Systematic Review

Interventions for behaviour change and self-management of risk in stroke secondary prevention: an overview of reviews

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Short Title: **Stroke secondary prevention: an overview of reviews**

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Abstract

Introduction. Optimised secondary prevention strategies that include lifestyle change are recommended after stroke. Whilst multiple systematic reviews address behaviour-change interventions, intervention definitions and associated outcomes differ between reviews. This overview of reviews addresses the pressing need to synthesise high-level evidence for lifestyle-based behavioural and/or self-management interventions to reduce risk in stroke secondary prevention in a structured, consistent way. **Methods**. Grading of Recommendations Assessment, Development and Evaluation (GRADE) criteria were applied to meta-analyses demonstrating statistically significant effect sizes to establish the certainty of existing evidence. Electronic databases MEDLINE, Embase, Epistemonikos and the Cochrane Library of Systematic Reviews were systematically searched, current to March 2023. **Results**. Fifteen systematic reviews were identified following screening, with moderate overlap of primary studies demonstrated (5.84% degree of corrected covered area). Interventions identified could be broadly categorised as Multimodal; Behavioural change; Self-management; Psychological talk therapies, albeit with overlap between some theoretical domains. Seventy-two meta-analyses addressing twenty-one preventive outcomes of interest were reported. Best-evidence synthesis identifies that for primary outcomes of mortality and future cardiovascular events post-stroke, moderate certainty GRADE evidence supports multimodal interventions to reduce cardiac events, with no available evidence for outcomes of mortality (all-cause or cardiovascular) or recurrent stroke events. For secondary outcomes addressing risk-reducing behaviours, best-evidence synthesis identifies moderate certainty GRADE evidence for multimodal lifestyle-based interventions to increase physical activity participation, and low certainty GRADE evidence

for behavioural change interventions to improve healthy eating post-stroke. Similarly low certainty GRADE evidence supports self-management interventions to improve preventive medication adherence. For mood self-management post-stroke, moderate GRADE evidence supports psychological therapies for remission and/or reduction of depression and Low/Very low certainty GRADE evidence for reduction of psychological distress and anxiety. Best-evidence for outcomes addressing proxy physiological measures identified Low GRADE evidence supporting multimodal interventions to improve blood pressure, waist circumference and LDL cholesterol. **Discussion/conclusion**. Effective strategies to redress risk-related health behaviours are required in stroke survivors to complement current pharmacological secondary prevention. Inclusion of multimodal interventions and psychological talk therapies in evidence-based stroke secondary prevention programmes is warranted given the moderate GRADE of evidence that supports their role in risk reduction. Given the overlap in primary studies across reviews, often with overlapping theoretical domains between broad intervention categories, further research is required to identify optimal intervention behavioural change theories and techniques employed in behavioural/self-management interventions.

Introduction

Stroke, a leading cause of death and disability, affects 15 million people worldwide annually[1]. Advances in acute stroke management have seen a decline in mortality rates[1], with 77 million stroke survivors anticipated globally by 2030[2]. This equates to a 25% increase in people living with stroke[3], in whom the recurrent event rate is high (20% for recurrent stroke and 7% for other cardiovascular events within five years) and associated with greater death or disability rates[4]. Optimised secondary prevention addressing all modifiable risk factors remains a pressing goal in stroke management[5, 6] reflected in the Stroke Action Plan for Europe(SAP-E)[7]. This calls for access to key preventative strategies of medications, surgical interventions and multisector interventions addressing lifestyle.

Post-stroke adherence with lifestyle-related health behaviours is low, with many risk behaviours long-standing and clustered[8-11]. Changing health behaviours is difficult, particularly in the context of cognitive and functional impairment barriers reported post-stroke[10]. Additionally, chronic conditions like stroke require active self-management of treatment, symptoms, lifestyle, and physical and psychological sequalae[12, 13].

Non-pharmacological, non-surgical stroke secondary prevention should complement medical management and use proven theoretical models and behaviour change techniques to support lifestyle change post-stroke[14]. Advice alone has proven insufficient in comprehensively addressing risk-related health behaviours that include medication adherence, physical activity participation, consuming a healthy diet, safe alcohol consumption, smoking abstinence and self-management of mood and psychological distress[14, 15]. A recent scoping review of stroke secondary prevention guidelines highlighted non-pharmacological, non-surgical secondary prevention recommendations are suboptimal, in this context[16].

In the last decade, multiple systematic reviews (SRs) have addressed lifestyle and self-management post-stroke[17-22]. However, inconsistencies in intervention definitions, theoretical underpinnings and inclusion criteria, coupled with overlapping studies between reviews, make discerning the evidence-base best supporting individuals to engage in and sustain risk reducing behaviours post-stroke difficult for clinicians, policy-makers and guideline development groups. This overview of reviews addresses a pressing need to synthesise high-level evidence in a structured, consistent way. The pre-published protocol details a two-phase approach. Firstly, to comprehensively summarise all relevant SRs and report the certainty of evidence for secondary prevention outcomes by intervention type, applying Grading of Recommendations Assessment, Development and Evaluation (GRADE) criteria[23](reported here). The second phase (reported separately) synthesises primary studies identified across reviews by secondary prevention outcomes and the underpinning theoretical approach using the Theoretical Domains Framework[24].

Methods

This Overview of Reviews maps published evidence for behavioural and/or self-management interventions and stroke secondary prevention outcomes, as summarised in the model pre-published with the protocol (Fig. 1)[25]. It is reported in accordance with the preferred reporting guideline for overviews of reviews of healthcare interventions (PRIOR) statement [26] and checklist (supplemental file S1).

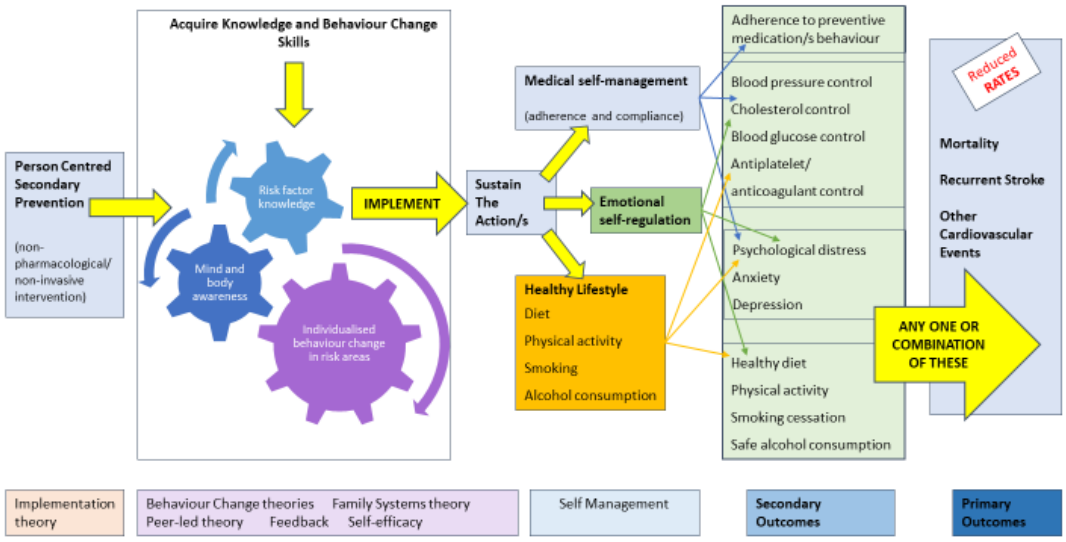


Fig. 1. Model for person-centred stroke secondary prevention using behaviour change and self-management strategies[25].

Specific objectives are to:

- Identify and summarise all available evidence by meta-analyses evaluating the effect of behavioural and/or self-management interventions on outcomes of mortality, cardiovascular morbidity, medication adherence and all population attributable and modifiable stroke risk factors.
- Critically appraise both the SR quality and the meta-analytical evidence provided by these SRs through GRADE criteria application.
- Provide a best-evidence synthesis for targeted secondary prevention outcomes.

SR inclusion criteria were guided by the Population, Intervention, Comparator, Outcome and Study Type (PICOS) construct[27] .

Population: Adults post-stroke or transient ischaemic attack (TIA), or cardiovascular disease populations where stroke sub-population data are provided.

Intervention: Intervention/s targeting risk reduction by changing health behaviours and/or by self-management.

Comparator: Usual care, or alternate active intervention.

Outcomes: Mortality, recurrent stroke, other cardiovascular events; Health/lifestyle behaviours (including medication adherence); Mood and psychosocial stress; Physiological risk factor measures.

Study design: SRs pooling randomised controlled trials (RCTs) of interventions to improve risk-reducing health behaviours post-stroke (e.g. secondary prevention medication adherence, healthy diet, physical activity participation, smoking cessation, safe alcohol consumption, and psychosocial stress management) and reporting secondary prevention outcome/s of interest. Only SRs with meta-analyses were included in phase 1 of the overview of reviews reported here.

Reviews pooling intervention trials to change health professionals' preventive practices, health systems and secondary prevention protocols, or to test drug, device or physical rehabilitation interventions only (e.g. exercise training) were excluded. Unpublished and grey literature were excluded[28].

Search strategy

A comprehensive search (current to March 2023) was conducted in MEDLINE, Embase, Epistemonikos and the Cochrane Library of Systematic Reviews databases, with no limitations

applied. Reference lists of included SRs were hand-searched. Full database search strategies are provided (supplemental file S2).

Screening and selection

Identified papers were uploaded to a web-based screening and extraction tool (Covidence). Two reviewers (PH, OL) independently screened potentially eligible reviews at title and abstract, and full text stages. Disagreements were resolved by discussion and by consultation with a third reviewer (ML).

Data extraction

Data were independently extracted from eligible SRs by two reviewers (PH, OL) using a proforma capturing bibliographical details, SR aims/inclusion criteria, number of primary studies, outcomes reported, and meta-analyses conducted. Primary study overlap across identified reviews was addressed and graphically represented using the Graphical Representation of Overlap for OVErviews (GROOVE) tool[29].

Quality appraisal

Included reviews were independently assessed by two of three reviewers (PH, OL, ML) using the risk of bias in systematic reviews (ROBIS) tool[30]. ROBIS generates an overall risk of bias rating following assessment across four domains. Reviewers who had authored an included SR (OL, ML), were exempted from that quality appraisal, ensuring impartiality.

Best evidence synthesis

All meta-analyses extracted by intervention type and outcome were rated as high, moderate, low or very low quality for certainty of evidence using GRADE criteria[23] with the rationale

for any downgrade applied provided. Where the original SR authors applied and reported GRADE criteria, results were adopted in this overview and reasons for any downgrades noted. Overview authors (PH, OL and ML) applied GRADE criteria to all remaining meta-analyses. A best-evidence synthesis was next applied. Where two or more meta-analyses reported the same outcome and intervention type, the best-evidence was selected based on the reviews' ROBIS ratings. Where reviews had the same quality rating, selection was based on the highest GRADE rating, and where the same, the most contemporary review was selected.

Results

The PRISMA flow diagram (Fig. 2)[31] details a total of 11175 unique records were screened, with reasons for exclusion reported (e.g. not SR of RCTs, not stroke, reviews of pharmacotherapy). Fifteen SRs with meta-analyses [17, 19, 20, 32-34, 21, 22, 35-41] were included in this overview.

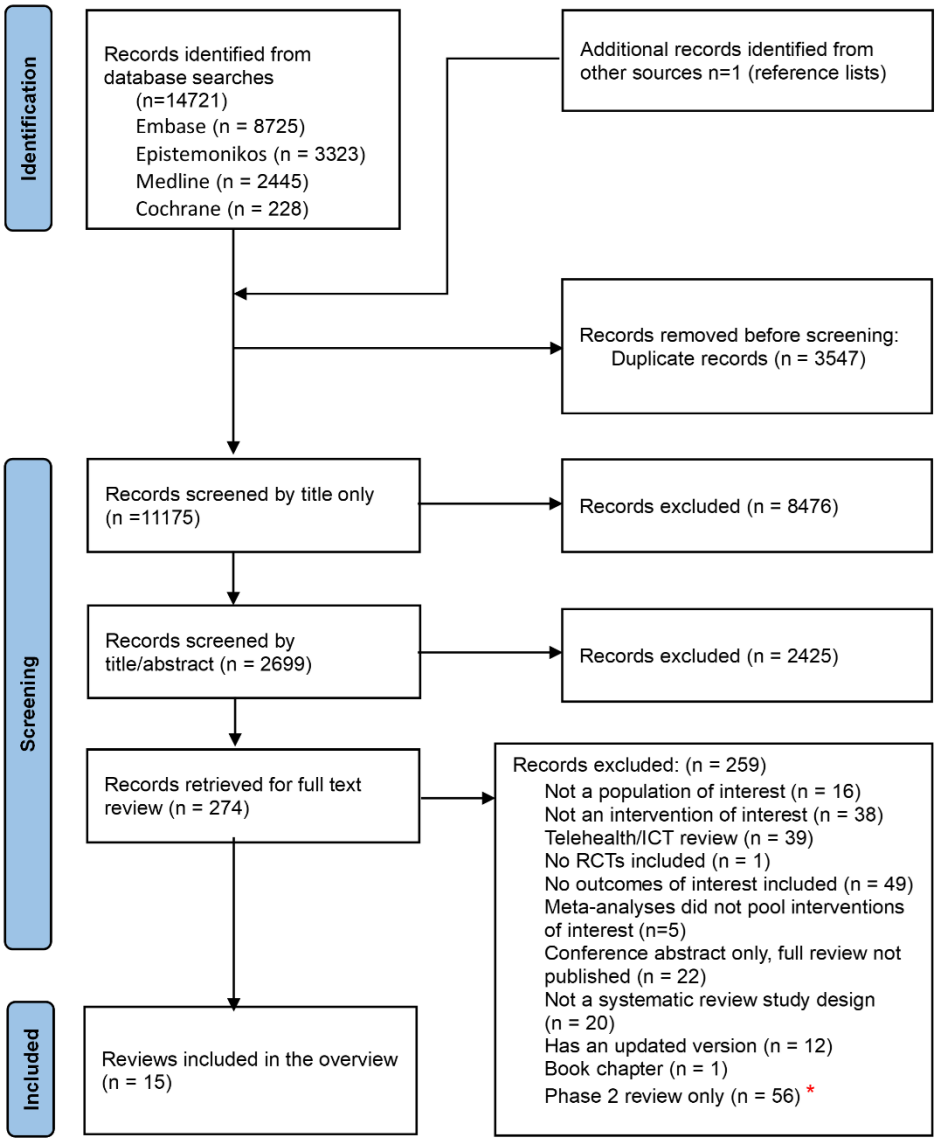
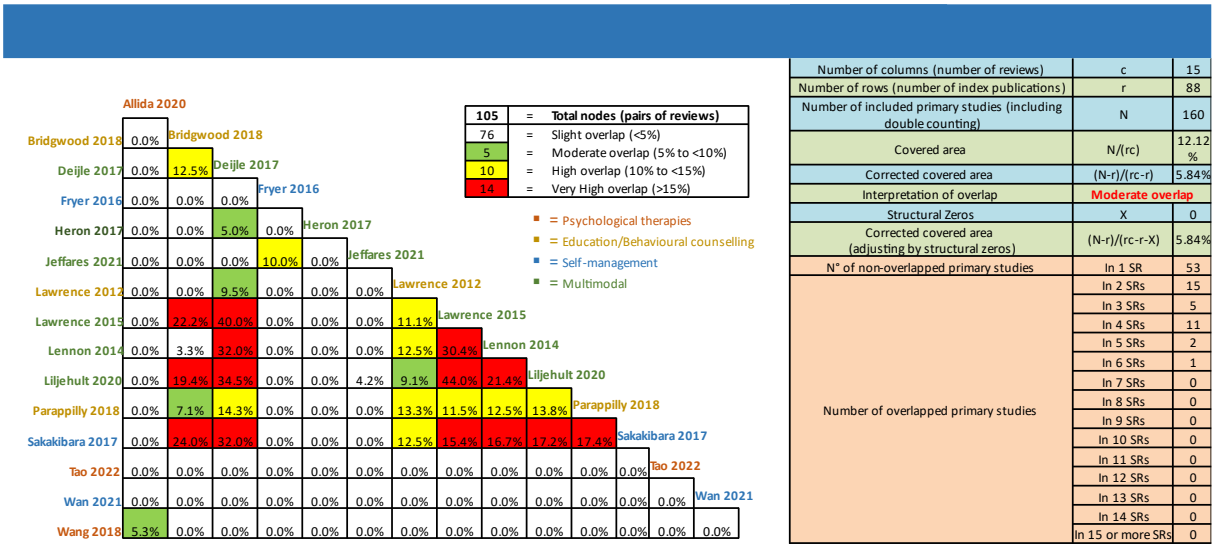


Fig. 2. PRISMA flow chart[31]. * these systematic reviews were excluded in phase 1 as they did not meet the inclusion criterion of reporting a meta-analysis or reported meta-analyses in mixed populations (typically cardiovascular). However, they potentially contained primary studies that may be eligible for inclusion in phase 2 which examines primary studies.

Description of included reviews

Included reviews dated from 2013 – 2022. One hundred and eighty-four RCTs were reported across the identified SRs, with 88 unique primary studies contributing to meta-analyses

conducted. A matrix of the evidence overlap linking the SRs with the primary studies contributing to their meta-analyses is presented in the Graphical Representation of Overlap for OVErviews (GROOVE)[29](Fig 3). A moderate overlap of primary studies was demonstrated with a 5.84% degree of corrected covered area (CCA).



Number of columns (number of reviews)	c	15
Number of rows (number of index publications)	r	88
Number of included primary studies (including double counting)	N	160
Covered area	N/(rc)	12.12 %
Corrected covered area	(N-r)/(rc-r)	5.84%
Interpretation of overlap	Moderate overlap	
Structural Zeros	X	0
Corrected covered area (adjusting by structural zeros)	(N-r)/(rc-r-X)	5.84%
N° of non-overlapped primary studies	In 1 SR	53
Number of overlapped primary studies	In 2 SRs	15
	In 3 SRs	5
	In 4 SRs	11
	In 5 SRs	2
	In 6 SRs	1
	In 7 SRs	0
	In 8 SRs	0
	In 9 SRs	0
	In 10 SRs	0
	In 11 SRs	0
	In 12 SRs	0
	In 13 SRs	0
	In 14 SRs	0
	In 15 or more SRs	0

Fig. 3. Graphical Representation of Overlap for OVErviews (GROOVE) and Overall results[29]. Systematic Review Font colour corresponds to the intervention category (refer to figure)

Quality appraisal of included reviews

The overall ROBIS quality rating for each SR was assessed. Breakdown by domain headings is available (supplemental file S3). Ten SRs were rated as having a low risk of bias [17, 19, 20, 32, 22, 36-39, 41], four were unclear[33, 21, 35, 40] and one was rated as having a high risk of bias[34].

Interventions and Outcomes

Detailed data extraction from all 15 included SRs is provided (supplemental file S4). Reviews targeted a variety of interventions which were broadly categorised as Psychological therapies including talking and contemplative therapies to manage/self-regulate mood post-stroke; Education/Behavioural counselling specifying activities to identify and improve modifiable risk factors; Self-management skills/techniques; and Multimodal interventions comprising targeted health education and behaviour change activities (+/- supervised exercise) focused on lifestyle and psychosocial health, as summarised in Table 1. Categories were determined through careful examination and discussion of the interventions as defined in each SR and mapping of the intervention components described to the Theoretical Domains Framework[24]. Despite discernible differences in the intervention types defined, considerable overlap of RCTs across review intervention types existed primarily between multimodal interventions and those of education/behavioural counselling and self-management where high and very high overlap were evident (Fig. 3).

Table 1. Intervention category definitions

	Intervention category	Definition	Theoretical Domains Addressed
1	**Psychological therapies**	Talking and contemplating therapies to help manage or self-regulate mood/thoughts after stroke that were structured and theoretically based, delivered by trained practitioners – e.g. cognitive behaviour counselling (CBT), mindfulness-based programmes	**Emotion**: complex interventions involving experiential, behavioural and psychological elements, where the individual attempts to deal with their situation **Skills**: proficiency acquired through practice
2	**Education / Behavioural counselling**	Educational health promotion secondary prevention strategies with specified activities to both identify and improve modifiable risk factors	**Knowledge**: designed to increase stroke knowledge and understanding, skills, intentions **Beliefs about consequences:** address outcomes and consequences **Goals**: defined in terms of behaviour and positive outcomes to be achieved
3	**Self-management support**	Included distinct self-management skills and/or techniques that needed to be employed in the intervention – e.g. problem-solving, goal-setting, decision-making, self-monitoring, coping-skills	**Beliefs about Capabilities**: involving self-efficacy and self-confidence building, behaviour support to enable empowerment, generate strategies to overcome barriers **Goals**: defined in terms of behaviour and positive outcomes to be achieved **Skills**: proficiency acquired through practice **Intentions**: conscious decision to change behaviour
4	**Multimodal programme**	Comprehensive programmes of targeted healthy lifestyle education and behaviour change or health promotion activities, with or without supervised exercise, focused on lifestyle risk factors and psychosocial health – broadly based on cardiac rehabilitation type interventions	**Knowledge**: Systematic instruction, training **Skills**: impart skills with opportunity to acquire proficiency through practice **Goals**: defined in terms of behaviour and positive outcomes to be achieved **Social influences:** provide social support for behaviour change, group identity and modelling of behaviour

Seventy-two meta-analyses, addressing twenty-one different outcome measures, were identified that mapped to the secondary prevention model underpinning this overview (Fig. 1). Table 2 details all meta-analyses identified by outcome and depicts the intervention efficacy and certainty of the evidence provided. Across all meta-analyses, twenty-eight demonstrated statistically significant effect sizes in favour of the intervention. No meta-analysis rated as having high GRADE certainty of evidence; four received a moderate GRADE, with the remaining rated low or very low.

Table 2. Categories and outcomes

Systematic Review / Secondary Prevention Outcomes	**Allida 2020 [37]**	**Bridgwood 2018 [22]**	**Deijle 2017 [33]**	**Fryer 2016 [32]**	**Heron 2017 [34]**	**Jeffares 2021 [39]**	**Lawrence 2012 [17]**	**Lawrence 2015 [20]**	**Lennon 2014 [19]**	**Liljehult 2020 [38]**	**Parappilly 2018 [35]**	**Sakakibara 2017 [21]**	**Tao 2022 [41]**	**Wan 2021 [40]**	**Wang 2018 [36]**
Intervention Category	Psychological therapies	Education/ Behavioural Counselling	Multi-modal	Self-management	Multi-modal	Multi-modal	Education/ Behavioural Counselling	Multi-modal	Multi-modal	Multi-modal	Education/ Behavioural Counselling	Self-management	Psychological therapies	Self-management	Psychological therapies
ROBIS	Low	Low	Unclear	Low	High	Low	Low	Low	Low	Low	Unclear	Unclear	Low	Unclear	Low
Mortality/ morbidity															
All cause death															
Vascular death															
Recurrent stroke															
Cardiovascular events								**Mod GRADE**							
Adherence															
Medication adherence											Very Low GRADE	Low GRADE			

Physiological factors															
Systolic blood pressure			Low GRADE					Low GRADE	Low GRADE	Low GRADE					
Diastolic blood pressure								Low GRADE	Low GRADE	Low GRADE					
Blood pressure target										Low GRADE					
Cholesterol control										Low GRADE					
Glucose/HbA1c															
BMI/wght/waist								Low GRADE							
Combined RF							Low GRADE								
Psychological distress															
Psychological distress															
Anxiety						Low GRADE		Low GRADE							Low GRADE
Depression cases	Very Low GRADE														**Mod GRADE**

Depression scores	Very Low GRADE					Low GRADE							Very Low GRADE	Very Low GRADE	**Mod GRADE**
Healthy lifestyle															
Healthy diet											Low GRADE				
Physical activity									**Mod GRADE**		Very Low GRADE				
Smoking															
Alcohol															
Combined							Low GRADE								

No effect Statistically significant effect/ GRADE

Best evidence synthesis of reported outcomes

Table 3 summarises the best evidence of effect identified for each outcome (irrespective of intervention type) and reasons for any downgrade applied (see also supplemental file S5). Risk of bias(ROB) in the primary studies included in meta-analyses that informed this process were accepted as appraised and reported in the systematic reviews (supplemental file S6). However, where the same primary study was appraised in more than one review, the most conservative quality assessment was documented. Where the systematic review used a ROB tool other than the Cochrane ROB tool, the primary studies were appraised independently by two authors (OL and PH) to ensure conformity across studies.

Mortality and cardiovascular morbidity

Table 3 Panel (A) identifies the best-evidence of effect for outcomes related to mortality and cardiovascular morbidity. Only one meta-analysis with a significant effect size was identified, providing moderate GRADE certainty for multimodal interventions in reducing future cardiac events post-stroke[20].

Adherence to secondary prevention medication behaviour

Table 3 Panel (B) identifies the best-evidence, with low GRADE certainty, for self-management interventions to improve post-stroke adherence to preventive

medication/s, drawn from two meta-analyses demonstrating effect for education/behavioural counselling[35] and supported self-management[21].

Physiological risk factors

Table 3 Panel (C) identifies the best-evidence, with low GRADE certainty, for outcomes of SBP, DBP, target BP <140mmHg, lipids, and waist circumference drawn from eleven meta-analyses with significant effects. Four reported efficacy of multimodal interventions for SBP reduction[19, 20, 33, 38] with best evidence drawn from the most recent[38]. Three reported efficacy of multimodal interventions for DBP reduction[19, 20, 38] and one demonstrated effect for LDLc reduction[38]. One meta-analysis, with low certainty evidence for multimodal interventions and body composition outcomes demonstrated a reduction in waist circumference[20].

Psychological

Table 3 Panel (D) identifies the best-evidence for the population attributable stroke risk factors(PAR) of psychosocial distress, anxiety and depression drawn from five meta-analyses addressing psychological interventions of cognitive behavioural therapy, talk therapy and contemplative therapy[36, 37, 41], multimodal interventions[39] and self-management interventions[40]. Psychological talking therapies demonstrated moderate GRADE certainty to positively affect depression[36] and low GRADE certainty to reduce the likelihood of a post-stroke depression diagnosis[37]. Low certainty evidence supports psychological therapies[36], and multimodal interventions[20, 39] to reduce post-stroke anxiety, with best-evidence reported as the most recent[39].

Healthy lifestyle

Table 3 Panel (E) summarises the best-evidence of effect for lifestyle-related behaviour changes, identifying moderate GRADE certainty for multimodal interventions and physical activity participation[19] and low GRADE certainty for education/behavioural counselling interventions and healthy eating[35]. Results were drawn from six reported meta-analyses addressing multimodal interventions, education/behavioural counselling interventions, self-management interventions and addressing outcomes that included smoking cessation and safe alcohol consumption[17, 19, 20, 33, 21, 35].

Table 3. Best-evidence syntheses of meta-analyses

Outcome	**Systematic review**	**Intervention category**	**RCT Studies**	**Participants**	**Effect Estimate[CI]**	**I^2**	**Quality of evidence (GRADE)**	**Reasons for down-grade**
Panel A Mortality and cardiovascular morbidity outcomes								
Cardiac events	Lawrence 2015[20]	Multi-modal programme	4	4053	OR 0.38 [0.16, 0.88]	0%	⊕⊕⊕◯ **Moderate**	ROB
Panel B Health behaviour: Adherence to preventive medication/s								
Medication adherence	Sakakibara 2017[21]	Self-management	5	802	SMD 0.31 [0.07, 0.56]	24%	⊕⊕◯◯ Low	ROB; Imprecision; Indirectness
Panel C Physiological risk factors								
SBP(mmHg)	Liljehult 2020[38]	Multi-modal programme	14	2222	MD −3.85 [−6.43, −1.28]	53%	⊕⊕◯◯ Low assigned by authors	ROB; Indirectness
DBP(mmHg)	Liljehult 2020[38]	Multi-modal programme	12	1711	MD −1.60 [−3.09, −0.11]	40%	⊕⊕◯◯ Low assigned by authors	ROB; Indirectness
SBP <140mmHg	Liljehult 2020[38]	Multi-modal programme	6	1546	RR 1.14 [1.03, 1.25]	23%	⊕⊕◯◯ Low	ROB; Indirectness

							assigned by authors	
LDLc(mmol/L)	Liljehult 2020[38]	Multi-modal programme	5	1003	SMD -0.23 [-0.41, -0.05]	36%	⊕⊕◯◯ Low assigned by authors	ROB; Indirectness
Waist circumference (cms)	Lawrence 2015[20]	Multi-modal programme	2	96	MD -6.69cm [-11.44, -1.93]	0%	⊕⊕◯◯ Low	ROB; Imprecision
Panel D Psychological distress outcomes								
Anxiety scores	Jeffares 2021[39]	Multi-modal programme	4	612	SMD 0.29 [0.12, 0.46]	9%	⊕⊕◯◯ Low assigned by authors	ROB; Indirectness
Depression diagnosis	Allida 2020[37]	Psychological therapies (talk)	6	521	RR 0.77 [0.62, 0.95]	36.16%	⊕◯◯◯ Very Low assigned by authors	ROB; Imprecision
Remission from depression	Wang 2018[36]	Psychological therapies (talk)	6	556	RR = 1.76 [1.37,2.25]	0%	⊕⊕⊕◯ **moderate assigned by authors**	ROB
Depression scores	Wang 2018[36]	Psychological therapies (talk)	7	859	SMD −0.76 [−1.22, −0.29]	91%	⊕⊕⊕◯ **moderate assigned by authors**	ROB; Inconsistency; Large effect increased quality of evidence
Panel E Health behaviour: Outcomes of healthy lifestyle participation								
Healthy diet	Parappilly 2018[35]	Education /Behavioural Counselling	3	425	SMD -0.21 [0.40, 0.02]	33%	⊕⊕◯◯ Low	ROB; Indirectness; Imprecision
Physical activity participation	Lennon 2014[19]	Multi-modal programme	5	657	SMD 0.24 [0.08, 0.41]	47%	⊕⊕⊕◯ **moderate**	ROB

GRADE: ⊕⊕⊕⊕ High certainty, ⊕⊕⊕◯ Moderate certainty, ⊕⊕◯◯ Low certainty, ⊕◯◯◯ Very Low certainty. Downgrade of the evidence: ROB: Unclear risk of bias across multiple domains in primary RCTs; Inconsistencies: widely varying point estimates/ inconsistent direction of effect/ confidence interval overlap/ heterogeneity; Indirectness: representativeness of population/ timeframe/ comparisons/ limited data; Imprecision: wide confidence interval/ magnitude of sample/ limited studies.

Discussion/Conclusion

Summary of findings

This overview integrates evidence across fifteen SRs with meta-analyses that evaluated interventions to change risk-related behaviours post-stroke (Fig. 1). Multimodal interventions were identified as having moderate GRADE evidence to reduce cardiac events and to improve physical activity participation post-stroke. Moderate GRADE evidence further supports psychological talk-therapies to reduce post-stroke depression as a risk factor for recurrence. Physical inactivity is second only to hypertension as a PAR for stroke[42] and increasing physical activity reduces the likelihood of recurrent stroke, myocardial infarction or vascular death post-stroke (odds ratio 0.6 (95%CI 0.4-0.8))[43]. Post-stroke depression is also strongly associated with recurrent events[44]. Thus, moderate GRADE evidence-based interventions to promote and sustain physical activity participation and reduce post-stroke depression are important clinically.

Healthy lifestyle after stroke is associated with reduced all-cause and cardiovascular death[45]. Poor adherence with physical activity, healthy eating, smoking abstinence, and secondary prevention medication reported post-stroke[9, 11], alongside high levels of anxiety[46], present legitimate secondary prevention targets. Multimodal interventions demonstrate moderate GRADE of evidence for increasing physical activity participation and low GRADE evidence for reducing anxiety and psychological distress, providing clearer direction for stroke secondary prevention service provision. Best dietary evidence in stroke secondary prevention previously drew from epidemiological studies and comparator populations alone[47]. This overview

provides, albeit low GRADE evidence, that education with behavioural counselling interventions can improve healthy eating post-stroke[35]. Similarly low GRADE evidence now supports self-management interventions to improve secondary prevention medication adherence behaviour[21] and reduce anxiety[32]. No evidence was identified for interventions to reduce smoking and alcohol consumption risk behaviours where current recommendations remain largely based on epidemiological data[48].

Best-evidence synthesis, applied to meta-analyses across six reviews[19, 20, 33, 22, 37, 38] covering three distinct intervention types (psychological therapies, educational/behavioural counselling, multimodal), provides inconclusive evidence for reduction in mortality, recurrent stroke rates or composite cardiovascular endpoints. Insufficient follow-up time was commonly highlighted in reviews[19, 20]. The most recent Cochrane Review of cardiac rehabilitation for coronary heart disease[49] reported short-term reductions in all-cause death, heart attack and hospital admissions, and longer-term (>36 months) reductions in cardiovascular death rates (Low to Moderate GRADE). While the current overview provides similar short-term evidence for cardiac events, evidence for cardiovascular mortality could not be elucidated. Future stroke secondary prevention trials need a minimum of 36-month follow-up and outcomes of fatal and non-fatal cardiovascular events to better match cardiology research.

Strengths and limitations

This overview illustrates that non-pharmacological, non-surgical stroke risk reduction reviews centre around four discrete intervention types. Reviews of psychological interventions tend to be distinct in terms of their primary studies. The remaining intervention types overlap in their included primary studies (Fig. 3). Multimodal programmes constituted the intervention type most addressed across SRs. Given the multiple and interactive components in programmes of this nature, they commonly contain intervention constituents matching self-management and/or education/behavioural counselling interventions. Overlap of this nature can present difficulty in ascertaining the successful working components[50]. Although not all reviews of multimodal programmes specified a supervised exercise component, most primary studies were modelled on cardiac rehabilitation. Post-stroke, combined lifestyle counselling with exercise has previously demonstrated a larger effect than either counselling or exercise alone for physiological risk factors including BP[51, 33]. Complex interventions can be technically difficult to review due to intervention characteristic variations and/or where outcomes reported do not directly measure the behaviour change intended[52]. It is interesting to note that physiological outcomes were most reported in meta-analyses of multimodal interventions where the outcomes with evidence of effect (SBP and DBP, LDLc and waist circumference) act as proxy measures for the health behaviour change targeted but cannot distinguish what health behaviour or combination of health behaviours produced the effect observed.

Stroke recurrence and outcomes are influenced by social determinants of health[53] which contribute to disparities in health behaviours, risk factors and outcomes post-

stroke. Income, education, social support/isolation, ethnicity, and environmental factors have been identified as confounding factors to be addressed in intervention studies[54]. We acknowledge that this overview of reviews with high level data synthesis does not consider these determinants in the context of stroke secondary prevention outcomes. Whilst beyond the scope of this overview, we recognise the need for a better understanding of the impact of social determinants of health in the evaluation of effective stroke secondary prevention interventions.

Implications

Findings from this overview are important in directing future comprehensive preventive strategies in clinical practice. Moderate GRADE evidence-based strategies identified for multimodal interventions now warrant inclusion in stroke secondary prevention guidelines and prevention programmes to reduce cardiovascular events and to increase physical activity participation. Similarly psychological talk therapies should be recommended and used to reduce post-stroke depression as a known risk factor for recurrent stroke. While it is recommended that theory-based behaviour change interventions incorporating behaviour change techniques[55, 56] are implemented in stroke secondary prevention, this overview with best-evidence synthesis does not delineate effective theoretical domains nor behaviour change techniques as mediators for behaviour change. Further research, as planned in phase two of this overview of reviews[25], is required to better explain the active components of successful interventions in RCTs as mapped to the underpinning

behaviour change techniques/theories. Primary study data, pooled by their theoretical underpinnings and secondary prevention outcomes would enable a better understanding and provide greater traction for clinical practice[57]. Further high quality RCTs with longer follow-up and outcomes addressing cardiovascular mortality and recurrent stroke are required.

Conclusion

The burden of recurrent stroke requires effective, evidence-based risk reducing behavioural strategies to complement current pharmacological secondary prevention. Multimodal interventions addressing behaviour change theoretical domains of knowledge, skills, goals and social influences should be employed to help reduce future cardiovascular events and increase physical activity participation after stroke. Similarly, psychological interventions addressing the theoretical domains of emotions and skills can be implemented to reduce post-stroke depression, where required. Inconclusive evidence for behavioural and self-management interventions to reduce mortality and recurrent stroke rates post-stroke remains.

Statements

All papers must contain the following statements after the main body of the text and before the reference list:

Acknowledgement (optional)

We acknowledge foundational work by the INSsPiRE network (International Network of Stroke Secondary Prevention Researchers) in identifying and conceptualising the need for this overview of reviews.

Statement of Ethics

An ethics statement is not applicable because this study is based exclusively on published literature.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions

PH: data acquisition, interpretation of the results, analysis, manuscript draft and revisions, integrity and accuracy of the data; ML and OL: substantial contributions to the conception and design, critical revisions of the manuscript, final approval and agreement on integrity of the data; CB: interpretation of the results, revisions of the manuscript, final approval and agreement on integrity of the data.

Data Availability Statement

All data generated or analysed during this study are included in this article and it's supplementary material files. Further enquiries can be directed to the corresponding author.

References [Numerical]

1. Krishnamurthi RV, Ikeda T, Feigin VL. Global, Regional and Country-Specific Burden of Ischaemic Stroke, Intracerebral Haemorrhage and Subarachnoid Haemorrhage: A Systematic Analysis of the Global Burden of Disease Study 2017. Neuroepidemiology. 2020;54(2):171-79.
2. Feigin VL, Stark BA, Johnson CO, Roth GA, Bisignano C, Abady GG, et al. Global, regional, and national burden of stroke and its risk factors, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. The Lancet Neurology. 2021;20(10):795-820.
3. Stevens E, Emmett E, Wang Y, McKevitt C, Wolfe C. The Burden of Stroke in Europe. Stroke Alliance for Europe; 2017.
4. Mohan KM, Wolfe CDA, Rudd AG, Heuschmann PU, Kolominsky-Rabas PL, Grieve AP. Risk and Cumulative Risk of Stroke Recurrence. Stroke. 2011;42(5):1489-94.
5. Talelli P, Greenwood RJ. Review: Recurrent stroke: where do we stand with the secondary prevention of noncardioembolic ischaemic strokes? Therapeutic Advances in Cardiovascular Disease. 2008;2(5):387-405.
6. Duncan PW, Bushnell C, Sissine M, Coleman S, Lutz BJ, Johnson AM, et al. Comprehensive stroke care and outcomes: time for a paradigm shift. Stroke. 2021;52(1):385-93.
7. Norrving B, Barrick J, Davalos A, Dichgans M, Cordonnier C, Guekht A, et al. Action Plan for Stroke in Europe 2018–2030. European stroke journal. 2018;3(4):309-36.
8. Andersen KK, Andersen ZJ, Olsen TS. Age-and gender-specific prevalence of cardiovascular risk factors in 40 102 patients with first-ever ischemic stroke: a Nationwide Danish Study. Stroke. 2010;41(12):2768-74.
9. Wali H, Kurdi S, Bilal J, Riaz IB, Bhattacharjee S. Health Behaviors among Stroke Survivors in the United States: A Propensity Score-Matched Study. Journal of Stroke and Cerebrovascular Diseases. 2018;27(8):2124-33.
10. Bailey RR, Phad A, McGrath R, Haire-Joshu D. Prevalence of five lifestyle risk factors among US adults with and without stroke. Disability and health journal. 2019;12(2):323-27.
11. Lennon O, Hall P, Blake C. Predictors of Adherence to Lifestyle Recommendations in Stroke Secondary Prevention. International journal of environmental research and public health. 2021;18(9):4666.
12. Barlow J, Wright C, Sheasby J, Turner A, Hainsworth J. Self-management approaches for people with chronic conditions: a review. Patient Education and Counseling. 2002;48(2):177-87.
13. Parke H, Epiphaniou Bsc MPCE, Pearce G, Taylor S, Sheikh A, Griffiths C, et al. Self-Management Support Interventions for Stroke Survivors: A Systematic Meta-Review. PLoS ONE. 2015;10:e0131448.
14. Lawrence M, Asaba E, Duncan E, Elf M, Eriksson G, Faulkner J, et al. Stroke secondary prevention, a non-surgical and non-pharmacological consensus definition: results of a Delphi study. BMC Res Notes. 2019;12(1):823-23.
15. Kleindorfer DO, Towfighi A, Chaturvedi S, Cockroft KM, Gutierrez J, Lombardi-Hill D, et al. 2021 Guideline for the Prevention of Stroke in Patients With Stroke and Transient Ischemic Attack: A Guideline From the American Heart Association/American Stroke Association. Stroke. 2021;52(7):e364-e467.
16. Hall P, von Koch L, Wang X, Lennon O. A Scoping Review of Non-Pharmacological, Non-Surgical Secondary Prevention Strategies in Ischaemic Stroke and TIA in National Stroke Guidelines and Clinical Audit Documents. Healthcare. 2022;10(3):481.
17. Lawrence M, Kerr S, McVey C, Godwin J. The Effectiveness of Secondary Prevention Lifestyle Interventions Designed to Change Lifestyle Behavior following Stroke: Summary of a Systematic Review. International Journal of Stroke. 2012;7(3):243-47.
18. MacKay-Lyons M, Thornton M, Ruggles T, Che M. Non-pharmacological interventions for preventing secondary vascular events after stroke or transient ischemic attack. Cochrane Database of Systematic Reviews. 2013 (3).
19. Lennon O, Galvin R, Smith K, Doody C, Blake C. Lifestyle interventions for secondary disease prevention in stroke and transient ischaemic attack: a systematic review. European Journal of Preventive Cardiology. 2014;21(8):1026-39.

20. Lawrence M, Pringle J, Kerr S, Booth J, Govan L, Roberts NJ. Multimodal Secondary Prevention Behavioral Interventions for TIA and Stroke: A Systematic Review and Meta-Analysis. PLoS One. 2015; 10(3).
21. Sakakibara BM, Kim AJ, Eng JJ. A Systematic Review and Meta-Analysis on Self-Management for Improving Risk Factor Control in Stroke Patients. International Journal of Behavioral Medicine. 2017;24(1):42-53.
22. Bridgwood B, Lager KE, Mistri AK, Khunti K, Wilson AD, Modi P. Interventions for improving modifiable risk factor control in the secondary prevention of stroke. Cochrane Database of Systematic Reviews. 2018 (5).
23. Guyatt GH, Oxman AD, Vist GE, Kunz R, Falck-Ytter Y, Alonso-Coello P, et al. GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. Bmj. 2008;336(7650):924-6.
24. Cane J, O'Connor D, Michie S. Validation of the theoretical domains framework for use in behaviour change and implementation research. Implementation Science. 2012;7(1):37.
25. Lennon O, Blake C, Booth J, Pollock A, Lawrence M. Interventions for behaviour change and self-management in stroke secondary prevention: protocol for an overview of reviews. Systematic Reviews. 2018;7(1):231.
26. Gates M, Gates A, Pieper D, Fernandes RM, Tricco AC, Moher D, et al. Reporting guideline for overviews of reviews of healthcare interventions: development of the PRIOR statement. BMJ. 2022;378:e070849.
27. Higgins JP, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, et al. Cochrane handbook for systematic reviews of interventions. John Wiley & Sons; 2019.
28. Becker L, Oxman A. Overviews of reviews. In: Higgins JPT, Green S (editors), Cochrane Handbook for Systematic Reviews of Interventions Version 5.1. 0 [updated March 2011]. The Cochrane Collaboration, 2011. Available from handbook cochrane org. 2011.
29. Pérez-Bracchiglione J, Meza N, Bangdiwala SI, Niño de Guzmán E, Urrútia G, Bonfill X, et al. Graphical Representation of Overlap for OVErviews: GROOVE tool. Research Synthesis Methods. 2022;13(3):381-88.
30. Whiting P, Savović J, Higgins JPT, Caldwell DM, Reeves BC, Shea B, et al. ROBIS: A new tool to assess risk of bias in systematic reviews was developed. Journal of clinical epidemiology. 2016;69:225-34.
31. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372:n71.
32. Fryer CE, Luker JA, McDonnell MN, Hillier SL. Self management programmes for quality of life in people with stroke. Cochrane Database of Systematic Reviews. 2016 (8).
33. Deijle IA, Schaik SMV, Wegen EEHV, Weinstein HC, Kwakkel G, Berg-Vos RMVd. Lifestyle Interventions to Prevent Cardiovascular Events After Stroke and Transient Ischemic Attack. Stroke. 2017;48(1):174-79.
34. Heron N, Kee F, Cardwell C, Tully MA, Donnelly M, Cupples ME. Secondary prevention lifestyle interventions initiated within 90 days after TIA or 'minor' stroke: a systematic review and meta-analysis of rehabilitation programmes. British Journal of General Practice. 2017;67(654):e57.
35. Parappilly BP, Field TS, Mortenson WB, Sakakibara BM, Eng JJ. Effectiveness of interventions involving nurses in secondary stroke prevention: A systematic review and meta-analysis. European Journal of Cardiovascular Nursing. 2018;17(8):728-36.
36. Wang S-B, Wang Y-Y, Zhang Q-E, Wu S-L, Ng CH, Ungvari GS, et al. Cognitive behavioral therapy for post-stroke depression: A meta-analysis. Journal of Affective Disorders. 2018;235:589-96.
37. Allida S, Cox KL, Hsieh CF, Lang H, House A, Hackett ML. Pharmacological, psychological, and non-invasive brain stimulation interventions for treating depression after stroke. Cochrane Database of Systematic Reviews. 2020 (1).
38. Liljehult J, Christensen T, Molsted S, Overgaard D, Mesot Liljehult M, Møller T. Effect and efficacy of lifestyle interventions as secondary prevention. Acta Neurol Scand. 2020;142(4):299-313.
39. Jeffares I, Merriman NA, Rohde D, McLoughlin A, Scally B, Doyle F, et al. A systematic review and meta-analysis of the effects of cardiac rehabilitation interventions on cognitive impairment following stroke. Disability and Rehabilitation. 2021;43(6):773-88.

40. Wan X, Chau JPC, Mou H, Liu X. Effects of peer support interventions on physical and psychosocial outcomes among stroke survivors: A systematic review and meta-analysis. International Journal of Nursing Studies. 2021;121:104001.
41. Tao S, Geng Y, Li M, Ye J, Liu Z. Effectiveness of mindfulness-based stress reduction and mindfulness-based cognitive therapy on depression in poststroke patients-A systematic review and meta-analysis of randomized controlled trials. Journal of Psychosomatic Research. 2022;163.
42. O'Donnell MJ, Chin SL, Rangarajan S, Xavier D, Liu L, Zhang H, et al. Global and regional effects of potentially modifiable risk factors associated with acute stroke in 32 countries (INTERSTROKE): a case-control study. The Lancet. 2016;388(10046):761-75.
43. Turan TN, Nizam A, Lynn MJ, Egan BM, Le N-A, Lopes-Virella MF, et al. Relationship between risk factor control and vascular events in the SAMMPRIS trial. Neurology. 2017;88(4):379-85.
44. Wu Q-e, Zhou A-m, Han Y-p, Liu Y-m, Yang Y, Wang X-m, et al. Poststroke depression and risk of recurrent stroke: A meta-analysis of prospective studies. Medicine. 2019;98(42):e17235.
45. Towfighi A, Markovic D, Ovbiagele B. Impact of a healthy lifestyle on all-cause and cardiovascular mortality after stroke in the USA. Journal of Neurology, Neurosurgery & Psychiatry. 2012;83(2):146-51.
46. Rafsten L, Danielsson A, Sunnerhagen KS. Anxiety after stroke: A systematic review and meta-analysis. J Rehabil Med. 2018;50(9):769-78.
47. English C, MacDonald-Wicks L, Patterson A, Attia J, Hankey GJ. The role of diet in secondary stroke prevention. The Lancet Neurology. 2021;20(2):150-60.
48. Meschia JF, Bushnell C, Boden-Albala B, Braun LT, Bravata DM, Chaturvedi S, et al. Guidelines for the primary prevention of stroke: a statement for healthcare professionals from the American Heart Association/American Stroke Association. Stroke. 2014;45(12):3754-832.
49. Dibben G, Faulkner J, Oldridge N, Rees K, Thompson DR, Zwisler AD, et al. Exercise-based cardiac rehabilitation for coronary heart disease. Cochrane Database of Systematic Reviews. 2021 (11).
50. Lunny C, Pieper D, Thabet P, Kanji S. Managing overlap of primary study results across systematic reviews: practical considerations for authors of overviews of reviews. BMC Medical Research Methodology. 2021;21(1):140.
51. D'Isabella NT, Shkredova DA, Richardson JA, Tang A. Effects of exercise on cardiovascular risk factors following stroke or transient ischemic attack: a systematic review and meta-analysis. Clinical Rehabilitation. 2017;31(12):1561-72.
52. Shepperd S, Lewin S, Straus S, Clarke M, Eccles MP, Fitzpatrick R, et al. Can we systematically review studies that evaluate complex interventions? PLoS Med. 2009;6(8):e1000086.
53. Yadav RS, Chaudhary D, Avula V, Shahjouei S, Azarpazhooh MR, Abedi V, et al. Social Determinants of Stroke Hospitalization and Mortality in United States' Counties. J Clin Med. 2022;11(14):4101.
54. Skolarus LE, Sharrief A, Gardener H, Jenkins C, Boden-Albala B. Considerations in Addressing Social Determinants of Health to Reduce Racial/Ethnic Disparities in Stroke Outcomes in the United States. Stroke. 2020;51(11):3433-39.
55. Michie S, Abraham C. Identifying techniques that promote health behaviour change: Evidence based or evidence inspired. Psychol Health. 2004;19:29-49.
56. Michie S, Richardson M, Johnston M, Abraham C, Francis J, Hardeman W, et al. The Behavior Change Technique Taxonomy (v1) of 93 Hierarchically Clustered Techniques: Building an International Consensus for the Reporting of Behavior Change Interventions. Annals of Behavioral Medicine. 2013;46(1):81-95.
57. Skivington K, Matthews L, Simpson SA, Craig P, Baird J, Blazeby JM, et al. A new framework for developing and evaluating complex interventions: update of Medical Research Council guidance. BMJ. 2021;374:n2061.

Supplemental File:

- **S1 PRIOR checklist**
- **S2 Search strategy**
- **S3 Risk of Bias in Systematic Reviews**
- **S4 Characteristics table**
- **S5 GRADE table**
- **S6 Risk of Bias in primary studies**

File S1: PRIOR checklist

PRIOR Checklist

(Gates M, Gates A, Pieper D, et al. Reporting guideline for overviews of reviews of healthcare interventions: development of the PRIOR statement. *BMJ* 2022;378:e070849. doi:10.1136/bmj-2022-070849.)

Section Topic	#	**Item**	**Location reported**
TITLE			
Title	1	Identify the report as an overview of reviews.	title
ABSTRACT			
Abstract	2	Provide a comprehensive and accurate summary of the purpose, methods, and results of the overview of reviews.	abstract
INTRODUCTION			
Rationale	3	Describe the rationale for conducting the overview of reviews in the context of existing knowledge.	Last paragraph - introduction
Objectives	4	Provide an explicit statement of the objective(s) or question(s) addressed by the overview of reviews.	1st section - methodology
METHODS			
Eligibility criteria	5a	Specify the inclusion and exclusion criteria for the overview of reviews. If supplemental primary studies were included, this should be stated, with a rationale.	PICOS – methodology section
	5b	Specify the definition of 'systematic review' as used in the inclusion criteria for the overview of reviews.	Study design – methodology section
Information sources	6	Specify all databases, registers, websites, organizations, reference lists, and other sources searched or consulted to identify systematic reviews and supplemental primary studies (if included). Specify the date when each source was last searched or consulted.	Search strategy – methodology section
Search strategy	7	Present the full search strategies for all databases, registers and websites, such that they could be reproduced. Describe any search filters and limits applied.	Supplemental file – referenced in methodology section

Selection process	8a	Describe the methods used to decide whether a systematic review or supplemental primary study (if included) met the inclusion criteria of the overview of reviews.	Screening – methodology section
	8b	Describe how overlap in the populations, interventions, comparators, and/or outcomes of systematic reviews was identified and managed during study selection.	Data extraction in methodology section
Data collection process	9a	Describe the methods used to collect data from reports.	Data extraction in methodology section
	9b	If applicable, describe the methods used to identify and manage primary study overlap at the level of the comparison and outcome during data collection. For each outcome, specify the method used to illustrate and/or quantify the degree of primary study overlap across systematic reviews.	n/a
	9c	If applicable, specify the methods used to manage discrepant data across systematic reviews during data collection.	n/a
Data items	10	List and define all variables and outcomes for which data were sought. Describe any assumptions made and/or measures taken to identify and clarify missing or unclear information.	Summarised figure 1and referenced in methodology section
Risk of bias assessment	11a	Describe the methods used to ***assess*** risk of bias or methodological quality of the included systematic reviews.	ROBIS tool Referenced in quality appraisal section - table in supplemental file
	11b	Describe the methods used to ***collect*** data on (from the systematic reviews) and/or ***assess*** the risk of bias of the primary studies included in the systematic reviews. Provide a justification for instances where flawed, incomplete, or missing assessments are identified but not re-assessed.	Included in GRADE assessment in best evidence syntheses section
	11c	Describe the methods used to ***assess*** the risk of bias of supplemental primary studies (if included).	n/a
Synthesis methods	12a	Describe the methods used to summarize or synthesize results and provide a rationale for the choice(s).	Best evidence synthesis using GRADE criteria – methodology section
	12b	Describe any methods used to explore possible causes of heterogeneity among results.	n/a
	12c	Describe any sensitivity analyses conducted to assess the robustness of the synthesized results.	n/a detail will be included in phase 2 publication

Reporting bias assessment	13	Describe the methods used to ***collect*** data on (from the systematic reviews) and/or ***assess*** the risk of bias due to missing results in a summary or synthesis (arising from reporting biases at the levels of the systematic reviews, primary studies, and supplemental primary studies, if included).	n/a
Certainty assessment	14	Describe the methods used to ***collect*** data on (from the systematic reviews) and/or ***assess*** certainty (or confidence) in the body of evidence for an outcome.	Best evidence synthesis using GRADE criteria – methodology section
RESULTS			
Systematic review and supplemental primary study selection	15a	Describe the results of the search and selection process, including the number of records screened, assessed for eligibility, and included in the overview of reviews, ideally with a flow diagram.	PRISMA flow chart. Description of reviews referenced and available in results section
	15b	Provide a list of studies that might appear to meet the inclusion criteria, but were excluded, with the main reason for exclusion.	Will be included in phase 2 reported separately

Section Topic	#	**Item**	**Location reported**
Characteristics of systematic reviews and supplemental primary studies	16	Cite each included systematic review and supplemental primary study (if included) and present its characteristics.	Supplemental file. Intervention and outcomes section – table 1 & 2 referenced and reported in results section
Primary study overlap	17	Describe the extent of primary study overlap across the included systematic reviews.	Description and figure 3 – results section
Risk of bias in systematic reviews, primary studies, and supplemental primary studies	18a	Present assessments of risk of bias or methodological quality for each included systematic review.	Quality section – results Supplemental file
	18b	Present assessments (***collected*** from systematic reviews or ***assessed*** anew) of the risk of bias of the primary studies included in the systematic reviews.	Supplemental file

	18c	Present assessments of the risk of bias of supplemental primary studies (if included).	n/a
Summary or synthesis of results	19a	For all outcomes, summarize the evidence from the systematic reviews and supplemental primary studies (if included). If meta-analyses were done, present for each the summary estimate and its precision and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Table 3 – best evidence syntheses in results section
	19b	If meta-analyses were done, present results of all investigations of possible causes of heterogeneity.	n/a
	19c	If meta-analyses were done, present results of all sensitivity analyses conducted to assess the robustness of synthesized results.	n/a
Reporting biases	20	Present assessments (*collected* from systematic reviews and/or *assessed* anew) of the risk of bias due to missing primary studies, analyses, or results in a summary or synthesis (arising from reporting biases at the levels of the systematic reviews, primary studies, and supplemental primary studies, if included) for each summary or synthesis assessed.	Included in GRADE assessment in results section
Certainty of evidence	21	Present assessments (*collected* or *assessed* anew) of certainty (or confidence) in the body of evidence for each outcome.	GRADE assessment table 3 referenced in results section
DISCUSSION			
Discussion	22a	Summarize the main findings, including any discrepancies in findings across the included systematic reviews and supplemental primary studies (if included).	Summary of findings section in discussion section paragraph 1-3
	22b	Provide a general interpretation of the results in the context of other evidence.	Implications section in discussion section – paragraph 6
	22c	Discuss any limitations of the evidence from systematic reviews, their primary studies, and supplemental primary studies (if included) included in the overview of reviews. Discuss any limitations of the overview of reviews methods used.	Strengths and limitations section in Discussion section – paragraph 4 - 5
	22d	Discuss implications for practice, policy, and future research (both systematic reviews and primary research). Consider the relevance of the findings to the end users of the overview of reviews, e.g., healthcare providers, policymakers, patients, among others.	Implications and conclusion headings- Discussion section – paragraph 6
OTHER INFORMATION			

Registration and protocol	23a	Provide registration information for the overview of reviews, including register name and registration number, or state that the overview of reviews was not registered.	Published – Reference #25
	23b	Indicate where the overview of reviews protocol can be accessed, or state that a protocol was not prepared.	As above
	23c	Describe and explain any amendments to information provided at registration or in the protocol. Indicate the stage of the overview of reviews at which amendments were made.	n/a
Support	24	Describe sources of financial or non-financial support for the overview of reviews, and the role of the funders or sponsors in the overview of reviews.	Online Declaration statement
Competing interests	25	Declare any competing interests of the overview of reviews' authors.	none
Author information	26a	Provide contact information for the corresponding author.	Title page
	26b	Describe the contributions of individual authors and identify the guarantor of the overview of reviews.	In journal submission portal
Availability of data and other materials	27	Report which of the following are available, where they can be found, and under which conditions they may be accessed: template data collection forms; data collected from included systematic reviews and supplemental primary studies; analytic code; any other materials used in the overview of reviews.	Supplemental file

File S2: SEARCH STRATEGY

MEDLINE (OVID)

Stroke

1. cerebrovascular disorders/ or exp basal ganglia cerebrovascular disease/ or exp brain ischemia/ or exp carotid artery diseases/ or exp intracranial arterial diseases/ or exp intracranial arteriovenous malformations/ or exp "intracranial embolism and thrombosis"/ or exp intracranial hemorrhages/ or stroke/ or exp brain infarction/ or vasospasm, intracranial/ or vertebral artery dissection/

2. (stroke or poststroke or post-stroke or cerebrovasc$ or brain vasc$ or cerebral vasc$ or cva$ or apoplex$ or SAH or TIA or transient isch?emic attack or vertebral artery dissection).tw.

3. ((brain$ or cerebr$ or cerebell$ or intracran$ or intracerebral) adj5 (isch?emi$ or infarct$ or thrombo$ or emboli$ or occlus$ or disorder$)).tw.

4. ((brain$ or cerebr$ or cerebell$ or intracerebral or intracranial or subarachnoid) adj5 (haemorrhage$ or hemorrhage$ or haematoma$ or hematoma$ or bleed$)).tw.

5. 1 or 2 or 3 or 4

Risk reduction

6. exp Health Education/ or exp Health Promotion/ or exp Health Behavior/ or exp Secondary Prevention/ or exp Counseling/

7. (health education or health promotion or health behavior or secondary prevention or counseling or counsel$).mp.

8. (health adj5 (educat$ or program$ or promotion$ or behavio?r)).tw.

9. (patient adj5 (educat$ or program$)).tw.

10. 6 or 7 or 8 or 9

11. ((secondary or multifactor$) adj3 (prevention or intervention)).tw.

12. (risk adj3 factor$ adj5 (reduc$ or manag$ or intervent$)).tw.

13. (lifestyle adj3 (intervent$ or advice)).tw.

14. (life?style adj3 (intervention$ or advice or alter$ or educat$ or chang$)).tw.

15. (behavio?r$ adj3 chang$).tw.
16. (health?care adj3 advice).tw.

17. non?pharmacologic$.tw.

18. 11 or 12 or 13 or 14 or 15 or 16 or 17

19. ethanol.mp. or exp Ethanol/

20. (alcohol$ or ethanol$ or wine or beer or spirit$ or ((problem or hazardous or harmful) adj3 drink$)).tw.

21. 19 or 20

22. exp Tobacco/ or "Tobacco Use Cessation"/ or exp smoking/ or exp smoking cessation/

23. tobacco.mp.

24. (tobacco or smok$).tw.

25. 22 or 23 or 24

26. diet$.tw.

27. (healthy adj3 eating).tw.

28. (diet adj3 chang$).tw.

29. 26 or 27 or 28

30. exercise.mp. or exp Exercise/

31. (physical adj3 activ$).tw.

32. 30 or 31

33. 10 or 18 or 21 or 25 or 29 or 32

34. 5 and 33

35. limit 34 to humans

Systematic reviews

36. meta-analysis/ or literature review/

37. systematic review.pt.

38. meta?analy$.tw.

39. ((systematic or quantitative or methodolog$) adj (overview$ or review$)).tw.

40. integrative research review$.tw.

41. 36 or 37 or 38 or 39 or 40

42. 35 and 41

EMBASE (Platform)

#1 'cerebrovascular disease'/de OR 'basal ganglion hemorrhage'/exp OR 'brain ischemia'/exp OR 'carotid artery disease'/exp OR 'cerebral artery disease'/exp OR 'brain arteriovenous malformation'/exp OR 'brain embolism'/exp OR 'occlusive cerebrovascular disease'/exp OR 'brain hemorrhage'/exp OR 'cerebrovascular accident'/exp OR 'brain infarction'/exp OR 'brain vasospasm'/exp OR 'artery dissection'/exp

#2 stroke:ti,ab,kw OR poststroke:ti,ab,kw OR 'post stroke':ti,ab,kw OR cerebrovsc*:ti,ab,kw OR 'brain vasc*':ti,ab,kw OR 'cerebral vasc*':ti,ab,kw OR cva*:ti,ab,kw OR apoplex*:ti,ab,kw OR sah:ti,ab,kw OR tia:ti,ab,kw OR 'transient ischaemic attack':ti,ab,kw OR 'transient ischemic attack':ti,ab,kw OR 'vertebral artery dissection':ti,ab,kw

#3 ((brain* OR cerebr* OR cerebell* OR intracran* OR intracerebral) NEAR/5 (ischemi* OR ischaemi* OR infarct* OR thrombo* OR emboli* OR occlus* OR disorder*)):ti,ab,kw

#4 ((brain* OR cerebr* OR cerebell* OR intracerebral OR intracranial OR subarachnoid) NEAR/5 (haemorrhage* OR hemorrhage* OR haematoma* OR hematoma* OR bleed*)):ti,ab,kw

#5 #1 OR #2 OR #3 OR #4

#6 'health education'/exp OR 'health promotion'/exp OR 'health behavior'/exp OR 'secondary prevention'/exp OR 'counseling'/exp

#7 'health education':kw OR 'health promotion':kw OR 'health behavior':kw OR 'health behaviour':kw OR 'secondary prevention':kw OR counseling:kw OR counsel*:kw

#8 ((health NEAR/5 (educat* OR program* OR promotion* OR behavior OR behaviour))):ti,ab,kw

#9 ((patient NEAR/5 (educat* or program*))):ti,ab,kw

#10 #6 OR #7 OR #8 OR #9

#11 ((secondary OR multifactor*) NEAR/3 (prevention OR intervention)):ti,ab,kw

#12 (risk NEAR/3 factor* NEAR/5 (reduc* OR manag* OR intervent*)):ti,ab,kw
#13 (lifestyle NEAR/3 (intervent* OR advice)):ti,ab,kw

#14 ('life style' NEAR/3 (intervention* OR advice OR alter* OR educat* OR chang*)):ti,ab,kw

#15 (behavior* OR behaviour*) NEAR/3 chang*):ti,ab,kw

#16 (('health care' OR healthcare) NEAR/3 advice):ti,ab,kw

#17 'non pharmacologic*':ti,ab,kw OR nonpharmacologic*:ti,ab,kw

#18 #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17

#19 'alcohol'/exp OR 'alcohol'

#20 alcohol*:ti,ab,kw OR ethanol*:ti,ab,kw OR wine:ti,ab,kw OR beer:ti,ab,kw OR spirit*:ti,ab,kw OR (((problem OR hazardous OR harmful) NEAR/3 drink*):ti,ab,kw)

#21 #19 OR #20

#22 'tobacco'/exp OR 'smoking cessation'/exp OR 'smoking'/exp OR 'tobacco use'/exp

#23 tobacco:kw

#24 tobacco:ti,ab,kw OR smok*:ti,ab,kw

#25 #22 OR #23 OR #24

#26 diet*:ti,ab,kw

#27 (healthy NEAR/3 eating):ti,ab,kw

#28 (diet NEAR/3 chang*):ti,ab,kw

#29 #26 OR #27 OR #28

#30 'exercise'/exp OR exercise:kw

#31 (physical NEAR/3 activ*):ti,ab,kw

#32 #30 OR #31

#33 #10 OR #18 OR #21 OR #25 OR #29 OR #32

#34 #5 AND #33

#35 #5 AND #33 AND [humans]/lim

#36 'meta analysis'/exp OR 'literature review'/exp

#37 'systematic review (topic)'

#38 'meta analysis'/exp OR 'meta analysis'

#39 (systematic:ti,ab,kw OR quantitative:ti,ab,kw OR methodolog*:ti,ab,kw) AND (overview*:ti,ab,kw OR review*:ti,ab,kw)

#40 'integrative research review*':ti,ab,kw

#41 #36 OR #37 OR #38 OR #39 OR #40

#42 #35 AND #41

Epistemonikos

stroke

1. (title:(stroke OR poststroke OR post-stroke OR cerebrovasc* OR "brain vasc*" OR "CVA" OR apoplex* OR "SAH" OR "TIA" OR "transient ischemic attack" OR "transient ischaemic attack" OR "vertebral artery dissection") OR abstract:(stroke OR poststroke OR post-stroke OR cerebrovasc* OR "brain vasc*" OR "CVA" OR apoplex* OR "SAH" OR "TIA" OR "transient ischemic attack" OR "transient ischaemic attack" OR "vertebral artery dissection"))

2. (title:((brain* OR cerebr* OR cerebell* OR intracerebral OR intracranial OR subarachnoid) AND (haemorrhage* OR hemorrhage* OR haematoma* OR hematoma* OR bleed*)) OR abstract:((brain* OR cerebr* OR cerebell* OR intracerebral OR intracranial OR subarachnoid) AND (haemorrhage* OR hemorrhage* OR haematoma* OR hematoma* OR bleed*)))

3. (title:((brain* OR cerebr* OR cerebell* OR intracerebral OR intracranial OR subarachnoid) AND (ischemi* OR ischaemi* OR infarct* OR thrombo* OR emboli*

OR occlus* OR disorder)) OR abstract:((brain* OR cerebr* OR cerebell* OR intracerebral OR intracranial OR subarachnoid) AND (ischemi* OR ischaemi* OR infarct* OR thrombo* OR emboli* OR occlus* OR disorder)))

4. 1 OR 2 OR 3 (title:((brain* OR cerebr* OR cerebell* OR intracerebral OR intracranial OR subarachnoid) AND (ischemi* OR ischaemi* OR infarct* OR thrombo* OR emboli* OR occlus* OR disorder)) OR abstract:((brain* OR cerebr* OR cerebell* OR intracerebral OR intracranial OR subarachnoid) AND (ischemi* OR ischaemi* OR infarct* OR thrombo* OR emboli* OR occlus* OR disorder))) OR (title:((brain* OR cerebr* OR cerebell* OR intracerebral OR intracranial OR subarachnoid) AND (ischemi* OR ischaemi* OR infarct* OR thrombo* OR emboli* OR occlus* OR disorder)) OR abstract:((brain* OR cerebr* OR cerebell* OR intracerebral OR intracranial OR subarachnoid) AND (ischemi* OR ischaemi* OR infarct* OR thrombo* OR emboli* OR occlus* OR disorder))) OR (title:(stroke) OR abstract:(stroke)) OR (title:(poststroke) OR abstract:(poststroke)) OR (title:(post-stroke) OR abstract:(post-stroke)) OR (title:(cerebrovasc*) OR abstract:(cerebrovasc*)) OR (title:("brain vasc*") OR abstract:("brain vasc*")) OR (title:(CVA*) OR abstract:(CVA*)) OR (title:(apoplex*) OR abstract:(apoplex*)) OR (title:(SAH) OR abstract:(SAH)) OR (title:(TIA) OR abstract:(TIA)) OR (title:("transient ischaemic attack" OR "transient ischemic attack") OR abstract:("transient ischaemic attack" OR "transient ischemic attack")) OR (title:("vertebral artery dissection") OR abstract:("vertebral artery dissection"))

(title:(stroke OR poststroke OR post-stroke OR cerebrovasc* OR "brain vasc*" OR "CVA" OR apoplex* OR "SAH" OR "TIA" OR "transient ischemic attack" OR "transient ischaemic attack" OR "vertebral artery dissection") OR abstract:(stroke OR poststroke OR post-stroke OR cerebrovasc* OR "brain vasc*" OR "CVA" OR apoplex* OR "SAH" OR "TIA" OR "transient ischemic attack" OR "transient ischaemic attack" OR "vertebral artery dissection")) OR (title:(((brain* OR cerebr* OR cerebell* OR intracerebral OR intracranial OR subarachnoid) AND (haemorrhage* OR hemorrhage* OR haematoma* OR hematoma* OR bleed*))) OR abstract:(((brain* OR cerebr* OR cerebell* OR intracerebral OR intracranial OR subarachnoid) AND (haemorrhage* OR hemorrhage* OR haematoma* OR hematoma* OR bleed*)))) OR (title:(((brain* OR cerebr* OR cerebell* OR intracerebral OR intracranial OR subarachnoid) AND (ischemi* OR ischaemi* OR infarct* OR thrombo* OR emboli* OR occlus* OR disorder))) OR abstract:(((brain* OR cerebr* OR cerebell* OR intracerebral OR intracranial OR subarachnoid) AND (ischemi* OR ischaemi* OR infarct* OR thrombo* OR emboli* OR occlus* OR disorder))))

Risk

5. (title:("health education" OR "health promotion" OR "health behavior" OR "health behaviour" OR "secondary prevention" OR counseling OR counsel*) OR abstract:("health education" OR "health promotion" OR "health behavior" OR "health behaviour" OR "secondary prevention" OR counseling OR counsel*))

6. (title:(health AND (educat* OR program* OR promotion* OR behavior OR behaviour)) OR abstract:(health AND (educat* OR program* OR promotion* OR behavior OR behaviour)))

7. (title:(patient AND (educat* OR program*)) OR abstract:(patient AND (educat* OR program*)))

8. 5 OR 6 OR 7 (title:(patient AND (educat* OR program*)) OR abstract:(patient AND (educat* OR program*))) OR (title:(health AND (educat* OR program* OR promotion* OR behavior OR behaviour)) OR abstract:(health AND (educat* OR program* OR promotion* OR behavior OR behaviour))) OR (title:("health education" OR "health promotion" OR "health behavior" OR "health behaviour" OR "secondary prevention" OR counseling OR counsel*) OR abstract:("health education" OR "health promotion" OR "health behavior" OR "health behaviour" OR "secondary prevention" OR counseling OR counsel*))

9. (title:(((secondary OR multifactor*) AND (prevention OR intervention))) OR abstract:(((secondary OR multifactor*) AND (prevention OR intervention))))

10. (title:(risk factor* AND (reduc* OR manag* OR intervent*)) OR abstract:(risk factor* AND (reduc* OR manag* OR intervent*)))

11. (title:((lifestyle OR life-style) AND (intervent* OR advice OR alter* OR educat* OR chang*)) OR abstract:((lifestyle OR life-style) AND (intervent* OR advice OR alter* OR educat* OR chang*)))

12. (title:((behavior* OR behaviour*) AND chang*) OR abstract:((behavior* OR behaviour*) AND chang*))

13. (title:((health care OR healthcare) AND advice) OR abstract:((health care OR healthcare) AND advice))

14. (title:(non-pharmacologic* OR nonpharmacologic*) OR abstract:(non-pharmacologic* OR nonpharmacologic*))

15. 9 OR 10 OR 11 OR 12 OR 13 OR 14 (title:(non-pharmacologic* OR nonpharmacologic*) OR abstract:(non-pharmacologic* OR nonpharmacologic*)) OR (title:((health care OR healthcare) AND advice) OR abstract:((health care OR healthcare) AND advice)) OR (title:((behavior* OR behaviour*) AND chang*) OR abstract:((behavior* OR behaviour*) AND chang*)) OR (title:((lifestyle OR life-style) AND (intervent* OR advice OR alter* OR educat* OR chang*)) OR abstract:((lifestyle OR life-style) AND (intervent* OR advice OR alter* OR educat* OR chang*))) OR (title:(risk factor* AND (reduc* OR manag* OR intervent*)) OR abstract:(risk factor* AND (reduc* OR manag* OR intervent*))) OR (title:(((secondary OR multifactor*) AND (prevention OR intervention))) OR abstract:(((secondary OR multifactor*) AND (prevention OR intervention))))

16. (title:(ethanol OR alcohol) OR abstract:(ethanol OR alcohol))

17. (title:(((alcohol* OR ethanol* OR wine OR beer OR spirit* OR (problem OR hazardous OR harmful)) AND drink*)) OR abstract:(((alcohol* OR ethanol* OR wine OR beer OR spirit* OR (problem OR hazardous OR harmful)) AND drink*)))

18. (title:(tobacco OR smok* OR "tobacco use cessation" OR "smoking cessation") OR abstract:(tobacco OR smok* OR "tobacco use cessation" OR "smoking cessation"))

19. (title:(diet* OR "healthy eating" OR (healthy AND eating) OR (diet AND chang*)) OR abstract:(diet* OR "healthy eating" OR (healthy AND eating) OR (diet AND chang*)))

20. (title:(exercise OR "physical activ*" OR (physical AND activ*)) OR abstract:(exercise OR "physical activ*" OR (physical AND activ*)))

21. 15 OR 16 OR 17 OR 18 OR 19 OR 20 (title:(exercise OR "physical activ*" OR (physical AND activ*)) OR abstract:(exercise OR "physical activ*" OR (physical AND activ*))) OR (title:(diet* OR "healthy eating" OR (healthy AND eating) OR (diet AND chang*)) OR abstract:(diet* OR "healthy eating" OR (healthy AND eating) OR (diet AND chang*))) OR (title:(tobacco OR smok* OR "tobacco use cessation" OR "smoking cessation") OR abstract:(tobacco OR smok* OR "tobacco use cessation" OR "smoking cessation")) OR (title:(((alcohol* OR ethanol* OR wine OR beer OR spirit* OR (problem OR hazardous OR harmful)) AND drink*)) OR abstract:(((alcohol* OR ethanol* OR wine OR beer OR spirit* OR (problem OR hazardous OR harmful)) AND drink*))) OR (title:(ethanol OR alcohol) OR abstract:(ethanol OR alcohol))

33. **Risk reduction AND Stroke**

(title: (("health education" OR "health promotion" OR "health behavior" OR "health behaviour" OR "secondary prevention" OR counseling OR counsel*)) OR abstract:(("health education" OR "health promotion" OR "health behavior" OR "health behaviour" OR "secondary prevention" OR counseling OR counsel*))) OR (title: ((health AND (educat* OR program* OR promotion* OR behavior OR behaviour))) OR abstract:((health AND (educat* OR program* OR promotion* OR behavior OR behaviour)))) OR (title: ((patient AND (educat* OR program*))) OR abstract:((patient AND (educat* OR program*)))) OR (title: (((secondary OR multifactor*) AND (prevention OR intervention))) OR abstract:(((secondary OR multifactor*) AND (prevention OR intervention)))) OR (title: ((risk factor* AND (reduc* OR manag* OR intervent*))) OR abstract:((risk factor* AND (reduc* OR manag* OR intervent*)))) OR (title: (((lifestyle OR life-style) AND (intervent* OR advice OR alter* OR educat* OR chang*))) OR abstract:(((lifestyle OR life-style) AND (intervent* OR advice OR alter* OR educat* OR chang*)))) OR (title: (((behavior* OR behaviour*) AND chang*)) OR abstract:(((behavior* OR behaviour*) AND chang*)))

OR (title: ((health care OR healthcare) AND advice) OR abstract:((health care OR healthcare) AND advice)) OR (title: (non-pharmacologic* OR nonpharmacologic*) OR abstract:(non-pharmacologic* OR nonpharmacologic*)) OR (title: (ethanol OR alcohol) OR abstract:(ethanol OR alcohol)) OR (title: ((alcohol* OR ethanol* OR wine OR beer OR spirit* OR (problem OR hazardous OR harmful)) AND drink*) OR abstract:((alcohol* OR ethanol* OR wine OR beer OR spirit* OR (problem OR hazardous OR harmful)) AND drink*)) OR (title: (tobacco OR smok* OR "tobacco use cessation" OR "smoking cessation") OR abstract:(tobacco OR smok* OR "tobacco use cessation" OR "smoking cessation")) OR (title: (diet* OR "healthy eating" OR (healthy AND eating) OR (diet AND chang*)) OR abstract:(diet* OR "healthy eating" OR (healthy AND eating) OR (diet AND chang*))) OR (title: (exercise OR "physical activ*" OR (physical AND activ*)) OR abstract:(exercise OR "physical activ*" OR (physical AND activ*)))
AND
(title:(stroke OR poststroke OR post-stroke OR cerebrovasc* OR "brain vasc*" OR "CVA" OR apoplex* OR "SAH" OR "TIA" OR "transient ischemic attack" OR "transient ischaemic attack" OR "vertebral artery dissection") OR abstract:(stroke OR poststroke OR post-stroke OR cerebrovasc* OR "brain vasc*" OR "CVA" OR apoplex* OR "SAH" OR "TIA" OR "transient ischemic attack" OR "transient ischaemic attack" OR "vertebral artery dissection")) OR (title:(((brain* OR cerebr* OR cerebell* OR intracerebral OR intracranial OR subarachnoid) AND (haemorrhage* OR hemorrhage* OR haematoma* OR hematoma* OR bleed*))) OR abstract:(((brain* OR cerebr* OR cerebell* OR intracerebral OR intracranial OR subarachnoid) AND (haemorrhage* OR hemorrhage* OR haematoma* OR hematoma* OR bleed*)))) OR (title:(((brain* OR cerebr* OR cerebell* OR intracerebral OR intracranial OR subarachnoid) AND (ischemi* OR ischaemi* OR infarct* OR thrombo* OR emboli* OR occlus* OR disorder))) OR abstract:(((brain* OR cerebr* OR cerebell* OR intracerebral OR intracranial OR subarachnoid) AND (ischemi* OR ischaemi* OR infarct* OR thrombo* OR emboli* OR occlus* OR disorder))))

Stroke
stroke OR poststroke OR post-stroke OR cerebrovasc* OR "brain vasc*" OR "CVA" OR apoplex* OR "SAH" OR "TIA" OR "transient ischemic attack" OR "transient ischaemic attack" OR "vertebral artery dissection" OR ((brain* OR cerebr* OR cerebell* OR intracerebral OR intracranial OR subarachnoid) AND (haemorrhage* OR hemorrhage* OR haematoma* OR hematoma* OR bleed*)) OR ((brain* OR cerebr* OR cerebell* OR intracerebral OR intracranial OR subarachnoid) AND (ischemi* OR ischaemi* OR infarct* OR thrombo* OR emboli* OR occlus* OR disorder))

Risk reduction
(("health education" OR "health promotion" OR "health behavior" OR "health behaviour" OR "secondary prevention" OR counseling OR counsel*)) OR ((health AND (educat* OR program* OR promotion* OR behavior OR behaviour))) OR ((patient AND (educat* OR program*))) OR (((secondary OR multifactor*) AND (prevention OR intervention))) OR ((risk factor* AND (reduc* OR manag* OR intervent*))) OR (((lifestyle OR life-style) AND (intervent* OR advice OR alter* OR

educat* OR chang*))) OR (((behavior* OR behaviour*) AND chang*)) OR ((health care OR healthcare) AND advice) OR (non-pharmacologic* OR nonpharmacologic*) OR (ethanol OR alcohol) OR ((alcohol* OR ethanol* OR wine OR beer OR spirit* OR (problem OR hazardous OR harmful)) AND drink*) OR (tobacco OR smok* OR "tobacco use cessation" OR "smoking cessation") OR (diet* OR "healthy eating" OR (healthy AND eating) OR (diet AND chang*)) OR (exercise OR "physical activ*" OR (physical AND activ*))

Combined using AND, limited to Title/Abstract

(title:((title:(stroke OR poststroke OR post-stroke OR cerebrovasc* OR "brain vasc*" OR "CVA" OR apoplex* OR "SAH" OR "TIA" OR "transient ischemic attack" OR "transient ischaemic attack" OR "vertebral artery dissection" OR ((brain* OR cerebr* OR cerebell* OR intracerebral OR intracranial OR subarachnoid) AND (haemorrhage* OR hemorrhage* OR haematoma* OR hematoma* OR bleed*)) OR ((brain* OR cerebr* OR cerebell* OR intracerebral OR intracranial OR subarachnoid) AND (ischemi* OR ischaemi* OR infarct* OR thrombo* OR emboli* OR occlus* OR disorder))) OR abstract:(stroke OR poststroke OR post-stroke OR cerebrovasc* OR "brain vasc*" OR "CVA" OR apoplex* OR "SAH" OR "TIA" OR "transient ischemic attack" OR "transient ischaemic attack" OR "vertebral artery dissection" OR ((brain* OR cerebr* OR cerebell* OR intracerebral OR intracranial OR subarachnoid) AND (haemorrhage* OR hemorrhage* OR haematoma* OR hematoma* OR bleed*)) OR ((brain* OR cerebr* OR cerebell* OR intracerebral OR intracranial OR subarachnoid) AND (ischemi* OR ischaemi* OR infarct* OR thrombo* OR emboli* OR occlus* OR disorder)))) AND (title:((("health education" OR "health promotion" OR "health behavior" OR "health behaviour" OR "secondary prevention" OR counseling OR counsel*)) OR ((health AND (educat* OR program* OR promotion* OR behavior OR behaviour))) OR ((patient AND (educat* OR program*))) OR (((secondary OR multifactor*) AND (prevention OR intervention))) OR ((risk factor* AND (reduc* OR manag* OR intervent*))) OR (((lifestyle OR life-style) AND (intervent* OR advice OR alter* OR educat* OR chang*))) OR (((behavior* OR behaviour*) AND chang*)) OR ((health care OR healthcare) AND advice) OR (non-pharmacologic* OR nonpharmacologic*) OR (ethanol OR alcohol) OR ((alcohol* OR ethanol* OR wine OR beer OR spirit* OR (problem OR hazardous OR harmful)) AND drink*) OR (tobacco OR smok* OR "tobacco use cessation" OR "smoking cessation") OR (diet* OR "healthy eating" OR (healthy AND eating) OR (diet AND chang*)) OR (exercise OR "physical activ*" OR (physical AND activ*))) OR abstract:((("health education" OR "health promotion" OR "health behavior" OR "health behaviour" OR "secondary prevention" OR counseling OR counsel*)) OR ((health AND (educat* OR program* OR promotion* OR behavior OR behaviour))) OR ((patient AND (educat* OR program*))) OR (((secondary OR multifactor*) AND (prevention OR intervention))) OR ((risk factor* AND (reduc* OR manag* OR intervent*))) OR (((lifestyle OR life-style) AND (intervent* OR advice OR alter* OR educat* OR chang*))) OR (((behavior* OR behaviour*) AND chang*)) OR ((health care OR healthcare) AND advice) OR (non-pharmacologic* OR nonpharmacologic*) OR (ethanol OR alcohol) OR ((alcohol* OR ethanol* OR wine OR beer OR spirit* OR (problem OR hazardous OR harmful)) AND

drink*) OR (tobacco OR smok* OR "tobacco use cessation" OR "smoking cessation") OR (diet* OR "healthy eating" OR (healthy AND eating) OR (diet AND chang*)) OR (exercise OR "physical activ*" OR (physical AND activ*))))) OR abstract:((title:(stroke OR poststroke OR post-stroke OR cerebrovasc* OR "brain vasc*" OR "CVA" OR apoplex* OR "SAH" OR "TIA" OR "transient ischemic attack" OR "transient ischaemic attack" OR "vertebral artery dissection" OR ((brain* OR cerebr* OR cerebell* OR intracerebral OR intracranial OR subarachnoid) AND (haemorrhage* OR hemorrhage* OR haematoma* OR hematoma* OR bleed*)) OR ((brain* OR cerebr* OR cerebell* OR intracerebral OR intracranial OR subarachnoid) AND (ischemi* OR ischaemi* OR infarct* OR thrombo* OR emboli* OR occlus* OR disorder))) OR abstract:(stroke OR poststroke OR post-stroke OR cerebrovasc* OR "brain vasc*" OR "CVA" OR apoplex* OR "SAH" OR "TIA" OR "transient ischemic attack" OR "transient ischaemic attack" OR "vertebral artery dissection" OR ((brain* OR cerebr* OR cerebell* OR intracerebral OR intracranial OR subarachnoid) AND (haemorrhage* OR hemorrhage* OR haematoma* OR hematoma* OR bleed*)) OR ((brain* OR cerebr* OR cerebell* OR intracerebral OR intracranial OR subarachnoid) AND (ischemi* OR ischaemi* OR infarct* OR thrombo* OR emboli* OR occlus* OR disorder)))) AND (title:((("health education" OR "health promotion" OR "health behavior" OR "health behaviour" OR "secondary prevention" OR counseling OR counsel*)) OR ((health AND (educat* OR program* OR promotion* OR behavior OR behaviour))) OR ((patient AND (educat* OR program*))) OR (((secondary OR multifactor*) AND (prevention OR intervention))) OR ((risk factor* AND (reduc* OR manag* OR intervent*))) OR (((lifestyle OR life-style) AND (intervent* OR advice OR alter* OR educat* OR chang*))) OR (((behavior* OR behaviour*) AND chang*)) OR ((health care OR healthcare) AND advice) OR (non-pharmacologic* OR nonpharmacologic*) OR (ethanol OR alcohol) OR ((alcohol* OR ethanol* OR wine OR beer OR spirit* OR (problem OR hazardous OR harmful)) AND drink*) OR (tobacco OR smok* OR "tobacco use cessation" OR "smoking cessation") OR (diet* OR "healthy eating" OR (healthy AND eating) OR (diet AND chang*)) OR (exercise OR "physical activ*" OR (physical AND activ*))) OR abstract:((("health education" OR "health promotion" OR "health behavior" OR "health behaviour" OR "secondary prevention" OR counseling OR counsel*)) OR ((health AND (educat* OR program* OR promotion* OR behavior OR behaviour))) OR ((patient AND (educat* OR program*))) OR (((secondary OR multifactor*) AND (prevention OR intervention))) OR ((risk factor* AND (reduc* OR manag* OR intervent*))) OR (((lifestyle OR life-style) AND (intervent* OR advice OR alter* OR educat* OR chang*))) OR (((behavior* OR behaviour*) AND chang*)) OR ((health care OR healthcare) AND advice) OR (non-pharmacologic* OR nonpharmacologic*) OR (ethanol OR alcohol) OR ((alcohol* OR ethanol* OR wine OR beer OR spirit* OR (problem OR hazardous OR harmful)) AND drink*) OR (tobacco OR smok* OR "tobacco use cessation" OR "smoking cessation") OR (diet* OR "healthy eating" OR (healthy AND eating) OR (diet AND chang*)) OR (exercise OR "physical activ*" OR (physical AND activ*))))))

Limited to systematic reviews

Cochrane Library

1. (MeSH descriptor: [Cerebrovascular Disorders] this term only OR MeSH descriptor: [Basal Ganglia Cerebrovascular Disease] explode all trees OR MeSH descriptor: [Brain Ischemia] explode all trees OR MeSH descriptor: [Carotid Artery Diseases] explode all trees OR MeSH descriptor: [Intracranial Arterial Diseases] explode all trees OR MeSH descriptor: [Intracranial Arteriovenous Malformations] explode all trees OR MeSH descriptor: [Intracranial Embolism and Thrombosis] explode all trees OR MeSH descriptor: [Intracranial Hemorrhages] explode all trees OR MeSH descriptor: [Stroke] this term only OR MeSH descriptor: [Brain Infarction] explode all trees OR MeSH descriptor: [Vasospasm, Intracranial] this term only OR MeSH descriptor: [Vertebral Artery Dissection] this term only)
(#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 **= #13**)

2. ((stroke OR poststroke OR post-stroke OR cerebrovsc* OR brain vasc* OR cerebral vasc* OR CVA* OR apoplex* OR SAH OR TIA OR transient ischaemic attack OR transient ischemic attack OR vertebral artery dissection)):ti,ab,kw (#14)

3. ((brain* OR cerebr* OR cerebell* OR intracran* OR intracerebral) NEAR/5 (ischemi* OR ischaemi* OR infarct* OR thrombo* OR emboli* OR occlus*)):ti,ab,kw (#15)

4. ((brain* OR cerebr* OR cerebell* OR intracerebral OR intracranial OR subarachnoid) NEAR/5 (haemorrhage* OR hemorrhage* OR haematoma* OR hematoma* OR bleed*)):ti,ab,kw (#16)

5. #13 OR #14 OR #15 OR #16 = **#17**

6. (MeSH descriptor: [Health Education] explode all trees OR MeSH descriptor: [Health Promotion] explode all trees OR MeSH descriptor: [Health Behavior] explode all trees OR MeSH descriptor: [Secondary Prevention] explode all trees OR MeSH descriptor: [Counseling] explode all trees) (#18 OR #19 OR #20 OR #21 OR #22) = #23

7. ((health education OR health promotion OR health behavior OR health behaviour OR secondary prevention OR counseling OR counsel*)):kw (#24)

8. ((health NEAR/5 (educat* OR program* OR promotion* OR behavior OR behaviour))):ti,ab,kw (#25)

9. ((patient NEAR/5 (educat* or program*))):ti,ab,kw (#26)

10. #23 OR #24 OR #25 OR #26 = **#27**

11. (((secondary or multifactor*) NEAR/3 (prevention or intervention))):ti,ab,kw (#28)

12. (((risk NEAR/3 factor* NEAR/5 (reduc* OR manag* OR intervent*)))):ti,ab,kw (#29)

13. ((lifestyle NEAR/3 (intervent* or advice))):ti,ab,kw (#30)

14. (((life style NEAR/3 (intervention* OR advice OR alter* OR educat* OR chang*)))):ti,ab,kw (#31)

15. ((((behavior* OR behaviour*) NEAR/3 chang*))):ti,ab,kw (#32)

16. ((((health care OR healthcare) NEAR/3 advice))):ti,ab,kw (#33)

17. ((non-pharmacologic* OR nonpharmacologic*)):ti,ab,kw (#34)

18. #28 OR #29 OR #30 OR #31 OR #32 OR #33 OR #34 **= #35**

19. ((ethanol):kw) OR (MeSH descriptor: [Ethanol] explode all trees) (#36 OR #37)

20. (((alcohol* OR ethanol* OR wine OR beer OR spirit* or ((problem or hazardous or harmful) NEAR/3 drink*)))):ti,ab,kw (#38)

21. #36 OR #37 OR #38 = **#39**

22. (MeSH descriptor: [Tobacco] explode all trees OR MeSH descriptor: [Tobacco Use Cessation] explode all trees OR MeSH descriptor: [Smoking] explode all trees OR MeSH descriptor: [Smoking Cessation] explode all trees) (#40 OR #41 OR #42 OR #43) =#44

23. (tobacco):kw

24. (((tobacco OR smok*))):ti,ab,kw

25. (#44 OR #45 OR #46) = **#47**

26. (diet*):ti,ab,kw #48

27. (((healthy NEAR/3 eating))):ti,ab,kw #49

28. (((diet NEAR/3 chang*))):ti,ab,kw #50

29. #48 OR #49 OR #50 = **#51**

30. ((exercise):kw) OR (MeSH descriptor: [Exercise] explode all trees) #52 OR #53

31. (((physical NEAR/3 activ*))):ti,ab,kw

32. #52 OR #53 OR #54 = #55

33. #27 OR #35 OR #39 OR #47 OR #51 OR #55 = **#56**

34. #17 AND #56 = **#57 limit to Cochrane Reviews**

File S3: Tabular presentation of ROBIS (Risk of Bias in Systematic Reviews) Result

Review	1. Study Eligibility Criteria	2. Identification and Selection of Studies	3. Data Selection and Study Appraisal	4. Synthesis and Findings	Overall Risk of Bias in the Review
1. Allida 2020	☺	☺	☺	☺	☺
2. Bridgwood 2018	☺	☺	☺	☺	☺
3. Deijle 2017	☺	?	?	?	?
4. Fryer 2016	☺	☺	☺	☺	☺
5. Heron 2017	☺	?	☺	☹	☹
6. Jeffares 2021	☺	☺	☺	☺	☺
7. Lawrence 2012	☺	☺	☺	☺	☺
8. Lawrence 2015	☺	☺	☺	☺	☺
9. Lennon 2014	☺	☺	☺	☺	☺
10. Liljehult 2020	☹	☺	☺	?	☺
11. Parappilly 2018	☺	?	?	☺	?
12. Sakakibara 2017	☺	?	?	☺	?
13. Tao 2022	☺	☺	☺	☺	☺
14. Wan 2021	☺	☺	☺	☹	?
15. Wang 2018	☺	☺	☺	☺	☺

☺ = low risk; ☹ = high risk; ? = unclear risk

File S4: Characteristics of Included Systematic Reviews

Systematic review	No. of RCT studies	Population	Intervention and stated aim	Outcomes reported	Main findings	Meta- analysis	ROBIS
Pharmacological, psychological, and non-invasive brain stimulation interventions for treating depression after stroke. **Allida** 2020	16 (from a total of 49) N =1469	Male & female diagnosed with post-stroke depression (included ischaemic & haemorrhagic)	Psychological therapy vs UC / attention control and +/- pharmacology to (1) reduce the prevalence of diagnosable depression after stroke (2)reduce levels of depressive symptoms, improve physical and neurological function. Intervention Category: Psychological therapies	(1)Depression (remission) (2)change in scores (i)depression, (ii) psychological distress Timepoints: (a)end of treatment and (b)end of f/u	Very low-certainty evidence suggests that psychological therapies can reduce the prevalence of depression	RR of effect of interventions on depression dx at (a): 6RCTs N=521 RR 0.77 [0.62, 0.95]; (b): 3RCTs N=201 RR 0.85 [0.59, 1.21] MD in change in depression scores at (a) 3 RCTs N=189 MD -6.20 [-8.24, -4.16] MD in change in psychological distress scores at (a) 2RCTs N=377 MD -0.21 [-1.89, -1.48]	Low risk
Interventions for improving modifiable risk factor control in the secondary prevention of stroke. **Bridgwood** 2018	16 (from a total of 42) N = 6051	Adults aged 18yrs and older with confirmed ischaemic/ haemorrhagic stroke/TIA	Educational and behavioural interventions for stroke patients vs usual care or without individualised advice to improve modifiable risk factor control. Exercise/physical rehab, knowledge and smoking cessation excluded (included organisational interventions not reported here). Intervention Category: Education/Behavioural Counselling	(1)Physiological e.g. BP, lipids, HbA1c, BMI, risk score; (2)Medication adherence; (3)Recurrent stroke; (4)MI;	Educational and behavioural interventions showed no clear benefit for any of the review outcomes, which included mean systolic and diastolic blood pressure, mean body mass index, achievement of HbA1c target, lipid profile, mean HbA1c level,	(1)MDs SBP: 11 RCTs N=1398: MD -2.81 mmHg (-7.02, +1.39); MDs DBP: MD -0.83 mmHg (-2.8, + 1.13); OR BP target achieved: 3 RCTs N=266 OR 1.34 [0.70, 2.59]; MD TC: 7 RCTs N=721: MD 0.1mmol/L (-0.28, +0.41); MD LDL: 4RCTs N=495: MD -0.13 mmol/L (-0.28, +0.02); MD BMI: 2RCTs N=127: MD + 0.22 kg/m²(-0.85, +1.29)(2) Medication adherence: 13 RCTs N=33762 no difference found; (3) Recurrent stroke: 4RCTs N=4333: OR 0.82 [0.37, 1.84]; TIAs: 2 RCTs N=N=4207: OR 1.09	Low risk

					medication adherence, or recurrent cardiovascular events.	[0.52, 2.30] (4) MI: 3 RCTs N=4277: OR 0.53 [0.17, 1.65];	
Lifestyle Interventions to Prevent Cardiovascular Events After Stroke and Transient Ischemic Attack: Systematic Review and Meta-Analysis. **Deijle** 2017	13 (from a total of 22) N = 1852	Adults with stoke/TIA	Lifestyle interventions focusing on behaviour change (1), cardiovascular fitness (2), combination (3) vs usual care, to prevent recurrence, reduce mortality, improve modifiable risk factors. Intervention Category: Multi-modal programmes	(1)Cardiovascular event rates; (2) Mortality; (3) Physiological e.g. BP, Cholesterol;	Lifestyle interventions are effective in lowering systolic blood pressure but no effect on cardiovascular event rate mortality, diastolic bloodpressure, or total cholesterol.	(1) RR CV events: 4 RCTs N=506 RR 0.79 [0.30, 2.06]; (2)Mortality: 5(4)RCTs N=1492: RR 1.16[0.82, 1.63]; (3)MDs SBP: 10 RCTs N=650 (all interventions) MD -3.6mmHg (-5.6, -1.6); MDs DBP: 8RCTs N=648 MD -0.15mmHg (-2.23, +1.93); MDs TC: 3RCTs N=126 MD 0.09mmol/l (-0.30, +0.48);	Unclear risk
Self-management programmes for quality of life in people with stroke. **Fryer** 2016	6 (from a total of 14) N = 648	Adults (aged 18 years and older)with stroke living in community	Self-management programmes (stroke specific & generic) vs usual care or active control (alternative intervention) to improve quality of life after stroke. Intervention Category: Self-management	(1)QoL; Self-efficacy; Activity limits; (not reported here) (2)Impairments (changes in mood scores)	Individual studies reported benefits for health-related behaviours such as reduced use of health services, smoking, and alcohol intake, as well as improved diet and attitude. However, there was no superior effect for such programmes in the domains of locus of control,	MD in change in psychological distress scores: 6 RCTs N=648 MD -0.56 (-1.27, + 0.15)	Low risk

					activities of daily living, medication adherence, participation, or mood.		
Secondary prevention lifestyle interventions initiated within 90 days after TIA or 'minor' stroke: a systematic review and meta-analysis of rehabilitation programmes. **Heron** 2017	2 (from a total of 4) N = 79	Adults, males and females, aged 18 years and older with a diagnosis of TIA and/or minor stroke	Comprehensive rehab programme within 90 days of diagnosis vs usual care to review effectiveness on patients' optimal functioning. Intervention Category: Multi-modal programmes	Resting systolic BP	Limited evidence of the effectiveness with no significant change in resting and peak systolic blood pressure, resting heart rate, aerobic capacity, falls, or mortality	MDs in resting SBP: 2RCTs N=76 MD 2.6mmHg (-7.93, +13.13)	High risk
A systematic review and meta-analysis of the effects of cardiac rehabilitation interventions on cognitive impairment following stroke. **Jeffares** 2021	5 N = 852	Adults aged 18+ with primary diagnosis of TIA or stroke	Cardiac rehabilitation and cardiac rehabilitation-type interventions. Intervention Category: Multi-modal programmes	(1) Post-stroke cognitive function (not reported here) (2) Psychological well-being (depression and anxiety)	Cardiac rehabilitation programmes had a small significant effect on depression and anxiety scores	Depression scores: 5 RCTs N=852: SMD(d) 0.15 (0.01, 0.29); Anxiety scores: 4 RCTs N=663: SMD(d) 0.29 (0.12, 0.46)	Low risk

The effectiveness of secondary prevention lifestyle interventions designed to change lifestyle behavior following stroke: summary of a systematic review. **Lawrence** 2012	3 N = 581	Adults aged 18+ who had a stroke/TIA	Educational/health promotional and other behavioural interventions to address one or more modifiable lifestyle risk factors to prevent recurrent stroke, and improve behavioural, physiological, psychological and/or learning outcomes. Intervention Category: Education/Behavioural Counselling	(1) Behaviour change e.g. tobacco use, physical activity, alcohol consumption, diet; (2) Physiological e.g. BP, lipids, Blood glucose, BMI, waist circumference; (3) Stroke recurrence	Secondary prevention lifestyle interventions are effective in terms of effecting positive change in lifestyle behaviours, and appear promising in relation to physiological outcomes however there was insufficient evidence to determine effect on stroke recurrence	(1) ORs in combined lifestyle behaviour: 3RCTs N=581: OR 0.81 [0.68, 0.96]; (2) ORs in combined physiological risk factors: 3RCTs N=581: OR 0.87 [0.75, 1.0]	Low risk

Multimodal secondary prevention behavioral interventions for TIA and stroke: a systematic review and meta-analysis. **Lawrence** 2015	16 (from a total of 20) N = 5976	Adults aged 18+ who had a stroke (broad definition included ischaemic/haemorrhagic/subarachnoid haemorrhage/ TIA)	Multimodal complex interventions vs UC/modified UC, addressing (1)medication education +/- compliance education; (2) education/active information provision on stroke/lifestyle/risk factors; (3)lifestyle behaviours - smoking, diet, physical activity, alcohol consumption, and/or amelioration of lifestyle risk factors. Intervention Category: Multi-modal programmes	(1)Physiological e.g. BP, lipids, glucose, BMI; (2)Behaviour change; (3)Psychological wellbeing; (4)Recurrence/CV events; (5)mortality	Significant effect of intervention on the reduction of systolic and diastolic blood pressure; Positivetrends were noted in relation to blood lipids and anthropomorphic measures; significant positive effect on medication compliance, anxiety, reduction in recurrence of cardiac events	(1) MDs BP: 10RCTs N=1407: combined SBP/DBP MD: -2.57mmHg (-3.57, -1.56); SBP MD -4.21mmHg (-6.24, -2.18); DBP: MD: -2.03mmHg (-3.19, -0.87). Combined lipids 9RCTs N=1342 MD: 0.02mmol/L (-0.06, 0.10); Bl Glucose 3RCTs N=120 MD: -0.07mmol/L (-0.16, 0.02); BMI 6RCTs N=433 MD: -0.25kg/m2 (-1.04, 0.54); Weight 3RCTs N=186 MD: -1.53kg (-4.48, 1.43); Waist Circumference 2RCTs N=96 MD: -6.69cm (-11.44, -1.93). (2) ORs for smoking quitters: 5RCTs N=250 OR 1.15 (0.67, 1.99); MDs for diet/daily fruit & veg: 2RCTs N=74 MD 0.46 (-0.27, 1.19). (3) MDs Anxiety scores: 2RCTs N=143 MD: -1.20 (-1.77, -0.63). (4)ORs stroke recurrence: 4RCTs N=4053 OR 1.14 [0.81, 1.60]; ORs Cardiac events: 4RCTs N=4053 OR 0.38 [0.16, 0.88]. (5) ORs Mortality: 3 RCTs N=4261 OR 1.03 [0.57, 1.85]	Low risk

Lifestyle interventions for secondary disease prevention in stroke and transient ischaemic attack: a systematic review. **Lennon** 2014	15 (from a total of 17) N = 7498	Participants with ischaemic stroke or TIA (ICD classified)	Lifestyle intervention packages incorporating any key component of targeted health education or health promotion on lifestyle-related issues, lifestyle counselling and/or aerobic exercise and broadly based on the cardiac rehabilitation model Vs usual care (routine pharmacotherapy and guideline based advice +/- sham intervention) for secondary disease prevention. Intervention Category: Multi-modal programmes	(1)Mortality; (2)Recurrent CVD rates;(3) Physiological e.g. BP, lipids; (4)Behaviour change e.g. physical activity; smoking; diet.	Promising blood pressure reductions; insufficient evidence on reduction in mortality, CVD event rates and cardio-metabolic risk factor profiles	(1) RR for mortality: 8RCTs N=2478 RR=1.13 [0.85, 1.5]). (2) RR CVD event rate: 4 RCTs N=1013 RR=1.16 [0.80, 1.17]. (3)Physiological: MDs BP: 6 RCTs N=1155 MD SBP: -1.34mmHg (-2.54, -0.14); MD DBP: −1.40 mmHg (−2.43, −0.37); MDs TC: 5RCTs N=806 MD -2.06 mmol/l (-5.21, 1.09). (4)SMDs for physical activity participation: 5 RCTs N=657 SMD 0.24 (0.08, 0.41).	Low risk

Effect and efficacy of lifestyle interventions as secondary prevention. **Liljehult** 2020	22 (from a total of 29) N = 7273	Adults (>= 18) with 1st or recurrent stroke or TIA	Counselling or educational (individual or group) interventions targeting single/multiple risk factors +/- supervised exercise. Intervention Category: Multi-modal programmes	(1)Physiological e.g. SBP,DBP, SBP<140, HR; lipids, glucose/HbA1c; BMI, weight, waist-hip ratio; (2)Mortality; (3)Recurrent stroke/TIA;	There may be a moderate beneficial effect on blood pressure, especially if the intervention includes supervised physical training	(1) RR for SBP<140: 6 RCTs N=1546, RR: 1.14mmHg [1.03, 1.25]; MD SBP 14 RCTs N=2222, MD −3.85mmHG [−6.43, −1.28]; MD DBP 12 RCTs N=1711, MD : −1.60mmHg [−3.09, −0.11]; MD TC 10 RCTs N=925, MD: −4.25mmol/L [−9.27, 1.22]; MD FBG 2 RCTs N=75, MD: −0.19mmol/L [−0.47, 0.10]; MD HbA1c 2 RCTs N=170, MD : 0.12 [−0.46, 0.70]; MD BMI 4 RCTs N=329, MD: −0.44kg/m2 [−1.38, 0.51]; MD weight 4 RCTs N=175, MD: −0.53kg [−4.09, 3.03]; waist-hip 2 RCTs N=75, MD: 0.0 [−0.04, 0.03 (2) RR of Mortality: 5 RCTs N=4668, (all causes)RR 0.97 [0.58, 1.61]. (3) RR of Recurrent stroke/TIA 4 RCTs N=4330, RR 1.08 [0.78, 1.50]	Low risk

Effectiveness of interventions involving nurses in secondary stroke prevention: A systematic review and meta-analysis. **Parappilly** 2018	16 N = 3568	Adult patients diagnosed with stroke/TIA	Secondary prevention interventions at any time post stroke/TIA where nurses had a primary role in risk factor modification vs usual care/modified usual care. Intervention Category: Education/Behavioural Counselling	(1) Physiological e.g. BP, lipids,HbA1c; (2)Behavioural change e.g. diet, physical activity, medication adherence, smoking cessation, alcohol consumption	Significant effect on reducing systolic blood pressure, diastolic BP, improved physical activity, diet, medication adherence. No effect on smoking cessation or reduction in the use of alcohol.	(1) Physiological SMDs: SMD SBP 7 RCTs N=1941, SMD −0.03mmHg (−0.26, 0.21); SMD DBP 5 RCTs N=1372, SMD 0.22mmHg (−0.20, 0.641); SMD lipids: TC 2 RCTs N=768, SMD -0.11mmol/L (-0.25, 0.04); LDL 2 RCTs N=578, SMD -0.64mmol/L (-1.30, 0.02); HDL 2 RCTs N=604, SMD 0.00mmol/L (-0.16, 0.17); HbA1c 3 RCTs N=809, SMD -0.17mmol/L (-0.59, 0.24). (2) Behaviour change SMDs: Diet 3 RCTs N=393, SMD -0.21(-0.40, -0.02); ORs on number of smokers 6 RCTs N=1592, OR = 1.12 (0.87, 1.45); ORs of Physical inactivity 5 RCTs N=1233, OR = 0.60 (0.37, 0.97); ORs of Alcohol use 3 RCTs N=984, OR=0.89 (0.46, 1.60)	Unclear risk

A Systematic Review and Meta-Analysis on Self-Management for Improving Risk Factor Control in Stroke Patients. **Sakakibara** 2017	14 N = 2303	Adults aged 18yrs and older post stroke/TIA	To improve risk factors in adults aged 18 years and older who have had a stroke/TIA using at least one self-management skill/technique identified as: 1)Setting goals/ planning actions; 2) Using resources; 3)Obtaining feedback on performance; 4) Making decisions; 5) Forming intentions to improve lifestyle behaviours; 6) Problem solving; 7) Self-monitoring. Intervention Category: Self-management	(1) Lifestyle behaviours - physical activity, diet/nutrition, smoking, alcohol, med adherence; (2) Physiological - BP, lipids;	Appears to be effective at improving overall risk factor control; Greatest effect seen on lifestyle behaviour risk factors particularly medication adherence	(1) Behaviour change SMDs: PA 7 RCTs N=730, SMD 0.08 [-0.08, 0.25]; Diet/nutrition 5RCTs N=490, SMD 0.14 [-0.08, 0.36]; Smoking 5RCTs N=533, SMD 0.20 [-0.18, 0.58]; Alcohol 3 RCTs N=138, SMD 0.12 [-0.37, 0.61]; Medication adherence 5 RCTs N=802, SMD 0.31 [0.07, 0.56]; (2) Physiological SMDs: BP 7 RCTs N=1474, SMD -0.16mmHg [-0.43, 0.11]; TC 5 RCTs N=946, SMD -0.06mmol/L [-0.24, 0.12];	Unclear risk
Effectiveness of mindfulness-based stress reduction and mindfulness-based cognitive therapy on depression in poststroke patients-A systematic review and meta-analysis of randomized controlled trials. **Tao** 2022	7 N = 502	Adults > 18 years diagnosed with stroke diseases with or without poststroke depression or mental fatigue	Mindfulness-based stress reduction (MBSR) and Mindfulness-based cognitive therapy (MBCT) interventions versus usual care, waitlist control, no treatment control, patient education with no mindful component on effectiveness in depressed mood poststroke Intervention Category: Psychological therapies	Depression scores	Both MBSR and MBCT significantly improved depressive symptoms in poststroke patients in the stable and acute period, immediately post intervention and up to 3 months follow-up, despite high heterogeneity.	Pooled depression scores: 7 RCTs N=502, SMD -0.93 [-1.34, -0.53] Poststroke depression patients: 4 RCTs N=315, SMD -1.27 [-1.71, -0.84]	Low risk

Effects of peer support interventions on physical and psychosocial outcomes among stroke survivors: A systematic review and meta-analysis. **Wan** 2021	3 (from a total of 11) N = 290	Adults over 18yrs of age, with 1st or recurrent ischaemic or haemorrhagic stroke	Peer led interventions - self management programmes, peer education, peer support, Vs inactive usual care to improve physical and psychosocial outcomes among stroke survivors. (QoL, social participation, physical - ADLs, limb function, not reported here) Intervention Category: Self-management	Depression scores	Peer support interventions could improve psychological (depression, anxiety) outcomes	Depression scores: 3 RCTs N=290, SMD −1.49 [−2.54, −0.44];	Unclear risk
Cognitive behavioral therapy for post-stroke depression: A meta-analysis. **Wang** 2018	23 N = 1972	Patients with post stroke depression diagnosed	CBT +/- antidepressants/placebo Vs attention/routine care or antidepressants alone Intervention Category: Psychological therapies	(1) Change in depression scores; (2) remission & response rates; (3) self-report anxiety	CBT showed positive effects on PSD	(1) SMDs Depression scores: 23 RCTs N=1972, SMD −0.83 [−1.05, −0.60]; CBT alone 7 RCTs N=859, SMD −0.76 [−1.22, −0.29]; CBT +antidepressant 14 RCTs N=970, SMD −0.95 [−1.20, −0.71] (2) RR Remission rates: 6 RCTs N=556, RR 1.76 [1.37, –2.25]; RR Response rates: 6 RCTs N=553) RR = 1.41 [1.22, 1.63]; (3) Anxiety SMDs 5 RCTs N=403, SMD −0.49 [−0.79, −0.19]	Low risk

Key: RCT: randomized control trial; UC: usual care; ROBIS: risk of bias in systematic reviews; ICD: international classification of disease; TIA: transient ischaemic attack; CVD: cardiovascular disease; MI: myocardial infarction; BP: blood pressure; SBP: systolic blood pressure; DBP: diastolic blood pressure; BMI: body mass index; TC: total cholesterol; PA: physical activity; QoL: quality of life; ADL: activities of daily living; RR: risk ratio; OR: odds ratio; MD: mean difference; SMD: standardised mean difference

File S5: GRADE of Evidence supporting interventions with statistically significant effects

Outcome	Systematic review	Intervention category	RCT Studies	N	Effect Estimate	I^2	Quality of evidence (GRADE)	Reasons for down-grade
Mortality and morbidity								
Cardiac events	Lawrence 2015	Multimodal programme	4	4053	OR 0.38 [0.16, 0.88]	0%	⊕⊕⊕◯ Moderate	ROB;
Adherence								
Medication adherence	Parappilly 2018	Education / behavioural counselling	2	238	SMD 0.41 [0.17, 0.65]	0%	⊕◯◯◯ Very Low	ROB; limited data; indirectness
	Sakakibara 2017	Self-management	5	802	SMD 0.31 [0.07, 0.56]	24%	⊕⊕◯◯ Low	ROB; Inconsistencies: v wide CIs; Indirectness
Physiological factors								
SBP	Liljehult 2020	Multimodal programme	14	2222	MD −3.85 [−6.43, −1.28]	53%	⊕⊕◯◯ Low assigned by authors	ROB; indirect outcome measures
	Deijle 2017	Multimodal programme	10	650	MD −3.6mmHg [-5.6, -1.6]	33%	⊕⊕◯◯ Low	Inconsistency; Indirectness (different interventions); Imprecision (small numbers individual studies)
	Lawrence 2015	Multimodal programme	10	1407	MD −4.21mmHg [-6.24, -2.18]	58%	⊕⊕◯◯ Low	ROB; Inconsistency (wide CI); Imprecision (mod heterogeneity);
	Lennon 2014	Multimodal programme	6	1155	MD −1.34mmHg[-2.54 , -0.14mmHg]	80%	⊕⊕◯◯ Low	ROB; Inconsistency; Indirectness

DBP	Liljehult 2020	Multimodal programmes	12	1711	MD −1.60 [−3.09, −0.11]	40%	⨁⨁◯◯ Low assigned by authors	ROB; indirect outcome measures
	Lawrence 2015	Multimodal programmes	10	1407	MD: −2.03 [-3.19, -0.87]	52%	⨁⨁◯◯ Low	ROB; Inconsistency (wide CI); Imprecision (mod heterogeneity);
	Lennon 2014	Multimodal programmes	6	1155	MD −1.40 mmHg [−2.43, −0.37]	91%	⨁⨁◯◯ Low	ROB; Inconsistency; Indirectness
SBP target <140mmHg	Liljehult 2020	Multimodal programmes	6	1546	RR 1.14 [1.03, 1.25]	23%	⨁⨁◯◯ Low assigned by authors	ROB; indirect outcome measures
Cholesterol control (LDLc)	Liljehult 2020	Multimodal programmes	5	1003	SMD −0.23mmol/L [-0.41, -0.05]	36%	⨁⨁◯◯ Low assigned by authors	ROB; indirectness, different interventions
Waist circumference	Lawrence 2015	Multimodal programmes	2	96	MD: −6.69cm [-11.44, -1.93]	0%	⨁⨁◯◯ Low	ROB; limited data
Pooled physiological	Lawrence 2012	Multimodal programmes	2	381	OR 0.87 [0.75, 1.0]		⨁⨁◯◯ Low	ROB; inconsistencies; limited data
Psychological distress								
Remission	Wang 2018	Psychological therapies	6	556	RR = 1.76 [1.37,2.25]	0%	⨁⨁⨁◯ moderate assigned by authors	ROB
Depression diagnosis	Allida 2020	Psychological therapies	6	521	RR 0.77 [0.62, 0.95]	36.16 %	⨁◯◯◯ Very Low (assigned by authors)	ROB; Imprecision
Depression scores	Wang 2018	Psychological therapies	7	859	SMD −0.76 [−1.22, −0.29]	91%	⨁⨁⨁◯ moderate assigned by authors	ROB; high heterogeneity; Large effect increased quality of evidence

	Allida 2020	Psychological therapies	2	189	MD −6.20 [8.24,4.16]	0%	⨁◯◯◯ Very Low (assigned by authors)	ROB; imprecision with very wide Cis
	Jeffares 2021	Multimodal programmes	5	772	SMD 0.15 [0.01, 0.29]	0%	⨁⨁◯◯ Low (assigned by authors)	ROB; indirectness – mixed pops, interventions
	Wan 2021	Self-management	3	290	SMD −1.49 [−2.54,−0.44]	94%	⨁◯◯◯ Very Low	ROB; lack of CI overlap, high heterogeneity; imprecision
	Tao 2022	Psychological therapies	7	502	SMD -0.93 [-1.34, -0.53]	77%	⨁◯◯◯ Very Low assigned by authors	Inconsistency; Imprecision
Anxiety scores	Wang 2018	Psychological therapies	5	403	SMD −0.49 [−0.79, −0.19]	55%	⨁⨁◯◯ Low (assigned by authors)	ROB; serious inconsistency due to heterogeneity
	Jeffares 2021	Multimodal programmes	4	612	SMD 0.29 [0.12, 0.46]	9%	⨁⨁◯◯ Low (assigned by authors)	ROB; indirectness – mixed pops, interventions
	Lawrence 2015 (HADS)	Multimodal programmes	2	143	MD −1.20 [-1.77, -0.63]	85%	⨁⨁◯◯ Low	ROB; heterogeneity, imprecision
Healthy lifestyle								
Physical activity participation	Lennon 2014	Multimodal programme	5	657	SMD 0.24 [0.08, 0.41]	47%	⨁⨁⨁◯ moderate	ROB
	Parappilly 2018	Education / Behavioural counselling	5	1233	OR 0.60 [037, 0.97]	56%	⨁◯◯◯ Very Low	Unclear risk of bias across multiple domains in ROBIS; Poor PEDro scores; intervention differences

Healthy diet	Parappilly 2018	Education / Behavioural counselling	3	425	SMD −0.21 [0.40, 0.02]	33%	⨁⨁◯◯ Low	ROB (fair to good PEDro scores <8/10); Different interventions; Imprecision
Combined lifestyle behaviours	Lawrence 2012	Multimodal programmes	3	581	OR 0.81 [0.68, 0.96]	Not reported	⨁⨁◯◯ Low	ROB; inconsistencies; limited data

GRADE:
⨁⨁⨁⨁ High certainty: true effect lies close to that estimated. Confident
⨁⨁⨁◯ Moderate certainty: true effect is likely to be close to that estimated. Moderately confident
⨁⨁◯◯ Low certainty: true effect may be substantially different from estimated effect. Limited confidence
⨁◯◯◯ Very Low certainty: true effect likely to be substantially different to that estimated. Little confidence

Downgrade of the evidence:
Downgrade of the evidence: ROB: Unclear risk of bias across multiple domains in primary RCTs;
Inconsistencies: widely varying point estimates/ inconsistent direction of effect/ confidence interval overlap/ heterogeneity;
Indirectness: representativeness of population/ timeframe/ comparisons/ limited data;
Imprecision: wide confidence interval/ magnitude of sample/ limited studies;
Publication bias

File S6: Risk of Bias of Primary Studies included in meta-analyses.

Study ID and outcomes			Risk of bias						
Systematic reviews ROB collected and presented from	**Primary study**	**Outcomes reported**	**Random sequence generation (Selection)**	**Allocation concealment (Selection)**	**Blinding of participants and personnel (Performance)**	**Blinding of outcome measure (Detection)**	**Incomplete data (Attrition)**	**Selective reporting**	**Other2**
Lawrence 2015, Liljehult 2020, Deijle 2017	Faulkner 2013	cardiac events, Blood pressure, waist circumference,	low	low	high	low	low	low	low
Lawrence 2015, Liljehult 2020, Deijle 2017	Kono 2013	cardiac events, Blood pressure, cholesterol	low	low	high	low	low	low	unclear
Liljehult 2020, Lawrence 2015, Lawrence 2012, Deijle 2017	McManus 2009	cardiac events, Blood pressure, anxiety	low	low	high	high	low	low	low
Lawrence 2015	Peng 2014	cardiac events	high	high	unclear	unclear	unclear	unclear	unclear
Lawrence 2015, Liljehult 2020, Deijle 2017	Adie 2010	Blood pressure	high	unclear	high	high	low	low	low
Lawrence 2015, Liljehult 2020, Deijle 2017	Chanruengvanich 2006	Blood pressure	unclear	unclear	high	high	low	low	high
Lawrence 2015, Parappilly 2018	Fleming 2013	Blood pressure, waist circumference, physical activity participation	high	unclear	unclear	high	high	high	high
Lawrence 2015, Liljehult 2020, Lennon 2014	Hornnes 2011	Blood pressure	low	unclear	low	high	high	low	low
Lawrence 2015, Liljehult 2020, Lennon 2014	Joubert 2009	Blood pressure, physical activity participation	unclear	high	high	high	high	low	high
Lawrence 2015, Liljehult 2020, Deijle 2017	Kirk 2014	Blood pressure, anxiety	unclear	unclear	high	low	low	low	low
Lawrence 2015	Goldfinger 2012/Negron 2014	Blood pressure	high	unclear	unclear	unclear	unclear	unclear	unclear

Lawrence 2015, Lawrence 2012	Eames 2013	anxiety, medication adherence	low	unclear	high	unclear	low	low	low
Lawrence 2015, Parappilly 2018	Sit 2007	medication adherence, physical activity participation, healthy diet	low	high	low	high	low	high	low
Liljehult 2020, Parappilly 2018	Wan 2016	medication adherence, healthy diet	low	low	high	low	low	low	high
Parappilly 2018, Liljehult 2020	Allen 2009	physical activity participation	low	low	high	low	low	low	high
Lennon 2014, Parappilly 2018	Green 2007	physical activity participation	unclear	low	not reported	low	low	low	not reported
Parappilly 2018	Olalya 2017 (new ROB)	physical activity participation	low	low	unclear	low	low	low	Pedro score 8 reported
Liljehult 2020, Parappilly 2018	Nir 2004	healthy diet	unclear	unclear	high	high	unclear	low	unclear
Liljehult 2020 Sakakibara 2017	Evans-Hudnall 2014	medication adherence	low	low	high	low	low	low	high
Sakakibara 2017, Deijle 2017, Liljehult 2020	Kim 2013	medication adherence, cholesterol	low	unclear	high	high	low	low	high
Sakakibara 2017, Bridgwood 2018	Kronish 2014	medication adherence	low	low	not reported	not reported	low	unclear	low
Sakakibara 2017, Bridgwood 2018	MacKenzie 2013	medication adherence	low	low	not reported	not reported	unclear	low	low
Sakakibara 2017	O'Carroll 2013 (new ROB)	medication adherence	low	unclear	high	unclear	low	low	Pedro score 5 reported
Liljehult 2020	Barker-Collo 2015	Blood pressure	low	low	high	low	high	low	unclear
Liljehult 2020, Deijle 2017	Boss 2014	Blood pressure, cholesterol	high	unclear	unclear	unclear	low	unclear	unclear
Liljehult 2020, Jeffares 2021	Cheng 2018	Blood pressure, cholesterol, depression	low	low	high	low	low	low	low
Liljehult 2020	Holzemer 2011	Blood pressure	low	unclear	high	high	high	unclear	high
Liljehult 2020	Irewall 2015	Blood pressure, cholesterol	low	low	high	high	low	low	low
Liljehult 2020	Joubert 2006	Blood pressure	low	unclear	high	high	unclear	high	high
Lawrence 2015, Deijle 2017	Ellis 2005	Blood pressure, anxiety	low	low	low	high	low	low	low
Deijle 2017, Lennon 2014	Lennon 2008	Blood pressure	low	low	low	low	low	low	low

Deijle 2017	Potempa 1995	Blood pressure	unclear	unclear	unclear	unclear	low	low	low
Deijle 2017	Toledano Zarhi 2011	Blood pressure	unclear	unclear	unclear	unclear	low	low	low
Lennon 2014	Brotons 2011	Blood pressure	low	low	not reported	high	low	low	not reported
Lennon 2014	Maasland 2007	Blood pressure	low	unclear	not reported	low	low	low	not reported
Lennon 2014	van der Ploeg 2007	physical activity participation	high	low	not reported	low	low	low	not reported
Lennon 2014	Gilham 2010	physical activity participation	low	unclear	not reported	low	low	low	not reported
Lennon 2014	Rimmer 2000	physical activity participation	unclear	unclear	not reported	unclear	low	low	not reported
Lennon 2014	Boysen 2009	physical activity participation	low	low	not reported	low	low	low	not reported
Wang 2018	He 2010	depression	unclear	unclear	high	high	low	unclear	unclear
Wang 2018	Tang 2014	depression	unclear	high	high	high	low	unclear	unclear
Wang 2018	Wang 2014	depression	unclear	unclear	high	high	low	unclear	unclear
Wang 2018	Lan 2015	depression	unclear	high	high	high	low	unclear	unclear
Wang 2018	Zhou 2015	depression	unclear	unclear	high	high	low	unclear	unclear
Wang 2018	Ge 2016	depression	low	unclear	high	high	low	unclear	unclear
Wang 2018	Mei 2012	depression	unclear	unclear	high	high	low	unclear	unclear
Wang 2018	Chen 2015	depression	low	unclear	high	high	low	unclear	unclear
Wang 2018	Li 2015	depression	low	unclear	high	high	low	unclear	unclear
Wang 2018	Yuan 2015	depression	unclear	unclear	high	high	low	unclear	unclear
Wang 2018	Gao 2017	depression	low	low	low	high	low	low	unclear
Allida 2020	Watkins 2007	depression	low	high	high	high	low	unclear	low
Allida 2020	Alexopoulus 2012	depression	low	unclear	high	high	unclear	unclear	low
Allida 2020	Kirkness 2017	depression	low	unclear	high	low	high	unclear	low
Allida 2020	Mitchell 2009	depression	low	unclear	high	low	high	high	low
Allida 2020	Fang 2017	depression	low	high	high	low	high	unclear	unclear
Jeffares 2021	Shi 2017	depression	unclear	not reported	unclear	high	high	unclear	not reported
Jeffares 2021	Matz 2015	depression	low	not reported	low	high	low	low	not reported
Jeffares 2021	Ihle-Hansen 2014	depression	unclear	not reported	low	low	low	low	not reported

Jeffares 2021	Lund 2012	depression	low	not reported	unclear	high	unclear	low	not reported
Wan 2021	Cadillac 2011	depression	unclear	not reported	unclear	low	high	low	not reported
Wan 2021	Min 2018	depression	unclear	not reported	unclear	unclear	low	unclear	not reported
Wan 2021	Zhang 2016	depression	unclear	not reported	unclear	high	low	unclear	not reported
Tao 2022	Baldo 2021	depression	low	low	high	low	low	low	low
Tao 2022	Johansson 2012	depression	unclear	low	high	high	low	low	low
Tao 2022	Xu 2015	depression	low	unclear	high	unclear	low	unclear	high
Tao 2022	Wang 2020	depression	low	unclear	high	unclear	high	low	unclear
Tao 2022	Huang 2017	depression	low	unclear	high	unclear	low	unclear	high
Tao 2022	Xue 2020	depression	low	unclear	high	unclear	low	unclear	high
Tao 2022	Zhang 2015	depression	unclear	unclear	high	unclear	low	unclear	high