SYSTEMATIC REVIEW

**Effects of exercise-based prehabilitation in children undergoing elective surgeries: a systematic review [version 2; peer review: 2 approved]**

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**Abstract**

**Background:** Prehabilitation is a therapeutic strategy involving preoperative physical exercises, nutritional support, and stress and anxiety reduction. This approach has been gaining popularity and has been seeing effective results in adults in terms of improving pre and postoperative outcomes. The purpose of this review was to summarise the evidence about the effects of exercise-based prehabilitation programs on various outcome measures in children post elective surgeries.

**Methods:** PubMed, Scopus, Web of Science, PEDro, CINAHL/EBSCO and EMBASE electronic databases were searched from inception to June 2021. Based on the inclusion criteria, titles and abstracts were independently screened by the authors. After that, a data extraction table of the selected studies which included the participants, type, and details of exercise intervention, outcome measures and results were analysed after which the quality assessment of the studies was done.

**Results:** The search yielded 2219 articles of which three articles fulfilled the inclusion criteria with two studies being randomized controlled trials and one being a quasi-experimental pre-post type of study. One randomized controlled trial was on the effects of exercise-based prehabilitation in reducing pulmonary complications post cardiac surgeries in children and the other two studies were on the effects of prehabilitation on functional capacity & pulmonary function. All the three articles found that exercise-based prehabilitation had a positive effect on children's post-surgery.

**Conclusion:** Although there is a paucity of evidence-based literature, we conclude based on the existing literature retrieved by our review that exercise-based prehabilitation improves postoperative outcomes and helps in reducing postoperative complications in children undergoing various surgeries.
Keywords
Pre-operative exercises, preoperative exercise, prehabilitation, exercise therapy, surgery, paediatric, children, adolescents

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Abbreviations used
ACBT: Active Cycle of Breathing Technique
CG: Control Group
FEV1: Forced Expiratory Volume 1
FEV1/FVC Ratio: Tiffeneau-Pinelli index
FVC: Forced Vital Capacity
IG: Interventional group
PEFR: Peak expiratory flow rate
POP: Postoperative Physiotherapy
POPE: Preoperative Physiotherapy Education
PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RCT: Randomized control trial
ROM: Range of Motion
TUGT: Time up and Go test
6MWT: Six-minute walk test
9SCT: 9 Step climbing test
10MWT: 10-minute walk test

Introduction
Major surgeries in children along with the deleterious effects of the condition that predisposes a child for the surgery lead to complications that need to be therapeutically managed in children.

Prehabilitation is a multimodal type of approach that helps a patient planned for any major surgery and also allows them to prepare to, manage the stressors in the pre-surgical period and also undertake the necessary rehabilitation successfully so that they can return to their pre-operative state with better and improved outcomes. Prehabilitation encompasses pre-operative physical exercises, nutritional support, and stress and anxiety reduction. The concept of prehabilitation dates as far back as World War II and was initially started not as a part of the pre-surgical procedure. Prehabilitation has its first mentions in articles in 1942 where it raised the fact that military recruits would be medically screened and treated with respect to their health and comorbidities, resulting in a higher number of acceptances, and came to light post-2011 after the systematic review published by Valkenet et al. about prehabilitation before joint, cardiac and abdominal surgeries.

Prehabilitation/preoperative exercise is a set of interventions done before surgery that helps the patient to be prepared for post-surgical stressors and also help improve their functional capacity (FC) through the exercises. Patients’ ability to function to their fullest capacity can deteriorate because of inactivity during the surgical period and even if the surgery has been successful there can be chances of deconditioning. Current studies and reviews done in prehabilitation concerning the adult population do show that there is improvement in the post-operative complications and length of stay and also in their post-operative pain. Therefore the concept of prehabilitation is said to not only help the patient prepare themselves before a major surgery for post-surgical complications, but it also helps the patient to understand the importance of it to reduce the complications, helping them promote physical fitness and also optimize their psychological wellbeing. This also helps the patients return to their normal levels of functionality that were present before surgery.

This review aims at examining the current body of evidence in the area of exercise-based prehabilitation in children undergoing various elective surgeries.

Methods
Search strategy
A data search was made on PubMed, Scopus, Web of Science, PEDro, EMBASE, CINAHL/EBSCO from inception to June 2021. The terms used for search for the pediatric population were the following: infant [Mesh], child [Mesh], adolescent [Mesh], children. The terms preoperative exercise [Mesh], exercise [Mesh], exercise therapy [Mesh], breathing exercises [Mesh], preoperative exercises [Mesh] were used related to the intervention and for the population type: general surgery [Mesh], paediatrics/surgery [Mesh] and surgical procedures operative [Mesh] were the terms used.
The search terms were combined with a Boolean operator ‘AND’ or ‘OR’ wherever applicable. The references of the included articles were also screened for possible relevant studies.

Selection criteria
The articles were screened based on the following pre-set criteria. The inclusion criteria include 1) Studies that included participants in the age group of 0-18 years; 2) Studies that include children undergoing elective surgeries; 3) Studies published in English language and 4) were either randomized control trial (RCT), Non-RCT, single group post, case study and case series and the exclusion criteria included were 1) studies with participants undergoing a prehabilitation program other than exercise 2) studies that included participants above 18 years.

Results
Characteristics of studies
All the data retrieved from the databases, summing up to 2219 articles, were fed in the Mendeley Desktop v1.19.8 after which duplicates were removed. The articles were then screened through the titles and 181 articles were found eligible, following this the abstract screening removed 150 articles, after which full-text screening was done, and 29 papers were excluded, eventually yielding three papers that meet the inclusion criteria of this review. The PRISMA flow chart as in Figure 1. Outlines details regarding the identification, screening, eligibility, and inclusion of the studies in this review.

Qualitative analysis
The risk of bias scoring was done using the NIH Quality assessment scales as shown in Figure 2. The quality assessment scales were used depending on the type of study. Two separate scales were used for the pre-post study design and the RCT. The scales covered everything regarding the type, duration of the study, the sample sizes, characteristics of the population and about its randomization, the interventions used, and whether participants and therapists were blinded. A score of 9/12 was rated for the pre-post type of study done by Sharma N et al.
**NIH – Study Quality Assessment Tools**

Quality was rated as 0 = poor (0–4 out of 14 questions)

i = for fair (5–10 out of 14 questions),

or ii = good (11–14 out of 14 questions);

NA: not applicable,

NR: not reported.

For Quasi-experimental pre-post study design

| Question no | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|-------------|---|---|---|---|---|---|---|---|---|----|----|----|
| Neha Sharma et al (15) | Yes | Yes | Yes | Yes | Yes | Yes | Yes | NR | NA | Yes | Yes | NA | i |

For RCTS

| Question no | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|-------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|
| Felcar et al (17) | Yes | Yes | NR | NR | NR | No | Yes | Yes | No | Yes | No | No | Yes | i |
| Neha Sharma et al (16) | Yes | Yes | NR | NR | NR | No | Yes | Yes | No | Yes | No | No | Yes | i |

**Figure 2. NIH study quality assessment tool.**

A score of 7/14 was given for the RCT done by Sharma N et al.\(^{15,16}\) and Felcar et al.\(^{17}\) respectively.

**Population of the included studies**

Of the three studies, the two studies included children scheduled for abdominal surgeries in the age group 5-17 years of age\(^{15,16}\) and the other study had children one-day-old to six-year-old with congenital heart disease who underwent heart surgeries.\(^{17}\)

**Intervention of the included studies**

All of the three studies included exercise-based prehabilitation as the main form of intervention. Of the three studies, one study focused on the use of exercise-based prehabilitation in reducing pulmonary complications through chest physiotherapy, clearance techniques, support and guidance to parents, and early mobilization.\(^{17}\) The other two studies included the N-PARP protocol\(^{17}\) used for prehabilitation This protocol included exercises to be given from the pre-operative period till POD5 and included breathing exercises, ROM exercises, and ambulation.\(^{15,16}\)

**Outcomes of the included studies**

Felcar et al.\(^{17}\) included the presence or absence of pulmonary complications as its major outcome measure, while Sharma N et al.\(^{15,16}\) had a pulmonary function and functional capacity (FC) as their main outcomes which included spirometer
Table 1. Summary of the exercise-based prehabilitation studies.

| Author                      | Study type | Participants                                      | Interventions                                      | Exercise and dosages                                                                 | Outcome measures         |
|-----------------------------|------------|---------------------------------------------------|---------------------------------------------------|--------------------------------------------------------------------------------------|--------------------------|
| Josiane Marques FELCAR, et al. | RCT        | 135 completed M = 73 F = 62 Congenital heart disease Age = 1 day old – 6 years | IG = Pre-operative and Postoperative physiotherapy | IG = Pre-op-ex: two sessions - clearance & expansion techniques, abdominal support, and advice to parents + post-op ex: airway clearance, pulmonary re-expansion and early mobilization | Primary Pulmonary Complications |
|                             |            |                                                   |                                                   |                                                                                      |                          |
|                             |            |                                                   |                                                   |                                                                                      | Yes-17 (25%)             |
|                             |            |                                                   |                                                   |                                                                                      | No-51 (75%)              |
|                             |            |                                                   |                                                   |                                                                                      |                          |
|                             |            |                                                   |                                                   |                                                                                      | Yes-29 (43.3%)           |
|                             |            |                                                   |                                                   |                                                                                      | No-38 (56.7%)            |
|                             |            |                                                   |                                                   |                                                                                      |                          |
|                             |            |                                                   |                                                   |                                                                                      | Pneumonia                |
|                             |            |                                                   |                                                   |                                                                                      | 7 (10.3%)                |
|                             |            |                                                   |                                                   |                                                                                      | 13 (19.4%)               |
|                             |            |                                                   |                                                   |                                                                                      |                          |
|                             |            |                                                   |                                                   |                                                                                      | Atelectasis              |
|                             |            |                                                   |                                                   |                                                                                      | 6 (8.8%)                 |
|                             |            |                                                   |                                                   |                                                                                      | 8 (11.9%)                |
|                             |            |                                                   |                                                   |                                                                                      |                          |
|                             |            |                                                   |                                                   |                                                                                      | Both                     |
|                             |            |                                                   |                                                   |                                                                                      | 4 (3.9%)                 |
|                             |            |                                                   |                                                   |                                                                                      | 8 (11.9%)                |
|                             |            |                                                   |                                                   |                                                                                      |                          |
|                             |            |                                                   |                                                   |                                                                                      | Secondary Time on mechanical ventilation |
|                             |            |                                                   |                                                   |                                                                                      | 35.8 (7-204)            |
|                             |            |                                                   |                                                   |                                                                                      | 36 (8-288)               |
|                             |            |                                                   |                                                   |                                                                                      |                          |
|                             |            |                                                   |                                                   |                                                                                      | Time of stay in the ICU |
|                             |            |                                                   |                                                   |                                                                                      | 6 days (3-13.7)          |
|                             |            |                                                   |                                                   |                                                                                      | 6 days (3-17)            |
|                             |            |                                                   |                                                   |                                                                                      |                          |
|                             |            |                                                   |                                                   |                                                                                      | Total time of hospital stay |
|                             |            |                                                   |                                                   |                                                                                      | 13.5 (7-27.7)           |
|                             |            |                                                   |                                                   |                                                                                      | 14 (8-44)                |
|                             |            |                                                   |                                                   |                                                                                      |                          |
|                             |            |                                                   |                                                   |                                                                                      | Duration of surgery      |
|                             |            |                                                   |                                                   |                                                                                      | 142.5 (93.7,193.7)      |
|                             |            |                                                   |                                                   |                                                                                      | 140 (100,240)            |
|                             |            |                                                   |                                                   |                                                                                      |                          |
|                             |            |                                                   |                                                   |                                                                                      | Time of CPB              |
|                             |            |                                                   |                                                   |                                                                                      | 41 (21.5-69.7)          |
|                             |            |                                                   |                                                   |                                                                                      | 41 (0-90)                |
|                             |            |                                                   |                                                   |                                                                                      |                          |
|                             |            |                                                   |                                                   |                                                                                      | other complications (breathing - sepsis and surgical site infection) |
|                             |            |                                                   |                                                   |                                                                                      | Yes-16 (23.5)            |
|                             |            |                                                   |                                                   |                                                                                      | No-52 (76.5)             |
|                             |            |                                                   |                                                   |                                                                                      |                          |
|                             |            |                                                   |                                                   |                                                                                      | Yes-35 (52.2)            |
|                             |            |                                                   |                                                   |                                                                                      | No-32 (47.8)             |
| Author              | Study type                          | Participants                                      | Interventions                                                                 | Exercise and dosages                                                                 |
|---------------------|-------------------------------------|--------------------------------------------------|-------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Neha Sharma, et al | One group pre-test–a post-test, quasi-experimental pilot trial | 8 Participated M = 6 F = 2 All Open abdominal surgery Age = 5-17 years children | IG = POPE + POP                                                                | IG = POPE: Deep breathing, trunk, pelvic mobility and leg ROM exercises. - 30min - 1 session - 1 day before surgery + POP: deep breathing & segmental breathing exercises, ACBT, limb ROM, and early ambulation program |

| Outcome measures       | IG                      | Pre | Post |
|------------------------|-------------------------|-----|------|
| **Primary**            |                         |     |      |
| Spirometry             |                         |     |      |
| FVC                    | 83.8 (74.1–93.4)         | 82.3 (71.9–92.7) |
| FEV1                   | 83.0 (69.3–96.3)         | 80.1 (68.7–91.6) |
| FEV1/FVC RATIO         | 105.1 (94.8–115.5)       | 100.4 (88.0–112.8) |
| PEFR                   | 68.2 (52.5–84.0)         | 67.7 (52.9–82.5) |
| **Secondary**          |                         |     |      |
| 6MWT                   | 464 (438–490)            | 417 (389–445) |
| Borg’s scale           | 6.4 (6.1–6.8)            | 5-7.2 (6.2–8.0) |
| 10MWT                  | 12.9 (11.4–14.4)         | 15.9 (13.3–18.5) |
| TUGT                   | 12.5 (11.2–13.9)         | 18.7 (15.2–22.2) |
| Chest expansion – T2   |                         |     |      |
| T3                    | 2.3 (1.9–2.8)            | 2.2 (1.8–2.6) |
| T4                    | 3.7 (3.0–4.5)            | 3.3 (2.4–4.2) |
| T10                   | 4.6 (4.0–5.2)            | 2.6 (2.1–3.2) |
| 9SCT                  | 13.8 (10.0–17.6)         | 18.7 (14.0–23.4) |
Table 1. Continued

| Author                     | Study type | Participants | Interventions | Exercise and dosages                                                                 | Outcome measures |
|----------------------------|------------|--------------|---------------|--------------------------------------------------------------------------------------|------------------|
| Neha Sharma, et al.        | RCT        | 21 included  | IG: POPE + POP CG: POP                           | IG = POPE: Deep breathing, trunk, pelvic mobility and leg ROM exercises. + POP: deep breathing & segmental breathing exercises, ACBT, limb ROM, and early ambulation program CG = POP: deep breathing & segmental breathing exercises, ACBT, limb ROM, and early ambulation program |                  |

Pre     | Post     | Pre     | Post     |
---------|----------|---------|----------|
Primary  |          |         |          |
Spirometry: FVC |          |         |          |
74 (72.5, 91) | 77 (68, 93.5) | 62 (49.5, 106.0) | 56 (48, 67)    |
FEV1     |          |         |          |
87 (63, 103) | 83 (60.5, 95.5) | 57 (37.0, 65.0) | 58 (48.5, 65.5) |
FEV1/FVC RATIO |          |         |          |
106 (89,117) | 98 (82, 116) | 92 (64.0, 106.0) | 89 (66, 102.5) |
PEFR     |          |         |          |
75 (41, 96) | 70 (44.5, 85.5) | 32 (29.0, 53.0) | 46 (38.5, 72.5) |
Secondary |          |         |          |
6MWT     |          |         |          |
469 (409, 492) | 410 (380, 413) | 423 (365, 513) | 381 (341, 468) |
10mWT    |          |         |          |
12.7 (11.5, 14.3) | 16.9 (14.6, 18.9) | 13.1 (11.8,14.8) | 19 (17.1,20.2) |
TUGT     |          |         |          |
12.9 (11.4,14.1) | 20.8 (17.2, 23.9) | 16.2 (11.7,19.8) | 21.8 (18.7, 24.3) |
Chest expansion – T2 |          |         |          |
2.3 (2.0, 2.7) | 2.1 (2.0, 3.0) | -2.0 (1.5, 2.1) | 1.5 (1.5, 2.0) |
T4       |          |         |          |
3.9 (3.1, 4.6) | 3.8 (2.2, 4.4) | 2.9 (1.7, 3.3) | 2.3 (1.8, 2.7) |
T10      |          |         |          |
4.8 (4.2, 5.5) | 4.0 (3.5, 4.9) | 4.1 (3.1, 4.3) | 3.0 (2.7, 3.6) |
9SCT     |          |         |          |
12.9 (10.5, 16.7) | 17.4 (16.0, 25.7) | 15.3 (13.9, 16.0) | 18.8 (17.0, 21.6) |

Abbreviations: RCT - Randomized control trial; IG - Interventional group; CG - Control Group; POPE - Preoperative Physiotherapy Education; POP - Postoperative Physiotherapy; ACBT - Active Cycle of Breathing Technique; ROM-Range of Motion; FVC-Forced Vital Capacity; FEV1 - Forced Expiratory Volume 1; FEV1/FVC Ratio - Tiffeneau-Pinelli index; PEFR - Peak expiratory flow rate; 6MWT - Six-minute walk test; 10MWT - 10-minute walk test; TUGT - Time up and Go test; 9SCT - 9 step climbing test.
values and Six-minute walk test (6MWT) respectively and others being 10-minute walk test (10MWT), Timed up and go test (TUGT), chest expansion. A detailed explanation of the studies is given in Table 1.

Data extraction
A data extraction table was made to summarize and cover all the details regarding the participants, study design, sample size, study groups, type and dosage of exercise intervention, outcomes measures, and conclusion for all the selected studies. A detailed description of the Data extraction is presented in Table 1.

Discussion
This systematic review aimed at identifying studies that gave an exercise-based prehabilitation intervention to children undergoing various surgeries. While searching articles for this review various studies were found that included post-operative exercise after surgery in children, but very few studies included prehabilitation in the routine clinical care of these patients.

Sharma N et al. published two studies in 2020 and 2021 about the effects of prehabilitation on pulmonary function and FC in the patients undergoing elective abdominal surgeries and Felcar et al. studied its effects in the reduction of post-op pulmonary complications in children undergoing cardiac surgery.

In the two studies conducted by Sharma N et al., the effects of prehabilitation on FC and pulmonary functions were studied using a spirometer as a measurement tool. There was a trend seen in both the studies that no major changes in the values of the spirometer (that includes Forced Vital Capacity (FVC), Forced Expiratory Volume 1 (FEV1), Tiffeneau-Pinelli index (FEV1/FVC ratio), Peak Expiratory Flow Rate (PEFR)) were seen in the pre-surgical period and on POD 5, but there was a decline seen from the pre-operative period to POD 1 and from POD1 to POD5. The only difference seen in the RCT compared to the pre-post study conducted by Sharma N et al. was that FVC improved post prehabilitation and surgery. Values of chest expansion seemed to be better in the IG than CG in the RCT. Lastly, one of the common findings in both the studies was that the values of 10MWT, TUGT, 9SCT were seen better in the CG of both studies rather than in the IG. This study implies that exercise-based prehabilitation, when given in a proper format and incorporated well in routine care can have beneficial effects in children during the post-operative period.

In the study done by Felcar et al., its was seen that children in the CG were seen to have a higher frequency of developing pulmonary complications such as pneumonia or atelectasis or both as compared to the IG that received both the treatment options, i.e., prehabilitation and post-operative exercises. This implies that children who received exercise-based prehabilitation have a lesser frequency of developing any other complications as compared to the children that didn’t receive prehabilitation.

Quality assessment of each of the studies was done by using the NIH Quality assessment scale. Two different scales were used for each type of study i.e. the pre-post type of study and the other for an RCT. The Pre-post study was done by Neha et al. had a scoring of 9/12 which acc to their scale was categorized as fair. This study included clearly stated objectives, had pre-set inclusion and exclusion criteria. The sample size was around 12 participants but enough to conclude about the effects of the N-PARP (prehabilitation protocol) in that set population and to conclude that the study could be done in a larger population. there is also no information regarding the blinding of the populations in this study.

The NIH Quality assessment is done for The articles of Felcar et al., and Neha et al. scored them (7/14) and (7/14) respectively which according to their scale belonged to the fair category. Both these RCTs did not have any details regarding the blinding and concealment of the participants.

Conclusion
Although few in number, the available literature leads us to the conclusion that exercise-based prehabilitation plays an important role in improving health-related outcome measures in children undergoing various surgeries.

Data availability
Underlying data
All data underlying the results are available as part of the article and no additional source data are required.

Reporting guidelines
Open Science Framework: PRISMA Checklist final.docx, https://doi.org/10.17605/OSF.IO/B3CPX. Data are available under the terms of the Creative Commons Attribution 4.0 International license (CC-BY 4.0).
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In my opinion, this is a brilliant systematic review aimed at examining the effects of exercise-based prehabilitation involving physical exercise, nutritional support, and stress and anxiety reduction, on various outcome measures in children undergoing elective surgeries.

The authors introduce the topic on the basis of many literature references. In the definition of prehabilitation (introduction, 3rd paragraph), it should be added, if necessary, that the exercise interventions can be performed actively by the patient himself or by a therapist. Especially in children under 3 years of age (compare participants in study Felcar et al. 2008), the intervention is more likely to be performed by a (physio)therapist.

All required steps of a systematic review were followed. It is a bit unclear why so many articles (especially full-text articles) were excluded. In Figure 1 it is only described that it happened "with reasons". It would be interesting to know if there were two or three categories/main reasons why the articles had to be excluded from the review.

In the subsequent discussion, the results obtained are very well discussed in the light of the literature. In addition, it should be critically discussed that in the studies of Sharma N et al. 2020, 2021, only eight participants took part in the study.

In summary, it is an excellent review with results not yet found in the existing literature.

Are the rationale for, and objectives of, the Systematic Review clearly stated?
Yes

Are sufficient details of the methods and analysis provided to allow replication by others?
Yes

Is the statistical analysis and its interpretation appropriate?
I cannot comment. A qualified statistician is required.

Are the conclusions drawn adequately supported by the results presented in the review?
Yes

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Exercise Science

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

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**Version 1**

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Forhad Akhtar Zaman
Department of Community Medicine & Family Medicine, All India Institute of Medical Sciences (AIIMS), Guwahati, Assam, India

I think this is an excellent systematic review aimed at reviewing studies of exercise-based prehabilitation intervention to children undergoing various surgeries.

The strength of the study was that the review was done very meticulously and it followed all the required steps of systematic review. This will be an important addition to the existing literature. As the selection criteria was very robust & specific, only three out of a whole lot of studies could be selected for the review. Although few in number, I really like the way in which the discussion was done and evidence presented. I hope the authors will correct the few numerical errors which has been mentioned in the report.

I have only a couple of minor points of clarification:
1. In the Methodology section, it was not mentioned why only randomized controlled trials & quasi-experimental studies were selected.
2. There is a mismatch between the number of total eligible titles (181) & total removed (150), thus full-text articles assessed for eligibility should have been 31, but it is mentioned as 33 in the PRISMA Flow chart (Fig-1). Also, out of 33 full-text articles which was assessed for eligibility, 29 papers were excluded, leaving 4 papers that ultimately met the inclusion criteria, but it is mentioned as 3.
Are the rationale for, and objectives of, the Systematic Review clearly stated?
Yes

Are sufficient details of the methods and analysis provided to allow replication by others?
Partly

Is the statistical analysis and its interpretation appropriate?
I cannot comment. A qualified statistician is required.

Are the conclusions drawn adequately supported by the results presented in the review?
Yes

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Communicable disease especially TB, HIV, Covid

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

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**Author Response 06 Jan 2022**

**Stephen Samuel**, Manipal Academy of Higher Education, Manipal, India

Dear F1000Research Team,

We thank the reviewer and the editorial team for taking out the time to conduct an in-depth review of our article. We thank you for the appreciation you have given us regarding this systematic review. We also thank you for the clarifications. The necessary changes have been made and addressed accordingly. The modified manuscript and the latest PRISMA flow chart with changes tracked in the word document have been uploaded.

**Reviewer Comment 1**

"In the Methodology section, it was not mentioned why only randomized controlled trials & quasi-experimental studies were selected."

**Reply** - The following types of study designs, i.e., RCT (Randomized Controlled Trials), Non-RCT, Single group Pre-post, Case study, and series were to be included; but during the data extraction and reviewing process only RCT and quasi-experimental studies were retrieved

**Reviewer Comment 2**

"There is a mismatch between the number of total eligible titles (181) & total removed (150), thus full-text articles assessed for eligibility should have been 31, but it is mentioned as 33 in the PRISMA Flow chart (Fig-1). Also, out of 33 full-text articles which was assessed for eligibility, 29 papers were excluded, leaving 4 papers that ultimately met the inclusion criteria, but it is mentioned as 3."

**Reply** - We thank the reviewer for the correction and we have made the necessary changes as suggested.


**Competing Interests:** No competing interests were disclosed.

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