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A Meta-Review of Lifestyle Interventions for Cardiovascular Risk Factors in the General Medical Population: Lessons for Individuals With Serious Mental Illness

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ABSTRACT

Objective: Individuals with serious mental illness die years younger than members of the general population, with cardiovascular disease and related risk factors accounting for the majority of deaths. Lifestyle interventions targeting these risk factors have begun to be developed for those with serious mental illness, but they have largely been created de novo rather than with information from work already done in the general population. This review aims to synthesize for a mental health audience the common factors for success in nonpharmacologic lifestyle interventions and identify specific considerations in adapting these models for those with serious mental illness.

Data Sources: We searched the PubMed and Cochrane databases for English-language reviews from 2003 to 2013. The search employed combinations of the following terms: *diabetes*, *diabetes mellitus*, *hypertension*, *hyperlipidemia*, *dyslipidemia*, *obesity*, *mental illness*, *schizophrenia*, *psychosis*, *bipolar disorder*, *lifestyle intervention*, *nonpharmacologic intervention*, *lifestyle modification*, and *weight gain*.

Study Selection: We identified 8,147 review articles from the PubMed and Cochrane databases. 123 articles were selected. The selected articles were reviews of dietary, behavioral, or exercise interventions that focused on obesity and related cardiometabolic risk factors.

Data Extraction: We undertook a qualitative "review of reviews" focusing on nonpharmacologic interventions for obesity and related cardiometabolic risk factors.

Results: Effects of interventions in the general population were meaningful but generally modest. Specific elements of diet, exercise, and behavioral therapy produced larger effects. Additionally, successful programs employed multiple components, personalization, longer duration, more frequent contact, and trained treatment providers. Interventions addressing these risk factors in people with serious mental illness typically incorporated some, but not all, of the elements demonstrated to be effective in general medical populations.

Conclusions: Studies from the general medical literature demonstrate considerable promise in addressing lifestyle risk factors. Existing programs will require tailoring to address the needs of those with serious mental illness and may be harder to implement given the challenges faced by this population. However, successful lifestyle interventions for those with serious mental illness can make a significant impact on the health and well-being of this vulnerable population and may inform future strategies for other underserved groups.

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Despite advances in therapy over the past decades, cardiovascular disease (CVD) remains the major cause of death in most developed nations, including the United States.[1] Certain groups are more vulnerable to CVD, including those with serious mental illness (SMI). This is most likely due to the heavy burden of risk factors in this population, with elevated rates of tobacco use, metabolic syndrome, obesity, and diabetes. Those with SMI often lead sedentary lives and eat more saturated fat and fewer fruits and vegetables than the general population. Medications used to treat mental illness, particularly the atypical antipsychotics, also contribute to weight gain, hyperlipidemia, and glucose dysregulation.[2] Mentally ill individuals die, on average, 8.2 years earlier than members of the general population.[3] Cardiovascular disease and its associated metabolic risk factors are a large contributor to early mortality.[4–6]

Lifestyle interventions that target diet, exercise, and behavior are a major part of the prevention and treatment of obesity and related comorbidities. Such interventions are beginning to be developed for those with SMI. Generally, these have been created de novo rather than as adaptations or implementations of existing models. However, extensive data have already been gathered regarding lifestyle modifications in the general population, and this information may be applicable to people with mental illness. This review aims to demonstrate for a mental health audience the common factors for success in nonpharmacologic lifestyle interventions and identify specific considerations in adapting these models for those with SMI. It will also discuss potential future research with an aim of building on the existing research base.

METHOD

Given the extensive number of studies completed on lifestyle interventions for obesity and related comorbidities, we undertook a "review of reviews," focusing on review articles of nonpharmacologic interventions for obesity, diabetes, dyslipidemia, and hypertension. We followed the methodology described by Smith et al,[7] synthesizing evidence from multiple review articles.

We searched the PubMed and Cochrane databases for English-language reviews from 2003 to 2013. The search employed combinations of the following terms: *cardiovascular*, *diabetes*, *hypertension*, *hyperlipidemia*,

Clinical Points

- Lifestyle interventions have a great potential to impact cardiometabolic risk factors in individuals with serious mental illness.
- A vast number of studies have been done on lifestyle interventions in the general population, and key elements to improving outcomes have been identified. Some, but not all, of these elements have been applied in creating interventions for individuals with serious mental illness.
- Incorporating these key elements into interventions for those with serious mental illness will require consideration of the specific challenges faced by this population.

dyslipidemia, *obesity*, *lifestyle intervention*, *non-pharmacologic intervention*, and *lifestyle modification*. English-language review articles from 2003 to 2013 were also retrieved using combinations of the search terms *mental illness*, *schizophrenia*, *psychosis*, *bipolar disorder*, *lifestyle intervention*, *lifestyle modification*, *non-pharmacologic intervention*, and *weight gain*. Further resources were identified by hand searches of the reference sections of the articles selected for inclusion.

Articles that were considered for inclusion were reviews of lifestyle interventions for cardiovascular risk factors, including obesity, diabetes, dyslipidemia, and hypertension. Lifestyle interventions included dietary modification, increase in physical activity, or cognitive and behavioral therapy. Interventions were done in the general population or in individuals with SMI. Serious mental illness was defined by a diagnosis of schizophrenia and other psychotic disorders, bipolar disorder, or major depression with psychotic features. Articles that did not define specific psychiatric diagnoses of participants but focused on individuals with SMI or severe and persistent mental illness were also included. Outcomes of included articles were change in weight or body mass index; emergence of diabetes; change in hemoglobin A_{1c} or fasting blood glucose; change in total cholesterol, low-density lipoprotein (LDL), triglycerides, or high-density lipoprotein (HDL); and change in systolic or diastolic blood pressure. In order to gather the largest amount of information, accepted articles included qualitative or narrative reviews in addition to meta-analyses and systematic reviews.

Excluded were articles that provided commentary or proposed guidelines rather than describing specific interventions; articles whose main focus was pharmacologic or surgical intervention; articles that described specific populations, such as the elderly or pregnant women; interventions that consisted of nutritional supplements or complementary and alternative medicine; interventions that had a narrow rather than a general focus, such as the reduction of dietary carbohydrates or adding sweet potatoes to diet; and reviews of 2 or fewer studies.

We classified the strength of evidence of the included reviews using the approach used by Kirk et al,[8] adapted from the Canadian Best Practice Initiative Methodology Background Paper. This method classifies systematic reviews (with or without meta-analysis) as the most rigorous for developing effective clinical recommendations (level 1). Nonsystematic reviews, including narrative reviews, are classified as suitable for developing promising clinical recommendations (level 2).[8]

RESULTS

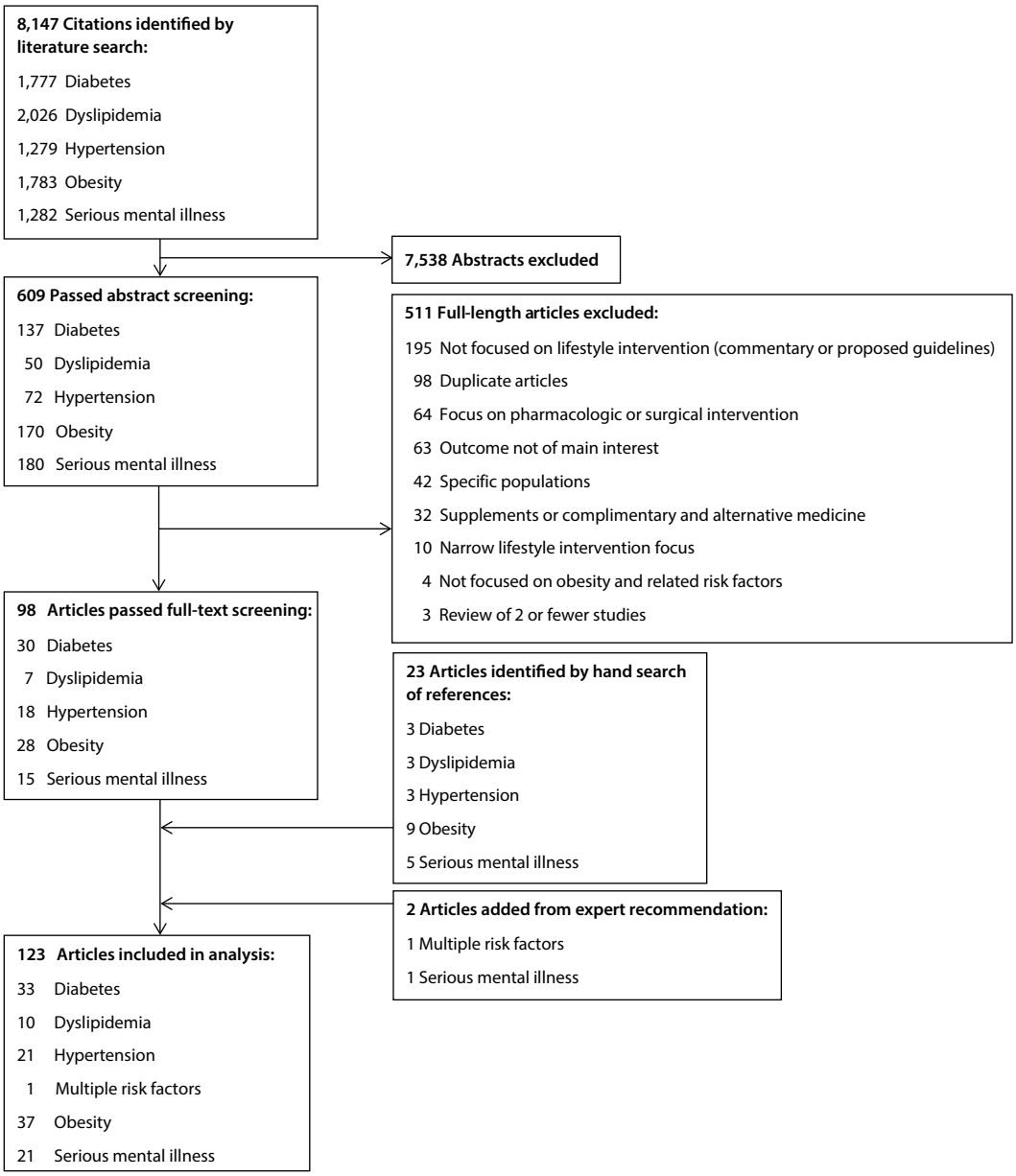
Figure 1 shows the flow of articles through the literature search and screening process. We identified 8,147 review articles from the PubMed and Cochrane databases. We examined the titles and abstracts and obtained full articles for any that appeared relevant. Two reviewers independently screened full-text articles for eligibility. They were not blinded to information such as authors or journal titles. Disagreements were resolved through consensus. Bibliographies of the selected articles were then scanned for further resources. We selected 102 reviews on lifestyle interventions in the general population and 21 reviews on lifestyle interventions in people with SMI. A total of 64 articles were systematic reviews (including meta-analyses), and 69 articles were narrative reviews. Supplementary eTable 1 (available at Psychiatrist.com) includes a complete description of the selected articles. All of the selected articles were considered in the analysis. However, a common core of studies was often analyzed in the selected articles, and thus there was a large overlap of information provided. Hence, not every selected review is described in detail in this article.

Interventions targeted single or multiple lifestyle components, focusing on diet, exercise, and behavioral change. Control groups generally received usual care. Participants received information through printed material, online resources, individual counseling, and group sessions. Interventions were staged in health care clinics and in community settings such as churches and workplaces. Physicians and other allied health professionals, dietitians, community health workers, lay educators, personal trainers, and peers all delivered the interventions. Interdisciplinary teams were common.[9,10]

Weight loss was the outcome most frequently studied.[11] Effects on weight were generally modest. Results of 2 systematic reviews found a weighted mean difference of −0.2 to −11.5 kg, with a maximum of 2 years of lifestyle intervention for weight loss when compared with controls.[9,12] At 1-year follow-up of interventions lasting 8 weeks to 1 year, systematic reviews (including 2 meta-analyses) found a weight loss of 1.4 to 6.7 kg.[13–15] In their Cochrane review of psychological interventions for weight loss, Shaw et al[16] found a weighted mean difference of −2.5 kg at less than 1-year follow-up (intervention duration 7 weeks to 6 months) for subjects receiving behavioral therapy compared to controls. At 6 months, Thomas et al[17] found a weighted mean difference of −1.1 kg for computer-based interventions compared to usual care and Wieland et al[18] found a mean difference of −1.5 kg for low glycemic index diets compared to other diets.

Multiple outcomes were studied with regard to diabetes, including fasting blood glucose and hemoglobin A_{1c}. However, the most commonly reported parameter was risk of

Figure 1. Literature Search Flow Diagram



disease emergence. In those with impaired glucose tolerance, incidence of progression to diabetes is approximately 11% per year.[19] One meta-analysis found a pooled hazard ratio of 0.51 (95% CI, 0.44–0.60) for developing diabetes in the lifestyle intervention arm compared to standard advice.[20] The Cochrane Collaboration later found that exercise and diet resulted in a pooled relative risk of 0.63 (95% CI, 0.49–0.79) for developing diabetes when compared to standard advice.[21]

Hypertension was another outcome focused on in the interventions. Systematic reviews[21,22] have found that dietary and exercise modifications have an overall modest impact on blood pressure, with a weighted mean decrease of approximately 4–5 mm Hg systolic and 2–4.6 mm Hg diastolic blood pressure when compared with standard recommendations.

Strict dietary modification (in controlled feeding studies) had a significant effect on lipids, with short-term decreases of approximately 7%–9% in total cholesterol and 10%–20% in LDL.[23] Effects were not as impressive in diet and exercise studies targeting weight loss and diabetes. The Cochrane Collaboration found no statistically significant changes in total cholesterol, LDL, or HDL with diet and exercise for preventing diabetes, though they did find a small decrease in triglycerides.[21]

Intermediate outcomes examining changes in behavior were also documented, though less frequently than the objective clinical data discussed above. These outcomes

Table 1. Key Elements in Lifestyle Interventions for Obesity and Related Risk Factors

Element	Level of Evidence (adapted from the Canadian Best Practice Initiative Methodology Background Paper)[a]
Diet	
Caloric restriction is more important than macronutrient content for weight loss	Level 2
Diets that are low in cholesterol, total fat, and saturated fats lower total cholesterol and LDL	Level 1
The Portfolio diet has shown a reduction in LDL that is similar to statins	Level 2
Decreasing sodium intake lowers blood pressure	Level 1
The DASH diet lowers blood pressure and lipids	Level 2
The OmniHeart diet lowers blood pressure and lipids	Level 2
The Mediterranean diet has beneficial effects on weight, blood pressure, lipids, and blood sugar	Level 2
Diabetes risk is decreased by intake of fiber and complex carbohydrates	Level 1
Exercise	
Weight loss is proportional to duration of activity and amount of exertion	Level 2
Duration of exercise correlates with improvement in lipids	Level 1
The amount of physical activity required to lower blood pressure is controversial	Level 1
Cognitive-behavioral therapy (CBT)	
Successful strategies include goal setting, self-monitoring, structured curricula, and increasing self-efficacy	Level 2
Other key elements	
The use of multiple components (diet, exercise, and CBT) improves outcomes	Level 1
Personalization improves outcomes	Level 1
Duration of at least 4 months of active intervention is associated with greater success	Level 2
Higher-intensity programs show better results than lower-intensity programs	Level 2
Multidisciplinary treatment teams are associated with more significant outcomes	Level 2
Training of program leaders increases effect size	Level 2
Face-to-face interventions are more efficacious than virtual meetings	Level 1

[a]Level 1 equals systematic reviews (with or without meta-analysis). Level 2 equals nonsystematic reviews, including narrative reviews.
Abbreviations: DASH = dietary approach to stopping hypertension, LDL = low-density lipoprotein.

include alterations in dietary and exercise patterns. Behavioral modification occurred at higher rates with lifestyle interventions than in control groups.[24] Several groups correlated behavioral change with the clinical outcomes discussed above, providing a link between the effects of the intervention and the desired reduction in cardiovascular risk factors.[11,25,26]

Lifestyle Modifications in the General Population: What Works?

Across studies, several factors were associated with a greater impact on outcomes. Specific elements of diet, exercise, and behavioral therapy have been shown to be superior. Additionally, successful programs employ multiple components, personalization, longer duration, more frequent contact, and trained treatment providers. Table 1 illustrates a summary of key elements in lifestyle interventions in the general population, including strength of evidence.

Diet

Dietary change is a core element of lifestyle modification. Many interventions provide dietary advice or education on healthy food choices meant to improve dietary habits.[27] Some programs also demonstrate methods of improving diet; examples include visits to grocery stores and cooking demonstrations.[28,29] A smaller number of studies provide meal replacements.[9]

Although there has been considerable debate about the best diet for weight loss, total macronutrient content appears to be less important than overall caloric restriction.[30] The effect of specific diets on other cardiovascular risk factors is more straightforward. Beneficial changes in lipids (including lower total cholesterol and LDL) predictably occur with diets that are low in cholesterol, total fat, and saturated fats.[23] The Portfolio diet, a plant-based diet that is low in saturated fat and cholesterol, has shown a similar reduction in LDL cholesterol to statin drugs.[31] Lower sodium intake decreases blood pressure. Reductions in both blood pressure and lipids can be achieved through the DASH (Dietary Approach to Stopping Hypertension) diet, which is rich in fruits, vegetables, and low-fat dairy, and is reduced in fats and cholesterol.[32,33] Replacing the carbohydrates of the DASH diet with protein and unsaturated fats (as in the OmniHeart diet) further decreases both blood pressure and lipids.[32,34] The Mediterranean diet (DASH diet plus garlic and increased omega-3 fatty acids) has also been shown to have a beneficial effect on lipids, blood pressure, and weight.[31,35] Additionally, the Mediterranean diet has been associated with decreased development of diabetes.[36] Diabetes risk is also decreased by eating fiber and complex carbohydrates (particularly those with low glycemic index.)[17,37]

Exercise

Exercise is another key nonpharmacologic intervention. Many programs follow the recommendation from the Centers for Disease Control and Prevention that adults exercise at moderate intensity for 30 minutes a day, most days of the week.[38] In the majority of studies, walking is the most commonly recommended physical activity, although other aerobic activities (such as biking) and resistance training are also employed.[39–41]

For improvement in most cardiometabolic risk factors, the type of exercise performed is less important than the amount of physical activity. Weight loss is proportional to duration of activity and amount of exertion. Engaging in less than 150 minutes of exercise per week has little impact on weight, while 150 minutes or more per week results in 2 to 3 kg of weight loss; exercising 225 to 420 minutes per week results in 5 to 7.5 kg of weight loss.[42] This conclusion is supported by Ross et al,[43] who surmised that daily exercise of at least 45 to 60 minutes is needed for weight loss. Duration of exercise also correlates with improvements in lipid profiles. Studies consistently indicate that increasing amounts of exercise boost HDL, with a 2007 meta-analysis by Kodama et al[31] showing that every 10-minute prolongation per workout raises HDL cholesterol by 1.4 mg/dL.

The amount of physical activity required to lower blood pressure is more controversial. A 2007 meta-analysis[44] showed that exercise frequency and intensity did not have an observed effect on the magnitude of blood pressure response. However, a more recent systematic review[45] on walking cites more favorable results with moderate- to high-intensity regimens, showing that exercising at higher maximal oxygen consumption or heart rate improves the magnitude and duration of changes in systolic blood pressure.

Cognitive-Behavioral Therapy

Cognitive-behavioral therapy (CBT) is the third essential piece in constructing a lifestyle intervention. Cognitive therapy aims to increase awareness of thoughts and examine their impact on emotion and behavior. Behavioral therapy employs a set of strategies to develop desirable actions and decrease undesirable actions. Although behavioral modification is more commonly employed than cognitive therapy in lifestyle interventions, both strategies are associated with outcomes of larger magnitude.[11,46] Increasing the number of strategies employed improves results; favorable outcomes are linked to studies that use 2 or more elements.[11] Specific CBT strategies include goal setting, self-monitoring of food intake and physical activity, and use of structured curricula.[11,47,48] Successful programs typically focus on improving self-efficacy, patients' perception of their ability to manage their health behaviors.[11]

Multiple Components

As stated above, dietary modification, exercise, and CBT are 3 key elements to creating a successful lifestyle intervention. Some interventions focus on just 1 of these components. However, programs utilizing all 3 elements lead to greater risk factor modification. This has been consistently demonstrated in programs targeting obesity, where many reviews document that multicomponent interventions are better at inducing total weight loss.[8] The Cochrane Collaboration also found that CBT, combined with diet and exercise, resulted in a weighted mean difference of 4.9 kg lost when compared to diet and exercise alone.[16]

Additive effects are also seen for multicomponent interventions targeting other cardiovascular risk factors. When exercise is combined with dietary changes, lipid profiles improve substantially, with incremental decline in LDL and total cholesterol levels.[23] Furthermore, a recent systematic review[40] of diabetes prevention studies reports that combined dietary and physical activity interventions (rather than those that target diet or exercise alone) have been shown to be most effective.

Personalization

Personalization of diet and exercise regimens increases patient participation and improves outcomes. Practitioners may tailor dietary interventions by addressing food preferences, occupation, family environment, and social support. When compared with groups receiving generic nutrition advice, those with personalized diet plans significantly increased the amount of fruit and vegetables ingested and decreased the percentage of calories consumed from fat.[24]

Duration of Treatment

Sufficient duration of treatment is another essential factor. A recent review[11] on cardiovascular risk factor reduction from the American Heart Association noted that most successful interventions targeting diet and exercise have an active phase of at least 4 months. Likewise, Venditti and Kramer[49] state that a 4- to 6- month initial intensive phase is a crucial component in lifestyle interventions targeting diabetes risk. Interventions that specifically address obesity display greater effects with longer duration, with improved outcomes seen in weight loss programs that are at least 6 months in duration.[8,50] Finally, interventions that target blood pressure correlate successful outcomes with length of treatment.[45]

Frequency of Contact

The frequency of patient contact, independent of the length of treatment, is an important factor in changing metabolic risk. A meta-analysis[51] of 17 interventions targeting diabetes prevention showed an increase of 0.26% total body weight loss for each additional lifestyle session attended. The Cochrane Collaboration noted a weighted mean difference of 2.3 kg lost when comparing high-intensity to low-intensity behavioral regimes.[16]

Treatment Providers and Location of Intervention

Interventions have employed a wide variety of treatment providers, including physicians, psychologists, nurses, nutritionists, educators, exercise specialists, and lay persons. Most interventions have been done outside of the doctor's office and are led by nonphysicians.[11] The reason for this practice may be the high cost of physician services and the relative lack of physician time to provide interventions. In-office, doctor-led counseling may also not be a very effective treatment. In fact, many positive lifestyle interventions done outside of the doctor's office actually use physician advice as the control.[11]

Some debate remains on whether other types of health care professionals may be superior to lay persons. Increasing

data support the use of peer community providers, who may be able to tailor messages to the unique needs and culture of their population. Outcomes appear to be most significant, however, when multidisciplinary teams include both professionals and lay leaders.[11] Regardless of whether providers are health care professionals or not, data suggest that experience and training of program leaders can influence the effect size.[49]

For all types of providers, face-to-face interactions have consistently shown greater efficacy than virtual meetings. A 2012 analysis[18] by the Cochrane Collaboration demonstrated that computer-based interventions resulted in significantly less weight loss at 6 months than in-person programs. Data from diabetes prevention programs reinforce that the relationship formed in face-to-face meetings is crucial to success.[49]

Applying General Lifestyle Interventions to People With SMI

All of these key elements have been shown to impact the success of lifestyle interventions in the general population; their use in interventions for individuals with SMI is likely to be associated with success in reducing cardiovascular risk. However, previous lifestyle interventions in patients with persistent mental illness have not consistently included these key elements. For example, higher intensity exercise has been shown to increase weight loss and improve lipid profiles.[31,42] Yet many interventions in SMI specifically target low-intensity exercise to improve adherence.[52] Additionally, numerous interventions in SMI lack structured curricula. Two systematic reviews[10,53] note that manualized interventions were rarely employed. Gierisch et al[54] also report in their meta-analysis that the majority of behavioral interventions for weight gain in SMI did not use manualized interventions. In addition, reviews[52,55] of interventions in individuals with SMI show that, as in the general population, single-component programs are less effective than those employing multiple components (exercise, diet, and behavioral modification). Yet interventions in SMI often fail to employ multiple components. Of the 11 studies included in the analysis by Alvarez-Jimenez et al,[56] only 1 included multiple components. Moreover, group sessions are commonly used in interventions in SMI.[57] In addition to being cost-effective, group experiences may be beneficial for decreasing social isolation in this population.[57] However, the use of a group format may decrease the ability to tailor interventions to an individual's needs. Furthermore, interventions in SMI are frequently of shorter duration than is recommended for success in the general population. For example, a systematic review of lifestyle interventions in psychosis by Bonfioli et al[58] noted a mean duration of 18 weeks, and a meta-analysis by Faulkner et al[59] on interventions to reduce weight in schizophrenia included trials of 12 to 16 weeks in duration. Many interventions in SMI also use lower-intensity interventions, with less than weekly contact in some studies.[60] Furthermore, Bonfioli et al[58] show that, in lifestyle interventions in SMI, individual treatment providers are employed more often than interdisciplinary teams, and these providers often do not have specific training.

The omission of these key elements in many lifestyle interventions in SMI may partially explain why their magnitude of effect does not equal that in the general population. One systematic review[10] on nonpharmacologic interventions in those with SMI states that mean weight loss in randomized controlled trials is 1.6 kg (95% CI, 0.3 to 2.9 kg) compared to 3.6 to 5 kg in the general population. This is supported by other systematic reviews. Alvarez-Jiménez et al[56] report a weighted mean difference of −2.56 kg (95% CI, −3.20 to −1.92) in reduction in body weight for nonpharmacologic interventions in individuals taking atypical antipsychotic compared with treatment as usual. Furthermore, a systemic review by Verhaeghe et al[61] shows a weighted average weight change of −1.96 kg (95% CI, −0.12 to −3.80) in individuals with SMI with lifestyle intervention. Additionally, Bonfioli et al[58] report a weight loss of 3.12% of initial weight in individuals with psychosis after lifestyle intervention; they observe that this is below the 5%–10% weight loss deemed sufficient to effect cardiometabolic risk.

Despite these outcomes, evidence exists that improvement in metabolic risk factors is possible in those with SMI; one review cautions against the "adoption of a nihilistic stance that perceives change as too difficult to warrant intervention."[55(p508)] In fact, several reviews show more promising results. For example, Gabriele et al[60] report a mean weight loss of 4.24 kg in individuals on atypical antipsychotics participating in behavioral interventions lasting 6 months. Additionally, a recent review[54] by the Agency for Healthcare Research and Quality, analyzing a broad array of nonpharmacologic interventions to address cardiovascular risk factors in adults with SMI, found that, compared with controls, behavioral interventions in persons with SMI resulted in a mean difference in weight of −3.13 kg (95% CI, −4.21 to −2.05). Notably, a recent randomized trial[62] of an intensive weight-loss intervention based in psychiatric rehabilitation facilities that incorporated many of the key evidence-based features resulted in weight loss of comparable magnitude to that seen in general populations.

Areas to Address in Adapting Existing Programs

While incorporating key features demonstrated to be effective in general medical programs is important for addressing cardiovascular risk factors in people with SMI, it is also critical to take into account the unique challenges faced by this population. Interventions need to be tailored to address factors including this population's low socioeconomic status, psychiatric symptoms, barriers to accessing healthy lifestyle options, and medication side effects.

Socioeconomic Status

People with SMI disproportionately suffer from poverty.[63] Because of this, certain resources for exercise (such as gym memberships or athletic clothing and shoes) may not be available. Additionally, those with low income often live in areas where the environment is less safe, so exercising

outdoors may not be a viable option. A review by Lowe and Lubos[53] discussed circumventing this by having participants walk up and down the stairs in their residence. Other options include distributing exercise videos or handouts, or, when economically feasible, providing gym memberships. Multiple reviews[64,65] report that providing YMCA memberships is an effective intervention. In-clinic exercise sessions may also overcome economic barriers to physical activity. For example, Bradshaw et al[66] discuss the use of in-clinic stationary bicycles, and Roberts and Bailey[65] report the use of in-clinic treadmills. Furthermore, free local resources, such as senior centers, may be investigated as potential sites for fitness activities. Kemp et al[57] also suggest that outdoor recreational activities in small groups may have the added benefit of social connectedness, and these activities could be staged in public spaces such as parks.

Poverty is also associated with poor diet; those with lower income generally eat fewer fruits, vegetables, and whole grain products than recommended.[67] This is partially due to limited access.[68] While providing groceries and meal replacements may temporarily address this problem, long-term change requires realistically accounting for food availability and preferences. Successful interventions have employed shopping trips to local grocery stores to demonstrate healthy options among available choices.[10,66] Additional strategies include taking participants out to nearby restaurants to help with food selection (as discussed by Bradshaw et al[66]) and obtaining menus from local fast food restaurants and highlighting healthy choices. Finally, Ganguli[69] focuses on reduction of food intake rather than complicated or expensive food substitution.

Access to Lifestyle Interventions

Many with SMI are unable to afford transportation to medical clinics or other sites offering lifestyle interventions.[70,71] A review by Galletly and Murray[72] supports problem-solving around this when meeting with intervention participants. When feasible, lifestyle modification programs may offer rides, bus or train fare, or public transit vouchers. Additionally, sessions may be held in locations that are convenient to participants. Lifestyle modification programs involving other underserved populations (such as ethnic minorities) have successfully held meetings in community centers, local schools, and churches.[73–75]

Psychiatric Symptoms and Cognitive Impairment

Psychiatric symptoms may interfere with consistent treatment. Uncontrolled symptoms often lead to chaotic lifestyles. Frequent relocations, illness relapse, and hospitalization have all been cited as causes of attrition in lifestyle modification programs.[65] Symptoms may also interfere with patients establishing a therapeutic alliance with providers.[76,77] This lack of alliance may be circumvented by incorporating lifestyle interventions into visits with established case managers and other known psychiatric providers.[55] Kemp et al[57] also demonstrate that use of a peer leader may help to overcome patient mistrust of providers.

Amotivation is often prominent in schizophrenia and major depression. Because of this, those with SMI may have decreased participation in program tasks and increased dropout rates. One way to target lack of motivation is the use of group settings, where example, encouragement, and competition may decrease attrition.[65] Additionally, the use of incentives increases participation and has been shown to improve outcomes.[64] Incentives include objects that promote health; Kemp et al[57] discuss the use of pedometers or blood glucose logs as incentives. Furthermore, the engagement of friends and family in lifestyle interventions may improve motivation. For example, the use of a "buddy scheme" has been shown to be an incentive for behavioral change.[65] In other underserved populations (including African Americans and Latinos), family involvement has been associated with greater response to lifestyle interventions.[78] Finally, facilitator engagement with participants has been shown to improve motivation.[65] Facilitators may call patients the night before appointments to ensure participant commitment in coming to sessions.

Additionally, patients with SMI often face cognitive impairment. Neuropsychiatric testing in this population reveals deficits in memory, executive function, attention, and processing speed. Baseline impairment is most severe in those with psychotic disorders, though deficits are still marked in those with bipolar and major depressive disorders.[79] To improve initial comprehension, language can be simplified and large font sizes used in printed materials. To overcome low literacy rates, instructors can read aloud and employ more visual materials. Improved retention can be targeted through the use of educational games, lesson repetition, frequent quizzes, and integration of mnemonic devices into modules.[10]

Medication Side Effects

Side effects of psychotropic medications may also need to be addressed when formulating lifestyle interventions for those with SMI. Antipsychotics, mood stabilizers, and some antidepressants impose significant sedation. This may make exercise difficult and could inhibit attention during educational groups. To offset this, activities can be timed for early morning, before medications are taken, or later in the day, when sedating effects have worn off.

Additionally, weight gain occurs with many psychotropic medications, particularly the atypical neuroleptics. Medications used to treat affective disorders, including mood stabilizers and antidepressants, also have an effect on body mass index. To combat this, lifestyle interventions may be initiated when first prescribing these medications. Physicians may choose to counsel patients on the likelihood of increased appetite and weight gain and provide education on diet and exercise options. Referral to other health professionals, such as dieticians, may also help to attenuate these effects.

DISCUSSION

The findings from this review demonstrate an extensive literature on lifestyle modification for cardiovascular risk

factors, including obesity. Hundreds (if not thousands) of programs have been developed for the general population. Specific elements of these programs are associated with improved outcomes. Higher intensity exercise and certain diets, such as the Mediterranean diet, lead to greater reduction in metabolic risk factors. Additionally, the use of goal setting, self-monitoring, structured curricula, and exercises that build self-efficacy are associated with greater effects. Other key elements in lifestyle interventions include the use of multiple components, tailoring, longer duration, higher intensity, the use of multidisciplinary treatment teams, training of program leaders, and face-to-face interventions.

The mental health literature has incorporated some, but not all, of these elements into lifestyle interventions for individuals with SMI. This is most likely due, in part, to the challenges commonly faced by this population. Negative symptoms and medication side effects may make high-intensity exercise or frequent clinic visits improbable, and perhaps patient adherence is increased by advocating for lower-intensity programs. Sequelae of other psychiatric symptoms, such as chaotic lifestyles and hospitalizations, may also interfere with completion of long-duration lifestyle interventions. Additionally, adherence to specific diets may be impeded by low socioeconomic status, and a focus on reduced caloric content may be more practical. The dearth of available resources in community mental health settings may also make it challenging to provide quality training to program directors or to spare multiple providers to participate in multidisciplinary treatment teams.

Thus, though successful lifestyle interventions in the general population may inform the creation of programs for those with SMI, addressing the unique needs of these patients is also an important step in program development. Intensive and multifactorial programs may be necessary to combat symptoms of mental illness, and creative solutions to socioeconomic limitations are essential.

Although the efforts of health care practitioners in designing and implementing lifestyle modifications are crucial, successful modification of metabolic abnormalities in patients with SMI will also require environmental and policy support. Promotion of health requires change in food advertising and labeling, education about nutrition and exercise, and improvement in urban planning. Longstanding change for individuals with SMI will also require hospitals, psychiatric facilities, and supported housing to overhaul practices and encourage healthy living.[55]

Despite the clinical applicability of our findings, several limitations should be noted. First, because our search was limited to the last decade, review articles on cardiometabolic risk factors that were published prior to 2003 were not directly accessed. However, these reviews covered articles dating back more than 45 years, and a hand search of reference sections was done to ensure that influential publications were not ignored. Second, we searched solely PubMed and the Cochrane Collaboration databases, and it is possible that we omitted a source listed elsewhere. Furthermore, we limited our search to English-language articles and may have missed reviews published in other languages. Additionally, while a broad inclusion strategy was chosen to optimize generalizability, there was significant heterogeneity across studies, including duration, treatment provider, and program format. Finally, it is likely that data from individual studies was used more than once in different reviews, which may have given undue weight to those studies.

Despite these limitations, there is still much to be learned from this examination of the general medical literature on lifestyle interventions, and its applicability to designing effective interventions in individuals with SMI. Because of the challenges faced by individuals with persistent mental illness, implementing lifestyle modifications may be difficult. However, successful interventions for those with SMI can make a significant impact on the health and well-being of this vulnerable population and may inform future strategies for other underserved groups.

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Supplementary material follows this article.

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Supplementary Material

Article Title: A Meta-Review of Lifestyle Interventions for Cardiovascular Risk Factors in the General Medical Population: Lessons for Individuals With Serious Mental Illness

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List of Supplementary Material for the article

1. **eTable 1** Description of Included Articles

Disclaimer

This Supplementary Material has been provided by the author(s) as an enhancement to the published article. It has been approved by peer review; however, it has undergone neither editing nor formatting by in-house editorial staff. The material is presented in the manner supplied by the author.

Supplementary eTable 1: Description of Included Articles

Diabetes Mellitus
Systematic Reviews

Author, year	Type of Review	Aim	Inclusion Criteria	Number Studies	Intervention Description/ Duration	Outcomes
Ali et al, 2012	Meta-analysis	Review studies that adapted the Diabetes Prevention Program trial's lifestyle intervention and to examine which program features influenced weight loss	Intervention studies; participants are adults age 18 years or older at high risk for diabetes mellitus; study documents pre- and post-intervention weights	28 studies (derived from 26 publications): 4 RCTs, 2 cluster RCTs, 20 single group pre-post studies, and 2 nonrandomized controlled studies	Lifestyle modification counseling Duration at least 9 months	The average weight loss of real-life programs, similar to the Diabetes Prevention Program, was about 4 percent from the participant's baseline weight at twelve months. Programs with media-assisted interventions (DVD and online) had results of weight loss similar to in-person interventions, but had lower attrition rates.
Baker et al, 2011	Systematic review	Review the behavioral change strategies for type 2 diabetes mellitus prevention programs	RCTs; participants include adults at risk of diabetes mellitus type 2; interventions include nutrition or exercise training	7 studies	Exercise training, physical activity, and/or nutritional intervention Unclear duration	Each of the studies included showed efficacy in preventing or delaying the development of diabetes mellitus type 2, although there was a small to moderate effect size seen in physical activity levels and weight loss. Asti Diabetes Prevention Program (Italy) and Vasterbotten Intervention Program (Sweden) had the highest relative risk.
Cardona-Morrell et al, 2010	Systematic review and Meta-analysis	Examine whether lifestyle interventions delivered to high risk adult patients in routine clinical care setting are feasible and effective in reducing diabetes risk	RCTs , cohort studies, and interrupted time series ; aim of diabetes risk reduction or diabetes prevention; intervention conducted in a routine clinical setting and administered by	12 studies included in review, 4 studies included in meta-analysis	Nutrition, physical activity, medication Duration at least 3 months	The weight reduction seen in intervention subjects was 1.8 kg more than the control groups, which is less than that found in the references. The heterogeneity of the studies makes it difficult

			healthcare providers			to determine whether the clinical setting, and frequency of visits with providers, effect outcomes.
Gillett et al, 2012	Systematic review	Review the clinical effectiveness and cost-effectiveness of nonpharmacologic interventions, including diet and physical activity, for the prevention of type 2 diabetes in people with intermediate hyperglycemia	RCTS; participants have intermediate hyperglycemia (mainly impaired glucose tolerance); interventions include diet alone, physical activity alone or diet + physical activity	9 RCTs	Diet, physical activity Duration at least 2 years	In people with impaired glucose tolerance, dietary changes and physical activity (with the goal of weight loss) are effective in reducing the progression to type 2 diabetes mellitus.
Gillies et al, 2007	Systematic review and Meta-analysis	Quantify the effectiveness of pharmacological and lifestyle interventions to prevent or delay type 2 diabetes in people with impaired glucose tolerance	RCTs; studies include an intervention to delay or prevent type 2 diabetes; one outcome is development of diabetes	21 RCTs, 17 included in meta-analysis	Diet, physical activity Duration not documented	The pooled hazard ratios were 0.51 (95% confidence interval 0.44 to 0.60) for lifestyle interventions v standard advice. These correspond to numbers needed to treat for benefit of 6.4 (95% confidence interval, 5.0 to 8.4), for lifestyle interventions.
Johnson et al, 2012	Systematic review	Examine "real-world" lifestyle intervention programs to prevent type 2 diabetes, and/or reduce BMI and weight, in high risk individuals	Studies of any design and any length of follow up; participants are adults at risk of type 2 diabetes; lifestyle interventions based on reproducible protocols; outcomes focus on diabetes incidence and changes in weight, BMI, and waist circumference	19 studies	Diet, physical activity At least 16 weeks in duration	Translational studies showed that implementation of protocols from the Diabetes Prevention Program and Diabetes Prevention Study result in a reduction in body weight and waist circumference in a range of settings. As a result, these protocols were effective in reducing the progression to type 2 diabetes in those at risk.
Kavookjian et al, 2007	Systematic review	Review the evidence for interventions addressing the self-management behavior of being active among adult diabetes	Both intervention studies and reviews; intervention studies had at least 1 follow-up measurement and were not included in	7 reviews (2 systematic reviews, 3 meta-analyses, 2 technical reviews) and 34 individual studies (18 RCTs and 16	Physical activity (structured vs non-structured) No clear duration	Overall findings were limited by the heterogeneity of the studies. Any level of physical activity had a

		patients	the reviews; reviews specifically addressed exercise, had a methodological description of target strategy, inclusion criteria, and results	nonrandomized trials)		benefit over sedentary lifestyle, with a greater improvement in glycemic control seen in structured physical activity programs (at least 150 minutes per week of moderate – intensity aerobic exercise and/or at least 90 minutes per week of vigorous exercise).
Nield et al, 2009	Systematic review	Assess the effect of dietary advice for adults with type 2 diabetes	RCTs; 6 months or longer; intervention includes dietary advice	18 studies	Dietary advice Duration at least 6 months	There are no high quality data on the efficacy of the dietary treatment of type 2 diabetes, however the data available indicate that the adoption of exercise appears to improve glycated hemoglobin at six and twelve months in people with type 2 diabetes.
Norris et al, 2002	Meta-analysis	Evaluate the efficacy of self- management education on glycated hemoglobin in adults with type 2 diabetes	RCTs; tested effect of self-management education on adults with type 2 diabetes; reported data on the effect of treatment on glycated hemoglobin	31 studies	Self-management education No clear duration	Self-management education decreases glycated hemoglobin in the short-term by about 0.76% more than the control group, and decreases glycated hemoglobin by 0.26% at 1-3 months. Increased contact time increases the effect.
Norris et al, 2005	Systematic review	Assess the effectiveness of behavioral weight control interventions for adults with type 2 diabetes	RCTs; studies examined weight loss or weight control strategies using dietary, physical activity, or behavioral intervention; follow up interval was at least 12 months	22 studies	Diet, physical activity Duration at least 12 months	For any intervention there was an average loss of 1.7kg or 3.1% of baseline body weight. In those receiving the same behavioral and diet intervention, the group with intensive physical activity intervention lost 3.9kg more than those receiving a less intensive or no physical activity intervention. Changes in

						glycated hemoglobin corresponded to differences in weight.
Orozco et al, 2008	Systematic review	Assess the effects of exercise, or exercise and diet, for preventing type 2 diabetes mellitus	RCTs; at least 6 months duration; reported diabetes incidence in people at risk for type 2 diabetes	8 studies	Diet, physical activity Duration 1 to 6 years	No statistical significant effects on diabetes incidence were observed when comparing exercise only interventions with standard recommendations or with diet only interventions. Exercise plus diet interventions reduced the risk of diabetes compared with standard recommendations (RR 0.63, 95% CI 0.49 to 0.79).
Povey et al, 2007	Systematic Review	Review the evidence for a healthy eating intervention on diabetes care	Participants are adults with type 1 or 2 diabetes,; studies included measurements taken before and after intervention	23 studies	Dietary counseling, physical activity No clear statement of duration	The heterogeneity of the studies made it difficult to draw conclusions based on the outcomes of the studies.
Schellenberg et al, 2013	Systematic review and meta-analysis	Assess the effects of comprehensive lifestyle interventions for prevention of diabetes in at-risk adults and for the prevention of diabetic complications in those with type 2 diabetes	RCTs; participants were adults diagnosed with type 2 diabetes or had risk factors for type 2 diabetes; interventions included an exercise component, diet component, and one other component; duration of at least 3 months with a minimum of 6 month follow up or intervention was at least 1 year without a follow-up; outcomes were progression to type 2 diabetes or progression to microvascular or macrovascular complications in those with diabetes	20 studies (9 at increased risk for type 2 diabetes, 11 with patient diagnosed with type 2 diabetes)	Physical activity, diet, Duration at least 3 months	There was moderate-strength evidence to show that lifestyle interventions helped to decrease the incidence of developing type 2 diabetes in those at risk. These interventions also resulted in a decrease in body weight or BMI in high risk patients. There is low-strength evidence that lifestyle interventions are beneficial in the prevention of all-cause mortality and insufficient evidence for the effect on macrovascular and microvascular comorbidities for those with type 2 diabetes.
Thomas et al, 2006	Systematic review	Assess the effects of	RCTs; studies are	14 studies	Physical activity	Compared with the

		exercise in type 2 diabetes mellitus	comparing aerobic, fitness or progressive resistance training exercise to a control group of no exercise; participants are adults with type 2 diabetes mellitus		Duration 8 weeks to 12 months	control, the exercise intervention significantly improved glycemic control as indicated by a decrease in glycated hemoglobin levels of 0.6% (-0.6 %HbA1c, 95% confidence interval (CI) -0.9 to -0.3; P < 0.05).
Thomas et al, 2009	Systematic review	Examine the effects of low glycemic index or low glycemic load diets on glycemic control in people with diabetes	RCTs; duration of 4 weeks; participants are adults with type 2 diabetes	11 studies	Diet Duration at least 4 weeks	With lower glycemic index or load diet there was a decrease in the glycated hemoglobin A1C of 0.5% (95% CI of - 0.9 to -0.1) and there were also significantly fewer hypoglycemic episodes when compared to high glycemic index diet.
Thomas et al, 2010	Systematic review	Investigate the impact of lifestyle interventions on the development of type 2 diabetes in those with glucose intolerance	RCTs; participants are nonpregnant adults; studies include at least 100 participants and are focused on activity or diet	Number of studies not included	Physical activity, diet No clear duration	For the incidence of type 2 diabetes, there was a risk reduction of 33% for dietary interventions, a 51% risk reduction for exercise interventions, and a 51% risk reduction in combined interventions. The interventions seemed to be more effective for those at high risk over age 60 in comparison to younger people at high risk.
Yoon et al, 2013	Systematic review	Review RCTs of lifestyle interventions to decrease the incidence of diabetes in patients with impaired glucose tolerance	RCTs; participants have impaired glucose tolerance; observation time is more than 6 months; one outcome is diabetes incidence	7 studies	Physical activity, diet Duration at least 6 months	Diet and exercise were effective in reducing the incidence of diabetes in those with impaired glucose tolerance, but did not have any impact on mortality.
Yamaoka et al, 2005	Meta-analysis	Assess the efficacy of lifestyle education for preventing type 2 diabetes in patients at high risk	RCT; duration of at least 6 months; intervention includes dietary education; participants are adults at high risk for	13 studies	Dietary education Duration at least 6 months	Lifestyle education reduced 2-hour oral glucose tolerance test plasma glucose by 0.84 mmol/l and one year

		developing type 2 diabetes	incidence of diabetes by about 50% in those with high risk of developing diabetes.
Diabetes Mellitus			
Narrative Reviews			
Author, year	Aim	Interventions Described	Outcomes
Champagne, 2009	Examine the Mediterranean diet approach for treating diabetes mellitus type 2	Mediterranean diet	No studies have shown a contraindication for the use of Mediterranean diet in those with diabetes mellitus type 2 and therefore, it may be a viable option for this population.
Davis et al, 2009	Review the major studies of lifestyle interventions in preventing type 2 diabetes and translation of lifestyle interventions beyond clinical trial settings.	Weight loss, diet, physical activity	Weight losses of 4-7% are significant in reducing the incident of type 2 diabetes. Many strategies exist that target weight loss in type 2 diabetes but one clearly superior strategy has not been identified.
Esposito, 2008	Examine the evidence of how lifestyle approaches affect the incidence and treatment of type 2 diabetes mellitus and metabolic syndrome	Weight loss, diet, physical activity	Interventions based on changes in lifestyle have shown that the incidence of type 2 diabetes can be reduced by 42% to 63%. The reduction of body weight and caloric intake are the main approaches to prevent and treat type 2 diabetes mellitus and metabolic syndrome.
Gill et al, 2008	Review the data from prospective cohort studies and controlled intervention trials to investigate whether there is evidence for differential physical activity guidelines for diabetes prevention in different populations	Physical activity	Any level of activity above a sedentary lifestyle can provide benefit in the prevention of type 2 diabetes with the greatest effect seen in those at highest risk, engaging in high levels of activity.
Horton, 2008	Examine the effects of various lifestyle interventions on the risk of diabetes and CVD among high risk populations	Physical activity, diet	Lifestyle modifications, including diet and physical activity, have shown a reduction in the progression from impaired glucose tolerance to type 2 diabetes and a reduction in multiple cardiovascular disease risk factors.
Kriska et al, 2004	Review four lifestyle interventions for the prevention of type 2 diabetes	Weight loss, physical activity, diet	The four trials included both diet and exercise, with the following goals: weight loss of 5-7% of initial body weight, physical activity of at least 150 to 200 min/week of moderate aerobic activity, and diet of low fat and high amounts of vegetables and fiber. These interventions reduced the incidence of progression to type 2 diabetes.
Madden et al, 2008	Determine the most effective type of diabetes prevention program, and examine post-intervention adherence to lifestyle changes	Diet, physical activity	Combination of diet and exercise produced the best results in preventing type 2 diabetes. Although most programs showed an improvement in their initial results, they were not able to maintain these results in the long

			term.
Magkos et al, 2009	Review the effectiveness of lifestyle modification in the management of metabolic syndrome and type 2 diabetes, and examine the feasibility of incorporating these changes into everyday routine	Diet, physical activity	Lifestyle interventions that include a low calorie diet and at least moderate levels of physical activity may reduce the risk of developing type 2 diabetes and minimize or delay the development of diabetic complications.
Peters et al, 2004	Discuss the efficacy of lifestyle interventions in the prevention and treatment of diabetes	Diet, physical activity	Results of lifestyle interventions include reduction in insulin resistance, increased insulin sensitivity, improved fasting and post-prandial glucose levels, and decreased glycated hemoglobin.
Pi-Sunyer, 2007	Examine the effect of lifestyle changes on the prevention of type 2 diabetes mellitus	Diet, physical activity, weight loss	Lifestyle changes in those with obesity or impaired glucose tolerance have been shown to prevent type 2 diabetes. The most successful interventions were those that led to loss of 7-10% of baseline weight and to an increase in physical activity.
Psaltopoulou et al, 2010	Evaluate dietary and lifestyle practices proposed for reducing the risk of type 2 diabetes	Diet, physical activity, weight loss	Nutrition (including a diet with low glycemic index and high in fiber) is beneficial, but there is a lack of evidence showing that this alone is effective in prevention of type 2 diabetes. Exercise and diet alone did not reduce the incidence of type 2 diabetes, but the combination is very effective.
Sanz et al, 2010	Assess the effects of exercise in the prevention and treatment of type 2 diabetes	Physical activity	In those at high risk for developing diabetes, diet and exercise combined reduced the incidence of diabetes by 50%. Physical exercise for 22 weeks was effective in decreasing the glycated hemoglobin by 0.38% to 0.51% in those with diabetes. There was no significant difference in the improvement of insulin sensitivity in those that performed resistance exercise in comparison to aerobic exercise.
Steyn et al, 2009	Review lifestyle interventions with a dietary component aimed at the prevention of type 2 diabetes	Diet, physical activity	Lifestyle interventions are effective in delaying the onset of or preventing type 2 diabetes. The best outcomes were from individual dietary counseling combined with physical activity.
Venditti, 2007	Summarize the adequacy, sustainability, and feasibility of behavior changes for weight loss and diabetes prevention	Diet, physical activity	For every kilogram of weight loss there was about a 16% reduction in the risk of developing diabetes, which was adjusted for diet and exercise. A decrease in total energy from fat and increased physical activity appeared to be related to sustained weight loss.
Venditti & Kramer, 2012	Describe necessary components for lifestyle modification to reduce diabetes risk	Diet, physical activity, behavioral therapy	Lifestyle interventions for diabetes risk require a minimum of 4 to 6 months of frequent contact. Initial weekly contact appears necessary for behavioral change. In-person

						contact is associated with largest effect sizes. Interactive feedback and social support are crucial.

Dyslipidemia
Systematic Reviews

Author, year	Type of Review	Aim	Inclusion Criteria	Number Studies	Intervention Description/ Duration	Outcomes
Mannu et al, 2013	Systematic review	Accumulate a detailed overview of literature on risk assessment and lifestyle management of incidental asymptomatic hypercholesterolemia	Focus on non-pharmacological treatment of hypercholesterolemia and article in the English language	Over 3600 were reviewed, unknown amount included	Diet, physical activity, tobacco cessation Unknown duration	Omega 3 fatty acids have shown an improvement in overall lipid profile, while trans-fatty acid intake have shown a negative effect on LDL, HDL, and triglycerides. Regular exercise, consisting of at least 30 minutes three to four times weekly, has been proven to show a decrease in VLDL, a slight decrease in LDL, and an increase in HDL. Smoking cessation increases serum levels of HDL.
Smart et al, 2011	Systematic review	Assess the effects of low-fat diets for acquired hypercholesterolemia and investigate the incidence of adverse effects from low-fat dietary interventions	Healthy adults (≥18 years of age); acquired hypercholesterolemia (defined by total cholesterol > 5.2mmol/L, LDL greater than 3 mmol/L, HDL < 1 mmol/L, or a combination of the above); low-fat dietary intervention (fat calorie intake <20% of total calories); at least 6 months of intervention	No RCTs met inclusion criteria	Low fat diet At least 6 months duration	Randomized control trials targeting low fat diet in healthy adults with acquired hypercholesterolemia are needed.
Tambalis et al, 2009	Systematic review	Review RCTs that evaluated the effect of aerobic resistance and combined exercise on blood lipid and lipoprotein concentrations	Exercise program of no less than 12 weeks; sedentary adults aged 18 years or older; both hyperlidemic and normolipidemic; and assessment of one of the following: total cholesterol, HDL, LDL, and/or triglycerides	84 studies (58 of these are RCTs)	Physical activity At least 12 weeks in duration	High intensity aerobic exercise increases the level of high density lipoprotein cholesterol. Exercise affected triglycerides, total cholesterol, and low density lipoprotein less often.
Tang et al, 1998	Systematic review	Assess the efficacy of dietary	Individualized dietary advice	19 RCTs	Diet counseling	Dietary advice can reduce

		advice on lowering serum total cholesterol and investigate the efficacy of different dietary recommendations	focused on fat intake; at least two groups; treatment assignment was randomized		Duration was at least 4 weeks	total cholesterol by 3-6%, which depends on the type of diet advocated.
Yu-Poth et al, 1999	Meta-analysis	Evaluate the effects of the National Cholesterol Education Program's Step I and Step II dietary interventions on major cardiovascular disease risk factors	Randomized studies; studies were designed to lower blood cholesterol concentrations or to decrease body weight for the primary purpose of preventing CVD; 2) the investigators used a randomized design; the subjects were free-living, prepared their own food, and were counseled by dietitians or other professionals about implementing low-fat diets; the intervention lasted ?3 wk. to stabilize plasma cholesterol concentrations.	37 studies	Dietary modification	Step I and Step II dietary interventions significantly decreased plasma lipids and lipoproteins. Plasma total cholesterol (TC), LDL cholesterol, triacylglycerol, and TC:HDL cholesterol decreased by 0.63 mmol/L (10%), 0.49 mmol/L (12%), 0.17 mmol/L (8%), and 0.50 (10%), respectively, in Step I intervention studies, and by 0.81 mmol/L (13%), 0.65 mmol/L (16%), 0.19 mmol/L (8%), and 0.34 (7%), respectively, in Step II intervention studies ($P < 0.01$ for all). HDL cholesterol decreased by 7% ($P = 0.05$) in response to Step II but not to Step I dietary interventions.
Dyslipidemia						
Narrative Reviews						
Author, year		Aim	Interventions Described		Outcomes	
Houston et al, 2009		Review nonpharmacologic treatment of dyslipidemia	Diet, physical activity, and nutritional supplements		Improvements in all parameters of dyslipidemia are seen with regular physical activity (recommended 60 minutes daily) including HDL, LDL, and triglycerides. Low carbohydrate ketogenic diet had greater weight loss, lower triglycerides, higher HDL, and no difference when compared to low fat diets. Portfolio diet showed a decrease in LDL. Eliminating trans-fat and achieving ideal body weight have also been shown to improve lipid profiles.	
Katcher et al, 2009		Discuss dietary factors and dietary patterns that affect the major lipid risk factors	Diet		For optimal LDL reduction there should be foci on viscous fiber and plant sterols/stanols. Consumption of fruits, vegetables, whole	

			grains, low-fat/skim dairy products, lean meats, poultry, and fish, and liquid vegetable oils, nuts, and seeds are promoted.
Kelly, 2010	Examine lifestyle changes that have the greatest effect on cholesterol with an emphasis on studies that were not available at the time of ATP III analysis	Diet, physical activity	A decrease in the intake of saturated and trans fats, increase intake of poly- and monounsaturated fats, moderate alcohol intake, supplementing plan sterols and stanols, and including an isocoloric intake of tree nuts will have the most beneficial improvements in lipid profiles. Aerobic exercise may provide additional benefits when performed regularly.
Stone, 2008	Review the evidence for lifestyle modifications to treat mixed dyslipidemia associated with diabetes mellitus and the metabolic syndrome	Diet, physical activity	Studies suggest that in treatment-naïve patients, the use of calorie-controlled, low saturated fat, Mediterranean diets rich in omega-3 fatty acids with restriction of glycemic load will improve lipid profiles. Physical activity has shown to be beneficial in patients with atherogenic mixed dyslipidemia.
Varaday et al, 2005	Examine the cholesterol -lowering efficacy of low saturated fat diets combined with exercise and nutritional supplementation	Diet, physical activity (moderate intensity training 3-7 times weekly for 40-60 minutes in duration)	Low saturated fat diets combined with exercise lowered total cholesterol, LDL cholesterol, and triglycerides by 7-8%, 7-15%, and 4-18%, respectively and increased HDL cholesterol levels by 2-8%.

Hypertension
Systematic Reviews

Author, year	Type of Review	Aim	Inclusion Criteria	Number Studies	Intervention Description/ Duration	Outcomes
Dickinson et al, 2006	Meta-analysis	Quantify the effectiveness of lifestyle interventions for hypertension	RCTs; duration of at least 8 weeks follow-up; studies comparing lifestyle with control interventions; participants are adults with blood pressure at least 140/85 mmHg	105 trials	Diet, exercise, alcohol and sodium restriction, supplementation with potassium, magnesium, or fish oil Duration at least 8 weeks	Robust statistically significant effects were found for improved diet, aerobic exercise, alcohol and sodium restriction, and fish oil supplements: mean reductions in systolic blood pressure of 5.0 mmHg [95% confidence interval (CI): 3.1–7.0], 4.6 mmHg (95% CI: 2.0–7.1), 3.8 mmHg (95% CI: 1.4–6.1), 3.6 mmHg (95% CI: 2.5–4.6) and 2.3 mmHg (95% CI:

						0.2–4.3), respectively, with corresponding reductions in diastolic blood pressure.
He et al, 2002	Meta-analysis	Assess the effect of a modest salt reduction on blood pressure	RCTs; intervention is a modest reduction in salt intake; duration of 4 or more weeks	18 studies (17 with hypertensives and 11 with normotensives)	Sodium restricted diet Duration at least 4 weeks	A modest reduction in sodium intake for at least four weeks is effective in lowering blood pressure in hypertensive and normotensive people.
He et al, 2013	Meta-analysis	Assess the effect of longer term modest reduction of salt intake on blood pressure (per sex and ethnic group) and on plasma renin activity, aldosterone, noradrenaline, adrenaline, cholesterol, LDL, HDL, and triglycerides	Randomized trials; intervention is a modest reduction in salt intake; no concomitant interventions; an outcome is reduction in 24 hour urinary sodium ; duration of at least 4 weeks	34 studies	Sodium restriction Duration at least 4 weeks	A modest reduction in salt intake has a significant effect on blood pressure in hypertensive and normotensive people regardless of their sex or ethnic group. Reduction to sodium of 6 grams daily has a significant decrease of blood pressure and sodium intake of 3 grams daily has an even more significant lowering of blood pressure.
Hooper et al, 2002	Meta-analysis	Assess long term effects of advice to restrict dietary sodium in adults with and without hypertension	RCTs, focus on reducing sodium intake; participants are healthy adults	11 studies (3 in normotensives, 5 in untreated hypertension, and 3 in those being treated for hypertension)	Diet (sodium restriction) Duration at least 26 weeks	Statistically significant decreases in systolic blood pressure (about 1.1 mm Hg) were seen in those with sodium restriction at 13 and 60 months following initial advice.
Horvath et al, 2008	Meta-analysis	Examine the long term effects of weight lowering interventions on high blood pressure	RCTs; compare diet, pharmacologic or invasive intervention for weight loss; follow up of at least 24 weeks	15 studies (7 on diet, 8 on pharmacologic weight reduction)	Diet, medication, invasive procedure for weight loss Duration of treatment was of at least 24 weeks	Dietary interventions focused on lowering weight also helped to lower blood pressure at 1 year following initiation of intervention.
Lee et al, 2010	Systematic review	Review the effects of walking on blood pressure	RCTs with a non-intervention control group; study samples aged 16 years and over; intervention	27 studies	Walking 4 days to 26 weeks in duration	Nine of the 27 studies showed a benefit of walking intervention on blood pressure control. Those that had a longer

			predominantly focused on walking; blood pressure was an outcome			period of walking intervention (24-26 weeks) showed this benefit.
Nicolson et al, 2004	Systematic review	Compare the effectiveness of lifestyle and drug interventions for treating patients with essential hypertension	RCTs; 8 or more weeks follow up; participants have blood pressure of at least 140/85 mm Hg; study compared lifestyle and drug interventions; outcome measures were cardiovascular morbidity and mortality and blood pressure	5 studies	Diet compared to medications (diuretics, beta blockers, centrally acting antihypertensives), yoga, biofeedback, relaxation response Duration at least 8 weeks	Evidence is limited and unclear on whether or not lifestyle interventions are better than drug therapy in decreasing blood pressure.
Siebenhofer et al, 2011	Meta-analysis	Assess the long-term effects of weight-reducing diets in hypertensive patient	RCTs; participants are adult hypertensive patients; study duration is at least 24 weeks; study compared weight-reducing dietary interventions to no dietary intervention	8 studies	Weight-reducing diet Duration at least 24 weeks	In those with primary hypertension, weight loss diets led to a reduction in body weight and blood pressure, but the magnitude of its effects are uncertain due to the small number of participants in the overall study.

Hypertension
Narrative Reviews

Author, year	Aim	Interventions Described	Outcomes
Beilin et al, 2004	Update lifestyle interventions related to blood pressure	complex dietary patterns, dietary sodium, exercise, alcohol reduction, coffee consumption, magnesium supplementation, antioxidant vitamins	The DASH diet, sodium restriction, weight loss, exercise, and alcohol restriction all lower blood pressure. Magnesium supplementation has not been shown to have an effect on blood pressure. Regular coffee consumption increases blood pressure. Emerging data shows that folate and Vitamin CoQ may lower blood pressure.
Bhatt et al, 2007	Discuss the major lifestyle modifications recommended for prevention and treatment of hypertension	Diet (Vegan, DASH, reduced sodium, increased potassium intake)	Blood pressure can be lowered by increased physical activity, weight loss, limited alcohol consumption, and reduced sodium intake. These lifestyle modifications can also reduce the incidence of hypertension in those with pre-hypertension.
Brook et al, 2013	Review the evidence for nonpharmacologic modalities to lower blood pressure in those with hypertension	Meditation, biofeedback, yoga, acupuncture, slow breathing, physical activity (resistance, aerobic, and isometric)	Aerobic exercise for more than 30 minutes/day for most days of the week and dynamic resistance exercises have the strongest evidence for the improvement of hypertension. There is insufficient evidence to conclude whether or not meditation,

			biofeedback, yoga, acupuncture, and slow breathing are effective in lowering blood pressure.
Frisoli et al 2011	Examine the effect of lifestyle interventions for blood pressure reduction in people with hypertension	Weight loss, physical activity, DASH diet, sodium restriction	Maximum blood pressure benefit was seen from those that exercised 61-90 minutes weekly. The DASH diet improved blood pressure within two weeks of initiation and persisted throughout the continuation of the diet. A combination of lifestyle intervention can be more beneficial that implementing one intervention at a time.
Hedayati et al, 2011	Review nonpharmacologic interventions for lowering blood pressure	Diet, sodium restriction, potassium, magnesium, calcium, weight loss, and moderation of alcohol intake	The best results for sodium restricted diet was seen when sodium was reduced to 33-50mmol/day. Reduction of weight, increase in physical activity, a low sodium diet, and limiting alcohol use have been effective in managing prehypertension and hypertension. Variable results have been seen on blood pressure with an increase in potassium intake.
Kaplan, 2004	Review lifestyle modifications for the prevention and treatment of hypertension	Tobacco cessation, physical activity, sodium restriction, increased potassium intake, moderation of alcohol consumption	Lifestyle modifications including sodium restriction and physical activity have been shown to improve blood pressure in those with prehypertension and hypertension, but there is limiting success in patients achieving significant lifestyle changes.
Karanja et al, 2004	Summarize effect of diet on blood pressure in the DASH, DASH-Sodium, And PREMIER studies	DASH diet, diet counseling	DASH diet reduced blood pressure by 11/6 mm Hg in those with Stage I hypertension. DASH diet and sodium restriction both improved blood pressure independently and when combined produced an even greater blood pressure reduction. Intense counseling seen in the PREMIER study may have the most significant impact on the disease risk, but may not be feasible in the office setting.
Kokkinos et al, 2005	Summarize the findings of observational studies that evaluated the effect of dietary approaches in the prevention of chronic hypertension	Diet (Mediterranean and DASH)	Diets like the Mediterranean diet (low in saturated fats and sodium; rich in fruits, vegetables, and fiber) are effective in the prevention of hypertension or as an adjunct to pharmacologic treatment.
McDonald et al, 2006	Summarize lifestyle changes that can be recommended for patients diagnosed with hypertension	Diet, aerobic exercise, reduction of alcohol consumption, weight loss	Dietary sodium restriction, increase of fruits and vegetables, and increasing aerobic exercise are recommended to improve high blood pressure. Evidence on the relationship

			between weight reduction and blood pressure reduction is inconclusive.
Miura et al, 2005	Review short-term and long-term studies, both observational and interventional, that investigate the relationship between dietary change and blood pressure reduction	Diet	DASH diet showed efficacy in lowering blood pressure and its implementation was seen to be feasible in the PREMIER trial. Long-term observational studies have shown that increasing intake of fruit and vegetables, and lowering consumption of red meats, may prevent hypertension.
O'Shaughnessy, 2006	Discuss elements of diet that are efficacious for reducing blood pressure in hypertension	Diet	Salt reduction is the most important dietary modification that can improve blood pressure. The PREMIER study shows how dietary counseling can lead to implementation of lifestyle changes and results.
Savica et al, 2010	Review nutritional factors that may affect blood pressure	Diet (sodium, potassium, calcium, fish oil, magnesium, protein, fiber, alcohol, vitamin D, DASH, DASH low sodium, and Mediterranean)	The prevention of obesity, low sodium/DASH combination diet, adequate potassium intake, and possibly sufficient intake of fish oil and magnesium all have been shown to reduce blood pressure.
Tejada et al, 2006	Discuss lifestyle modifications that prevent the development of hypertension and reduce the amount of pharmacologic treatment in those with hypertension	Weight loss, increased physical activity, sodium restriction, potassium supplementation, moderation of alcohol use, and smoking cessation	Evidence shows that smoking cessation, weight loss, adoption of a DASH-type diet, dietary salt restriction, increased potassium intake, regular exercise, and moderation of alcohol use are effective in lowering blood pressure.

Multiple Risk Factors

Narrative Reviews

Author, year	Aim	Interventions Described	Outcomes
Artinian et al, 2012	Provide evidence-based summary of effective physical activity and dietary interventions among adult individuals	Diet, physical activity, and behavioral therapy	The following strategies are most strongly associated with greater efficacy: use of specific, proximal goals; providing regular feedback; use of self-monitoring; use of motivational interviewing strategies, particularly when an individual is resistant or ambivalent; provision for direct or peer-based long-term support and follow-up, to offset the declining adherence that typically begins at 4–6 months in most behavior change programs; use of self-efficacy in the intervention; use a combination of strategies in an intervention; and development of a personalized plan and use of individualized, culturally-appropriate strategies.

Obesity

Systematic Reviews

Author, year	Type of Review	Aim	Inclusion Criteria	Number Studies	Intervention Description/ Duration	Outcomes
Brown et al, 2009	Systematic Review	Determine the effectiveness of long-term lifestyle interventions for the prevention of weight gain in adults	RCTs and controlled before and after studies of a lifestyle intervention in adults with a BMI less than 35 kg/m2 reporting weight at least 2 years post randomization	39 studies	Diet +/-exercise and behavioral therapy 24 to 97 months in duration	11 of 39 comparisons produced significant improvement in weight at 2 years or longer with mean difference weight change ranging from -0.5 to -11.5 kg.
Buckland et al, 2008	Systematic review	Review and analyze epidemiological studies on the Mediterranean diet and obesity	Use of Mediterranean diet, weight was an outcome measure	21 studies (7 cross-sectional, 2 cohort, and 11 intervention)	Mediterranean diet No clear duration	Out of the 21 studies identified, 13 reported that adherence to a Mediterranean Diet significantly reduced the probability of overweight/obesity, promoted weight loss, or resulted in more weight loss than a control diet.
Curioni & Lourenco, 2005	Meta-analysis	Assess the effectiveness of dietary interventions and exercise in long-term weight loss in overweight and obese people	RCTs with at least 1 year follow-up data, participants are overweight or obese adults	33 studies	diet, exercise or diet and exercise 10 to 52 weeks in duration	Compared to diet alone, diet associated with exercise produced a 20% greater weight loss (13 kg vs 9.9 kg; p=0.063). The combined intervention also resulted in a 20% greater sustained weight loss after 1 y (6.7 kg vs 4.5 kg; p=0.058).
Dansinger et al, 2007	Meta-analysis	Examine the effect of dietary counseling compared with usual care on body mass index (BMI) over time in adults	RCTs of ≥16 weeks in duration in overweight adults that reported the effect of dietary counseling on weight	46 studies	Counseling for weight loss focusing on diet +/- exercise 2.5 to 48 months in duration	The maximum net treatment effect was -1.9 (95% CI, -2.3 to -1.5) BMI units at 12 months.

Eyles & Mhurchu, 2009	Systematic Review	Summarize evidence for the long-term effectiveness of tailored nutrition education for adults, including priority population groups	RCTs or quasi-randomized controlled trials employing a parallel design; intervention had at least 6 months of follow-up; participants were adults	16 studies	Psychoeducation and behavioral counseling on diet Duration of follow-up 6 to 24 months	Tailored nutrition education was more effective than generic nutrition education and control: those in the tailored group were found to consume WMD 0.35 servings of fruits and vegetables per day more and WMD –2.20% energy from total fat less than participants receiving generic nutrition education.
Galani and Schneider, 2006	Meta-analysis	Assess the mid- to long-term effectiveness of lifestyle interventions in the prevention and treatment of obesity	RCTs of lifestyle interventions in overweight or obese adults with minimum observation period of 1 year	30 studies	Details of interventions not described 1 to 7 years of observation (includes follow-up data)	In overweight people, the mean difference between intervention and control was -2.19 kg (95% CI -2.81 to -1.57). In obese people, the mean difference between intervention and control was -2.30 (95% CI -3.67 to -0.92).
Gourlan et al, 2011	Meta-analysis	Determine the global effect that lifestyle interventions have on physical activity among obese individuals, variations in effect depending on the physical activity indicator used, and the dose characteristics of the intervention	RCTs or quasi-experimental studies of obese participants in lifestyle interventions that include promotion of physical activity, physical activity outcome measurements or physical fitness were reported	46 studies	Pscyhoeducation and cognitive behavioral therapy to increase physical activity 3 weeks to 24 months in duration	Interventions globally have an impact on the physical activity of obese populations (Cohen's d = 0.44, 95% CI 0.31 to 0.57). Interventions of less than 6 months reported significantly larger effects than longer interventions.
Kodama et al, 2011	Meta-analysis	Review the weight loss or maintenance effect of the internet component in obesity treatment programs	RCTs, participants were overweight or obese adults, intervention included a web-user group, intervention included controlling diet or increasing physical activity, outcome was change in weight	25 studies	Web-based intervention or adjunct, focusing on diet and/or physical activity 3 to 30 months in duration	Use of the internet has a modest but significant effect on weight loss with difference between web users and non-web users of -0.68 kg. Using the internet as an adjunct was effective (difference in weight loss of -1.0 kg) but using it as a substitute for face-to-face contact was unfavorable (difference in weigh + 1.27 kg).
Lemmens et al, 2008	Systematic review	Identify effective intervention and intervention elements in obesity prevention interventions in adults	RCTs, non-randomized trial, or interrupted time-series designs; aimed at prevention of obesity in non-obese adults; have minimum of 3 months of follow-up	9 studies	Focus on diet and/or physical activity Follow-up duration of 4 months to 7.5 years	One dietary intervention and three combined dietary and physical activity interventions produced significant results at the end of follow-up.

Mastellos et al, 2013	Meta-analysis	Assess the effectiveness of dietary or physical activity interventions based on the transtheoretical model stages of change to produce sustainable weight loss	RCTs; one of the outcome measures of the study was weight loss, measured as change in weight or body mass index (BMI); participants were overweight or obese adults only	3 studies	Transtheoretical stages of change counseling in combination with diet or physical activity, or Both 9 to 24 months in duration	The included studies produced inconclusive evidence that transtheoretical stages of change interventions led to sustained weight loss (the mean difference between intervention and control groups varied from 2.1 kg to 0.2 kg at 24 months; 2971 participants; 3 trials; low quality evidence).
Olander et al, 2013	Meta-analysis	Identify which behavior change techniques are associated with increases in self-efficacy and physical activity	RCTs, non-randomized controlled trials, quasi-experimental studies or studies with pre-post design; sample is obese adults; one intervention aim is to increase physical activity; outcome includes a change in self-efficacy	61 studies	Most common theoretical basis is Social Cognitive Theory; focus on physical activity +/- diet and weight loss Duration not documented	A small effect of the interventions was found on self-efficacy (Cohen's *d* = 0.23, 95% CI 0.16 to 0.29). A medium effect was found on physical activity (Cohen's *d* = 0.50, 95% CI 0.38 to 0.63). Action planning, time management, self-monitoring, and planned social support were associated with positive changes in self-efficacy.
Paul-Ebhohimhen & Avenell, 2009	Systematic review	Compare the effectiveness of group-based to individual-based modes of delivery for obesity treatments	RCTs, participants are adults with BMI ≥ 28 kg/m2, follow-up for at least one year, principle outcome change in weight or BMI	5 RCTs	Psychoeducation and behavioral therapy; focus on diet and physical activity Duration 8 to 26 weeks	At 1 year, there was a statistically significant weight change in group-based over individual treatment with a WMD of -1.4 kg (95% CI -2.7 to -0.1 kg).
Sargent et al, 2012	Systematic review	Examine effectiveness of nurse-led lifestyle interventions for obesity in primary care	RCTs or non-randomized controlled trials, Participants are adults, interventions have a lifestyle change component and are delivered by a nurse in primary care, outcome includes quantitative measure of risk factors associated with obesity	28 studies	Traditional counseling and counseling based on theoretical behavioral change strategies 1 to 20 counseling sessions	No difference in effect between nurse-delivered interventions and those delivered by other healthcare members. Counseling was more effective than health screening. Counseling based on behavioral change theory was more effective than the same dose of non-behavioral counseling.
Shaw et al, 2005	Meta-analysis	Assess the effects of psychological interventions for overweight or obesity as a means of achieving sustained weight loss	RCTs; one of the outcome measures of the study was weight change measured by any method; participants were followed for at least three months; the study participants were adults (18 years or older) who	36 studies	Behavioral therapy, cognitive-behavioral therapy, cognitive therapy, psychotherapy, relaxation therapy and hypnotherapy; focus on diet, exercise, or both 7 to 156 weeks in duration	Behavior therapy was found to result in significantly greater weight reductions than placebo when assessed as a stand-alone weight loss strategy (WMD -2.5 kg; 95% CI -1.7 to -3.3). Combined interventions resulted in a greater weight reduction. Increasing the intensity of the behavioral intervention significantly increased the weight reduction (WMD -2.3 kg; 95% CI -1.4 to - 3.3). Cognitive-

			were overweight or obese (BMI > 25 kg/m2) at baseline			behavior therapy, when combined with a diet / exercise intervention, was found to increase weight loss compared with diet / exercise alone (WMD -4.9 kg; 95% CI -7.3 to - 2.4).
Shaw et al, 2006	Meta-analysis	Assess exercise as a means of achieving weight loss in people with overweight or obesity	RCTs; participants are adults with overweight or obesity at baseline; loss to follow-up of participants of less than 15%	43 studies	Exercise, +/- dietary intervention 3 to 12 months in duration	Exercise combined with diet resulted in a greater weight reduction than diet alone (WMD -1.0 kg; 95% confidence interval (CI) -1.3 to -0.7). Increasing exercise intensity increased the magnitude of weight loss (WMD -1.5 kg; 95% CI -2.3 to -0.7). Exercise as a sole weight loss intervention resulted in significant reductions in diastolic blood pressure (WMD -2 mmHg; 95% CI -4 to -1), triglycerides (WMD -0.2 mmol/L; 95% CI -0.3 to -0.1) and fasting glucose (WMD - 0.2 mmol/L; 95%. CI -0.3 to -0.1); higher intensity exercise resulted in greater reduction in fasting serum glucose than lower intensity exercise (WMD -0.3 mmol/L; 95% CI -0.5 to -0.2)
Thomas et al, 2007	Meta-analysis	Assess the effects of low glycemic index or load diets for weight loss in overweight or obese people	RCTs, participants are overweight or obese adults	6 studies	Dietary intervention 5 weeks to 6 months in duration	The decrease in body mass (WMD -1.1 kg, 95% confidence interval (CI) -2.0 to -0.2, P < 0.05) (n = 163), total fat mass (WMD -1.1 kg, 95% CI -1.9 to -0.4, P < 0.05) (n =147) and body mass index (WMD -1.3, 95% CI -2.0 to -0.5, P < 0.05) (n = 48) was significantly greater in participants receiving low glycemic index compared to other diets. The decrease in total cholesterol was significantly greater with low glycemic index compared to other diets (WMD -0.22 mmol/L, 95% CI -0.43 to -0.02, P < 0.05), as was the change in LDL-cholesterol (WMD -0.24 mmol/L, 95% CI -0.44 to -0.05, P < 0.05).
Tsai & Wadden, 2005	Systematic review	Describe the components, costs, and efficacy of the major commercial and organized self-help weight loss programs in the United States	RCTs or case series, at least 12 weeks in duration with follow up of at least a year, Adult participants	10 studies	Commercial weight loss programs including behavioral therapy, focusing on diet and exercise 12 weeks to 2 years in duration	Of 3 randomized, controlled trials of Weight Watchers, the largest reported a loss of 3.2% of initial weight at 2 years. One randomized trial and several case series of medically supervised very-low-calorie diet programs found that patients who completed treatment lost approximately 15% to 25% of initial weight. With the exception of 1 trial of Weight Watchers, the evidence to support the use of the major commercial and self-help weight loss programs is suboptimal.

Wieland et al, 2012	Meta-analysis	Assess the effects of interactive computer-based interventions for weight loss or weight maintenance	RCTs or quasi-randomized controlled trials; participants were overweight or obese adults; follow up was at least 4 weeks; loss to follow up was less than 20%	14 studies	Computer-based interventions, focusing on diet and/or exercise 4 weeks to 30 months in duration	Computer-based interventions led to greater weight loss than minimal interventions (mean difference (MD)) -1.5 kg; 95% confidence interval (CI) -2.1 to -0.9; two trials) but less weight loss than in-person treatment (MD 2.1 kg; 95% CI 0.8 to 3.4; one trial). Computer-based interventions were superior to a minimal control intervention in limiting weight regain (MD -0.7 kg; 95% CI -1.2 to -0.2; two trials), but not superior to infrequent in-person treatment (MD 0.5 kg; 95% -0.5 to 1.6; two trials).
Wu et al, 2009	Meta-analysis	review the effect of diet-plus-exercise interventions vs. diet-only interventions on both long-term and short-term weight loss	RCTs; intervention duration minimum of 6 months; participants were obese or overweight adults	18 studies	Diet and exercise or diet alone 3 to 24 months in duration	overall standardized mean differences between diet-plus-exercise interventions and diet-only interventions at the end of follow-up were -0.25 (95% CI -0.36 to -0.14). Pooled weight loss was 1.14 kg (95% CI 0.21 to 2.07) or 0.50 kg m-2 (95% CI 0.21 to 0.79) greater for the diet-plus-exercise group than the diet-only group.

Obesity

Narrative Reviews

Author, year	Aim	Interventions Described	Outcomes
Butryn et al, 2011	Provide an overview of the principles of behavioral weight loss treatment, review short and long-term effectiveness, and describe strategies for improving weight loss	Behavioral therapy	Behavioral therapy results in loss of 8 to 10 kg, or 8% to 1 of initial body weight.
Jakicic & Davis, 2011	Review the effects of physical activity on body weight	Physical activity	Physical activity can have a modest influence on decreasi body weight, with magnitude occurring in a dose-respons manner; physical activity combined with diet results in gr weight loss; physical activity may be most beneficial for minimizing weight regain.
Johannsen et al, 2007	Examine the role of physical activity in weight maintenance	Physical activity	60 to 90 minutes of moderate-intensity physical activity e day is required to maintain a reduced body weight.
Jones & Wadden, 2006	Describe behavioral methods to modify maladaptive eating and activity habits to achieve a healthy weight	Behavioral therapy	Behavioral therapy is effective in inducing a loss of 7% to 1 of initial weight. Weight loss has increased almost three f over the past 30 years as treatment duration has increase the same amount (from average of 8.4 weeks in 1974 to average 31.4 weeks in the period from 1996 to 2002). Self monitoring is perhaps the most important component of treatment.
Katz, 2005	Examine evidence for dietary interventions for weight control	Diet modification	Short-term weight loss is achieved by caloric restriction, regardless of diet composition. There is little evidence abo

			dietary interventions for sustainable weight loss, though there is a suggested association between a health-promoting diet and lifestyle and lasting weight control.
Keogh & Clifton, 2005	Summarize evidence on the use of meal replacements as a weight loss strategy	Diet modification (meal replacement)	4 RCTs support the view that meal replacements may be advantageous while 2 RCTs do not. Subjects in uncontrolled studies lost weight successfully using meal replacements.
Kirk et al, 2012	Synthesize the available evidence for the most effective lifestyle interventions for weight management	Cognitive and behavioral and/or psychoeducation interventions, focusing on diet and/or physical activity	Greater weight loss is associated with: multi-component interventions, greater education of health professionals, individualized and tailored counseling, specific target goals, longer duration physical activity (greater than 250 min per week), and duration greater than 6 months, regular contact.
Macfarlane &Thomas, 2009	Describe major community initiatives targeting an increase in physical activity	Physical activity and Diet modification	Exercise alone rarely results meaningful weight loss. Diet alone can result in weight loss. Greatest effects are seen with diet and exercise in combination.
Miller & Dunstan, 2004	Summarize current evidence relating to the effectiveness of physical activity interventions for treating overweight and obesity and type 2 diabetes	Psychoeducation and behavioral modification, focusing on diet and/or physical activity	Strategies that combine diet and physical activity are more effective than physical activity strategies alone; limited evidence suggests that continued professional contact can help sustain weight loss
Pi-Sunyer, 2006	Describe lifestyle treatment plans for controlling cardiometabolic risk factors	Behavioral modification, focusing on diet	Behavioral modification approaches are useful in facilitating adherence to specific dietary regimens. Self-monitoring, low-calorie diet, and regular physical activity are cardinal behaviors of successful long-term weight management.
Ross & Janssen, 2000	Examine the effect of exercise alone on weight loss	Exercise	Substantial reductions in obesity will result when daily exercise is performed at moderate intensity for 45 to 60 minutes per day without decreasing caloric intake.
Sharma, 2007	Review existing behavioral interventions for preventing and treating obesity in adult population that were published between 2000 and September 2006	Behavioral interventions, most targeting both physical activity and diet	Obesity prevention and treatment interventions must focus on both physical activity and nutrition behaviors. Interventions should be based on behavioral theories. More interventions should target community settings. Interventions must be at least 6 months in duration. Trained educators must be used in delivery of interventions. One-on-one counselling is superior.
Van Dorsten & Lindley, 2011	Describe cognitive and behavioral approaches in the treatment of obesity	Cognitive and behavioral therapy	CBT is effective for weight loss. More successful programs employ extended treatment periods, clearly defined goals, combining multiple dietary and physical activity strategies, and increasing long-term provider contact.
Wadden et al, 2004	Examine efficacy of lifestyle modification for long-term weight control	Behavioral therapy, diet and exercise	There are no definitive data to support one dietary approach over another for long term weight control. Portion-controlled servings have the strongest evidence. Long-term provider contact and longer duration of intervention is associated with greater weight loss.
Wadden et al, 2007	Review the short- and long-term results of lifestyle modification and methods to improve them	Behavioral therapy, diet and exercise	Group therapy, completion of daily food records, increased treatment duration, and tailoring of food plan are associated with greater intervention success. Less structured exercise regimens appear to be associated with greater adherence.
Wadden et al, 2012	Examine new developments within lifestyle modifications for obesity	Behavioral therapy, diet and exercise	Caloric restriction rather than macronutrient composition is the key determinant of weight loss. Choice of diet should address patient preferences. Weekly contact for 20 to 26

			weeks is preferable. Monitoring of food and weight, structured curriculae, and regular feedback from interventionist are associated with greater success.
Winett et al, 2005	Review effective weight-loss and physical activity interventions, including internet delivery systems	Behavioral therapy, diet and exercise, including internet delivery	Higher dose, longer-term interventions that focus on self-regulation strategies have shown modest but meaningful weight loss. Tailored programs delivered via the internet may provide one vehicle for engaging large groups of people.
Wing & Gorin, 2003	Review behavioral techniques for treating the obese patient	Behavioral therapy	Successful behavioral interventions should include the following strategies: goal-based interventions, focus on diet and physical activity, the use of behavioral techniques (including self-monitoring and goal-setting), intensive contact, and individualization of treatment.

Serious Mental Illness
Systematic Reviews

Author, year	Type of Review	Aim	Inclusion Criteria	Number Studies	Intervention Description/ Duration	Outcomes
Álvarez-Jiménez et al, 2008	Meta-analysis	determine the effectiveness of non-pharmacological interventions to control antipsychotic-induced weight gain in patients with schizophrenia	RCTs, adults, at least 75% of participants diagnosed with a schizophrenia spectrum disorder	10 RCTs	CBT and nutritional counseling, group and individual, focusing on diet and/or exercise Duration not stated	For weight, WMD=72.56 kg (95% CI 73.20 to 71.92 kg); for BMI, WMD=70.91 kg/m2 (95% CI 71.13 to 70.68 kg/m2).
Bonfioli et al, 2012	Meta-analysis	Update evidence for non-pharmacologic interventions for weight loss in psychotic patients	RCTs, at least 50% of participants aged 18-65, diagnosis of schizophrenia and related disorders, bipolar disorder, depression with psychotic features	13 RCTs	CBT and psychoeducation, group and individual, focusing on diet and/or exercise Duration 2-12 months (mean 18 weeks)	Active treatment lost -0.98 BMI points compared to controls (3.12% of initial weight).
Bradshaw et al, 2005	Systematic review	Investigate the efficacy of healthy living interventions for adults with a diagnosis of schizophrenia or schizo-affective disorder	Participants were adults aged 16 years and over with a diagnosis of schizophrenia or schizo-affective disorder; interventions were to promote healthy living and were delivered on either an individual or group basis, studies were primary research, experimental or quasiexperimental,	9 studies	Psychoeducation, diet and/or physical activity interventions Duration not reported for all studies	In weight management studies, 17 of 20 patients in the intervention group lost weight. In exercise intervention studies, 2 of 3 studies showed an increase in physical fitness in the intervention group. In the dietary study, results were inconclusive.

			measures were taken before and after an intervention.			
Cabassa et al, 2010	Systematic review	Rate the methodological quality of lifestyle intervention outcome studies for persons with SMI, summarize intervention strategies, examine physical health outcomes, and evaluate the inclusion of racial and ethnic minority groups in these studies	Interventions conducted in the United States, report health outcomes, include adults diagnosed with SMI	23 studies	Psychoeducation, group and individual, focusing on diet and exercise Duration 30 minutes to 52 weeks	18 studies did statistical analysis of outcomes. 10 of 18 reported statistically significant weight loss. For single group pre-post design, there was a mean loss of 4.3±5.6 pounds. For quasi-experimental studies mean weight loss was 5.9±.6 pounds. For RCTs, mean weight loss was 3.7±2.3 pounds.
Cimo et al, 2012	Systematic review	Identify effective lifestyle interventions that enhance care in individuals with type II diabetes and schizophrenia or other schizoaffective disorders	participants have a medical diagnosis of both type II diabetes and schizophrenia or schizoaffective disorder, the outcome measures include HbA1c, fasting blood glucose, body mass index, or weight lost	4 studies	Psychoeducation for physical activity and diet Duration 6 to 12 months	Inpatient interventions had a positive impact on weight, BMI and blood glucose measurements. The outpatient intervention has a positive impact on weight, BMI, and diabetes management knowledge.
Das et al, 2012	Meta-analysis	Evaluate the evidence for pharmacologic and behavioral interventions to attenuate weight gain associated with second generation antipsychotics in individuals with schizophrenia	Not documented	Not documented	Behavioral therapy, CBT, psychoeducation for physical activity and/or diet Duration not documented	Behavioral therapies have the most consistent beneficial results. Weight lost in intervention group compared to controls ranged from 0.5 to 4.0kg.
Faulkner et al, 2003	Systematic review	Review the literature on the effectiveness of interventions designed to control weight gain in schizophrenia	Majority of patients had a diagnosis of schizophrenia, weight loss was an outcome goal, weight loss was measured body weight (lbs/kg), body mass index (BMI),waist circumference, waist-to-hip circumference ratio or per cent body fat	16 studies	Behavioral modification, with dietary and physical activity counseling Mean duration of 23.5 weeks	All behavioral (including diet and/or exercise) interventions reported small reductions in, or maintenance of, weight.

			(%)			
Faulkner et al, 2007	Meta-analysis	Determine the effects of both pharmacological (excluding medication switching) and non-pharmacological strategies for reducing or preventing weight gain in people with schizophrenia.	clinical randomized controlled trials comparing non pharmacological intervention for weight gain (diet and exercise counselling) with standard care or other treatments for people with schizophrenia or schizophrenia-like illnesses	5 RCTs	Cognitive behavioral therapy, with dietary and/or physical therapy components Duration 12 to 16 weeks	For prevention of weight gain, 2 RCTs showed a significant treatment effect with WMD -3.38 kg (CI -4.2 to -2.0) between intervention and control. For treatment of weight gain, 3 RCTs showed a WMD -1.69 kg (CI -2.8 to -0.6) between intervention and control.
Gabriele et al, 2009	Systematic review	Evaluate the effectiveness of behavioral interventions in treating and preventing atypical antipsychotic-associated weight gain	Behavioral interventions for weight loss or prevention of weight gain, at least 80% of participants on atypical antipsychotics	16 studies	CBT, counseling for diet and/or physical activity Duration 10 weeks to 18 months	Mean weight loss by treatment duration was 2.63kg for 12- to 16-week interventions, 4.24kg for 6- month interventions, and 3.05kg for 12- to 18-month interventions.
Galletly & Murray, 2009	Systematic Review	Review strategies used for managing weight in individuals with SMI in community settings	participants had severe mental illness and were currently living independently in community settings, weight loss was identified as a primary outcome, the study provided sufficient information to identify basic intervention strategies and outcomes, and findings of the study were reported in a peer-reviewed, English-language journal	16 studies	Behavioral therapy, with primary focus on diet (2 studies also included physical activity) Duration 6 to 52 weeks	The average weight loss across all of the interventions was 6.21 pounds. The median weight loss was 5.3 pounds. The average reduction in BMI was 1.53 points. The median reduction in BMI was 1.5 points. Significant ($p < 0.05$) within-subject results were reported in 6 of the 11 weight loss studies.
Gierisch et al, 2013	Systematic review	Evaluate interventions to improve CVD risk factors in adults with SMI	RCTs of ≥ 2 months in duration; participants are adults with a diagnosis of a primary psychotic disorder, bipolar disorder, or psychotic depression; participants have diabetes, or hypertension, or dyslipidemia, or CVD, or are obese, overweight, or	35 studies	Psychoeducation and CBT, focusing on diet, exercise, or diet and exercise Duration not reported	Compared with controls, behavioral interventions yielded weight change of mean difference -3.13 kg; 95% CI,-4.21 to -2.05.

			taking atypical antipsychotics			
Loh et al, 2006	Systematic review	Assess the potential for behavioral therapy for the management of obesity in individuals with schizophrenia	Participants have diagnosis of schizophrenia or schizoaffective disorder, weight loss was an outcome goal and was assessed using a standard measure	23 studies	Behavioral modification, psychoeducation, and/or calorie restriction Mean duration 25.68 weeks	Weight loss or decreased BMI was reported in 20 of 23 studies, and was statistically significant in 17 studies. Studies of duration 26 or longer had an average weight loss of -30.94 lbs (range -102 lbs to +0.9 lbs) compared to an average loss of -3.94 lbs (range -7.8 to +5.27 lbs) in studies of 16 weeks or less. Studies using behavioral modification as the intervention showed the greatest amount of weight loss (mean -39.98 lbs, range -7.28 to -102 lbs).
Lowe & Lubos, 2008	Systematic review	Evaluate the effectiveness of weight management interventions for people with serious mental illness taking atypical antipsychotics	Participants include adults (aged 16-65), with a diagnosis of schizophrenia or schizoaffective disorder, treated with atypical	8 studies	Psychoeducation or exercise and dietary interventions Duration 10 to 224 weeks	Average weight loss was 2.0 to 6.0 kgs in intervention groups. Due to methodological quality, there is limited evidence on the effectiveness of either psychoeducation or programs including educational and exercise components.
Verhaeghe et al, 2011	Systematic review	Evaluate the effectiveness of lifestyle interventions targeting physical activity and eating habits in persons with severe mental disorders	Participants include adults with severe mental disorders, with primary outcome changes in Body Mass Index and body weight	14 studies	Psychoeducation and/or behavioral therapy for physical activity and diet Mean duration 20 ± 10.8 weeks (range 10-52 weeks)	In the intervention groups, weight loss and decrease in mean BMI was observed in 11 studies. This was statistically significant in five studies. Average weight change in the intervention groups was -1.96 ±1.84 kg (-1.74%) versus +1.77 ± 2.12 kg (+2.28%) in the control groups. Average BMI change in the

			intervention groups was -0.87 ± 0.69 kg/m2 versus +0.64 ± 0.96 kg/m2 in the control groups.
Serious Mental Illness Narrative Reviews			
Birt, 2003	Describe management of weight gain associated with atypical antipsychotics	Behavioral therapy, diet and physical activity interventions	Behavioral interventions have been shown to be effective in the management of weight gain associated with antipsychotic therapy.
Bushe et al, 2005	Examine the role of lifestyle interventions in controlling weight in schizophrenia	Diet, physical activity, and behavioral interventions	Weight management and significant lifestyle changes are attainable goals in schizophrenia patients.
Faulkner et al, 2006	Provide an overview of pharmacologic and nonpharmacologic strategies for antipsychotic-associated weight gain and metabolic disturbance	Cognitive and behavioral group therapy, and individual therapy, focus on both diet and exercise	Modest weight-gain prevention or weight loss is possible in the short term.
Ganguli, 2007	Provide an overview of behavioral therapy for weight loss in schizophrenia	Behavioral therapy, focus on physical activity and/or diet	Behavioral therapy for weight reduction has been employed with variable success in patients with schizophrenia and schizoaffective disorder.
Kemp et al, 2009	Examine efficacy and effectiveness of lifestyle interventions for persons with mental illness at a service delivery level	Diet and physical activity interventions	Longer duration programs are necessary to maintain weight loss.
Roberts et al, 2011	Examine evidence for incentives and barriers to lifestyle interventions for people with severe mental illness	Cognitive and behavioral therapy , diet and physical activity interventions	Barriers to participation include illness symptoms, treatment effects, lack of support and negative staff attitudes. Incentives to participation include symptoms reduction, peer and staff support, knowledge, person attributes, and participation of staff.
Werneke et al, 2003	Summarize the evidence on effectiveness of behavioral interventions for weight gain in the general population and in-patients treated with atypical antipsychotics	Behavioral therapy, mostly focused on diet	Of seven studies with control groups, only two studies yielded a significant result; there is currently very limited evidence available for efficacious behavioral interventions in overweight patients treated with antipsychotics.