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The Graded Repetitive Arm Supplementary Program (GRASP): a Systematic Review

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Abstract

Purpose of Review To determine and examine the evidence of GRASP in an upper limb rehabilitation setting for survivors of stroke.

Summary Five databases were searched: CINAHL Complete, Medline (OVID), Embase, Cochrane Methodological Register, and Open Grey resulting in 8 studies for this review. Studies that included survivors of stroke using GRASP, participants over 18 years, and full-text articles were used. The Down's and Black checklist and Critical Appraisal Skills Programme were used to assess risk of bias.

Recent Findings A narrative synthesis of results, including setting and exercise time, was conducted to provide a comprehensive overview of the clinical measures. The findings of this review revealed that those who used GRASP showed an increase in hand strength/dexterity, upper limb function, and in the activities of daily living. The setting of GRASP provides implications for the way the program can be delivered in the future.

Keywords GRASP · Rehabilitation · Stroke-upper limb

Introduction

Stroke is the second leading cause of death and the third leading cause of disability worldwide [1]. It is estimated that, globally, stroke will affect 13.7 million individuals this year [2] and every year, 100,000 people in the UK will have a stroke [3]. It has often been reported rehabilitation or recovery of upper limb impairment following stroke is less focused on than lower limb within the health care sector worldwide [4, 5]. Fifty percent of stroke survivors still have problems at 6 months and demonstrate a disconnect between what can be done with the limb and actual use of the arm and hand in daily life [6–8].

Having a community-based rehabilitation program has been shown to improve quality of life, improved day-to-day activities, and independence [9]. This therefore provides an opportunity to provide ongoing upper limb rehabilitation. It is well established that this rehabilitation needs to be high intensity, repetition, and provides the opportunity for task-oriented exercises [10–15].

The Graded Repetitive Arm Supplementary Program (GRASP) provides the potential to deliver this type of therapy in the community or home setting. This stroke-specific program includes both exercises and educational components, with three levels, dependent on the patient's ability. GRASP has been shown to be highly effective with very little resources [10, 16–18] with the focus on complimenting and enhancing therapy [10]. With GRASP, the individuals are given a booklet of exercises, that contains a progression of exercise repetitions that they can proceed to work through on their own. This program also has a set amount of practice time for the survivor to proceed with encouraging them to use their affected arm [17, 18]. There are two parts to the GRASP; the exercises and a behavioural component consisting of an exercise log and a commitment contract [18].

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This is used to help the participants to track their daily exercise time and hold them accountable to daily practice [18]. Although randomized control trial level evidence is available [18], there is a gap in knowledge relating to the optimal setting, fidelity, and delivery of the program. Despite being designed to complement other therapies [5, 19], there is also lack of information focusing on using GRASP in conjunction with other interventions and therapies.

This paper aims to investigate the evidence of the effect of the GRASP intervention for upper limb rehabilitation in stroke patients and specifically consider the make-up of successful programs.

The objectives of this review are:

1. To consider the association between participant demographics and the provision of GRASP as an intervention option.
2. To understand the settings in which GRASP is implemented with stroke survivors.
3. To evaluate the effect of intervention dose on clinical outcomes and to evaluate the effect of any additional interventions used in conjunction with GRASP.
4. To identify any gaps in the current literature.

Materials and Methods

This systematic review followed the methodology recommended by the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols (PRISMA-P) [20]. Electronic searches were carried out in the CINAHL Complete, Medline (OVID), Embase (OVID), Cochrane Methodological Register, and Open Grey databases. The finalized studies were compiled and a manual search through the reference lists for additional studies and systematic reviews occurred on December 9, 2022.

Search Strategy

The search strategy included key words Stroke, Graded Repetitive Arm Supplementary Program (GRASP), upper limb impairment (arm, hand, shoulder), upper limb rehabilitation, exercise therapy, and upper extremity exercises (see appendix 1). The search strategy can be found in the supplementary material. Limits were applied while searching the databases, given that GRASP started in 2005. The limits placed during the screening of the titles and abstracts, full-text reading, and GRASP outside the survivors use (i.e. caregiver's thoughts, therapists' views). However, studies were included if GRASP was used in conjunction with another intervention.

Eligibility

Any study was included (qualitative or quantitative) with a minimum of one outcome measure of interest. Studies that included participants over the age of 18, who had a diagnosis of stroke, with no limits on time since onset of stroke were included. Interventions delivered in any setting were included. No restrictions were made on the comparison or control group. The primary outcome of interest was upper limb function. All outcome measures related to change in upper limb use and recovery were included.

Screening of Studies

ProQuest RefWorks [21] was used to organize, upload, and deduplicate references from the three databases. The results from each were uploaded into their specific folder in RefWorks and deduplication occurred. Finally, the studies were merged and transferred to Covidence where titles and abstracts were screened by two authors (NJK, NK). Any conflicts were resolved by a third author (KP). Covidence was used for the screening process of the remaining studies. Studies labelled "maybe" were screened. The full texts were examined, and a discussion was held between the two review authors to resolve the issue; if the issue remained unachieved, a third review author was consulted to resolve any disputes.

Data Extraction and Quality Assessment

Data extraction and quality assessment were conducted by two different authors (NJK, NK). Data extraction involved a standardized template generated by authors via Covidence. Due to the anticipated variety in study designs across studies retrieved, study quality assessment was carried out using Downs and Black checklist [22]. This checklist has been found to be feasible to assess the quality of both randomized and non-randomized controlled trials and has been previously used in stroke research [23–25]. This review used the modified version (see appendix 2), as this checklist is often used to document reliability and validity within quantitative studies [22, 26]. For the qualitative studies, the Critical Appraisal Skills Programme (CASP) checklist was used. The CASP tool is a well-known program that is used for health-related studies [27, 28]. CASP consists of 10 questions designed specifically for qualitative research and systematic reviews [28]. CASP was used to appraise the semi-structured interviews of the survivors of stroke regarding their use of GRASP [29].

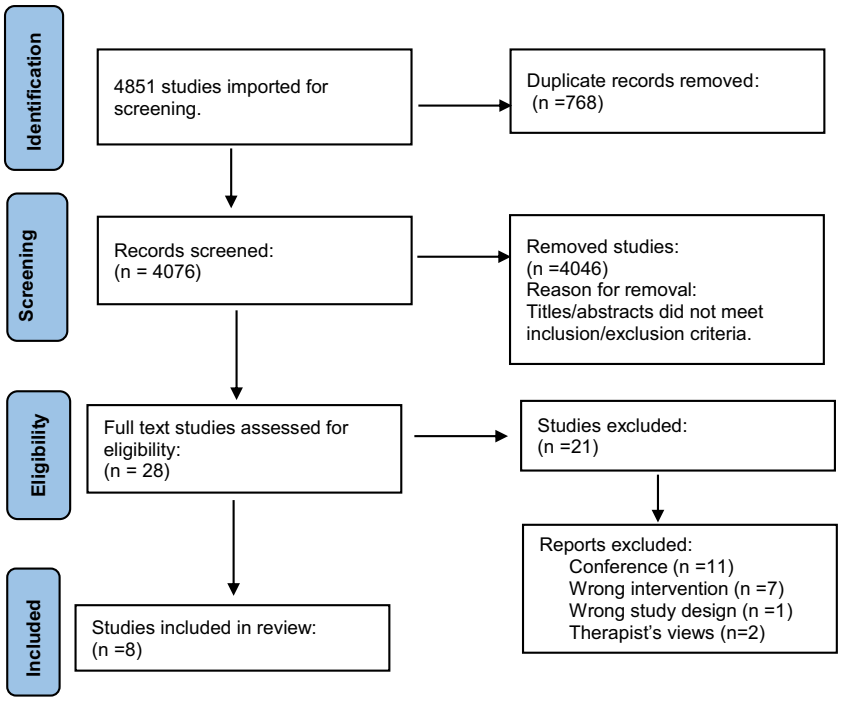

Fig. 1 PRISMA flow diagram [34]

Data Analysis

The participant demographics, mean age, frequency of female/male, and weeks since stroke were calculated. The type of study was analyzed, and the mean exercise time was calculated. A narrative analysis of data was carried out under the different upper limb measurements which were used in each article.

Results

From the initial 4851 studies, 768 duplicates were removed, leaving 4076 studies to undergo screening; we included 8 studies in this systematic review [5, 6, 18, 29, 30•, 31••, 32••, 33].

The results of the search are displayed in the PRISMA-P flow chart in Fig. 1.

Characteristics of Studies

This review included 188 participants across 8 studies (see Table 1). Within these studies, the number of participants ranged from 8 to 103, with the mean sample size of 23.5. Various study designs were included: 1 pilot study, 3 randomized controlled trials, 2 cross-sectional designs, 1 pre-post double baseline repeated measure, and 1 mixed method. One case study design was included. Seven included less than 100 participants [5, 6, 29, 30•, 31••, 32••, 33]. Four studies took place in a clinical setting [5, 18, 29, 33], three in the participant's home [6, 30•, 31••, 32••].

Four of the 8 studies were conducted in Canada [6, 18, 32••, 33], and one in Italy [5] (see Table 2). Four studies had more males than females (95:74) [18, 29, 31••, 33], two were equal distribution [5, 6], and two studies had more females than males [30•, 32••] whereas most individuals participating in the studies were older (mean age of 67.2/range of 28.8–88.1 years). Stroke type was documented in four studies [5, 18, 30•, 33]. All eight studies documented the individual's time since stroke which is highly important in recovery [5, 6, 18, 29, 30•, 31••, 32••, 33].

The mode of delivery among the studies included either of face to face ($n=4$) and remote delivery ($n=5$). Table 3 focuses on the specifics of the study, for instance the exercise time and study length. Six of these studies used GRASP as an intervention or as the focus of their study; however, only one used it in conjunction with another program [5]. Most of the studies included contained an intervention group. One study used GRASP-like videos as the intervention group and one used GRASP as the control. This was the only study that was found that showed a GRASP control group. The exercise time ranged anywhere from 10 to 60 min lasting for 1–10 weeks with 5–48 sessions. However, participants completed a varying number of sessions [29]. Half of the participants ($n=4$) completed GRASP once a day, and the other half ($n=4$) several times throughout the day. Homework or individual practice time away from a therapist was only documented in two of the studies [29, 32••].

Table 1 Study design

Author	Arnao 2019	Harris 2009	Levy 2019	Murdolo 2017	Simpson 2017	Wilson 2021	Yang 2021a	Yang 2021b
Total number of participants	18	103	10	8	8	19	9	13
Setting	Inpatient rehabilitation centres	Inpatient rehabilitation centres	Clinic/Home	Inpatient rehabilitation centre	Home	Home	Online group/home	Local community centre
Mode of recruitment	Not stated	Hospital admissions	Previous participants from another study	Referral by OT	An outpatient stroke rehabilitation program	9 inpatient, 10 outpatients at hospital	Self-referral	Self-referral
Study design	Randomized controlled trial	Randomized controlled trial	Feasibility study	Mixed methods design	Repeated measures	Randomized controlled trial	Mixed methods	Case report

Table 1 displays the study methods of each included study

Table 2 Demographics and stroke information

Author	Arnao (2019)	Harris (2009)	Levy (2019)	Murdolo (2017)	Simpson (2017)	Wilson (2021)	Yang (2021a)	Yang (2021b)
Country	Italy	Canada	Australia	Australia	Canada	Australia	Canada	Canada
Gender (F/M)	9/9	44/59	3/7	3/5	4/4	7/3	4/5	7/6
Age average (range)	76 years*	69 years*	61.5 years (47–79)	69.63 years (54–87)	66.4 years (53–76)	73.6 years (49–90)	65.9 years (39.87–83.30)	62.12 years (28.8–88.1)
Stroke type	Ischemic	Infarction, haemorrhage, lacunar	CVA	Not stated	Not stated	Ischemic, haemorrhagic	Not stated	Not stated
Time since stroke (mean)	Recruited 1–6 weeks after stroke	2 weeks + 6 days (20 days)	Varied (Range: 1 year 1 month–29 years 4 months)	0–1 week (2.75 days)	39 weeks (273 days)	17.45 weeks (122.45 days)	286.13 weeks (65.86 months)	247.6 weeks (57 months)

Table 2 shows the participant demographics and stroke history. *No range given for the age of participants

A wide variety of measurements were used within the eight studies (Supplementary 1). Most of these measurements were used to examine the survivor of stroke's upper extremity's function pre and post intervention. The stroke impact scale (SIS) was the most popular among the outcome measures, with it being used in half of the reported studies [29, 30•, 31••, 32••]. The Chedoke arm and hand inventory (CAHAI) and grip strength were used in three out of the 8 studies [6, 18, 29, 32••].

Clinical Outcomes

Hand Strength and Dexterity

Grip strength, using a dynamometer, was the most used measurement ($n = 3$ studies). Improvements in grip strength was demonstrated in all three studies [6, 18, 32••].

Table 3 The Graded Repetitive Arm Supplementary Program

Author	Arnao (2019)	Harris (2009)	Levy (2019)	Murdolo (2017)	Simpson (2017)	Wilson (2021)	Yang (2021a)	Yang (2021b)
Mode of delivery	In person	Semi-structured interviews (in person or telephone)	An online, self-administered questionnaire	Group setting	Binder with instructions	Home/phone	Home/in person	Telephone
Intervention group	GRASP + tRNS	GRASP	Motor training program based on GRASP	GRASP	H-GRASP	EDNA system (Elements)	GRASP	GRASP
Control group	GRASP + sham stimulation in addition to standard rehabilitation	Education booklet	None	None	None	GRASP	None	None
Exercise time prescribed (SD, mean)	20 min*	60 min*	60 min*	10 to 60 min (SD: 20.4) (mean: 28.44 min)	60 min (mean: 472.2 min)	30 min*	60 min (SD: 5.37, mean: 63.3)	60 min (SD: 12.4, mean: 58.4)
Homework time	Not stated	Not stated	Not stated	28.44 min a day	Not stated	Not stated	Not stated	60 min
Total length of time (total)	4 weeks	4 weeks	10 weeks	Range: 1–3 weeks*	8 weeks	8 weeks	10 weeks	10 weeks
Total number of sessions	5	24	12	Varied	48	3–4	10	10

Table 3 displays the specifics of GRASP. *No SD or average listed (*SD* standard deviation)

Upper Extremity Function

Upper extremity function was measured by several outcome measures. The CAHAI was used in three studies and showed improvements in scores throughout the study [6, 18, 29]. When looking at the change scores, a range of 19 [6]–63 [6, 29] was reported. Two studies used the ARAT measure [18, 32••]. Two studies used the motor activity log (MAL) assessment to assess upper extremity function [6, 18]; however, the greatest change of range within the MAL quality of movement, as documented in one study [18], was 0.7–3.5.

The last four upper extremity function tests followed the same trend of improvement as the previous tests. The UL-MAS, NIHSS, mRS, and BBT were each used in three separate studies and showed improvements within the studies [5, 29, 30•].

Activities of Daily Living

Activities of daily living were measured by several tests. The SIS was the most common ($n = 4$) [29, 30•, 31••, 32••].

Other Clinical Measures

Five other measurements were included; self-efficacy for exercise scale (SES), system usability scale (SUS), multidimensional scale of perceived social support (MSS), Montreal Cognitive Assessment (MoCA), and neurobehavioral function inventory (NFI) were used in two studies [30•, 33]. Changes were seen in these measurements in both studies [30•, 33].

Risk of Bias

Eight of the studies used quantitative methods and can be seen in Table 4. The quantitative checklist can be broken down into five categories; category 1: questions 1–10 focus on reporting, category 2: questions 11–13 external validity, category 3: questions 14–20 internal validity (bias), category 4: questions 21–26 internal validity (confounding, selection bias), and category 5: question 27 power [22]. In summary, all studies presented with low risk, but one study [30•] had a low risk across all 5 categories. Two studies presented with high risk mainly in categories 2 and 3 [31••, 32••].

The qualitative risk of bias demonstrated low risk in all studies except one [29] (Table 5).

Demographics

Studies demonstrated improvements in the upper extremity function [5, 6, 18, 29, 30•, 31••, 32••, 33]. Within two studies recruiting from inpatient facilities, improvement was demonstrated, indicating this program can also be used successfully in the inpatient setting, with acute care patients [4, 29].

Social Support

One study [33] included technology as part of the intervention and outlined the benefit of having carers available. Not only technological help, but the carers provided some level of encouragement and motivation to their family member. This study found that the participants who had less social support reported to practice the exercises less [33]. This is in line with previous studies carried out on the role of carers and an increase in health outcomes [35–37].

Within the study by Murdolo et al. (2017) [29], 75% of participants needed help from a family member to complete the GRASP exercises, indicating the importance of this support. It was also reported [18] that when family members were involved, there was a positive reaction to the exercises, and they felt more positive in contributing to the recovery journey [18] and having this social support involved could be beneficial to their recovery [18, 38].

Table 4 Quantitative studies risk of bias

	Arnao 2019	Harris 2009	Levy 2019	Murdolo 2017	Simpson 2017	Wilson 2021	Yang 2021a	Yang 2021b
1. Is the hypothesis/aim/objective of the study clearly described?								
2. Are the main outcomes to be measured clearly described in the Introduction or Methods section?								
3. Are the characteristics of the patients included in the study clearly described?								
4. Are the interventions of interest clearly described?								
5. Are the distributions of principal confounders in each group of subjects to be compared clearly described?								
6. Are the main findings of the study clearly described?								
7. Does the study provide estimates of the random variability in the data for the main outcomes?								
8. Have all important adverse events that may be a consequence of the intervention been reported?								
9. Have the characteristics of patients lost to follow-up been described?								
10. Have actual probability values been reported (e.g. 0.035 rather than <0.05) for the main outcomes except where the probability value is less than 0.001?								
11. Were the subjects asked to participate in the study representative of the entire population from which they were recruited?								
12. Were those subjects who were prepared to participate representative of the entire population from which they were recruited?								
13. Were the staff, places, and facilities where the patients were treated, representative of the treatment the majority of patients receive?								
14.Was an attempt made to blind study								

Table 4 (continued)

subjects to the intervention they have received?								
15. Was an attempt made to blind those measuring the main outcomes of the intervention?								
16. If any of the results of the study were based on "data dredging", was this made clear?								
17. In trials and cohort studies, do the analyses adjust for different lengths of follow-up of patients, or in case-control studies, is the time period between the intervention and outcome the same for cases and controls?								
18. Were the statistical tests used to assess the main outcomes appropriate?								
19. Was compliance with the intervention/s reliable?								
20. Were the main outcome measures used accurate (valid and reliable)?								
21. Were the patients in different intervention groups (trials and cohort studies) or were the cases and controls (case-control studies) recruited from the same population?								
22. Were study subjects in different intervention groups (trials and cohort studies) or were the cases and controls (case-control studies) recruited over the same period of time?								
23. Were study subjects randomized to intervention groups?								
24. Was the randomized intervention assignment concealed from both patients and health care staff until recruitment was complete and irrevocable?								
25. Was there adequate adjustment for confounding in the analyses from which the main findings were drawn?								
26. Were losses of patients to follow-up taken into account?								
27. Did the study have sufficient power to detect a clinically important effect where the probability value for a difference being due to chance is less than 5%?								

Low risk: green, unclear risk: yellow, and high risk: red

Clinical Experience

In the two studies that focused on the clinicians' use of GRASP, it stated that they found GRASP positive and were able to modify the exercises if needed [10, 39]. Following clinician interviews, concerns over prescribing GRASP at home were expressed. However, they perceived the program well, and identified advantages within the program [10]. In a study that looked at how often GRASP was used among clinicians, 22% used the program in the past and 50% report using GRASP on a regular basis. Positive feedback surrounding the use for their patients and the ease and benefits for themselves during their work time was seen in the clinicians who use GRASP on a regular basis [39]. Some of the clinicians liked the fact the GRASP was free and widely available online [10]. This is in conjunction to what a previous study found; that the exercises needed to be adapted due to participants experiencing pain when completing the program during the first 2 weeks [29].

Table 5 Qualitative studies

	Murdolo 2017
1. Was there a clear statement of the aims of the research?	
2. Is a qualitative methodology appropriate?	
3. Was the research design appropriate to address the aims of the research?	
4. Was the recruitment strategy appropriate to the aims of the research?	
5. Was the data collected in a way that addressed the research issue?	
6. Has the relationship between the researcher and participants been adequately considered?	
7. Have ethical issues been taken into consideration?	
8. Was the data analysis sufficiently rigorous?	
9. Is there a clear statement of findings?	
10. How valuable is the research?	

Low risk: green and unclear risk: yellow

One study found that in-patient therapy can be anywhere from 2 to 6 h [18]. It is understandable why exercises are prescribed outside a therapy session to provide some relief and remove some of the burden for the therapist. However, clinicians expressed concern over prescribing the GRASP exercises at home as they were concerned the movements may not be carried out currently and that they felt it undermined their work [39]. Having a clinician's point of view of GRASP could provide insight for future stroke rehabilitation. Perhaps providing patients with videos or having them video themselves [33] could ease the burden on the clinicians.

In a study that looked at survivors as well as clinicians in the early stages of rehabilitation found that the clinicians had a significant role in the survivors' rehab process. Therapists expressed thoughts that not all survivors would not be able to perform the movements outside of the rehabilitation time. This coincides with the concern raised about the quality of the exercises once the survivor is left to do the exercises alone [10, 39]. Survivors share a similar feeling of positivity and optimism to what has been reported in the included studies of this review [10, 29, 31••, 32••].

Method of Delivery

Four of the eight survivors of stroke studies use some sort of technology in their intervention. Only two virtual studies that were ongoing during the pandemic were included in this review [30•, 31••].

In a study using tablets, participants were asked to video themselves while performing the exercises which was later analyzed by researchers [33]. This has potential in easing the fear that the clinicians expressed in allowing individuals to go home and perform exercises. With recording the weekly exercises, clinicians would be able to see if their patient is performing the exercise movements correctly. In an earlier study, participants received weekly phone calls from the therapist to address progress and exercise adherence [6].

Due to the advantage of using very little resources, GRASP has been adapted to any setting and participant needs. For instance, GRASP has been performed in clinical, community, online, and as a homework-based therapy [5, 6, 18, 29, 30•, 31••, 32••, 33]. Given the environment, therapy equipment would possibly be a bit different for everyone; for example, if GRASP was online exclusively, some equipment may be tailored to what the individual already has allowing the person to work out with their own items. GRASP focuses on activities of daily living focusing on the impacted arm [17, 18]. Having these virtual aspects, such as telephone calls, can be beneficial in group studies, as they can provide the individualized care that participants may need.

Conclusion

This review adds to the depth of knowledge surrounding stroke and upper limb rehabilitation. This review highlights several key factors, such as GRASP as a control compared to an upper limb program, carer support, rehabilitation time and setting, and technology. As life emerges out of the global pandemic, all of us have learned how important support of others is as well as how useful technology is. Seeing the many benefits will hopefully provide more opportunities for stroke rehabilitation to be accessed by those who cannot travel, and perhaps provide more hybrid rehabilitation to occur. This review will allow therapists to have access to the research on GRASP and the outcomes it has produced. Hopefully, this will provide evidence for future therapists and researchers around GRASP.

This review has a few limitations. One, there were only a few studies included in the review. Perhaps a wider scope such as including GRASP protocols to provide a wider range of studies. Another limitation is that there were several studies without a control group to compare GRASP to. Even though it shows great outcomes from the studies which did use GRASP, it would be useful to compare this program to other upper limb rehabilitations. This systematic review also has several strengths. First, this protocol follows the methodology outlined by the PRISMA-P and the Cochrane handbook for systematic reviews. Secondly, the GRASP has demonstrated improvement after this program in both the acute and chronic stage post stroke in addition to community-based programs [5, 16, 18, 32••].

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Author Contribution Natalie J. Klempel and Niamh Kennedy were involved in the conception, design, data screening, data extraction, data analysis and interpretation, and write up of the manuscript. Katy Pedlow was also involved in the conception, design, interpretation, and review of the manuscript. All authors have read and agreed to the published version of the manuscript.

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Declarations

Conflict of interest The authors declare no competing interests.

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Disclaimer All tables and figures are our own. Figure 1 was adapted and cited from Moher D, Liberati A, Tetzlaff J, Altman DG, and PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLos Med. 2009; 6(7), 1–6. https://doi.org/10.1371/journal.pmed.1000097. Table 4 is adapted and cited from Downs SH, Black N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. *Journal of Epidemiology and Community Health*. 1998; 52:377–84. DOI: 10.1136/jech.52.6.377. Table 5 is adapted and cited from Critical Appraisal Skills Programme (2018). CASP (Systematic Review) Checklist. [online] Available from: https://casp-uk.net/casp-tools-checklists/. [Accessed 04/04/2022].

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- • Of importance
- •• Of major importance

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