A systematic review and meta-analysis on self-management for improving risk factor control in stroke patients

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Abstract

Purpose—The aim of this review was to describe the self-management interventions used to improve risk factor control in stroke patients, and quantitatively assess their effects on: 1) overall risk factor control from lifestyle behaviour (i.e. physical activity, diet and nutrition, stress management, smoking, alcohol, and medication adherence), and medical risk factors (i.e. blood pressure, cholesterol, blood glucose); and 2) individual risk factors (e.g. physical activity, blood pressure, cholesterol).

Methods—We systematically searched the PubMed, PsycINFO, CINAHL, and Cochrane Database of Systematic Reviews databases to September 2015 to identify relevant randomized controlled trials investigating self-management to improve stroke risk factors. The self-management interventions were qualitatively described, and the data included in meta-analyses.

Results—Fourteen studies were included for review. The model estimating an effect averaged across all stroke risk factors was not significant, but became significant when four low quality studies were removed (SMD = 0.10 [95% CI = 0.02 to 0.17], $I^2 = 0\%$, $p=0.01$). Subgroup analyses revealed a significant effect of self-management interventions on lifestyle behaviour risk factors (SMD = 0.15 [95% CI = 0.04 to 0.25], $I^2 = 0\%$, $p=0.007$) but not medical risk factors. Medication adherence was the only individual risk factor that self-management interventions significantly improved (SMD = 0.31 [95% CI = 0.07 to 0.56], $I^2 = 0\%$, $p=0.01$).

Conclusions—Self-management interventions appear to be effective at improving overall risk factor control, however, more high quality research is needed to corroborate this observation. Self-

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Compliance with Ethical Standards

Conflict of Interest: BMS declares that he has no conflict of interest. AJK declares that she has no conflict of interest. JJE declares that she has no conflict of interest.

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent: Informed consent was obtained from all individual participants included in the study.

management has a greater effect on lifestyle behaviour risk factors than medical risk factors, with the largest effect at improving medication adherence.

Keywords

Meta-analysis; Chronic Disease; Stroke; Risk Factors; Self-management; Secondary Prevention

Introduction

Stroke is the second leading cause of death worldwide, and a leading cause of acquired disability in adults [1–2]. In the United States, 795,000 people experience a stroke each year [3]. Previous stroke is a major risk factor for having another stroke. It is estimated that 18% [4] to 30% [5] of individuals who have had a stroke will have another stroke within 5 years of the initial event. In fact, 25% of the annual number of strokes reported in the United States are recurrent events [6]. Secondary strokes are associated with higher mortality rates, greater levels of disability, and increased costs relative to initial events [4]. The aging population combined with reduced stroke mortality suggests an increasing prevalence of individuals surviving a stroke, and thus importance of secondary prevention [3].

Stroke risk factors are related to both medical conditions (e.g. hypertension, high cholesterol, and high blood glucose leading to diabetes), and lifestyle behaviours (e.g. physical inactivity, poor diet, smoking, and high alcohol consumption) [7]. The INTERSTROKE study of 3000 cases identified ten medical conditions and lifestyle behaviour factors associated with 90% of the risk of stroke [7]. The authors concluded that targeted interventions that reduce blood pressure and smoking, and promote physical activity and a healthy diet could substantially reduce the burden of stroke [7]. Modification of lifestyle behaviours is therefore paramount for stroke prevention [7–9].

Stroke prevention is highly influenced by lifestyle behaviours which suggests that individuals have a large degree of control in developing their own preventative habits. However, despite knowledge of the number of recurrent events and the importance of healthy lifestyle behaviours to manage stroke risk factors, evidence shows that many individuals continue with behaviours and have health conditions that may have contributed to the stroke in the first place. For example, 70% of stroke survivors have hypertension [9], 77% have impaired glucose tolerance or type 2 diabetes mellitus [10], and 18 to 44% are obese [11]. In addition, individuals with stroke are not physically active, 40% report non-adherence to medication regimens [12], and many have unhealthy dietary patterns [13].

Secondary prevention efforts to change lifestyle behaviours and sustain those changes over time are warranted. Active, self-management interventions can engage people in the process of their health-related behavior change [14–15]. Self-management refers to the individual's ability to manage the symptoms, treatment, physical and psychosocial consequences and lifestyle changes inherent in living with a chronic condition [16]. These programs are shown to have better outcomes relative to passive interventions in which the means for lifestyle behaviour change is simply via education and information sharing [17]. A key reason for the success of self-management programs is that they empower individuals to manage and control their lifestyle behaviours over time. By establishing key self-management skills (e.g.

goal setting; decision making; self-monitoring) [14–15], and emphasizing the use of these skills, individuals are more likely to sustain healthy lifestyle behaviour changes [18] after the program has ended than individuals who lack self-management skills.

A recent Cochrane review meta-analyzed results from studies investigating both educational and behavioural interventions for the secondary prevention of stroke [19]. Although the authors found that the interventions were not associated with clear differences in any of the review outcomes [19], the conclusions are limited in that the resulting pooled effect was derived using evidence from both behavioural and passive educational programs. The findings therefore do not provide a clear picture of the independent effect of active, lifestyle behavioural interventions. No review has specifically examined self-management interventions to improve or manage stroke risk factors. Therefore, questions remain as to what interventional research exists in this area, and the effects of such interventions at controlling and managing stroke risk factors.

The purpose of this review is to describe the self-management interventions, and quantitatively assess their effects on: 1) overall risk factor control; and 2) individual risk factors (physical activity, diet and nutrition, stress management, smoking, alcohol, medication adherence, blood pressure, cholesterol, blood glucose).

Methods

The reporting in this review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines [20].

Inclusion/exclusion criteria

Randomized controlled trials (RCT) were included for review if they involved a self-management intervention to improve risk factors in adults (aged 18 years and older) who have had a stroke or transient ischemic attack (TIA). Studies were only included if the intervention required active involvement of the study participants to improve their lifestyle behaviours using at least one of the key self-management skills/techniques of: 1) setting goals/planning actions; 2) using resources; 3) obtaining feedback on performance; 4) making decisions; 5) forming intentions to improve lifestyle behaviours; 6) solving problems; and/or 7) self-monitoring [14–15]. Additional inclusion criteria were: clear definition of intervention and control treatments; published in a peer-reviewed journal and written in English; and baseline and post-intervention data. Studies were excluded if they were comparing two or more self-management interventions without a control group, and if more than half of the study sample included individuals without a stroke diagnosis, or if the study did not report results specific to the individuals who have had a stroke.

Information sources/Search

The Pubmed, CINAHL, and PsycInfo electronic databases were searched for relevant literature published up until September 2015 using the search strategy detailed in Appendix A. No limits were placed on the electronic search.

The Cochrane Database of Systematic Reviews in addition to the electronic databases were searched for relevant reviews on self-management and secondary prevention in individuals with stroke. The reference lists of all relevant papers and reviews were searched for additional studies.

Study selection

All titles from the electronic search were screened for eligibility by two study authors. Papers with relevant titles were imported into Refworks [21], an online reference managing system. After removing duplicate titles, all abstracts were reviewed by the same study authors. The full papers of those studies of interest were read by the first author to determine their final eligibility. Additional papers of interest found in reference lists were obtained and also read to determine eligibility.

Data collection process/Data items

Data from eligible studies were extracted by the second author and tabulated for comparison. Extracted data included author, year, country, sample size and characteristics, details of the intervention and control programs, outcome measures, measurement time points, and key results (including recurrent event rates). The first and second authors assessed the methodological quality (e.g. randomization, blinding, intention-to-treat) of each study using the 11-item Physiotherapy Evidence Database (PEDro) scale [22–23]. PEDro scores range from 0 to 10, and scores less than 6 are considered to have low methodological quality, as per the PEDro database statistics [22]. Discrepancies in scores were resolved through discussion.

Meta-analyses

Studies reporting continuous data were meta-analyzed using the standardized mean difference (SMD) [24]. The SMD is used as a summary statistic in meta-analysis when different studies assess the same outcome but measure it using different instruments [24]. In such instances, it is necessary to standardize the results of the studies before they can be combined. The SMD is the effect size in each study (i.e. difference between the intervention and control group) relative to the variability observed in that study [24]. If medians and ranges or interquartiles were reported, we converted them to means and standard deviations [25]. A negative SMD indicated that the control group experienced a greater change in the outcome than the intervention group. Cohen offers the following guidelines for interpreting the magnitude of the SMD: small = 0.2; medium = 0.5; and large = 0.8 [26]. Pooled odds ratios (OR) for dichotomous data were estimated using the Mantel-Haenszel method [27].

When different studies measured the same risk factor using different scales (i.e. continuous or dichotomous), we performed two separate meta-analyses, and combined the results using a generic inverse variance meta-analysis [24]. We converted ORs to SMDs using the formula $((3/\pi)\ln(\text{OR}))$ [28]. The OR 95% confidence intervals (CI) were converted to SMD 95% CIs using the formulas $(\ln(\text{lower limit}))$ for the lower limit, and $(\ln(\text{upper limit}))$ for the upper limit [24]. To perform a generic inverse variance meta-analysis, the SMD 95% CIs were then converted to standard errors using the formula $(\text{upper limit} - \text{lower limit})/3.92$ [24] and entered into Review Manager 5.3 (Review Manager 5.3) for analysis. If CIs and p-

values were reported but not standard deviations, we estimated the standard deviations using Review Manager 5.3 [29]. We estimated an effect size averaged across all risk factors also using a generic inverse variance meta-analysis [24]. A sensitivity analysis was performed excluding studies with low methodological quality (i.e. PEDro < 6).

Two subgroup analyses were performed. The first was to estimate an effect size averaged across the lifestyle behavioural risk factors (i.e. physical activity, diet and nutrition, stress management, smoking, alcohol, and medication adherence), because the primary purpose of self-management interventions is to change behaviour. The second estimated an effect size averaged across the medical risk factors (i.e. blood pressure, cholesterol, blood glucose).

Study authors were contacted for information if data for meta-analyses were missing. Fixed effect models were used if the statistical heterogeneity, quantified using the I^2 , was less than 50% [30]. Random effect models were used for all other cases. The primary meta-analyses estimated the effects immediately following completion of the intervention. All meta-analyses were performed using Review Manager 5.3 [29].

Results

Fourteen studies were included for review as shown in Figure 1. Overall, the sample sizes ranged between 36 [31] and 600 [32]. Included studies were from the United Kingdom [33–37], United States [32, 38–39], Canada [40–41], Thailand [42], South Korea [31], and Israel [43]. One multinational study was also included [44]. The PEDro scores of the 14 studies ranged from 5 [35, 37, 41–42] to 8 [32, 34, 44].

Each of the studies reported on at least one relevant risk factor: physical activity, $n = 7$ [31, 33, 35, 38–40, 44]; diet and nutrition, $n = 5$ [31, 35, 39, 40, 43]; smoking, $n = 5$ [31, 33, 34, 39, 40]; alcohol, $n = 2$ [35, 39]; medication adherence, $n = 5$ [28, 31, 36–37, 39]; blood pressure, $n = 7$ [32–34, 36–37, 41–42]; cholesterol, $n = 5$ [31–34, 42]; glucose, $n = 1$ [34]. No studies reported on stress management.

Three studies reported on recurrent stroke or TIA events [36, 41, 44]. Although in all three studies there were no differences between the groups, recurrent event rate was not the primary objective of the studies, nor were they powered for this variable.

Although several studies each reported on more than one stroke risk factor, nine interventions had a focus on self-management for lifestyle behaviours in general [31–35, 38–40, 43], two interventions had a specific focus on self-management for physical activity [42–44], two interventions had a focus on blood pressure [36, 41], and one on medication adherence [37].

The most common self-management techniques used in the interventions were feedback on performance ($n = 13$), goal setting/action planning ($n = 12$), resource utilization ($n = 8$), and problem solving ($n = 6$). The number of techniques used in each of the 14 interventions ranged between two and six (median of three techniques). The duration and number of sessions ranged between 2 weeks [37] and 24 months [44], and 2 [37, 40] to 13 [42]

sessions, respectively. The mean length of each individual session ranged between 38.5 and 73 minutes.

In seven studies, the interventions were administered in-person [32, 34, 36–37, 40, 43–44], six on an individual basis [34, 36–37, 43–45], one using a group format [32], and one using both individual and group formats [40]. Three studies delivered the intervention via telehealth, using a telephone [33, 38] or the internet [31], and four studies used a combination of both in-person and telehealth delivery [35, 39, 41–42]. Three studies used an attention control group [37–38, 44], one study used a 1-year wait list control [32], and the 10 other studies utilized usual care [31, 33–36, 39, 40–43].

The number of studies reporting on a single outcome ranged from one (blood glucose) [34] to seven (physical activity [31, 33, 35, 38–40, 44] and blood pressure [32–34, 36–37, 41–42]). The sample sizes used in the meta-analyses ranged from 138 (alcohol consumption) to 1474 (blood pressure). The number of studies and sample sizes for each outcome are presented in Table 4a. Study details are presented in Table 1.

Meta-analyses: Effect size by risk factor

The effects of self-management on each of the lifestyle behaviour and medical risk factors are presented in Tables 2a to 2g. The effect on glucose from the single study is shown in Table 3a.

The only risk factor that self-management had a significant effect on was medication adherence (SMD = 0.31 [95% CI = 0.07 to 0.56], $I^2 = 0\%$, $p = 0.01$), as shown in Table 2e.

Meta-analyses: Overall effect size

A total of 5305 observations from 14 studies were used to estimate the effect of the self-management interventions averaged across all stroke risk factors. The inverse variance meta-analysis model was not significant, as shown in Table 3a (SMD = 0.06 [95% CI = -0.02 to 0.14], $I^2 = 25\%$, $p = 0.15$).

Sensitivity analysis—After removing four studies with low methodological quality [35, 37, 41–42], a total of 4703 observations resulted in a significant effect averaged across the risk factors favouring the intervention group, as shown in Table 3b (SMD = 0.10 [95% CI = 0.02 to 0.17], $I^2 = 0\%$, $p = 0.01$).

Subgroup analysis—Our meta-analysis estimating the effect of self-management interventions on only the lifestyle behaviour risk factors resulted in a significant effect (SMD = 0.15 [95% CI = 0.04 to 0.25], $I^2 = 0\%$, $p = 0.007$), as shown in Table 4a. Conversely, the medical risk factor model was not significant (SMD = -0.07 [95% CI = -0.20 to 0.06], $I^2 = 0\%$, $p = 0.29$) as shown in Table 4b.

Discussion

This review estimated the effect of self-management interventions focusing on goal setting/ action planning, resource utilization, feedback on performance, decision making, intention

formation, problem solving and/or, self-monitoring at improving risk factor control in stroke patients. After removing studies with low methodological quality, meta-analysis of 10 studies revealed a statistically significant effect of self-management interventions averaged across eight lifestyle behaviour and medical stroke risk factors.

Importantly, our results also demonstrate that self-management interventions have a significant effect averaged across the lifestyle behaviour stroke risk factors. A primary purpose of self-management interventions is to facilitate better management of the symptoms, and lifestyle behaviour changes inherent in living with chronic conditions [16], and therefore our findings are consistent with the hypothesized purpose of self-management support programs. Contrary to these findings, the effect of self-management on medical risk factors was not significant. The efficacy of lifestyle modification at improving blood pressure [46–47] and glucose control [48], as well as lowering cholesterol [49] is well established. A path in which lifestyle behaviour modification precedes changes to medical conditions is thus implied and represents a plausible explanation as to why a significant effect was observed on lifestyle behaviour but not medical risk factors. The length of time after which positive changes to lifestyle behaviours result in significant effects on hypertension, glucose tolerance, and cholesterol levels is an area for future study.

Interestingly, interventions in nine studies [31–35, 38–40, 43] had a focus on risk reduction in general. These interventions follow the paradigm that because unhealthy lifestyle behaviours cluster together [50–51], interventions to reduce overall risk are more relevant and beneficial than individual approaches [51–53]. For example, research shows that 99% of smokers have additional unhealthy lifestyle behaviour such as unhealthy diet, alcohol consumption, or insufficient physical activity [50–51]. Moreover, evidence in the heart disease literature speaks to the benefits of multi-modal interventions focusing on diet, exercise, and stress management at improving coronary risk and psychosocial factors [52].

At the individual risk factor level, our results show that self-management interventions have a significant effect at improving medication adherence. This is an important finding because studies consistently show medication adherence to be suboptimal within the stroke population [33, 54–55]. Evidence shows that 25% of stroke patients discontinue one or more of their prescriptions at just 3 months post-discharge [54], and that overall adherence to stroke medication maybe less than 50% [56]. This is despite evidence that medication adherence contributes to risk reduction [57], and guidelines that recommend antiplatelet therapy and reduction of both blood pressure and cholesterol levels for secondary prevention [8–9]. Moreover, according to several studies [7] and national guidelines [8–9], the treatment of hypertension is an important intervention for secondary prevention of ischemic stroke. In fact, the American Heart/Stroke Association has stated that a reduction in stroke recurrence is associated with an average lowering of blood pressure by 10mm Hg systolic/5 mm Hg diastolic [9]. Therefore, that self-management interventions improve medication adherence in individuals who have had a stroke is an important finding of this review.

Knowledge of self-management for improving risk factor control in stroke patients is currently limited to only a few high quality randomized controlled trials. Therefore, the findings in this review should be interpreted with caution. Several other limitations of this

review are noteworthy. First, there was heterogeneity in the study protocols. Many studies used different instruments to measure the lifestyle behaviour outcomes, several of which have yet to be validated. As well, the duration of the interventions, and length, number, and administration of sessions varied by study. Furthermore, the number and types of self-management skills used in each intervention lacked consistency. Despite this, the statistical heterogeneity was within an acceptable range to combine data, and each intervention included for review helped to develop self-management skills that have previously been shown to be effective at changing lifestyle behaviour. Second, our meta-analyses were on the immediate effects after the end of the interventions. However, at present there is insufficient follow-up data to meta-analyze longer-term retention on any risk factor (i.e. three studies report follow-up data for blood pressure, two studies for physical activity, and one study for each of cholesterol, diet and nutrition, and medication adherence). Thus, future research should include follow-up data collection and report on the longer-term retention of the effect of self-management interventions. Next, two studies [33, 44] required conversion of the data from medians and interquartile ranges to means and standard deviations, and several studies required conversion of ORs to SMDs to estimate the effect sizes. Conversion of data and effect sizes has the potential to increase error, especially in studies with small sample sizes, due to the use of mathematical formulas that only provide conversion estimates. Finally, our review only included studies published in English, and therefore, some relevant literature published in other languages may have been excluded.

Conclusion

This review produced mixed findings regarding the effectiveness of stroke self-management interventions at improving risk factor control in individuals with stroke. At the individual risk factor level, self-management interventions were shown to be effective at improving medication adherence. However, self-management interventions appear to help to reduce the risk of stroke at the overall level, and specifically for the lifestyle behaviour risk factors, however, more high quality research is warranted to corroborate these observations.

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Appendix A: Search strategy

((((((((((randomized controlled trial) OR rct) OR clinical trial) OR randomized clinical trial) OR prospective controlled trial) OR randomized comparative trial)))) AND
 (((((((secondary prevention) OR lifestyle) OR behaviour change) OR physical activity) OR diet) OR nutrition) OR stress) OR smoking) OR hypertension) OR blood pressure) OR waist to hip ratio) OR bmi) OR blood glucose) OR diabetes) OR alcohol) OR cholesterol)))) AND
 (((((((self management) OR chronic disease management) OR chronic disease self management) OR self-management support) OR self regulation) OR self monitoring))))
 AND (((((((stroke) OR transient ischemic attack) OR neurological condition) OR neurological disease) OR ischemic stroke) OR hemorrhagic stroke) OR lacunar stroke))))).

Figure 1.

Selection process of studies examining the effect of self-management programs on stroke risk factor control

Table 1

Study characteristics

Author; Year; Country; Sample size; Pedro Score; Intention to Treat (ITT)	Sample Characteristics	Intervention duration and frequency	Self-management skills	Outcome Measures	Measurement timepoints
Adie and James 2010 [33] England n = 56 Pedro score = 6	Intervention (n=29): Mean age (sd) = 73.6 (8.0) years; Male = 12; Stroke = 15; TIA = 14 Control (n=27): Mean age (sd) = 71.2 (9.7) years; Male = 16; Stroke = 17; TIA = 10	Four 20 minute telephone sessions (after 7–10 days, and 1, 3, and 4 months) with a researcher.	- Goal setting/action planning - Resource utilization - Feedback	- Physical activity (minutes/week) - Self-reported smoking status - 12 hour systolic and diastolic blood pressure - Total cholesterol	Baseline and 6 months
Boysen et al. 2009 [44] Denmark, China, Poland, Estonia n = 276 Pedro score = 8	Intervention (n=133): Median age (IQR) = 69.7 (60.0–77.7) years; Male = 89; Stroke = 157; Education 13 years = 33; Smoker = 49 Control (n=143): Median age (IQR) = 69.4 (59.6–75.8) years; Male = 88; Stroke = 157; Education 13 years = 21	Six 20 minutes in-person sessions with a physiotherapist or neurologist over 2 years	- Goal setting/action planning - Resource utilization - Feedback - Decision making	- Physical activity scale for the elderly (PASE) - Systolic and diastolic blood pressure - Total cholesterol	Baseline, 3, 6, 9, 12, 18, and 24 months
Chanruengvanich et al. 2006 [42] n = 62 Pedro score = 5	Intervention (n=31): Mean age (sd) = 62.8 (7.4) years; Male = 10; Education > highschool = 11 Control (n=31): Mean age (sd) = 63.2 (7.1) years; Male = 10; Education > highschool = 18	Three in-person sessions, and 10 telephone sessions with a researcher over 13-weeks.	- Goal setting/action planning - Feedback - Intention formation - Problem solving - Self-monitoring	- Systolic and diastolic blood pressure - Total cholesterol	Baseline, and 6 and 12 weeks
Damush et al. 2011 [38] USA n = 63 Pedro score = 7	Intervention (n=30): Mean age (sd) = 67.3 (12.4) years; Male = 30 Control (n=33): Mean (sd) age = 64.0 (8.4) years; Male = 32	Six 20 minute telephone session with a nurse, a physician assistant, or a researcher over 3 months.	- Goal setting/action planning - Resource utilization - Feedback - Problem solving - Self-monitoring	- Minutes of exercise during the past week	Baseline, 3 and 6 months
Ellis et al. 2005 [34] Scotland n = 192 Pedro score = 8	Intervention (n=100): Mean age (95% CI) = 64.3 (62.4–66.4) years; Male = 54; Stroke = 71; TIA = 29 Control (n=105): Mean age (95% CI) = 65.8 (64.0–67.5) years; Male = 52; Stroke = 78; TIA = 27	Three 30 minute outpatient consultations with a Stroke Nurse Specialist over 3 months.	- Goal setting/action planning - Resource utilization - Feedback	- Self-reported number of cigarettes per day - Systolic and diastolic blood pressure - Random blood glucose - HbA1C - Total cholesterol	Baseline and 5 months
Evans-Hudnall et al. 2014 [39] USA n = 52 Pedro score = 6	Intervention (n=27): Mean age (sd): 56.0 (9.9) years; Male = 16; Education highschool = 18 Control (n=25): Mean age (sd): 49.7 (10.7) years; Male = 16; Education highschool = 21	Three 30–45 minute sessions with a health educator over 4 weeks Session 1 in-person; sessions 2–3 via phone.	- Goal setting/action planning - Resource utilization - Feedback - Decision making - Problem solving - Self-monitoring	Questions from the US Behavioral Surveillance Survey on: - Medication adherence - Alcohol consumption - Smoking - Number of fruit and vegetable servings	Baseline and 4 weeks

Author; Year; Country; Sample size; Pedro Score; Intention to Treat (ITT)	Sample Characteristics	Intervention duration and frequency	Self-management skills	Outcome Measures	Measurement timepoints
				- Minutes of moderate physical activity	
Gillham and Endacott 2010 [35] England n = 50 Pedro score = 5	Intervention (n=25): Mean age (sd) = 67.7 (12.0) years Control (n=25): Mean age (sd) = 68.9(13.2) years	One in-person session and two follow-up telephone calls at 2 weeks and 6 weeks after the initial interview.	- Goal setting/action planning - Feedback	- Weekly number of 20 minute exercise sessions - Weekly portions of fruit and vegetables - Weekly alcohol servings	Baseline and 3 months
Green et al. 2007 [40] Canada n = 197 Pedro score = 7	Intervention (n=97): Mean age (sd) = 66.3 (12.4) years; Males = 56; Education >highschool = 93 Control (n=100): Mean age (sd) = 67.2 (12.4) years; Males = 59; Education >highschool = 97	One 15–20 minute in-person session with a nurse. One 3-hour group session, one to two months after the initial visit.	- Goal setting/action planning - Decision making - Problem solving	Shift from passive to active stage of change in: - Physical activity - Diet - Smoking	Baseline and 3 months
Kim et al. 2013 [31] South Korea n = 36 Pedro score = 7	Intervention (n=18): Mean age (sd) = 67.4 (7.3) years; Males = 13; Education >middleschool = 11 Control (n=18): Mean age (sd) = 63.9 (7.4) years; Males = 10; Education >middleschool = 10	Completion of 9 web-based modules in 9 weeks.	- Resource utilization - Feedback	- Single question on medication adherence - Self-report smoking status (yes/no) - Self-report consumption of fruits and vegetables, and alcohol	Baseline and 3 months
Kronish et al. 2014 [32] USA n = 600 Pedro score = 8	Intervention (n=301): Mean age (sd) = 63 (11.0) years; Males = 181; Education >highschool = 208 Control (n=299): Mean age (sd) = 64 (11.0) years; Male = 123; Education >highschool = 209	Six, 90 minute peer-led, community-based, group (8–10 people) sessions over 6 weeks.	- Goal setting/action planning - Resource utilization - Feedback - Problem solving	- 8-item Morisky Medication Adherence Scale - Systolic and Diastolic blood pressure - LDL cholesterol	Baseline and 6 months
Mackenzie et al. 2013 [41] Canada n = 56 Pedro score = 5	Total sample (n = 56): Older than 65 years = 33; Male = 38; Stroke = 36; TIA = 20; Education < 9 years = 9	One in-person assessment with a stroke physician. Six monthly telephone calls with a nurse.	- Goal setting/action planning - Feedback - Self-monitoring	- Self-report number of missed pills (weekly) - Systolic and diastolic blood pressure	Baseline and 6 months
McManus et al. 2014 [36] n = 450 Pedro score = 6	Intervention (n=220): Mean age (sd) = 69.3 (9.3) years; Male = 166; Education > highschool = 192 Control (n=230): Mean age (sd) = 69.6 (9.7) years; Male = 164; Education > highschool = 184	2 to 3 one-hour sessions to train participants to self-monitor. One session with family doctor.	- Resource utilization - Feedback - Self-monitoring	- Systolic and diastolic blood pressure	Baseline, and 6 and 12 months
Nir et al. 2004 [43] Israel n = 155 Pedro score = 6	Intervention (n=73): Mean age (sd) = 72.3 (6.8) years; Males = 38; Mean education years (sd) = 8.6 (4.9) Control (n=82): Mean age (sd) = 73.8 (7.6) years; Males = 42; Mean education years (sd) = 8.5 (4.8)	Twelve 1–2 hour in-person sessions with a trained nursing student.	- Goal setting/action planning - Feedback	- Self-report dietary habits	Baseline, 3 and 6 months

Author; Year; Country; Sample size; Pedro Score; Intention to Treat (ITT)	Sample Characteristics	Intervention duration and frequency	Self-management skills	Outcome Measures	Measurement timepoints
O'Carroll et al. 2013 [37] Scotland n = 58 Pedro score = 5	Intervention (n=29); Mean age (sd) = 68.4 (11.3) years; Male = 20; Stroke = 20; TIA = 9 Control (n=29); Mean age (sd) = 70.7 (10.5) years; Male = 17; Stroke = 15; TIA = 14	Two 30–45 minute in- person sessions with a trained researcher over 2 weeks.	- Goal setting/action planning - Feedback - Intention formation - Problem solving	- Medication Events Monitoring System (MEMS) – a pill bottle that electronically records openings. - Systolic and diastolic blood pressure	1, 2, and 3 months

Table 2

Effect size by stroke risk factor

a. Physical activity					Standardized Mean Difference, Fixed 95% CI	
Risk factor	N	Std error	Weight (%)			
Adie 2010 [33]	56	0.27	10.1		0.23 [-0.30, 0.76]	
Boyson 2009 [44]	276	0.12	51.2		0.03 [-0.21, 0.27]	
Damush 2011 [38]	63	0.25	11.8		0.11 [-0.38, 0.60]	
Evans-Hudnall 2013 [39]	52	0.28	9.4		-0.11 [0.66, 0.44]	
Gillham 2010 [35]	50	0.29	8.8		0.42 [-0.15, 0.99]	
Green 2007 [40]	197	0.30	8.2		-0.05 [-0.64, 0.54]	
Kim 2013 [31]	36	1.14	0.6		1.81 [-0.42, 4.04]	
Total:	730		100		0.08 [-0.08, 0.25]	
Heterogeneity $\text{Chi}^2 = 4.82$, $df = 6$ ($P = 0.57$); $I^2 = 0\%$ Test for overall effect: $Z = 0.98$ ($P = 0.33$)						
b. Diet and nutrition					Standardized Mean Difference, Fixed 95% CI	
Risk factor	N	Std error	Weight (%)			
Evans-Hudnall 2013 [39]	52	0.28	15.5		-0.06 [-0.61, 0.49]	
Gillham 2010 [35]	50	0.28	15.5		0.57 [0.02, 1.12]	
Green 2007 [40]	197	0.33	11.1		0.08 [-0.57, 0.73]	
Kim 2013 [31]	36	0.34	10.5		0.41 [-0.26, 1.08]	
Nir 2004 [43]	155	0.16	47.4		0.02 [-0.29, 0.33]	
Total:	490		100		0.14 [-0.08, 0.36]	
Heterogeneity $\text{Chi}^2 = 4.09$, $df = 4$ ($P = 0.39$); $I^2 = 2\%$ Test for overall effect: $Z = 1.27$ ($P = 0.20$)

Note: We analyzed the effect averaged across both diastolic and systolic blood pressures. In doing so, we first derived an estimate of effect on each type of blood pressure using study data. We then combined the two independent estimates to obtain an averaged effect, as shown in the table.

Table 3a

Effect size averaged across stroke risk factors (14 studies):

Risk factor	Studies	N	Std error	Weight (%)	Standardized Mean Difference, Fixed 95% CI	
Alcohol	31, 35, 39	138	0.25	2.9	0.12	[-0.37, 0.61]
Blood Pressure	32–34, 36–37, 41–42	1474	0.14	9.1	-0.16	[-0.43, 0.11]
Cholesterol	31–34, 42	946	0.09	22.0	-0.06	[-0.24, 0.12]
Diet and nutrition	31, 35, 39–40, 43	490	0.11	14.7	0.14	[-0.08, 0.36]
Glucose	34	192	0.15	7.9	0.00	[-0.29, 0.29]
Medication adherence	31–32, 37, 39, 41	802	0.13	10.6	0.31	[0.06, 0.56]
Physical activity	31, 33, 35, 38–40, 44	730	0.08	27.9	0.08	[-0.08, 0.24]
Smoking	31, 33–34, 39–40	533	0.19	4.9	0.20	[-0.17, 0.57]
	Total:	5305		100	0.06	[-0.02, 0.14]
Heterogeneity $\text{Chi}^2 = 9.30$, $\text{df} = 7$ ($P = 0.23$); $I^2 = 25\%$						
Test for overall effect: $Z = 1.45$ ($P = 0.15$)

Table 3b

Sensitivity analysis averaged across stroke risk factors (10 studies):

Risk factor	Studies	N	Std error	Weight (%)	Standardized Mean Difference, Fixed 95% CI	
Alcohol	31, 39	88	0.54	0.5	0.50 [-0.56, 1.56]	
Blood Pressure	32-34, 36	1298	0.06	40.5	0.17 [0.05, 0.29]	
Cholesterol	31-34	884	0.10	14.6	-0.04 [-0.24, 0.16]	
Diet and nutrition	31, 39, 40, 43	440	0.12	10.1	0.06 [-0.18, 0.30]	
Glucose	34	192	0.15	6.5	0.00 [-0.29, 0.29]	
Medication adherence	31-32, 39	688	0.16	5.7	0.13 [-0.18, 0.44]	
Physical activity	31, 33, 38-40, 44	680	0.09	18.0	0.05 [-0.13, 0.23]	
Smoking	31, 33-34, 39-40	533	0.19	4.0	0.20 [-0.17, 0.57]	
	Total:	4703		100	0.10 [0.02, 0.17]	
Heterogeneity $\text{Chi}^2 = 5.04$, $\text{df} = 7$ ($P=0.66$); $I^2 = 0\%$ Test for overall effect: $Z = 2.52$ ($P = 0.01$)						

Table 4a

Subgroup analyses – Effect size averaged across lifestyle behaviour risk factors:

Risk factor	Studies	N	Std error	Weight (%)	Standardized Mean Difference, Fixed 95% CI	
Alcohol	31, 35, 39	138	0.25	4.7	0.12	[-0.37, 0.61]
Diet and nutrition	31, 35, 39–40, 43	490	0.11	24.2	0.14	[-0.08, 0.36]
Medication adherence	31–32, 37, 39, 41	802	0.13	17.3	0.31	[0.06, 0.56]
Physical activity	31, 33, 35, 38–40, 44	730	0.08	45.7	0.08	[-0.08, 0.24]
Smoking	31, 33–34, 39–40	533	0.19	8.1	0.20	[-0.17, 0.57]
	Total:	2693		100	0.15	[0.04, 0.25]
Heterogeneity $\text{Chi}^2 = 2.37$, $\text{df} = 4$ ($P = 0.67$); $I^2 = 0\%$ Test for overall effect: $Z = 2.70$ ($P = 0.007$)

Table 4b

Subgroup analyses – Effect size averaged across medical risk factors:

Risk factor	Studies	N	Std error	Weight (%)	Standardized Mean Difference, Fixed 95% CI
Blood Pressure	32–34, 36–37, 41–42	1474	0.14	23.3	–0.16 [–0.43, 0.11]
Cholesterol	31–34, 42	946	0.09	56.4	–0.06 [–0.24, 0.12]
Glucose	34	192	0.15	20.3	0.00 [–0.29, 0.29]
	Total:	2612		100	–0.07 [–0.20, 0.06]
Heterogeneity $\text{Chi}^2 = 0.64$, $\text{df} = 2$ ($P = 0.73$); $I^2 = 0\%$ Test for overall effect: $Z = 1.05$ ($P = 0.29$)