therapeutic exercise. (2X per week for 6weeks) G ₀ = read prescribed materials 30(30) NR	6 weeks	Read prescribed exercise materials 30(30)	Depression	BDI	Posttest outcomes showed a relatively slight decrease in mean scores (decrease in depression) for both experimental and control groups, as a result of the intervention (p=NR)
McDermott et al, (2016) Ireland	Asymptomatic HIV patients 18-65 Females(3), males(8) N=11 84.6% (15.4%)	G ₀ : Aerobic exercise training: Circuit training on treadmill, cycle ergometer, and cross trainer for 31-52min per session; 3X per week on 40-75% HRR G ₀ = received no intervention; n= 6 (5) 60%	16 weeks	No exercise n= 7 (6)	Cognition Physical Activity level	MOCA global score; Trail marking Test A; Trail marking Test B Actigraph GT3X+Tri Axis Accelerometer	There were no significant changes in global scores on the Trail A (p=0.46), Trail B (p=0.12) or MOCA (0.51) There was no significant change in PA level (p=>0.05)
Aweto et al, (2016) Nigeria	Asymptomatic and mild symptom HIV patients 18 yr and above	G ₀ : Aerobic exercise: on cycle ergometer for 40mins per session; 3X per week (50-60% HRR)	6 weeks	Only counseling n=20 (15)	Depression	BDI	Comparisons between the pre-test and post-test depression mean score of the study group and between the study group and

	Females(25), males(15) N=40 84.5% (15.5%)	n= 20 (18) G ₀ : Only counseling. NR					the control group showed that there was significant improvement (BDI: P=0.001)
Jagers et al, (2015) USA	Asymptomatic (63%), Mild symptom (10%), Severe symptom AIDS patients (25%), Missing report (2%) 18 and Older Males(37), females(12) N=93 52.69% (47.31%)	G ₀ : Aerobic exercise (30 mins on treadmill 50-70% MHR) 2x per week Resistance exercise (upper and lower-body resistance training): 1 set of 12 repetitions each (on plate-loaded Hammer Strength machines; upper anterior and posterior legs on Life Circuit machines; free eights) for 20 x3=60 mins, 2x per week G ₀ : engaged in sedentary activity n=46(26) but there are two missing results NR	6 weeks	Engaged in sedentary lifestyle n=47(23) but there are 3 missing results	Anxiety, Depression Anxiety	SDS; POMS-30; PSS	Following a 6-week exercise intervention no changes were observed among self-reported HIV-related symptom frequency or the associated distress (SDS) (p=>0.05). There was a significant decrease (p = 0.003) in self-reported mood disturbance (POMS), which dropped from 31.92 ± 6.87 pre-intervention to 6.38 ± 4.51 post-intervention. On analyzing the PSS scores there was no significant difference (p=>0.05). within the study group following the 6-week intervention.
Fillipas et al, (2006) Australia	NR 18 and above Men N=40 87.5% (12.5%)	G ₀ : Aerobic exercise: on treadmill, cycle ergometer, stepper or a cross trainer for 2 times/wk; 20mins (60-75% MHR) + Resistance exercise: 3sets of 10 repetitions (60-80% 1RM) for 30mins, 2x per week G ₀ = Unsupervised walking program 81%	24 weeks	Unsupervised walking program n=20(18)	cognitive function	GS-ES	Over the six months, the experimental group improved their self-efficacy while the control group stayed much the same so that the between-group difference was 6.8 points (95% CI 3.9 to 9.7, p=0.004).
Neidig et al, (2003) USA	Asymptomatic and mild symptomatic, non-AIDS patients 18 and above	G ₀ : Aerobic exercise on either treadmill, cycle ergometer or walking for 60mins, 3x per week (60-80% VO2 Max) G ₀ = maintain usual activity	12 weeks	maintain usual activity n=30(30)	Depression	POMS; CES-D; BDI	There was significant improvement using the CES-D (p=0.03) and also on the BDI (p= 0.06). Again, the study group also showed significant

Males (52), females (8)	n=30(18)	improvements on overall POMS scores (p= 0.01)
N=60	NR	
80% (20%)		

Key: NR= Not recorded; G₁= Group 1(exercise group); G₀= Group 0 (control group); RM= Repetition maximum; MHR=Maximum heart rate; HRR=heart rate reserve; VCT=Voluntary Counseling and Treatment center; GHQ-28= General Health Questionnaire; MOCA= Montreal cognitive assessment; GS-ES= General Self-Efficiency Scale; CES-D= Center for Epidemiological Studies-Depression scale; BDI= Beck's Depression Inventory; POMS= Profile of Mood State; PSS= Perceived Stress Scale; SDS= Symptom Distress Scale; VO2 Max= Maximum Oxygen consumption

Table 1
Characteristics of Included Studies

Mental health

Seven studies reported on the effect of an exercise intervention on mental health. The duration of the interventions ranged from 6 to 24 weeks, exercise session was from 31 to 80 min, and the sessions per week were from 2 to 3 times per week. None of the included studies provided any follow-up data. Three studies [23, 36, 37] involved supervised aerobic and resistance exercise programme. Three studies [34, 35, 38] involved supervised aerobic exercises only, one study McDermott, Zaporozhan [34] involved supervised and unsupervised exercises are given three times per week (2 supervised sessions and one unsupervised session), while another study involved self-administered therapeutic exercise intervention [34]. For aerobic and resistance exercises: Jaggars, Hand [36] has a control group that engaged in the sedentary activity; while a study Fillipas, Oldmeadow [37] had Unsupervised walking programme as control and another study Dianatinasab, Fararouei [23] has a "behavioural disease counselling and treatment" control group. For aerobic exercises: Neidig, Smith [38] has a "usual activity" control, Aweto, Aiyegbusi [35] engaged "only counselling" control and a study [34] maintained a "no intervention" control. For therapeutic exercises: Daniels and Van Niekerk [39] utilised a "read prescribed materials" control.

Physical activity Level

Only one study [34] reported the effect of an exercise intervention on physical activity level. McDermott, Zaporozhan [34] utilised supervised aerobic exercises only and maintained a "no intervention" control.

Participants of the included studies

Mental health

A total of 346 participants were included in this review Participants were within the age range of 18 years and above, and the majority (222 or 64.16%) had asymptomatic HIV (Stage one) based on the WHO clinical staging for HIV/AIDS [40], The location of studies varied as two studies were located in the USA [36, 38] and one study each in Nigeria [35], Iran [23], Australia [37], South Africa [39] and Ireland [34] (Table 1)

Physical activity Level

Only one RCT [34] was included and involved 11 participants with asymptomatic HIV patients, aged 18-65. The location of the study was Ireland.

Outcome of intervention

All the included studies assessed for mental health using different measurement tools, namely the profile of mood state questionnaire - POMS-30 [36, 38], General Health Questionnaire-28 - GHQ-28 [23], Beck's Depression Inventory-BDI [35, 38, 39], Montreal cognitive assessment - MOCA global score, Trail marking test A & B [34], Symptom Distress Scale-SDS, and Perceived Stress Scale-PSS [36], The Generalized Self-Efficacy Scale (GS-ES) [37], and Centre for Epidemiologic Studies Depression Scale (CES-D) [38]. One study assessed physical activity using Actigraph GT3X+Tri Axis Accelerometer [34].

Quality appraisal and risk of bias assessment

The risk of bias within the included studies is provided in Table 2. The major sources of bias in the included studies were performance bias (absence of subject and therapist blinding) in all the studies. Overall, based on the PEDro scale, four studies [23, 34, 35, 39] were judged as fair/moderate quality studies (Table 3). Two studies [37, 38] were judged as high-quality studies and one study [36] was judged as low quality. Further details are provided below:

Study	Random allocation	Concealed allocation	Baseline comparability	Blinding of subjects	Blinding of Therapists	Blinding of assessor	Adequate follow-up	Intention to treat analysis	Between-group comparison	Point estimates and variability	Total score
Dianastinab et al 2018	Yes	No	Yes	No	No	No	No	No	Yes	Yes	4/10
Daniels & Niekerk 2018	Yes	No	No	No	No	No	Yes	No	Yes	Yes	4/10
McDemortt et al 2016	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes	5/10
Aweto et al 2016	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes	5/10
Jaggers et al 2015	Yes	No	No	No	No	No	No	No	Yes	Yes	3/10
Nedig et al 2003	Yes	No	Yes	No	No	Yes	No	Yes	Yes	Yes	6/10
Fillipas et al 2006	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	8/10

Table 2
A Quality appraisal using the PEDro scale

Study	Timepoint	Mental health
Dianastinab et al., 2018	Immediately post Intervention	{Int. (17.07 ± 6.71) vs Cont. (30.80 ± 14.28); p= 0.001; d= NR }
Daniels & Niekerk., 2018	Immediately post Intervention	{Int. (4.85 ± 2.85) vs Cont. (2.75 ± 2.10); p=0.011; d=1.96}
McDermott et al., 2016	Immediately post Intervention	{Int. (27.4±1.7) vs Cont (26.3 ± 2.7); p=NS; d=NR} {Int. (30.7±6.4) vs Cont. (25.2 ± 8.9); p=NS; d=NR} {Int. (72.3±18.6) vs Cont. (59.7 ± 26.6); p=NS; d=NR}
Aweto et al., 2016	Immediately post Intervention	{Int. (3.50±1.27) vs Cont. (8.33±5.80); p=0.001; d=NR}
Jaggers et al., 2015	Immediately post Intervention	{Int. (24.97±2.41) vs Cont. (31.04±04); p=NS; d=NR} {Int. (6.38±4.51) vs Cont. (16.70 ± 5.14); p<0.05; d=NR} {Int. (17.61±0.88) vs Cont. (19.55 ± 1.34); p<0.05; d=NR}
Nedig et al., 2003	Immediately post Intervention	{Int. (12.2 ± 28.3) vs Cont.(32.3 ± 40.0); p=NS; d=NR} {Int. (7.2 ± 7.1) vs Cont.(14.1 ± 11.3); p=0.028; d=NR} {Int. (5.6 ± 6.3) vs Cont.(8.7 ± 7.1); p=NS; d=NR}
Fillipas et al., 2006	Immediately post Intervention	{Int. (35.3±8.4) vs Cont. (30.5±9.6); p<0.001; d=NR}
Int = Intervention group; Cont = Control group; p = p-value; d = effect size; Except otherwise stated, outcomes are reported as: [Int (Mean ± SD) vs Cont (Mean ± SD); p-value; d (effect size)		

Table 3
Outcome values for mental health

Study	Timepoint	Physical activity level
McDermott et al., 2016	Immediately post Intervention	{Int(38.9±17.5) vs Cont(31.8±9.8); p=NS; d=NR}
Int = Intervention group; Cont = Control group; p = p-value; d = effect size; Except otherwise stated, outcomes are reported as: [Int (Mean ± SD) vs Cont (Mean ± SD); p-value; d (effect size)]		

Table 4
Outcome values for PA level

Eligibility criteria

The authors from the seven (7) studies reported on the Inclusion and Exclusion criteria used in recruiting and screening participants for their respective studies. Hence the low risk of bias was evident in the whole studies.

Random allocation

Seven studies reported on using the randomization process to allocate their eligible participants to the different groups. Thus, they are free of selective reporting bias.

Concealment of allocation

There was lack of concealed allocation, detection bias for not reporting or providing enough information about blinding of the assessor and no intention to treat analysis in six [23, 34-36, 38, 39].

Baseline comparability

There are no baseline differences in the characteristics of the measured variables among the included participants in all the studies and are free of non-equivalence bias.

Bias on blinding

Only two studies reported on the assessor and personnel blinding [37, 38] and were thus judged to have a low risk of bias in this regard.

The bias of outcome measurement from <85% of initial participants (incomplete outcome data)

Three (42.9%) studies reported adequate follow-up [34, 37, 39] (Table 3). Overall, 84 out of 346 participants at baseline withdrew from the included studies accounting for ~24% of the total number of participants. Withdrawal rates within individual studies ranged from 12.5% [37] to 47.31% [36] (Table 1). However, a high risk of attrition bias exists as five [23, 34-38] of the seven included studies (71.43%) reported withdrawal rates of >15%. However, one study [39] reported that no participant withdrew from the study. Two (28.57%) studies have a low risk of incomplete outcome bias by having a retention rate ranging from 87.5% to 100% due to low attrition [37, 39]. The withdrawal rate between comparison groups was similar in most groups. Almost all the included studies mentioned participant who did not comply with their exercise intervention or withdrew from the study. Only two authors [34, 37] reported information on adherence to the exercise intervention. Adherence ranged from 60% [34] to 81% [38].

Narrative Synthesis

A narrative synthesis was done by determining how the studies are related. Thus, the key concepts were itemised, compared and contrasted translating the studies into one another and synthesising the translations to identify concepts which go beyond individual accounts and was used to produce an interpretation of the effects of physical exercise on mental health, physical activity level and social participation.

Physical activity level

One study [34] which assessed Physical activity level, and which was not included for meta-analysis, evaluated the effectiveness of aerobic exercise in improving the physical activity level in 11 HAART treated HIV-infected patients (age range 18 – 65 years). The study was conducted in Ireland for 16 weeks whereby five participants (age= 43 ± 4 years) were allocated to the exercise group and six participants (age = 44 ± 11 years) to the control group. One participant from each group did not complete the study. The experimental group received aerobic training (treadmill, cycle ergometer and cross trainer) of equal duration per supervised session) for 31-52 minutes per session at 40-45% HRR, three times per week, while the control group (n=7) received no

treatment. Physical activity level was determined as sedentary/light/moderate/vigorous physical activity (hour per week) using the Actigraph GT3X+ Tri-Axis Accelerometer. The study reported no significant change in the physical activity level in the exercise group compared to the control group ($p>0.05$) but provided no information on the effect size of the intervention.

Mental health

Seven studies [23, 34-39], reported the effectiveness of exercise training on mental health. There are variations in the outcome tools that were used to assess mental health across individual studies. Three moderate quality studies [23, 34, 35, 39], and one high-quality study [37] reported a significant effect of exercise training on mental health in the intervention group compared to the control group. One moderate quality study [34] did not find a significant effect of exercise training on mental health in the intervention group compared to the control group in the three different outcome tools that were used to measure mental health. One high-quality study [38], reported a significant effect of exercise training on mental health in the intervention group compared to the control group in one (CES-D) out of the three different outcome tools that were used. Also, one low-quality study [36] reported a significant effect of exercise on mental health in one (POMS) out of the three different outcome tools that were used in the intervention group compared to the control group. Only one [39] out of the seven studies reported the effect size for mental health in the intervention group compared to the control group.

Sub-component analysis for mental health

Anxiety/Stress

Two studies [23, 36] assessed anxiety and were not included for meta-analysis. One study [23] conducted in Iran examined the effectiveness of a 12-week aerobic and resistance exercises in relieving symptoms of anxiety in 40 female asymptomatic HIV patients (age range 20 - 40 years). Six participants from the experimental group and four participants from the control group did not complete the study. The experimental group received a combination of aerobic and resistance exercise training (aerobic exercise: 40-45% MHR for 45mins) + (Strengthening exercise: three sets of eight repetitions on 50-55% RM for 15mins) 3 x per week) while the control group received behavioural disease counselling. Anxiety was determined as a subscale of the GHQ-28 scale. The study reported that there were no beneficial effects of a 12-week exercise programme on anxiety in the exercise group compared to the control group ($p = 0.07$).

One study conducted in the USA [36] involved 49 (asymptomatic = 63%, Mild symptom = 10%, Severe symptom AIDS patients = 25%, Missing report on status =2%) participants (age range 18 and older) that included 37 (75.51%) males and 12 (24.49%) females. The experimental group received a combination of aerobic and resistance exercise training (aerobic exercise: 30 minutes on a treadmill at 50-70% MHR; 2x per week + Resistance exercise: upper and lower-body resistance training: 1 set of 12 repetitions each on plate-loaded Hammer Strength machines; upper anterior and posterior legs on Life Circuit machines; free weights, and the biceps brachii and deltoids using free weights) for 20 mins x 3 = 60 mins, 2x per week while the control group were engaged in sedentary activity. Stress was determined using the Symptom Distress Scale, and the Perceived Stress Scale. The study reported that the perceived stress (measured with the PSS) significantly increased in the sedentary control group but not the exercise group. The study suggested that 6 weeks of structured combination exercise training may have a protective effect and thus prevented a similar worsening trend in the perceived stress in the exercise group as evident in the control group.

Cognitive function

Two studies [34, 37] assessed cognition which was not included for meta-analysis. One moderate quality study [34] involved 11 asymptomatic HIV patients (age range 18 - 60 years). The experimental group ($n=5$; age= 43 ± 4 years) received aerobic exercise training (Circuit training on a treadmill, cycle ergometer, and cross trainer for 31-52min per session; 3X per week at 40-75% HRR) while the control group ($n=6$; age= 44 ± 11 years) received no exercise. Cognitive function was determined using global scores on the Trail A, Trail B or Montreal cognitive assessment. The study found no significant changes in the cognitive function between the experimental and control study groups and concluded that a 16-week aerobic exercise programme has no beneficial effects on cognitive function ($p = 0.51$) in PLWHA.

A high-quality study [37] conducted in Australia involved 40 males, aged 18 and above. The clinical staging of the participants was not reported. The experimental group received a combination of aerobic and resistance exercise training programme (Aerobic exercise: on a treadmill, cycle ergometer, stepper or a cross-trainer at 60 - 75% MHR, 2 times/week; 20mins per session + Resistance exercise: three sets of 10 repetitions, at 60-80% 1RM, for 30mins, 2x per week) while the control group were engaged in an unsupervised walking program. Cognitive function was determined using the GS-ES -10 scale. The study suggests that 24 weeks of structured combinational exercise training significantly improved cognitive function in the exercise group ($p = 0.04$) compared to the control group.

Meta-analyses – Effects of interventions

This review conducted one meta-analysis for studies on depression (mental health). Three of the included studies [23, 36, 39] compared combined exercises (aerobic exercise, and resistance training) with no exercise. Two studies [35, 38] compared aerobic exercise with normal/usual routine activity.

Heterogeneity

Heterogeneity ($p<0.01$) was evident in the main meta-analysis which could be as a result of the differences in gender, location, variation in the type and dose of exercise intervention administered, measurement tools, and the number of participants (6 – 30 participants) across the studies. Sensitivity analysis was

carried out with only those categories greater than two studies since heterogeneity exists in the meta-analysis. Thus, the results and reasons include:

Mental Health (Depression)

Five [23, 35, 36, 38, 39] of the seven included studies assessed depression as an outcome for mental health. For these five studies, a large overall standardized mean difference SMD = -0.89, 95%CI: -1.77, -0.01) for mental health in favour of the exercise group was found in the random-effect model for post-intervention values. There was a significant overall effect ($Z = 1.97, p = 0.05$) of exercise compared to the control group at post-intervention. However, statistical heterogeneity was high ($I^2 = 91\%, X^2 = 53.14, df = 5, p < 0.00001$) (forest plot- Figure 2). The results demonstrate a significant trend towards a decrease in depressive symptoms for participants in the exercise compared to no exercise group; aerobic exercise compared to normal routine activity group; aerobic and resistance exercise compared to other control groups. Measuring tools used from the included studies were: GHQ-28; BDI; MOCA global score; Trail marking Test A; Trail marking Test B; SDS; POMS; PSS; GS-ES; CES-D. (Table 1).

Sensitivity analysis

After the main meta-analysis, the first sensitivity analysis was done for depression that excluded the trial by Daniels and Van Niekerk [39] because of missing data about the prescribed exercise minutes per session and/or sessions per week, and the requirement that exercises are self-administered as a home programme. A large overall significant effect was found (SMD= -1.23 [95% CI: -1.77, -0.69], $Z = 12.06 (p = < 0.00001)$). However, statistical heterogeneity was evident ($I^2 = 67\%, X^2 = 12.06, df = 4, p = 0.02$) (forest plot- Figure 3).

A second sensitivity analysis was also conducted for depression and excluded two clinical trials in which the control and exercise groups appeared to be non-equivalent due to large differences in the baseline values of depression - [36] (Experimental Group= 14.40 (12.20), Control group = 9.40 (9.10) and [39] Experimental group = 6.17 (3.97), Control group = 4.64 (2.79). A large significant effect was found (SMD= -1.01 [95% CI: -1.45, -0.57], $Z = 4.48 (p = < 0.00001)$). The statistical heterogeneity was low ($I^2 = 39\%, X^2 = 4.94, df = 3, p = 0.18$). (forest plot- Figure 4).

Grade Rating: The effect estimate demonstrates that physical exercise has an overall significant effect of 0.89 points (95% CI: -1.77, -0.00, $p < 0.05$) for depression due to mental health when comparing exercise group to controls, and which can be accepted as moderate evidence. The true effect is likely to be close to the estimate of the effect, but there is a possibility that it may be substantially different. This outcome was downgraded from high to moderate GRADE quality of evidence, because of the inability of authors to conceal allocation in the assignment of participants to experimental and control groups.

Discussion

No study fully measured all the aspects of mental health, instead, they only selected and measured three aspects of mental health such as anxiety/mental distress [36], depression [23, 35, 36, 38, 39], cognitive disorder [34], and psychological disorder [23]. These studies suggest that it is also possible that other aspects of mental health may be improved by exercises in PLWHA and corroborates the findings of other studies [41, 42].

Meta-analysis for depression included five studies [23, 35, 36, 38, 39], cognitive disorder [34] and presents overall evidence that exercise training was effective in ameliorating the symptoms of depression in PLWHA. Thus, there is evidence that aerobic exercises or combinational (aerobic + resistance) exercises performed 2-3 times/week, at 40 – 60 minutes per session, and for between 6-24 weeks, effectively ameliorated the symptoms of depression in PLWHA. The evidence grade rating of this effect is high and therefore, may have significant clinical importance. The findings of this study agree with evidence from other studies [1, 15, 43, 44], which reported on the effectiveness of physical exercises in ameliorating depression in PLWHA. Previous studies provided evidence where both aerobic and resistance exercise have independent and combined positive effects on various indicators of mental health in people living with HIV [41]. Similarly, an earlier systematic review [15] found evidence that performing an aerobic exercise or a combination of aerobic and resistive exercise at least three times per week for at least five weeks can lead to improvements in symptoms of depression for adults with HIV. Also, four earlier systematic reviews [10, 45-47] restated the effectiveness of physical exercise on psychological outcomes, such as depression [46], and health-related quality of life [45]. It was reported that aerobic exercises particularly, improve the quality of life, hope, desire to continue living, and depression [45, 47]. A significant improvement on the Profile of Mood States Depression-Dejection subscale was found with aerobic exercise intervention (MD = -7.68 points, 95% CI [-13.47, -1.90], $n = 65, I^2 = 94\%$ [47]. Another systematic review by Gomes Neto, Ogalha [45] indicates that combined (aerobic and progressive resistance) exercises can improve health-related quality of life. A recent systematic review [43] show that exercise has a large effect on depression (SMD = -0.84, 95%CI = [-1.57, -0.11], $p = 0.02$) and anxiety (SMD = -1.23, 95%CI = [-2.42, -0.04], $p = 0.04$) compared to controls in PLWHA. However, their review included nine studies on both conventional and unconventional exercises like yoga which is considered a mind-body practice that integrates various body poses, breathing techniques, and utilises deep meditation [48]. This may explain why their study has statistically high heterogeneity (SMD = -0.84 points, 95% CI [-1.57, -0.11], $n = 201, I^2 = 94\%; X^2 = 2.27, df = 8, p = 0.02$), and weakens our confidence in the estimate of effect. Importantly, their findings cannot be strictly attributed to the effects of physical exercises alone, unlike this study, which included only studies that investigated conventional exercises alone.

A recent review paper [49] highlights the physiological basis for the observed beneficial effects of exercises on mental health. The review highlights that aerobic exercise could increase the size and function of important brain regions, such as the hippocampus, and thus may improve the brain control responses to stress, reduce inflammation, and increase resistance to oxidative stress. All of which may likely contribute to the benefits of exercise on mental health and cognition. Other aspects of mental health (cognition and anxiety) appraised in the narrative synthesis showed a similar trend, through a meta-analysis was not conducted because of a paucity of RCTs in the literature that studied these aspects of mental health in PLWHA. It was, however, observed that most of the studies (four studies) reported a significant effect of exercises on mental health in the intervention group compared to the control group.

Physical Activity Level

Only one moderate quality study [34] reported the effect of an exercise intervention on physical activity level and did not find any significant difference ($p > 0.05$) between the groups. It assessed the physical activity level with Actigraph GT3X+Tri Axis Accelerometer. However, the sample size is small, and there is no report regarding the effect size to estimate the clinical significance of their findings.

Social Participation

No study reported the effectiveness of exercise training on social participation in PLWHA. Thus, there is a great need for future research studies to evaluate the effectiveness of exercise training on social participation in PLWHA. This is because several studies [50-53] have identified a link between physical activity profile and social participation probably due to the effects of physical activity on mental health, especially mood [54-56]. However, a causal relationship between these variables have not been established in PLWHA and needs to be investigated. This agrees with the view of a previous author that HIV and rehabilitation research should also focus on social participation [28]. This is important in this population considering that social stigmatization is still a big problem facing PLWHA in different countries of the world, and which may lead to low self-esteem, mood disorders, and withdrawal from social activities [57] thereby resulting in a sedentary lifestyle. The added effects of declining ambulatory function, which is often restricted with polypharmacy and rise in complications associated with HIV infection [58] may add to the lack of physical activity and restriction in participation in community-based social activities. The resulting multi-system (neurological, musculoskeletal, cardiopulmonary and metabolic) dysfunction may impair walking function, as well as the quality of life [59]. Limited social participation may also be related to a feeling of low self-esteem or rejection [60]. Therefore, any intervention that may improve mental health by improving mood, and self-esteem in PLWHA, may also improve their physical functioning and likewise social participation.

Conclusion

Implications for practice

The overall trend in the included studies suggests that exercise may prove useful and effective in ameliorating the symptoms of mental disorders regardless of which aspect of mental health was assessed. Evidence regarding the effectiveness of exercise training on depression favours exercise when compared to control and suggests that Combinational exercise (Aerobic exercise: 40–45% MHR for 45 min) + (Strength training exercise: 3 sets of 8 repetitions on 50–55% RM for 15 min); 3x per week [23] OR Aerobic exercise training on cycle ergometer at 50–60% HRR for 40 min per session; 3X per week for 6 weeks [35] OR Combined exercise: Aerobic exercise (30 min on treadmill at 50–70% MHR) and Resistance exercise (upper and lower-body resistance training: 1 set of 12 repetitions each on plate-loaded Hammer Strength machines; upper anterior and posterior legs on Life Circuit machines; free eights), 50 min/session; 2X/week for 6 weeks [36] OR Aerobic exercise training (on either treadmill, cycle ergometer or walking, at 60–80% VO_2 Max, 60 min per session; 3X per week for 12 weeks [38], may improve mood disorders while therapeutic exercise; 2X per week for 6 weeks [39] may improve psychological (affective-attitudinal and cognitive-perceptual profile) wellbeing. These findings have important implications for practice, especially in sub-Saharan African where despite the existing evidence of the beneficial value of physical activity in ameliorating symptoms of mental health, yet physical activity is neglected as a routine rehabilitation modality in the mental healthcare systems [61]. Importantly, mood disorders, which is common in HIV conditions due to the infection and side effects of the medication (HAART) in patients, have also been linked to poor adherence to medications and consequently, poor health outcomes [1–6]. If physical activity/exercises ameliorate symptoms of mood disorders (depression), it may also improve adherence to medication and likewise other related health outcomes. Therefore, public health policies and initiatives designed to increase participation in exercises may have the potential to improve mental health and general wellbeing among PLWHA.

There were notable potential sources of bias such as incomplete outcome reporting, small sample size, short intervention duration, blinding of therapists and assessors, on which basis we downgraded our confidence in the estimate of effect and therefore further rigorous and high-quality studies are required to guide practice. Meanwhile, the paucity of RCTs on the effectiveness of exercise on other aspects of mental health (apart from depression), physical activity level and social participation made it difficult to form a scientific opinion that will guide practice in these areas. Consequently, there is a need for more rigorous studies in these areas considering the health benefits that the PLWHA may derive from such interventions if proven to be of therapeutic value.

Implications for Research

Most studies that evaluated the effectiveness of exercises on mental health and physical activity level were underpowered to detect the difference in mean between the intervention and control groups. Most of them failed to provide information on the adherence rate to estimate its effect on sample size. These weaknesses may affect the validity of the findings. For depression, the heterogeneity of the primary meta-analysis was high and highlights some issues that need to be addressed in future studies. For instance, the sensitivity analysis excluded two studies for i.) missing data about the prescribed exercise minutes per session and/or sessions per week, and the requirement that exercises are self-administered as a home programme [39], and ii.) the non-equivalence of the control and exercise groups before the trials due to large differences in the baseline values of depression [36, 39]. The exclusion of these studies resulted in a low heterogeneity in the meta-analysis of the remaining studies, which strengthens the view that the flaws in the excluded studies distorted the homogeneity of the data. These problems are possibly related to flaws in trials design/documentation and implementation of randomisation which should be addressed in future studies.

Furthermore, the only study [34] on the effectiveness of physical exercises on physical activity level found no effect but was underpowered. Invariably, there is a possibility that the true effects of exercise training on physical activity level in PLWHA were underestimated in the study. Also, most behavioural intervention

studies assessing the effects of physical activity level usually incorporate a behaviour change model.[62] This helps in developing lifestyle promotion strategies to accumulate physical activity as well as appropriate walking plans for enhancing, motivating, and overcoming barriers to physical activity. Importantly, such behavioural intervention studies are driven by specified behaviour change theories/models aimed at identifying modifiable predictors of subjects' behaviours towards physical activity [63]. McDermott, Zaporozjan [34] did not fulfil all these requirements, and may partly explain why their study was unable to find a significant difference in the physical activity level when the intervention group is compared to the control group. Therefore, there is a need for future studies to address these gaps to enhance the validity of their findings.

Limitations

There are several limitations to this study. Apart from the fact that various outcome tools with different validity and reliability values were used to measure mental health in the included studies, mental health is somewhat subjective and therefore difficult to objectively/accurately measure. Besides, the self-reported psychometric instruments used in data collection for the included studies are prone to recall bias. Also, no study measured all aspects of mental health, rather some aspects of mental health such as perceived stress [36], depression [35, 38, 39], mood [36, 38], cognitive disorder [34], mental distress [36] and psychological disorder [23] were measured. Considering these limitations, there is a need to develop more encompassing outcome measurement tools that will assess most, if not all aspects of mental health; and which should be valid, and reliable to guide practice. However, the application of the standard mean difference seemed to address these limitations and provided a good comparative basis to evaluate the effectiveness of exercise intervention on variables of interest across the studies.

List Of Abbreviations

Human immune deficiency virus HIV

Acquired immune deficiency syndrome AIDS

Antiretroviral therapy ART

Highly antiretroviral therapy HAART

People living with HIV/AIDS PLWHA

Risk of bias ROB

Review Manager RevMan

Randomized control trials RCTS

Medical subject heading MeSH

Allied and Complementary Medicine Database AMED

Cumulative Index to Nursing and Allied Health Literature CINAHL

Excerpta Medica database EMBASE

Allied and Complementary Medicine Database AMED

Physiotherapy Evidence Database PEDro

Grading of Recommendations Assessment Development and Evaluation GRADE

International platform of registered systematic review and meta-analysis protocols INPLASY

Preferred Reporting Items for Systematic Reviews and Meta-analyses PRISMA

standardised mean difference SMD

Medical Outcomes Study MOS

Nigeria Health Research Ethics Committee NHREC

World Health Organisation WHO

Profile of Mood State Questionnaire – 30 POMS-30

General Health Questionnaire-28 GHQ-28

Beck's Depression Inventory BDI

Montreal cognitive assessment MOCA

Symptom Distress Scale SDS

Perceived Stress Scale PSS

Generalized Self-Efficacy Scale GS-ES

Centre for Epidemiologic Studies Depression Scale CES-D

Declarations

Ethics approval and consent to participate

This is not applicable as human subjects are not involved.

Consent to publish

Not applicable

Availability of data and materials

The datasets supporting the conclusions of this article are available in the institutional University of Nigeria repository and will be made easily available on request when required.

Competing interests

The authors declare that there is no conflict of interest

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Authors' Contributions

SCI and UV conceived the study, participated in literature search and review, data extraction, study design and coordination, performed the statistical analysis, and helped draft the manuscript. EAD, participated in data extraction and helped drafted the manuscript. EFE, and IFO participated in literature search and review, data extraction and helped draft the manuscript. HM, AAT, OUP, and GF participated in the design of the study, coordination, and helped draft the manuscript. All authors read and approved the final manuscript.

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Figures

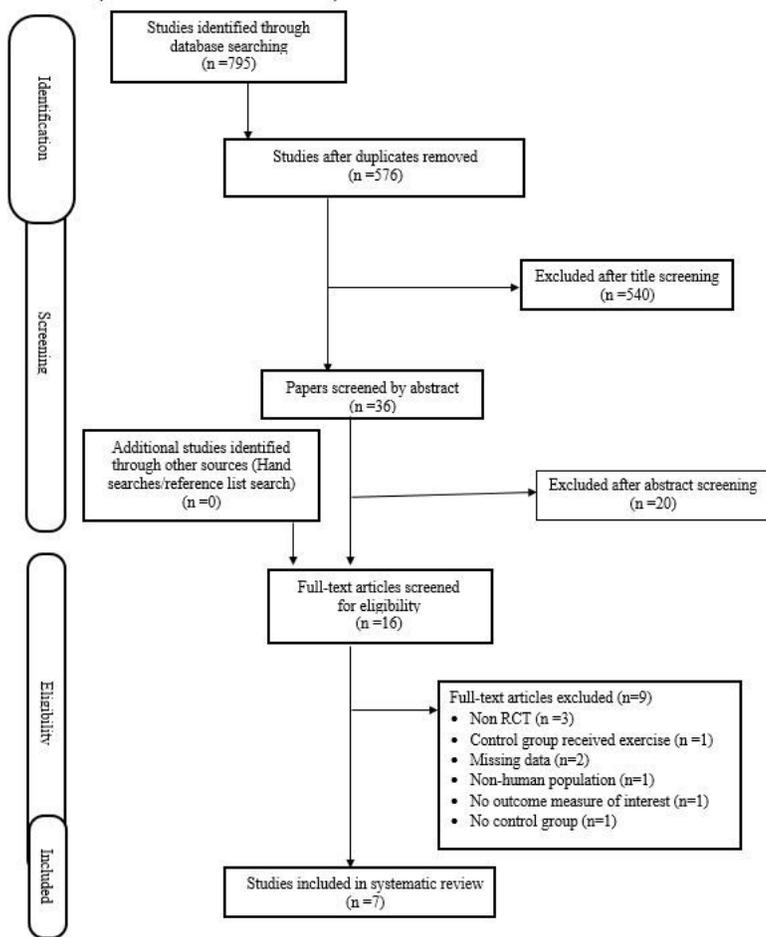


Figure 1
 PRISMA Diagram for mental health, physical activity level, social participation: adapted from Moher, Shamseer & Clarke, et al., 2015; Preferred Reporting Items for Systematic Reviews and Meta Analyses

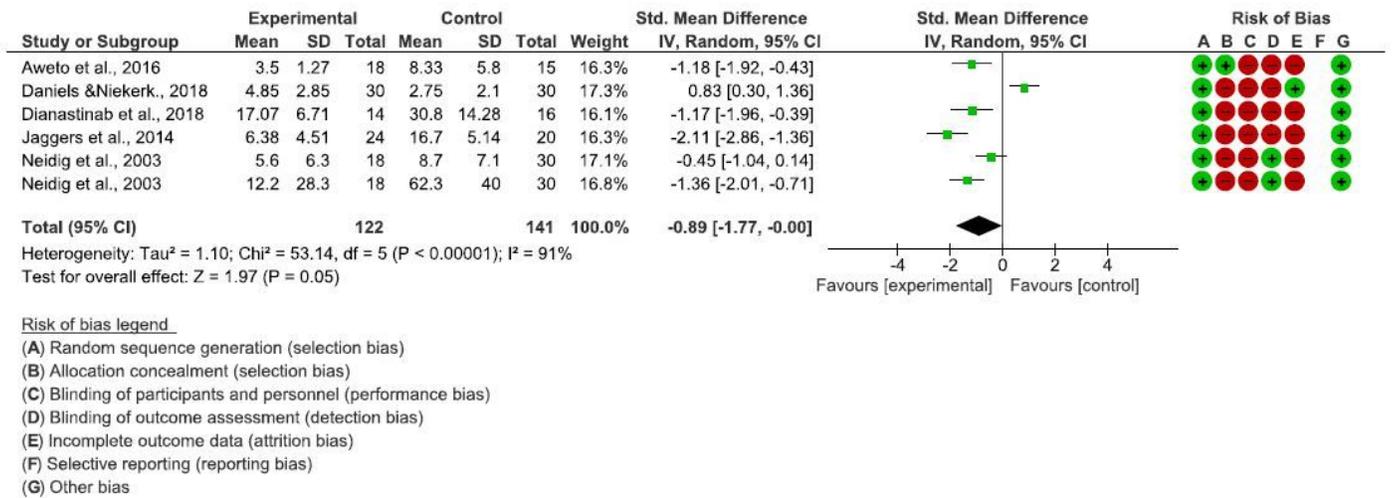
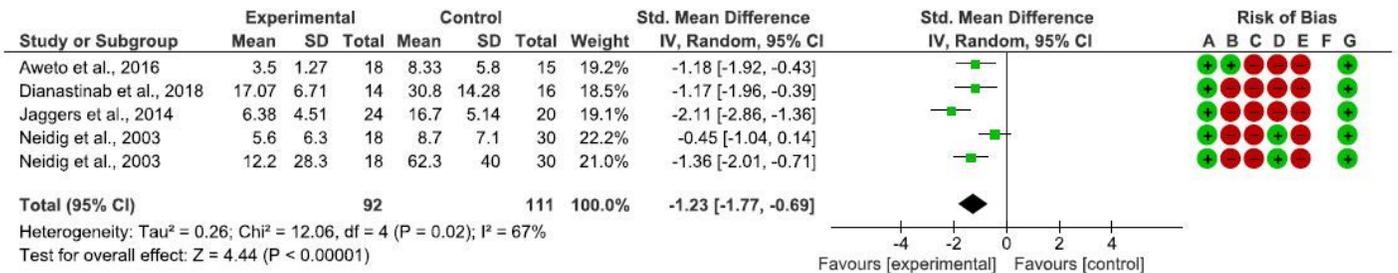


Figure 2
 Forest plot for mental health: meta-analysis of five studies

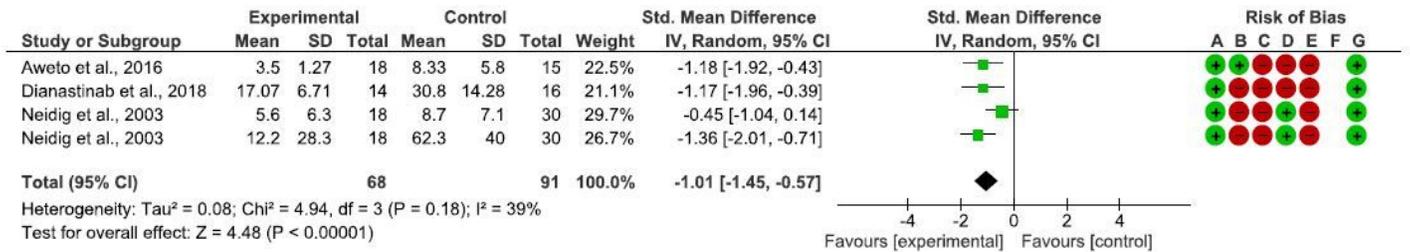


Risk of bias legend

- (A) Random sequence generation (selection bias)
- (B) Allocation concealment (selection bias)
- (C) Blinding of participants and personnel (performance bias)
- (D) Blinding of outcome assessment (detection bias)
- (E) Incomplete outcome data (attrition bias)
- (F) Selective reporting (reporting bias)
- (G) Other bias

Figure 3

Forest plot for mental health: sensitivity analysis of four studies



Risk of bias legend

- (A) Random sequence generation (selection bias)
- (B) Allocation concealment (selection bias)
- (C) Blinding of participants and personnel (performance bias)
- (D) Blinding of outcome assessment (detection bias)
- (E) Incomplete outcome data (attrition bias)
- (F) Selective reporting (reporting bias)
- (G) Other bias

Figure 4

Forest plot for mental health: sensitivity analysis of three studies

Supplementary Files

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