Healthy Ageing: The state of the evidence and available resources

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National Seniors Australia

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PROJECT OVERVIEW

One of the focal points for age care reform is wellness, reablement, and restorative care. While there are many information resources on healthy ageing, it isn't clear to the members of National Seniors Australia (NSA) which ones are reliable and up-to-date. NSA engaged world leading experts in this area from the Australian National University to provide this up-to-date review on the key topics:

- Diet
- Alcohol and smoking
- Cognitive ability
- Active lifestyle
- Medical and metabolic factors, and
- Mental health.

Further, a review of online resources was completed. This project was oversighted by the NSA Research Director, Professor John McCallum and edited by Dr Karen Rees.

EXECUTIVE SUMMARY

Australia's population is growing older and a greater proportion of Australians are living longer than ever before. As a result, more people are developing, and living longer with, diseases and disabilities associated with ageing. With escalating health care demands the expected increase in burden of disease in Australia has been reported to be unsustainable. On an individual level, disease and disability can impair quality of life and wellbeing by restricting activity, mobility, social connectedness, and community participation.

The notion of healthy ageing has therefore become a priority for both individuals and governments. Healthy ageing has been defined by the World Health Organization to be:

> *"The extent to which an individual or group is able to realize aspirations and satisfy needs, and to change or cope with the environment; health is a resource for everyday life, not the objective of living: it is a positive concept emphasizing social and personal resources as well as physical capabilities."*

Preventing and managing disease and disability are key priorities in the quest for healthy ageing. Health outcomes are determined by many factors across the lifespan, including biological, socio-environmental, and life-course factors. Some of these determinants are not modifiable. However, a large number of chronic diseases share modifiable risk factors related to lifestyle, including diet, and physical exercise.

Accordingly, there is growing consumer demand for health information relating to disease prevention and chronic disease management, particularly through online mediums. Given the vast quantity of health information and misinformation available online, a clear source of reliable information on healthy ageing and risk reduction is paramount.

This report was commissioned by National Seniors Australia to evaluate the current state of play in evidence pertaining to the association between modifiable risk factors and healthy ageing. In addition, the report sought to identify and explore the availability of online healthy ageing resources that seniors may access to assess their risk of chronic disease and find information about preventing physical and cognitive decline in later life.

The key findings of this report include:

1. Adhering to National Health and Medical Research Council (NHMRC) dietary guidelines, which may be achieved by following Mediterranean or DASH-style dietary patterns, contributes towards healthy ageing by protecting against the development of many chronic diseases, including cardiovascular disease and Type 2 diabetes;
2. Tobacco smoking remains the single most prominent and modifiable risk factor for poor health outcome;
3. Whilst there is some evidence that light to moderate alcohol consumption may be protective against some chronic conditions, in general, alcohol consumption – particularly heavy consumption – is related to increased health risks;
4. An active lifestyle – including physical, social, and cognitive activity – reduces the likelihood of chronic disease, and may encourage other lifestyle habits promoting healthy ageing;
5. Whilst there are good quality, evidence-based online resources for diet, smoking, and physical activity, there is a paucity of good quality resources for social and cognitive activity. Similarly, resources often lack ongoing support for interventions; and
6. Australian online resources that contain assessment tools and interventions for alcohol consumption are poorly publicised.

BACKGROUND TO THE REVIEW

As we continue to live for longer, it is more important than ever to consider how best to support people to age well. One way to think about healthy ageing is living with minimal disease burden. Disease burden reflects both the number of years of life lost to premature death as well as years lost to disability and inability to perform everyday functions independently[1]. Australian Institute of Health and Welfare (AIHW) data indicates 66% of disease burden in Australia is attributable to chronic conditions, including cardiovascular disease, diabetes, chronic kidney disease, cancer, and dementia[1]. Thus, management of chronic conditions is an important consideration towards healthy ageing.

Chronic conditions are long-lasting conditions that typically have persistent effects[2]. Although it is not necessarily the case, chronic conditions often result in death or severe disability[2]. AIHW data suggests that 35% of the population have at least one chronic condition (asthma, Type 2 diabetes, coronary heart disease, cerebrovascular disease, arthritis, depression, or high blood pressure), and many people have more than one chronic condition at a time[2]. Where possible, timely detection and effective medical management of chronic conditions is an important consideration to reduce unnecessary disease burden[3]. Generally though, most chronic conditions will persist from their onset for the reminder of a person's life[2].

Chronic conditions are, at best, limited in the extent to which they are treatable, and in some cases are untreatable. Thus, for people to age in good health the best-case scenario is to avoid developing a chronic condition at all. Research suggests that adjusting risk factors at the population level will result in a decrease in the incidence of a condition[4]. While there are risk factors for chronic diseases that cannot be altered (e.g. genetics and age), many risk factors are related to lifestyle and therefore can be modified. These include diet, alcohol and smoking, active lifestyle, and medical and metabolic conditions.

The Australian government provides evidence-based guidelines that inform practitioners and the public on the modifiable lifestyle factors common to the burden of chronic disease. These include dietary[5], alcohol consumption[6], and physical activity guidelines[7]. Whilst these guidelines are excellent resources it is important to note that research continues in these areas and may outdate the research upon which the guidelines are based.

The modern consumer has a multitude of health resources at their fingertips. The e-health industry – that is, health information that is accessible online – is currently booming. There are both private, commercial, and publically funded information resources available targeting health and lifestyle as well as interventions to promote positive behavioural change, particularly in the physical activity and diet sphere. Nevertheless, appropriate caution is necessary when considering online health resources. The quality of the consumer health information available on the internet is vast, ranging from personal opinions of non-professionals to intensively researched evidence-based material. Further, due to the cost of researching and developing high-quality education materials and intervention tools, many resources require registration and payment, thus impeding open access. It is therefore difficult for the average consumer to navigate this space freely and with confidence.

The objectives of this report are therefore threefold:

1. To identify the current state of the Australian guidelines on diet, alcohol consumption, smoking, as well as physical, social, and cognitive activity;
2. To complete a review of the most recent literature on modifiable risk factors since the release of the Australian guidelines identified; and
3. To identify and evaluate the available online resources that provide information, education, assessment tools, and interventions to support behaviour change regarding healthy ageing, diet, alcohol consumption, smoking, physical activity, and social and cognitive activities.

This report consequently focuses on modifiable risk factors relevant to the most prevalent chronic conditions associated with age and disease burden; that is, cardiovascular disease, type 2 diabetes, chronic kidney disease, cancer, and dementia. An advantage of this approach is that risk factors are often not specific to individual conditions and are likely to have benefits for a wide range of health outcomes not listed herein.

Methodology and general literature search strategy

Australian government websites, including the Australian Institute of Health and Welfare (AIHW), Department of Ageing, and the National Health and Medical Research Council (NHMRC) were explored to obtain the most recent Australian guidelines on modifiable lifestyle behaviours.

A literature review was conducted through *Cochrane Library and PubMed* databases, using MeSH (Medical Subject Heading) search terms, to identify systematic reviews, meta-analyses, literature reviews, and high quality research. Articles that were published since the NHMRC guidelines or that addressed a gap in knowledge were prioritised to be included in this report.

The internet was searched for publically accessible e-health resources focusing on the targeted modifiable lifestyle behaviours and prevention of chronic disease. The search focused on government and non-profit organisation websites originating in Australia. These websites were then subjectively evaluated based on the following criteria:

i. The quality of the information presented;

ii. The adherence to Australian guidelines;

iii. The breadth of the content of the resource (e.g. information, tools for assessing current behaviour/risk, intervention tools, monitoring and tracking tools, assistance and support);

iv. If an intervention tool is provided – the theoretical or evidence-based efficacy; and

v. Accessibility of the resource.

LITERATURE REVIEW

Healthy ageing includes living a healthy lifestyle with high quality of life and low disease burden. An effective way to attain these goals is to minimise modifiable lifestyle risk factors associated with chronic conditions. These include eating and lifestyle habits, active lifestyle, and medical and mental health conditions. In order to attain change in these risk factors, research suggests that informing people about risk factors at the population level is likely to gain some benefit, although this is better served when people are provided services to support their change.

This review identifies risk factors associated with chronic diseases, notes evidence-based recommendations on healthy lifestyle habits that are associated with reduced risk of these conditions, and identifies services that may support people in any efforts to alter their lifestyle risk factors for chronic conditions. This information, combined with the goal-setting and behavioural change information to be provided via the National Seniors Health Ageing portal, offers an effective way to disseminate information encouraging people to achieve their aim of ageing healthily.

Diet

Eating a balanced and varied diet containing many essential vitamins and minerals is considered important to maintaining good general health. Diet affects healthy ageing both directly and via other medical factors such as weight, cholesterol, and diabetes (as will be discussed in detail later). In fact, the NHMRC argues that improving diet is the single most important behavioural change that will significantly impact health[5]. The direct effects of diet on health and chronic disease is linked to the intake of nutrients and minerals, including antioxidants, fats, cholesterol, fibre, sugars and carbohydrates, calcium, and sodium (salt).

Dietary habits have shifted notably within the last 50 years, with people increasingly eating higher amounts of animal-based protein and fewer fruits, vegetables, and high-fibre foods, while portion size has also increased considerably[8]. The 2013 NHMRC Australian Dietary Guidelines[5] recommend a wide variety of nutritious foods from the five food groups, including vegetables, fruit, grains, lean meat, and dairy products, be consumed daily by all adult age groups. This amounts to at least five serves of vegetables, two serves of fruit and reduced fat dairy, one small serve of lean meat or chicken, between four and six serves of wholegrain cereals, and plenty of water each day. In addition, foods containing saturated fat, added salt and sugars, as well as alcohol should be limited. Currently, it is estimated that 46% of Australian adults do not regularly consume sufficient fruit and vegetables as part of their diets[9]. Further, the majority of the burden of disease in Australia is associated with poor nutrition and excess intake of foods high in energy, saturated fats, and added or refined sugars, or insufficient intake of nutrient dense foods[5].

There are no dominant mechanisms that can succinctly explain the protective effects of a well-balanced diet. Instead, the mechanisms are complex and multifactorial and often attributed to components found in these foods, such as vitamins and minerals, as well as dietary fibre and low energy density[5]. Following is a review of the latest evidence related to these mechanisms that support and extend the NHMRC guidelines. The most recent evidence on nutrients and minerals as well as dietary patterns is reviewed to understand the 'potential synergies' between foods on health outcomes. This will be followed later by an overview of the publically available resources that assist individuals to make healthy choices about diet and nutrition.

Antioxidants

Antioxidants are a compound found in foods that neutralise *free radicals*, chemicals with a harmful composition associated with chronic inflammatory response[10]. The body is unable to generate antioxidants itself so they must be obtained in the form of vitamins from dietary sources such as fresh fruit and vegetables[11]. They also occur in other plant based foods such as coffee, tea, wine, and chocolate.

Mechanisms and health risks associated with antioxidants

Antioxidants play an important role in regulating the effects of oxygen free radicals where they may otherwise cause the body stress and inflammation (i.e. oxidative stress)[10]. By combatting oxidative stress, antioxidants help to reduce natural cell death, inflammation, accumulation of cellular debris, and formation of cholesterol deposits on the walls of blood vessels, while promoting recovery of blood vessel tissue and modulating blood flow[10]. Antioxidant intake is also believed to reduce insulin resistance, allowing the body to more efficiently process sugars, contribute to blood pressure stability, and reduce systemic inflammation[12].

The benefits of antioxidant intake include lower likelihood of cardiovascular disease[12], diabetes[13], end-stage kidney disease[14], prostate, breast, and pancreatic cancers[15; 16; 17], and dementia[11].

Dietary Fats

Dietary fats are most frequently discussed in two forms: saturated and unsaturated. *Saturated fats* are often found in dairy products, baked goods, processed foods, and fried foods[5]. *Saturated fats* tend to be associated with adverse health outcomes and it is generally recommended to limit their overall intake. *Unsaturated fats,* including monounsaturated (MUFAs) and polyunsaturated fatty acids (PUFAs), are more generally associated with health benefits. In particular, omega fatty acids (e.g. omega-3 and omega-6 PUFAs) are essential fats that are unable to be created by the human body. These fats are commonly found in fish, vegetable oils, nuts, poultry, lean meat, egg, milk, and margarines spreads[18; 19].

In addition to saturated and unsaturated fats there is a third group of fats known as *trans fats*. These are fats that start out as unsaturated fats but when processed (e.g. high temperature frying of some oils or deliberately making liquid oils become solids), take a similar composition to saturated fats[20]. Literature on trans fats in the context of healthy ageing is limited. However, these fats are often considered preferable to avoid, much in the same way as would be recommended for saturated fats[5].

The Current Australian Guidelines (NHMRC, 2013) for Consumption of Fats per Day
• Total fat should account for between 20 and 35% of energy (kilojoule) intake
• Saturated fats and trans fats should not comprise more than 10% of total energy intake per day
• Between 4 and 10% of energy should come from linoleic acid (omega-6 PUFA) and between 0.4% and 1% from alpha-linolenic acid (omega 3-PUFA)

Mechanisms and health risks associated with fats

Low dietary intake of saturated fats is associated with reduced insulin sensitivity[21], improved sugar processing, lower fasting blood sugars[22], and lower cholesterol and other fats in the bloodstream. Actively reducing saturated fat intake is associated with reduced total and LDL ("bad") cholesterol levels[23].

Conversely, higher unsaturated fat intake is associated with reduced cholesterol in the bloodstream[19; 23], fewer blood-based fats, and reduced systemic inflammation[24], and weaker research indicates unsaturated fat intake is associated with reduced blood pressure[10; 25]. Unsaturated fats are also believed to reduce both LDL ("bad") cholesterol, maintain bone health, regulate metabolism, and stimulate skin and hair growth[18].

Consuming unsaturated fats is therefore associated with reduced risk of stroke and blood pressure issues[26], and there is preliminary evidence that they may be associated with reduced risk of type 2 diabetes[27], gastric cancer[28], and the reduction of disease severity in people with chronic kidney disease[24]. Research also suggests high fish intake is likely to reduce the risk of dementia, although it is unclear whether this effect is tied to unsaturated fats or other qualities of fish[29].

Lower intake of overall fats and saturated fats is associated with reduced risk of endometrial cancer[30] although there is debate within the literature with regards to this relationship[31]. This is perhaps due to the complex relationship between fats and health. For example, although reduced fat diets tend to be associated with weight loss, simply reducing overall fat consumption appears to have no effect on cardiovascular or cerebrovascular disease[32]. In fact, because of the range of foods in which fats are found, a reduced fat diet that increases carbohydrates and limits saturated fats, may not confer the best chances of good health[23]. For instance, regular consumption of dairy products, which contain both saturated and unsaturated fats, is associated with reduced risk of type 2 diabetes [33; 34].

Another dietary fat is cholesterol, both a type of fat found in food, as well as a fat found naturally in the body. When examining the impact of dietary intake of cholesterol as a risk factor for blood cholesterol levels and chronic disease, the literature is limited. Cholesterol intake has been shown to have a modest effect on increasing total blood cholesterol[35] but it has no profound influence on the balance of the high-density lipoprotein (HDL) to low-density lipoprotein (LDL) ratio, which is the greatest predictor of disease risk when considering cholesterol[36]. Nonetheless, lower dietary cholesterol intake is associated with less likelihood of developing Type 2 diabetes[37], and cancers of the pancreas [38] and breast[39]. Please note, that blood cholesterol levels and health outcomes are reviewed further below.

Fibre

There are two broad groups of dietary fibres: soluble (which dissolve in water) and insoluble (which do not dissolve in water)[40]. Soluble fibres are found in bran, flaxseeds, oat, cereal, and pears, and tend to delay the emptying of the stomach and slow digestion by forming a gel as they dissolve[40]. Conversely, insoluble fibres are found in brown rice, barley, cabbage, celery, and whole grains, and increase the efficiency with which the stomach processes foods[40].

The Current Australian Guidelines[5] for Daily Fibre

Men		Women	
19 to 70 years	6 serves	19 to 50 years*	6 serves
70 + years	4/5 serves	51 to 70 years	4 serves
		70+ years	3 serves

A serve of fibre looks like:

- 1 slice of wholegrain bread or ½ a medium roll or flat bread (40g)
- ½ cup cooked rice, pasta, noodles, barley, buckwheat, semolina, polenta, bulgur or quinoa (75–120g)
- ½ cup cooked porridge (120g), 2/3 cup wheat cereal flakes (30g) or cup muesli (30g)
- 3 crispbreads (35g)
- 1 crumpet (60g) or 1 small English muffin or scone (35g)

**Note – pregnant women recommended 8.5 serves and lactating women recommended 9 serves*

Mechanisms and health risks associated with dietary fibre

Together, dietary fibres are believed to elicit the release of satiety hormones, leading to weight reduction and improved glucose metabolism [40; 41; 42]. Dietary fibres also improve immune functioning[43], help to neutralise toxic chemicals and bacteria in the stomach[44], reduce blood pressure, and lower blood cholesterol levels by supporting its breakdown – especially LDL ("bad" cholesterol) – and inhibit its generation[40; 41].

There is no evidence to date indicating the level of fibre intake deemed "too much". Nevertheless, high consumption of insoluble fibre may lead to adverse effects including flatulence, bloating, and diarrhoea(45). Many foods high in dietary fibre also have high levels of antioxidants, providing a combined benefit(46).

Dietary fibre is associated with reduced risk of cardiovascular disease[40], Type 2 diabetes, chronic kidney disease[47], and colorectal, breast[45], renal[48], and pancreatic cancers[49]. One study has even suggested that for every additional 7g of fibre consumed per day, risk of both cardiovascular disease and coronary heart disease decreases by 9%[50]. However, it is unlikely most people are consuming the recommended amount of dietary fibre on a regular basis: in the United States, people consume only around half of the recommended daily intake of fibre[47].

Sugars And Carbohydrates

Sugar is a type of carbohydrate that comes in a number of guises, including fructose, glucose, lactose, and sucrose. Whilst it is generally recognised that the intake of sugar should be limited, it tends to be over-represented in many people's diets. Natural sugars are found in fruit, vegetables and dairy products, but can also be introduced to foods, most commonly in the form of sucrose from sugar cane added to many processed food and drinks.

Both the NHMRC and the World Health Organization recommend[51] that no more than 5-10% of daily dietary energy should comprise added sugars.

Mechanisms and health risks associated with sugar

Lower intake of sugars and carbohydrates is associated with fewer bloodstream fats and higher levels of HDL ("good") cholesterol, although the extent of this effect remains in debate[52]. Because of its association with other risk factors such as body weight, there is limited evidence detecting direct associations between sugars and health. However, research more readily identifies associations between health and sugar-sweetened beverage consumption[53]. For example, sugar-sweetened beverages are associated with several cardiovascular detriments including higher blood pressure [54] and weight gain[55].

Thus, higher sugar and carbohydrate intake is associated with increased risk of stroke[56], diabetes[55], chronic kidney disease[57], cancers of the pancreas, colon, and breast[53; 58], and dementia[59].

However, it is important to also consider the glycaemic index of dietary sugars. Foods with a high glycaemic index have a sugar content that is rapidly processed by the body, which means a larger, shorter-lasting peak in blood sugar levels in response, compared to other foods. Normally, a lower glycaemic index is preferred, especially for its impact on insulin effectiveness relevant to diabetes[60]. Soluble fibres help to delay the processing of food and can contribute to a lower glycaemic response[40].

Calcium

Whilst calcium is well known for its benefits regarding bone strength and density, it appears that too much may have adverse effects on the body. Calcium sources include dairy foods such as milk, cheese and yoghurts. Calcium-fortified products are also available and include soy milk, rice drinks, and some breakfast cereals.

The Australian recommended daily intake for calcium [61] varies according to age and stage of life. The following table is for males and (non-pregnant, non-lactating) females:

The Current Australian Guidelines (NHMRC, 2013) for Consumption of Calcium
• Males 19 to 70 years = 1000 mg/day – upper limit 2500mg/day
• Males 70+ years = 1300 mg /day – upper limit 2500mg/day
• Females 19 to 50 = 1000/mg/day – upper limit 2500mg/day
• Female 51+ years =1300mg / day – upper limit 2500mg/day

Recommended dietary intake of calcium is associated with reduced blood pressure[62], cholesterol[63], and fat absorption[64], and may help to bind bile and fatty acids in the lower gastro-intestinal tract, reducing their capacity to harm surrounding tissue[65]. However, high levels of calcium intake may also have adverse effects on health. Consistently higher-than-recommended intake is associated with arterial calcification and consequent cardiovascular events[66], and it is proposed that intake of lactose through dairy products promotes oxidative stress and contribute to detrimental effects such as chronic inflammation[67].

Thus, calcium may have a u-shaped association with general health. This is notably the case for risk of cardiovascular disease where both higher and lower than recommended levels of calcium intake are associated with stroke, myocardial infarction, and cardiovascular disease in general [63; 68; 69; 70]. Higher intake of calcium appears to reduce the risk of type 2 diabetes [64] although the evidence is unclear for cancers: risk for some cancers has been reported to increase with calcium intake [33] while risk for others decreases[67].

Sodium (Salt)

Salt is required for cell function and nerve signal transmission[71], and plays an important role in ensuring the body retains appropriate blood volume and supply to organs, which affects primary organ function[72]. However, excessive salt (sodium) consumption is harmful to general health. Foods high in added sodium include some breads and cereal products, cheeses, and many processed foods.

The NHMRC[5] recommends limiting added salt in foods. The current advice is to consume no more than 1600mg/day for adults, with an upper limit of 2300mg/day. Foods low in sodium can include fresh and unprocessed foods, such as fresh vegetables and fruit, frozen or tinned vegetables, fruit, and legumes (with no added salt), meats, fish, and milk.

Mechanisms and health risks associated with salt

Salt has its strongest effects on the cardiovascular system. Reducing salt intake is associated with reducing blood pressure, especially for those with high blood pressure [73; 74; 75]. Conversely, excessive salt intake is associated not only with higher blood pressure, but also increased fluid retention, high protein discharge in urine, systemic inflammation, impaired processing of oxygen particles, and dysfunction of blood vessel linings[76]. However, benefits of reducing salt disappear after a certain point, with some studies suggesting extremely low salt intake (<2.3g per day) may in fact increase cardiovascular disease risk[73].

Thus, both higher- (>12g of table salt per day; or 5g of sodium) and considerably lower-than-average (<6.5g salt/day; 2.6g sodium) salt intake is associated with risk of both cardiovascular disease and death [77; 78]. For people with normal-range blood pressure, salt intake does not appear to impact the risk of cardiovascular disease, although it provides a modest increase in risk for people with high blood pressure[73]. High salt intake is associated with a number of factors placing stress on the kidneys [79], and may predispose gastric cancers[80].

These latest research findings regarding the optimum levels of salt/sodium intake per day contradict the current NHMRC guidelines. It is important to note that the NHMRC guidelines are formed from a comprehensive body of evidence, suggesting this is an area of the research that warrants close observation.

Dietary Patterns

Food and nutrients are not consumed in isolation. There has been a great surge of research interest in the synergies of foods that are consumed and how these relate to health and health outcomes across the lifespan. Further, whilst being conscious of individual dietary factors can help improve the healthy intake of nutrients, for some people it may be easier, and more valuable to their health, to shift their overall dietary patterns.

Western Diet

The Western diet is a common dietary pattern for many people in Australia. It is typified by a high energy intake from fats (35-45% of daily intake) – particularly saturated fats – sugar, and salt, accompanied by low intake of fibre, calcium, and vitamin D[81; 82]. Depending on the population in which it is examined, the Western diet is not necessarily associated with changed risk of health outcomes. Rather it is unlikely to show any benefits in mitigating disease risk[83; 84]. In contrast to other dietary patterns, the Western diet has been associated with increased risk of type 2 diabetes [85] and several cancers including colon[81], breast[86], prostate, digestive tract, and lung cancer[87].

Mediterranean Diet

The Mediterranean dietary pattern is typified by high intake of plant foods – such as fruit, vegetables, whole grains, nuts, and legumes – moderate intake of fish, and low intake of eggs, meat, and full-fat dairy, often with low levels of alcohol and olive oil added to the meal (Figure 1)[88]. The Mediterranean diet has been associated with reduced oxygen-related stress following meal consumption[89], strong anti-inflammatory and anti-oxidant effects, and has been linked to lower blood pressure[90; 91], lower risk of obesity and lower cholesterol[90]. The Mediterranean diet is also associated with improved insulin tolerance and blood vessel malleability[91].

With these benefits it follows that adherence to a Mediterranean diet pattern confers many advantages for the cardiovascular system and is associated with reduced risk of type 2 diabetes[90], dementia[92; 93], and breast, colorectal, and gastric cancers[94].

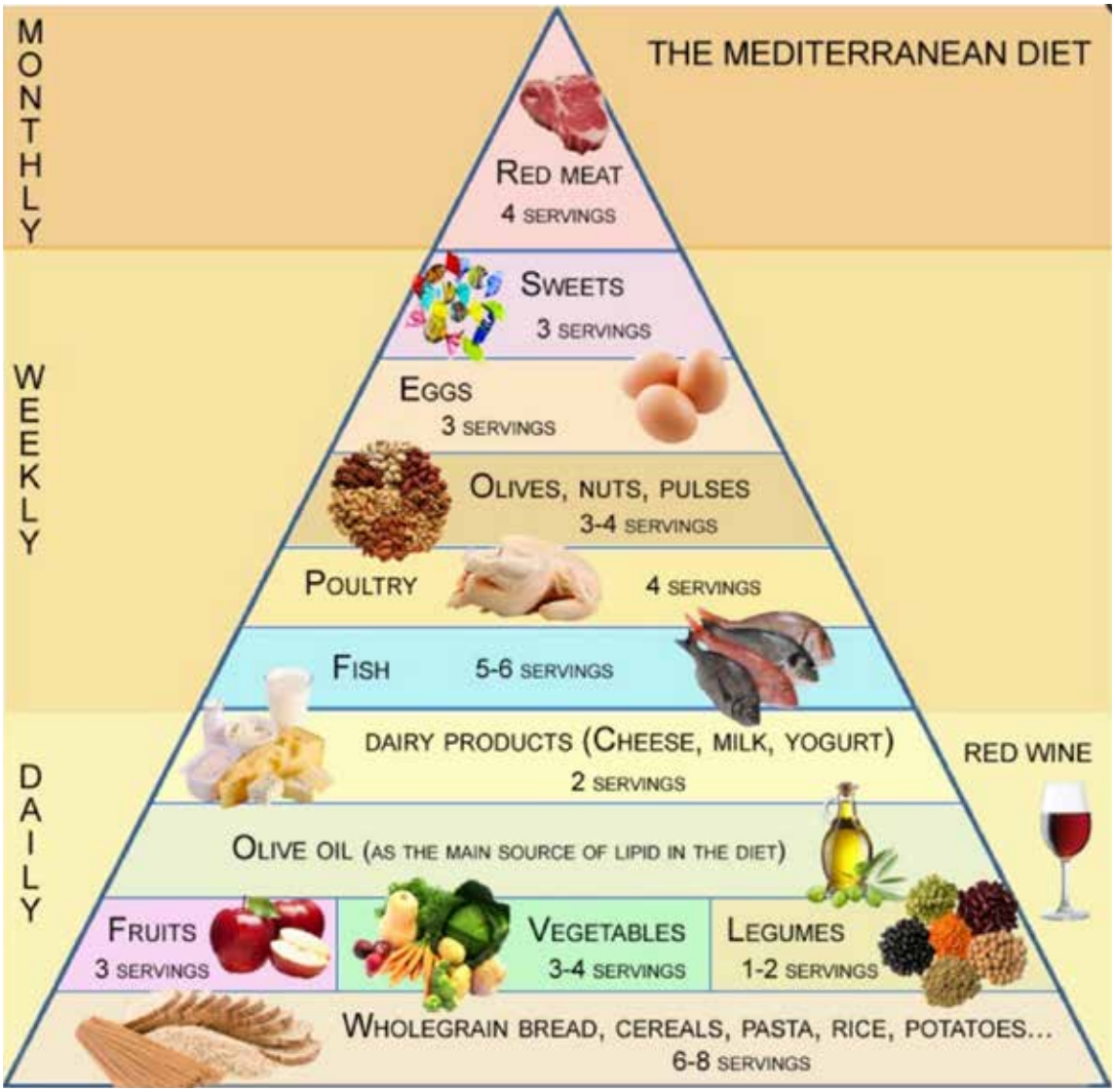

Figure 1. *The Mediterranean diet pyramid with servings. (Source: Aleman et al., 2016, p. 681)*

Dash Diet

The Dietary Approaches to Stop Hypertension (DASH) diet proposes dietary habits aimed at reducing cardiovascular risk factors. It emphasises high intake of fruits, vegetables, protein, fibre, low-fat dairy, whole grains, poultry, fish, and nuts. The aim of the diet is to ensure healthy intake of minerals associated with reduced blood pressure, including potassium, sodium, and calcium. DASH also stipulates low intake of fats, cholesterol, red meat, sweets, and sugar-containing beverages[95].

The DASH diet is associated with health benefits including reduced blood pressure[96], cholesterol[97], and fasting blood glucose levels[98]. In accordance with its aims, a DASH diet is associated with lower risk of all-cause death, cardiovascular disease [99] and stroke[96; 100]. However, a DASH diet is also associated with reduced risk of diabetes[100], and colorectal, breast[99; 101], lung[102], and brain cancers[103].

Daily and Weekly DASH Servings

Food Group	*Daily Servings*
Grains	6 - 8
Meats, Poultry and Fish	≤ 6
Vegetables	4 - 5
Fruit	4 - 5
Low fat dairy	2 - 3
Sodium	2,300mg
	Weekly Servings
Nuts, seeds, dry beans, peas	4 - 5
Sweets	≤5

Summary and conclusions – Diet

Key Dietary Findings

- A varied diet high in nutritious and unprocessed foods, including vegetables, fruits, wholegrains, and low fat meats and dairy is key to good health
- Exchanging saturated fats with unsaturated fats may be a single dietary modification that could elicit high health benefits
- Evidence suggests the Mediterranean and DASH diets are good examples of dietary patterns that meet the Australian dietary guidelines.

The literature presented above generally supports the current NHMRC recommended Australian dietary guidelines of 2013. When specifically looking at healthy ageing and reducing the risk of chronic disease, a varied diet that is high in nutritious and unprocessed foods, including vegetables, fruit, wholegrains, as well as low fat meats and dairy is paramount. Such a diet optimises the intake of necessary antioxidants, fibre, calcium, and unsaturated fats, as well as lowering the intake of saturated fats and added salts and sugars.

With regards to changing current unhealthy eating patterns the literature suggests that exchanging saturated fats with unsaturated fats may elicit high health benefits, particularly through the improvement of blood cholesterol levels. Lower intake of saturated fats and higher intake of polyunsaturated fats is associated with an 18-27% reduced risk of cardiovascular disease[23; 32]. Examples of complete dietary patterns that are beneficial can be found in the Mediterranean or DASH-style diets. Both of these diets are consistent with the Australian dietary guidelines and provide a whole-diet based approach that may be easier to follow for some individuals than attempting to make individual changes to a current diet that does not meet the guidelines.

Alcohol and smoking

Alcohol consumption and smoking are two common lifestyle features that impact a person's health. Both are directly modifiable, albeit not necessarily easy to change. The two have been extensively researched for their relationship to general health and are the topic of frequent caution in many guidelines.

Alcohol

Many people consume alcohol as part of their regular lifestyle and yet alcohol misuse is a major concern for overall health, estimated to contribute 4.6% of global disease burden[104]. In Australia, it is estimated that around 15% of men and 11% of women drink alcohol at either "risky" or "high risk" levels[9], suggesting that for most people, reducing alcohol consumption may be advisable. However, people are increasingly aware that small amounts of alcohol consumption may offer some health benefits[105].

Alcohol consumption is typically discussed in relation to *standard drinks*. Despite some variation internationally, a standard drink is consistently close to 10g of alcohol, the definition applied in Australia[6]. This allows for the fact that different alcoholic beverages are often served in different sizes and contain different alcohol content. For reference, a standard drink is roughly equivalent to a 30mL nip of spirits and means that a regular size can or stubbie of beer tends to contain around 1.4 standard drinks, a restaurant serving of white wine around 1.4 standard drinks, and a restaurant serving of red wine around 1.6 standard drinks[6]. While there is some variation, researchers tend to define heavy consumption of alcohol to exceed four standard drinks per day.

It should be noted that the NHMRC's current (2009) stance on the consumption of alcohol is that there is no level of drinking alcohol that can be considered to be free or safe from risk[6]. The current NHMRC Australian guidelines to reduce health risks from drinking alcohol are therefore designed to advise on the level of drinking alcohol that will allow healthy adults to reduce their risk of adverse alcohol-related outcomes. It recommends that men and women (who are not pregnant or lactating) over the age of 18 should drink no more than two standard drinks per day in order to reduce the health risks over their lifetime.

Mechanisms and health risks associated with alcohol consumption

When consumed in high quantities, alcohol is associated with many health hazards. Several diseases are direct consequences of alcohol misuse (e.g. alcohol use disorders, alcoholic liver disease, and alcohol-induced pancreatitis)[104], and heavy consumption of alcohol raises the risk of a number of other conditions.

Ongoing heavy consumption of alcohol is associated with an increase in harmful hormone activity, rigidity of blood vessel walls, and inhibition of chemicals that induce relaxation of blood vessel walls, resulting in higher blood pressure[106]. It is also associated with increased systemic inflammation through numerous chemical and hormone changes[106], increased cellular damage associated with impaired oxygen processing[107], liver stress[108], and changes to localised DNA and oestrogen metabolism[109].

Heavy alcohol consumption is therefore unsurprisingly linked to increased risk of cardiovascular disease, including coronary heart disease and stroke[106; 110], diabetes[111; 112], breast, pancreatic, mouth, throat, and colorectal cancers[108], and dementia[113].[1]

[1] Although the focus of the present discussion is habitual consumption, it is important to acknowledge that there are additional immediate harmful effects of alcohol (e.g. increased risk of cardiovascular event with moderate alcohol consumption) that differ to the effects of habitual consumption[114].

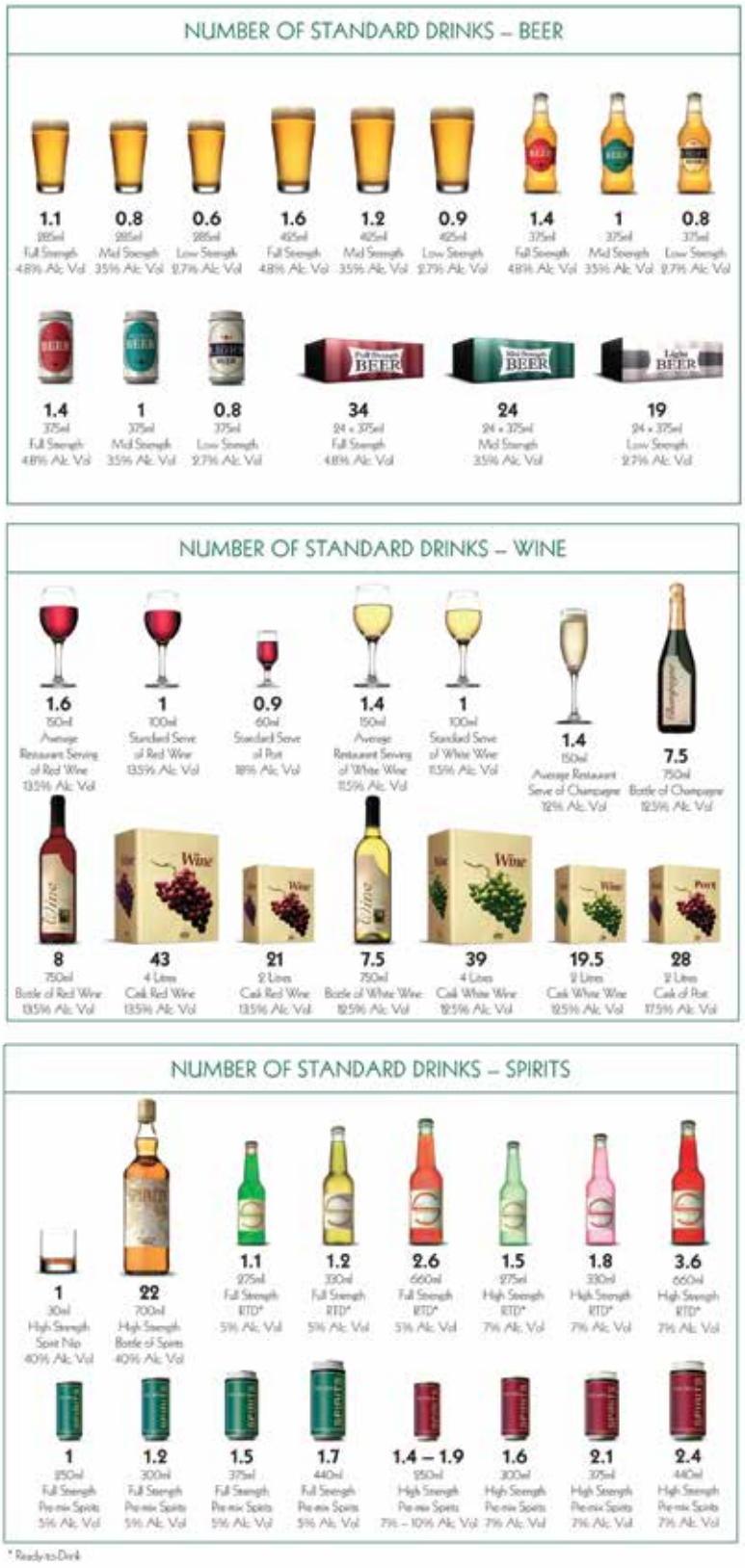

Figure 2. *NHMRC graphic depicting number of standard drinks per alcohol type (source: https://www.nhmrc.gov.au/health-topics/alcohol-guidelines).*

Despite health hazards being associated with heavy consumption, there is research to suggest that alcohol has some health benefits when consumed at low doses in contrast to no alcohol consumption at all. Definitions again vary, but typically *light consumption* of alcohol is considered to be 1-2 standard drinks or less per day, and *moderate consumption* to be less than four standard drinks per day. Evidence points to a J- or U-shaped relationship (Figure 3) between alcohol and the risk of many diseases. This means that initial protective effects of alcohol peak at low levels of consumption and then decline (often rapidly), not just to nullify benefits but to reverse them and increase disease risk.

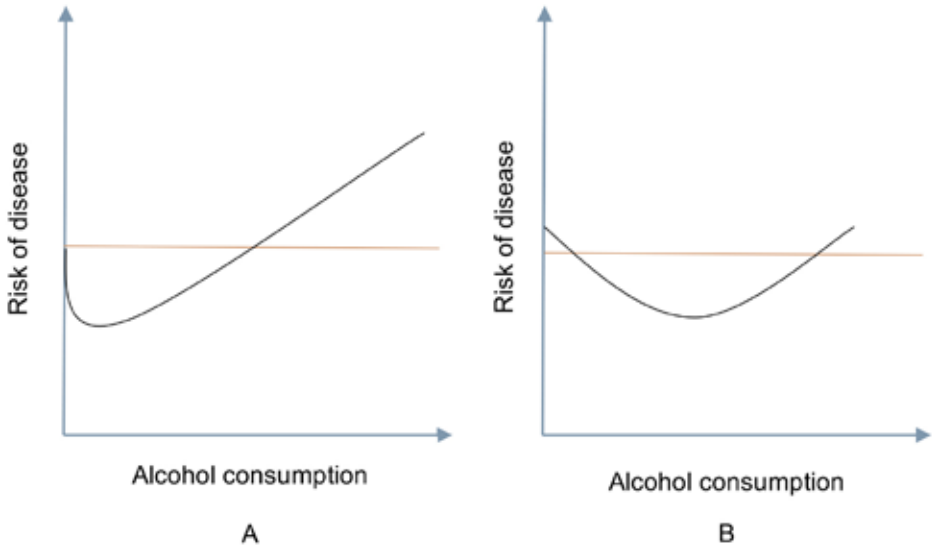

Figure 3. *Graphs showing possible J-shaped (A) and U-shaped (B) interactions between alcohol consumption and risk of disease.*

Moderate consumption of alcohol (i.e. between light and heavy consumption) has mixed effects on healthy ageing – often studies will disagree with one another regarding benefits or harm, while effects differ noticeably between different health outcomes. However, light consumption of alcohol tends to be associated with protective effects, for example, compared to not drinking alcohol, light consumption is believed to increase malleability of blood vessel walls, increase levels of high density lipoproteins (HDL or "good" cholesterol), reduce levels of low density lipoproteins (LDL or "bad" cholesterol)[106; 115], increase anti-inflammatory effects[106; 112], induce antioxidant effects[116], and improve insulin sensitivity and modulation of blood-sugar levels[106]. It has also been suggested that light consumption of alcohol may have protective benefits under the "hormesis theory", suggesting gentle exposure to toxins may stimulate natural defensive responses, such as mechanisms to combat systemic stress associated with impaired oxygen processing or inflammation[113].

Thus, *light* consumption of alcohol is associated with reduced risk of cardiovascular disease[106], stroke[110], diabetes[111; 112], chronic kidney disease[115], and dementia, including Alzheimer's disease and vascular dementia[105; 117]. However, it is important to note that, in many cases, the optimal amount of daily alcohol consumption to reduce risk of disease is one standard drink or less – often an amount less than one normal beverage serving.

There has been some speculation that different alcoholic beverages may have different risk profiles. Research in this area remains limited although initial indications suggest that wine may have more benefits than other beverages, an effect that is likely attributable to the higher levels of antioxidants found in wine[111].

Reflecting the NHMRC's views that there is no guaranteed "safe" or "no risk" level of alcohol consumption[6], there is research suggesting that even low levels of alcohol consumption may increase the risk of some conditions (e.g. breast cancer)[118]. However, the guidelines suggest that consuming no more than two standard drinks on a given day reduces the risks of disease and injury[6]. Research evidence clearly supports these suggestions – potential protective benefits of alcohol peak at low consumption, within the low-risk range provided by the NHMRC, while reviews often suggest that deliberately consuming alcohol as a means to achieving improved health aims is hazardous. One review summarised succinctly that the risks associated with alcohol consumption (from addiction to alcohol-related conditions) outweigh the benefits that may be obtained through light alcohol consumption[106].

Smoking

Tobacco smoking is one of the least controversial factors influencing healthy ageing. It is widely accepted that smoking has substantial detrimental effects on health, with the evidence so strong that warning messages have been included on Australian cigarette and tobacco product packaging for many years. Cigarettes are estimated to contain around 4,000 different chemicals, 400 of which are considered harmful[119]. Research suggests that non-smokers not only live longer but the additional years of life are at better quality of life than smokers[120]. Subsequently, there is no "safe" level for smoking of tobacco products, and a large public health promotion to reduce population based smoking levels to zero.

Mechanisms and health risks associated with tobacco and smoking

Tobacco smoking increases resting heart rate[121], raises LDL ("bad") cholesterol, lowers HDL ("good") cholesterol, thickens blood, narrows blood vessels, increases the clotting capacity of blood, and triggers the release of free radicals[119]. As a consequence of tar accumulating in the lungs, smoking reduces the efficacy of the exchange of respiratory gases, limiting the amount of oxygen absorbed and the expulsion of carbon dioxide, and increasing the intake of carbon monoxide, nitrogen dioxide, and sulphur dioxide[122]. Carbon monoxide, nitrogen dioxide, and sulphur dioxide are believed to interfere with oxygen transportation and reduce the effectiveness of haemoglobin in regulating blood-stream sugars and gases[122]. Thus, combined with similar detriments associated with nicotine, smoking interferes with pancreatic function and increases insulin resistance, leading to increased cell death, blood sugar levels, and cholesterol imbalance[119]. Tobacco smoking also contributes to genetic alterations leading to unusual cell growth and development[123].

Smoking is therefore associated with a number of health conditions. Longer duration and higher intensity of smoking is associated with increased risk of diabetes [124] and chronic kidney disease[125], while being a current smoker is associated with greater risk of cardiovascular disease[121], stroke[120], dementia[120; 126], and several cancers including head and neck[123], pancreatic[108], breast[127], urinary tract[128], and lung cancers[129]. Smoking is believed to cause up to 90% of lung cancer [129] and for people who die of cancer, it is estimated this occurs 10 years earlier in smokers than if they did not smoke[127]. Smoking is also likely to affect the health of those nearby, for example, exposure to secondary smoke increases the risk of cancer [130] and cardiovascular disease[131].

Summary and conclusions - Alcohol and Smoking

Key Findings for Smoking and Alcohol

- Whilst light to moderate levels of alcohol consumption may have some benefits in reducing risk of chronic disease, NHMRC guidelines advise that there are no safe levels of alcohol consumption.
- Tobacco smoking remains the modifiable risk factor with the greatest capability to influence risk of chronic disease.

In summary, there are great risks associated with heavy consumption of alcohol, and those who consume at these levels should consider reducing their consumption to a *maximum* of two drinks per day in accordance with NHMRC recommendations to reduce their risk of adverse health outcomes. While there appear to be some health benefits in light alcohol consumption, it would be ill-advised for people to increase their alcohol consumption to gain these benefits. Any protective effects of alcohol peak very quickly, often less than one regular serving of an alcoholic beverage, and the risks associated with increasing alcohol consumption are likely to outweigh any benefits gained.

While there is some suggestion that smokers may have lower blood pressure[121] and BMI[119] compared to non-smokers, the vast majority of research indicates that smoking has no overall health benefits and numerous detriments. Thus, current smokers are encouraged to make efforts to cease smoking. Ceasing smoking comes with considerable health benefits. Within 48 days of quitting smoking, the levels of HDL ("good") cholesterol has been found to increase by around 15%[119]. Quitting smoking is also associated with reduced blood pressure[121]. In fact, the risk of developing many chronic conditions, including cardiovascular disease and dementia, reduces to similar levels as never-smokers within approximately 10 years of ceasing smoking [119; 132].

Active lifestyle

An active lifestyle is not just a good way to access many enjoyable activities, but also an effective way to improve the likelihood of ageing well. Most people readily think of physical activity when they consider an active lifestyle, but there are important benefits from being both socially and cognitively active as well.

Physical activity

Most people are well aware that physical activity is an important part of a healthy lifestyle yet it is not unusual to hear people chastise themselves for insufficient physical activity. Statistical data suggests this may be appropriate: 35% of Australians lead sedentary lifestyles (i.e. report no physical activity), while 70% report low physical activity in their lifestyles[9].

The Australian Department of Health physical activity and sedentary behaviour guidelines suggest 150-300 minutes of moderate physical activity or 75-150 minutes of vigorous physical activity per week for adults 18 to 64 years of age (or an equivalent combination of both), including being active most days, muscle strengthening activities on at least 2 days every week, and minimising the amount of time spent in prolonged sitting. Moderate intensity physical activity includes brisk walking, recreational swimming, social tennis, and dancing activities that require some effort. Vigorous intensity is physical activity that requires more effort and results in breathing faster, for example, running, fast cycling and heavy lifting tasks. For adults over 65 years of age the recommendations are to be physically active for at least 30 minutes each day.

Mechanisms of physical activity and health risks associated with sedentary behavior

Performing physical activity has wide-ranging benefits including improved blood vessel tissue health, wider blood vessels, increased resistance to blood vessel injury, increased peripheral blood flow, and increased immune responses. It is associated with decreased heart rate, lower blood pressure (especially systolic), reduced arterial stiffness, reduced systemic inflammation, and less oxygen-related stress [133; 134; 135]. Physical activity is also well known to contribute to weight loss, reduce abdominal fat, and increase cardio respiratory fitness[136]. More subtly, physical activity is associated with increased insulin sensitivity, glucose absorption from the bloodstream[137], and the release of chemicals promoting new tissue growth and connections in the brain[138].

Higher levels of physical activity are associated with reduced risk of cardiovascular disease[135], diabetes[137], breast[139], colon, and all-form cancers[140], and dementia[133]. Physical activity is also recommended in the management of many conditions, often associated with reduced likelihood of developing comorbid conditions[136], increasing quality of life[141], and assisting in management of symptoms[142].

Social activity

In contrast to physical activity, many people do not think of social interaction when they think of their health. However, social interaction plays an important part in a healthy lifestyle. Social support is believed to elicit positive effects on disease management via two mechanisms. The first is largely a direct effect whereby social support promotes more positive thinking, emotions, and behaviour. The second mechanism is more of an enabling effect whereby emotional and practical support, and increased access to relevant information, helps facilitate a buffer from some of the stress associated with emotional problems or concerns[143]. Social interaction may also motivate health behaviours and provide additional sources of information relating to better health practices[144].

Social support is associated with better health outcomes at all stages of disease impact, including development and onset, prognosis, and management of health conditions[145]. Conversely, loss of social support is detrimental to health. For example, the death of a spouse is associated with poor health outcomes. Nevertheless, having at least one person who can continue to serve as a confidante nullifies the health risk. The presence of a confidante is associated with fewer depressive symptoms, better self-rated health, and fewer days spent sick in bed[146].

Mechanisms affecting health

While the majority of research examines social support in populations of people with existing health concerns, the limited literature projecting risk of specific illnesses suggests that lower social support has been associated with greater activation of immune, endocrine, and metabolic systems, reduced systemic inflammation and metabolic syndrome[147], while higher social support is also associated with increased complexity of neural connections and increased brain volume[144].

Higher social support is consequently associated with reduced risk of cardiovascular disease[147], Type 2 diabetes[148], cancer[147], dementia[144], and death from any cause[149]. The benefits of social support for those already with a health condition include reduced stress, better psychological wellbeing and quality of life, and increased likelihood of successful treatment adherence [145; 150; 151].

Cognitive activity

A final important aspect of an active lifestyle is cognitive activity. Cognitive activity often promotes social interaction, sense of achievement, and enjoyment in similar ways to social activity. However, research exploring the effects of cognitive activity on health tend to focus on mental health – in the context of this review, dementia. Cognitive activity has been identified as an effective factor in improving or maintaining cognitive health. However, to date, there are no guidelines on the optimum amount of cognitive activity for health benefits, nor is there a consensus on the best activities to perform.

Mechanisms affecting health

Tasks designed to be cognitively stimulating are associated with increased brain activation, which may reflect increased synaptic growth and repair ("neurogenesis" and "neuroplasticity")[152]. Attention and memory are believed to improve as outcomes of this beneficial neurogenesis and neuroplasticity[153]. Higher engagement in cognitively demanding activities – such as reading books or newspapers, writing letters or emails, and playing games – is also associated with reduced accumulation of the extracellular plaques that are hallmarks of Alzheimer's disease[154]. Having a more active cognitive lifestyle, including both occupational and social activities, is associated with a 40% decreased risk of dementia compared to low cognitive activity[155].

Summary and conclusions – Active lifestyle

Key Findings for Activity

- Engaging in regular physical, social, and cognitive activity reduces the risk for a number of chronic diseases and has many benefits for healthy ageing.
- The AIHW not only recommends regular physical activity to improve and maintain health, but also less sedentary time.

The AIHW data[9] suggests a considerable majority of Australians are spending too much time sedentary, as well as not performing enough physical activity. Even for those who meet the recommended physical activity levels to gain the health benefits, their likelihood of ageing well and in good health could be further increased with additional physical activity.

Although some of these benefits can be attained with relatively little exercise – for example 15 minutes of daily exercise is estimated to reduce risk of death by cardiovascular disease by approximately 15%[135] – the benefits of exercise tend to accumulate with greater activity. There are a number of methodological difficulties in comparing different intensities of exercise. However, as a general rule, higher intensity exercise tends to require less time per session to achieve health benefits. Therefore the current Australian physical activity and sedentary behaviour guidelines remain relevant.

A lifestyle including regular social activity has many benefits for healthy ageing, which suggests social activity should be considered an important factor in a healthy lifestyle. There are no evidenced-based thresholds available for the benefits to health as a function of "number" of social interactions or social support persons, nevertheless, promoting social activity as a pathway to ageing well is important and the benefits should be better promulgated.

Cognitive stimulation is an effective way to retain positive cognitive health. Any activity that is either novel or mentally challenging is likely to provide cognitive stimulation. Many people find "brain training" games appealing however evidence of their efficacy is typically lacking[156]. While they are likely to benefit targeted brain functions (e.g. programs designed to improve memory or speed of processing may achieve this), there is little evidence of the generalisability across different brain functions[157]. Nevertheless, the evidence is building that remaining cognitively active and stimulated is beneficial for brain health and dementia risk reduction.

Medical and metabolic factors

Medical conditions, themselves, often serve as risk factors for other chronic conditions. In many cases these medical conditions stem from failing to observe healthy lifestyle habits, contributing to further risk factors. However, individual medical factors are often strongly tied to chronic conditions, especially if untreated. They may have a direct influence on healthy ageing, but it is important to note the close relationships they often share – many health outcomes share the risk factors of obesity, cholesterol, diabetes, depression, and metabolic syndrome, further compounding adverse effects on health. These factors are reviewed here in turn.

Weight and body mass

AIHW data suggests approximately 68% of adult men and 55% of women are overweight or obese[9]. Weight categories are usually measured through the Body Mass Index (BMI) or waist circumference. BMI is calculated as a ratio of weight to height (kg/m^2), and is categorised as underweight (BMI < 18.5), normal (18.5 – 25), overweight (25 – 30), or obese (> 30)[9; 158]. Waist circumference is measured at the top of the hips, around the height of the navel. It is more sensitive to adiposity (the amount of fat gathered around the midriff) but is less commonly used than BMI as it is does not adjust for height. A waist measurement exceeding 94cm for men and 80cm for women is indicative of overweight, while obese exceeds 102cm for men and 88cm for women[9]. Finally, some studies utilise a waist-to-hip ratio to evaluate whether the location in which body mass is distributed may predict different outcomes. The waist-to-hip ratio compares the waist circumference to a similar measurement around the hips.

The Australian Department of Health recommends a healthy BMI for adults within the "normal" range, between 18.5 and 24.9. Noted exceptions include a lower healthy BMI for people of Asian background, and higher for people with Polynesian origin, older people and those with higher than normal levels of lean body tissue, for example, elite athletes.

Mechanisms affecting health

Obesity leads to changes in a number of hormonal signals associated with feeding, energy expenditure, and systemic inflammation, and is believed to impact many bodily systems via interaction with the hypothalamus-pituitary-adrenal axis (a multiple-organ system in the body)[159]. However, more independently, being overweight is associated with higher blood pressure and cholesterol[158], and adiposity (having a large amount of fat accumulated around the midriff) is associated with higher blood pressure, insulin resistance, cholesterol imbalance, hormonal imbalances, abnormal heart structure, oxidative stress, and sleep-disordered breathing[160].

Being overweight or obese is associated with increased risk of stroke[161], chronic kidney disease[162], and cancers including gall bladder[163], breast[164], and ovarian cancer[165]. Meanwhile, a lower waist circumference is associated with reduced risk of Type 2 diabetes [166] and lower risk of lung[167], breast, endometrial, digestive, liver, biliary, and leukaemia cancers[165]. Having either overweight BMI or a greater amount of adiposity is associated with increased risk of cardiovascular disease and Type 2 diabetes [160; 168].

Importantly though, being underweight in older age is likely to confer risks to healthy ageing as well. Some research suggests around one in every six people (16.4%) who are underweight, have similar metabolic abnormalities to people who are obese [169] and may be associated with decreased likelihood of surviving heart attack, [170] and increased risk of dementia [171].

Cholesterol

Notwithstanding its notoriety, cholesterol serves vital functions in the human body. It is predominantly involved in lining cell walls, especially in the central nervous system[172]. However, abnormal levels of cholesterol are an issue for the Australian population. Overall, around 32.5% of the Australian population are estimated to have abnormal total cholesterol levels, which corresponds very closely to abnormal levels of LDL cholesterols (32.8%) and moderately to HDL cholesterol (23.3%)[173]. Often cholesterol is discussed as "good" cholesterol (High Density Lipoproteins or HDL cholesterol) and "bad" cholesterol (Low Density Lipoproteins or LDL cholesterol). In healthy functioning, LDL is involved in transporting blood-based fats from the liver to peripheral tissue and regulating synthesis of additional cholesterol[174]. Where this becomes detrimental is when higher levels of LDL retain fats within blood vessels, promoting the formation of fatty plaques[174]. Similarly to LDL, HDL also enables blood-based fats to be transported within the blood stream, although it additionally functions to remove cholesterol from accumulations within arteries and return it to the liver for excretion or re-use[174]. Thus, the balance between LDL and HDL is important to regulating the presence of fats circulating within the blood stream.

Mechanisms affecting health

When discussed as the common metabolic condition, high cholesterol normally refers to elevated total cholesterol levels. When total cholesterol is high, this normally manifests as higher levels of LDL cholesterol and lower HDL cholesterol [174]. This cholesterol profile is associated with increased accumulation of fatty deposits on blood vessel walls and hardening of artery walls [174]. It is also associated with impaired efficiency of the role HDL cholesterol plays in reducing stress associated with processing of oxygen [175] and disrupted functioning of the blood brain barrier [176], a barrier serving to separate the blood stream and the chemically sensitive environment surrounding brain cells. Finally, high cholesterol promotes chronic inflammation, bile excretion, digestive infections, uncontrolled cellular generation, and reduced natural cell death [174; 175].

Compelling evidence links high cholesterol to cardiovascular disease: as fatty deposits accumulate in accordance with high levels of LDL cholesterol, these plaques tend to increase in number and size, and may obstruct and/or rupture blood vessels[174]. However, strong evidence suggests that maintaining healthy cholesterol levels protects against many other diseases including Type 2 diabetes[177], colorectal[175], breast[178], and liver cancers[179]. For dementia, healthy cholesterol in mid-life (40-59 years of age), but not necessarily in late life (60+ years), is especially helpful in reducing dementia risk[176; 180]. High levels of cholesterol are also commonly seen alongside chronic kidney disease and are associated with worsened disease progression. However, it is unclear to what extent high cholesterol leads to chronic kidney disease and to what extent it is a symptom[181].

Diabetes

Diabetes, or *diabetes mellitus*, is a metabolic disorder characterised by an imbalance between levels of insulin, secreted by the pancreas, and blood sugars. Insulin plays an important role in the body processing sugars from the blood stream. Thus, in people with diabetes, insulin levels tend to be lower and blood sugars higher. Diabetes is normally discussed with reference to two types: Type 1 diabetes is an auto-immune disease most often acquired early in life and, because it is characterised in deficits producing insulin, typically requires treatment with insulin. Type 2 diabetes tends to develop later in life and is most often influenced by lifestyle behaviours. It is characterised by blood sugars rising rapidly after eating, meaning it may be managed by either insulin treatment or other medications[182]. Diabetes has many effects on the human body as a whole, and given the association of Type 2 diabetes with poor diet and obesity, it can be difficult to determine what factors are diabetic-specific and what are a result of comorbidities. Nonetheless, diabetes has mechanisms linking it to cardiovascular disease, chronic kidney disease, and dementia, while it is associated with increased incidence and reduced survival in several cancers including colorectal[183], breast[184], pancreatic, lung, bladder, gastric, prostate, and kidney cancers[185].

Mechanisms affecting health and associations with chronic diseases

High blood glucose levels are associated with increased oxygen-related stress, inflammation, dysfunction of blood vessel tissues, changes to heart muscle, and formation of plaques along blood vessel walls[186], promoting the risk of cardiovascular disease[187; 188].

These same effects may contribute to the risk of dementia via effects on cerebral blood vessels[182]. However, as the brain requires considerable energy, metabolism of sugars may play an important role in explaining cognitive performance; indeed, unusual insulin profiles are observed in some forms of dementia [182; 189], although how these may specifically contribute to cognitive decline and dementia is unclear.

The strongest link between diabetes and chronic health conditions is with chronic kidney disease. Diabetes is considered one direct cause of chronic kidney disease incidence, and accelerates its progression[190]. Diabetes-associated chronic kidney disease is estimated to occur in 30-40% of people with Type 1 diabetes and in around 25% in those with Type 2 diabetes[190], ultimately contributing to around 50% of people with end-stage kidney disease[187]. Rates of this “diabetic kidney disease” have been increasing far more rapidly than

overall rates of chronic kidney disease, an increase largely attributed to the proportion of people with Type 2 diabetes[190]. This association may be explained through the increased prevalence of advanced glycated end (AGE) products in diabetes[191]. These AGE products are normally processed by the kidneys but their presence actually inhibits effective kidney function[191]. This contributes to an ongoing excess of AGE products which perpetuates lower kidney function because the kidneys are unable to clear the existing AGE products and, as AGE products accumulate, kidney function becomes further compromised[191].

Metabolic syndrome

While independent risk factors may impact the risk of disease, the risk factors themselves often interact with one another to further increase risk of chronic disease. An example of such a scenario is metabolic syndrome. Metabolic syndrome refers to a combination of three or more specified risk factors. The specified risk factors vary between definitions used by different organisations although the most common definitions consistently specify: a) obesity (by BMI) or central obesity (by waist circumference); b) diabetes, insulin resistance, or high fasting blood sugars; c) high blood pressure; and d) high blood-based fats [192]. Depending on the definition applied, it may also include high excretion of liver proteins in urine or low HDL ("good") cholesterol levels[192; 193]. The prevalence of metabolic syndrome in Australian adults is estimated to be between 21.7% and 30.7%[193].

Mechanisms affecting health and associations with chronic diseases

Metabolic syndrome shares the same risk mechanisms as its individual components, including blood and circulatory effects, hormonal imbalances, and disruptions with many wide reaching systems linking multiple organs[194; 195]. Consequently, it is also similarly linked to increased risk of chronic diseases [192; 194; 195; 196].

It is presumed that these factors do not simply overlap, but the presence of multiple risk factors within metabolic syndrome is believed to increase the risk of disease beyond its individual factors, especially Type 2 diabetes and cardiovascular disease[195]. However, exploring this hypothesis is statistically difficult as features of metabolic syndrome are often indicators of disease, not just risk factors. For example, high blood pressure may be an early indicator of cardiovascular disease, while insulin resistance may similarly be an early marker of Type 2 diabetes. Thus, research in this area is often informed by understanding of the interaction between the different mechanisms contributing to the syndrome rather than comparing risk effects as occurs for many other risk factors.

Mental Health

The importance of mental health to general health outcomes is often under-considered. By definition, mental health is important to the experience of healthy ageing as it reflects more positive experiences in all areas of life, but it also impacts physical health. The World Health Organization[197] defines mental health as a state of wellbeing where an individual can realise their full potential, be productive and contribute to the community, as well as cope with normal life stresses. Therefore, poor mental health inhibits these abilities. Threats to good mental health include mental illness such as depression and anxiety disorders.

Mechanisms affecting health

Depression and poor mental health have been associated with a number of bodily systems. For example, the sympathetic nervous system and hypothalamic-pituitary-adrenal axis, both of which function to increase physiological arousal in response to threat, can be chronically activated by poor mental health. This can lead to a number of detrimental effects including higher blood pressure, resting heart rate, cardiac workload, overproduction of chemical signals inducing inflammation, and insulin resistance[198; 199]. Poorer mental health is also associated with reduced physical activity and increased body weight[200], increased likelihood of smoking[201], and poorer treatment adherence including adherence to medication protocols[198]; all factors associated with additional wide-reaching physiological effects.

On a localised scale, poor mental health is associated with increased inflammation around the brain, physiological stress associated with oxygen metabolism, and structural damage to the brain[202; 203]. It also increases susceptibility to cardiac arrhythmia, metabolic issues, cardiovascular reactivity, and impaired capacity to respond to localised or systemic inflammation[198].

Depression is a strong predictor of cognitive impairment and dementia, and higher symptomatology is associated with higher risk[203; 204]. Most associations between mental health and chronic diseases are via general psychological stress or anxiety. In this way poorer mental health is associated with increased risk of cardiovascular disease[205], Type 2 diabetes[201], and chronic kidney disease[206].

The associations between mental health and physical health tend to be very strong. For example, having anxiety raises the risk of cardiovascular disease to a similar extent as being overweight or obese[207]. The relationship between mental health and disease is often bi-directional as well. Clearly identifiable bi-directional relationships are seen between mental health and diabetes [201] and chronic kidney disease[206], while mental health concerns are highly prevalent in cancer[143], cardiovascular disease[205], and dementia[204].

Summary and conclusions – medical and metabolic factors

Key Findings for Medical and Metabolic Factors

- Maintaining healthy weight, cholesterol, and blood sugars are important to ageing well.
- Many medical and metabolic factors exacerbate the risk of developing a chronic health condition.
- Having multiple risk factors for chronic conditions is considered more harmful than their individual effects alone.

The latest literature supports Australian guidelines that indicate maintaining a healthy weight and cholesterol levels, and reducing the risk of Type 2 diabetes and metabolic syndrome, reduces the risk of chronic disease and improves the likelihood of ageing well. In addition, the link remains strong between mental health and chronic condition risk. Maintaining a healthy weight range, through lifestyle behaviours such as following a nutritional diet, limiting alcohol consumption, performing physical exercise, and not smoking, has an interactive benefit in that it reduces the risk of developing high cholesterol, Type 2 diabetes, metabolic syndrome, and mental illness, and assists in the management of these conditions.

Whilst a healthy weight range is of great importance to overall physical and mental health, healthy ageing, and reduction in the risk of chronic disease, it is important to note the measurements of weight status discussed are designed to be generalisable to the average person and do not take into account individual differences such as body composition (proportion of bone, muscle, and fat etc.) and body shape. Another important consideration is that, while the risk of developing Type 1 diabetes is largely not considered to be modifiable, adopting optimum lifestyle behaviours as per the above Australian guidelines, with modifications as discussed with health practitioners where necessary, has been shown to be beneficial in diabetes management[208].

Online resources for lifestyle risk factors

The internet provides boundless opportunities to source information quickly and easily. It is, therefore, little surprise that the internet is increasingly being used to find health and medical information. It has been estimated that the percentage of internet users who search for health information online is close to 80%[209], with commercial sites making up the majority of websites used. With a plethora of information so close to hand, it is desirable for consumers to have the capacity to separate the strongest resources from the remaining available resources. However, the quality of online resources is not always apparent, making it essential that a clear source of reliable information on healthy ageing is easily accessible and identifiable for consumers.

The following is a selective review of available online resources for health and healthy ageing. As outlined earlier, the internet was searched for publically accessible, e-health resources focusing on the modifiable lifestyle behaviours targeted in the preceding literature review. The search prioritised government and non-profit organisation websites originating in Australia. In selecting key resources, the criteria considered included the quality of information presented on the website, the extent to which content adhered to Australian guidelines, the breadth of the content of the resource, whether an intervention tool was provided, and if so, if the tool had a theoretical or evidence base, and the accessibility of the resource.

Table 1 lists the websites identified and evaluated for this review and indicates categories of the types of information and tools that are available within them. These include:

- Guidelines and recommendations (government-issued recommendations on a lifestyle factor);
- Information (resources identifying benefits or risks associated with a behaviour, and resources identifying good lifestyle behaviours);
- Self-assessment and preparation tools (resources providing self-assessment tools, such as self-tests, and resources helping to link people to services that may support them to change their behaviour);
- Self-support and intervention tools (services actively guiding behaviour change, e.g. online programmes); and
- Ongoing personalised support resources (services offering personal contact, e.g. helplines).

	Guidelines	Information	Preparation	Interventions	Personalised
Diet					
CSIRO	×	×	✓	×	×
Eat for Health	✓	✓	✓	×	×
Healthy Weight Guide	×	✓	✓	✓	×
Heart Foundation	×	✓	✓	×	×
Live Lighter	×	✓	✓	×	×
NHMRC	✓	✓	×	×	×
University of Newcastle	×	×	✓	×	×
Alcohol					
Alcohol Think Again	✓	✓	✓	×	×
Counselling Online	×	×	(✓)	(✓)	✓
Down Your Drink (UK)	×	✓	✓	✓	×
Department of Health	✓	✓	✓	×	×
DrinkWise	×	✓	×	×	×
The Right Mix	✓	✓	✓	✓	×
NHMRC	✓	✓	×	×	×
Smoking					
Help to Quit	×	✓	✓	×	×
Make Smoking History	×	✓	✓	×	×
Quit	×	✓	✓	✓	✓
Physical activity					
Department of Health	✓	✓	✓	✓	×
Healthy Weight Guide	×	×	✓	✓	×
Heart Foundation	✓	✓	✓	×	×
National Seniors Australia	✓	✓	×	×	×
Social activity					
Meetup	×	×	✓	×	×
Cognitive activity – for dementia					
Alzheimer's Australia	×	✓	✓	✓	×
Cambridge Brain Sciences (UK)	×	×	×	✓	×
Your Brain Matters	×	✓	✓	✓	×
Obesity					
AIHW	✓	✓	✓	×	×
Department of Health	✓	✓	✓	×	×
Healthy Weight Guide	×	✓	✓	✓	×
Cholesterol					
AIHW	✓	✓	×	×	×
CSIRO	✓	✓	×	×	×
Health Direct	×	×	✓	×	×
Heart Foundation	×	✓	✓	×	×
Diabetes					
Department of Health	N/A	✓	×	×	×
Diabetes Australia	N/A	✓	✓	×	✓
Health Direct	N/A	✓	×	×	×
Mental health					
Beyond Blue	N/A	✓	✓	✓	✓
Black Dog Institute	N/A	✓	✓	✓	✓
High Res	N/A	×	✓	✓	×
Lifeline	N/A	×	✓	×	✓
Mind Health Connect	N/A	✓	✓	×	×
Mind Spot	N/A	✓	✓	✓	✓
Mood Gym	N/A	×	✓	✓	×
SANE Australia	N/A	✓	×	×	✓
Suicide Call Back Service	N/A	✓	✓	×	✓

Table 1. *Types of information and tools available in selected online resources*

Diet

There are many dietary resources available online. In the current search, prioritising Australian government and not-for-profit organisation resources, these resources function best to raise awareness of guidelines and the health benefits and risks associated with diet. For the most part, assessment and planning resources focused on self-assessment tools allowing people to reflect on their current diet rather than resources that also supported a person to plan ahead when making changes to diet.

Evidence-based guidelines are well resourced with the National Health and Medical Research Council (NHMRC) publishing the guidelines both formally as a report[2] and, with support from the Department of Health, in a more consumer-friendly form via the *Eat for Health* website.[3] The formal guidelines are presented alongside a comprehensive literature review outlining the research on which they are based. Both the guidelines website and *Eat for Health* offers consumers access to simplified prompts such as printable summaries, posters, and fridge magnets.

General information on how to observe a healthy diet and health risks and benefits is an area particularly well-supported. This information was offered by all resources except the CSIRO and University of Newcastle dietary assessment pages. Notably, the *Healthy Weight Guide*[4] and the Heart Foundation[5] provide comprehensive information written in plain language to inform their audience about healthy dietary factors. For a more scientifically-inclined audience, the NHMRC website again offers information within the literature review providing background on the effects of diet on health risks and benefits. Many useful factsheets are available reflecting both healthier eating and health outcomes associated with diet on the *Live Lighter*[6] website. However, these must be downloaded and read as documents, reducing their accessibility for web users.

Several online resources offer self-assessment tools for diet. These include CSIRO[7] and University of Newcastle[8] websites. Both offer an evidence-based assessment of dietary patterns, providing both an overall score, and feedback on where the respondent may be able to improve their diet. The *CSIRO Healthy Diet Score* is based on the NHMRC formal guidelines while the quizzes designed by the University of Newcastle are approximately consistent with their recommendations. However, the CSIRO measure may have some commercial motives for their instruments with the score presented alongside the suggestion that their "Total Wellbeing Diet" may help respondents improve their score.

While several websites offered support for people looking to plan changes to their diet, the *Healthy Weight Guide* website was a standout resource as it offered tools to help people plan changes to their diet but these tools would also have applicability to a wide range of lifestyle factors. In general, most planning resources for diet related primarily to recipe suggestions, such as in the case of *Eat for Health,* Heart Foundation, and *Live Lighter* websites.

Only one online resource*, the Healthy Weight Guide,* was identified as actively supporting people as they attempted to adjust dietary habits. This resource focuses on weight as an outcome and, therefore, also includes physical activity within its tools, providing participants with the opportunity to set and track goals, including dietary changes.

Sadly, the dietary resources outlined above tend to be poorly promoted. While NHMRC and CSIRO resources appeared on the first page of our Google internet search for "diet Australia", the University of Newcastle's *Healthy Eating Quiz* did not appear until the ninth page (84th search result) and none of the *Healthy Weight Guide*, *Heart Foundation*, or *Live Lighter* websites appeared in the first ten pages (i.e. top 100 results). At the time of the review, no satisfactory personalised support services were identified for diet.

[2] https://www.nhmrc.gov.au/guidelines-publications/n55
[3] https://www.eatforhealth.gov.au/
[4] http://healthyweight.health.gov.au/
[5] https://www.heartfoundation.org.au/
[6] https://livelighter.com.au/
[7] https://my.totalwellbeingdiet.com/healthy-diet-score
[8] http://healthyeatingquiz.com.au/

Alcohol

Australian guidelines for the consumption of alcohol are well disseminated. They are formally published alongside their accompanying literature review on the National Health and Medical Research Council (NHMRC)[9] website. They are re-stated in simple form on the *Alcohol Think Again*[10] website and conveyed alongside plain-language information, although in an aesthetically simple format, on the Department of Health's[11] website. Guidelines are also published on one of the factsheets available on the Department of Veterans' Affairs' *The Right Mix*[12] website, although neither the guidelines nor links to this factsheet appeared obviously within main webpage content.

Information on the effects of alcohol on the body and its contribution to risk of health complications is published on all the websites we mention, except *Counselling Online*. *Alcohol Think Again, DrinkWise*[13], and The Right Mix are all notably good at disseminating this research for a lay audience. *Alcohol Think Again* has a number of infographics and brief pages identifying risks associated with alcohol consumption, but also contains detailed information on the mechanisms through which alcohol may contribute to specific diseases. *DrinkWise* is targeted at an audience of teens and/or their parents. This means information is available in very simplified form but the breadth of content covered is still considerably comprehensive. *The Right Mix* contains very readable and simple information on a number of effects of alcohol to health and wellbeing. However, the website user must scroll through information, without having access to a reference menu, in order to explore all the content available, which may limit how usable some find the content. The NHMRC website is the strongest scientific source of information of the resources we identified, with guidelines accompanied by a comprehensive review detailing their rationale. The Department of Health provides some brief useful information although the structure of the webpage is not user-friendly in comparison to other websites listed.

Many sites also have useful resources to help someone plan changes to their alcohol consumption. *The Right Mix* includes assessment tools for both drinking and lifestyle motivation, and has tools to help people form a plan for change based on some recommended strategies. *Alcohol Think Again* offers self-assessment tools for alcohol consumption as well as an interactive standard drink activity, and tips on how to maintain low health risks associated with alcohol consumption. The Department of Health website also offers a brief quiz to test people's understanding of the current guidelines for alcohol consumption. Finally, the *Counselling Online*[14] website appears to have plans for content that will be devoted to some useful planning resources, however, the majority of content on this website is currently inactive.

For resources supporting active changes to alcohol consumption, *The Right Mix* website was the only active Australian resource identified by the present search. In terms of active support, this website is relatively basic with the most useful tools focusing on monitoring of change relative to identified goals. The *Counselling Online* website again appears to have upcoming utility in supporting those actively changing, although at present its self-help modules are inactive. Given the sparsity of appropriate resources available from Australian sources, we also thought it appropriate to mention the UK-based *Down Your Drink*[15] website. This website is available to Australian users and allows users to access information specific to their current situation. This includes journal recording tools and self-assessments among its tools.

Surprisingly, there is no single national resource providing telephone support to people seeking further information or support regarding alcohol consumption. However, these services are available in every state via the Alcohol Drug Information Service (ADIS). It appears the gap for a single national provider may be filled by the *Counselling Online* website and helpline. *Counselling Online* currently offers a web-based chat service with peer support forums earmarked for activation soon.

[9] https://www.nhmrc.gov.au/guidelines-publications/ds10
[10] http://alcoholthinkagain.com.au/
[11] http://www.alcohol.gov.au/internet/alcohol/publishing.nsf/Content/home
[12] https://www.therightmix.gov.au/
[13] https://drinkwise.org.au/
[14] https://www.counsellingonline.org.au/
[15] https://www.downyourdrink.org.uk/

Unfortunately, resources for alcohol consumption aren't effectively publicised online. While information resources are readily available – *Alcohol Think Again*, Department of Health, *DrinkWise*, and NHMRC websites all appeared on the first page of our Google search (i.e. within the first 10 results) – those supporting active change to alcohol consumption and providing personal support are difficult to find. Neither the *Counselling Online* or *The Right Mix* website appeared within the first 10 pages (i.e. within the first 100 results) of a Google search of "alcohol and Australia", meaning that, in reality, these services are unlikely to be readily identifiable to a general user of the internet.

Smoking

There are many publically available smoking resources online. We have elected to speak about only three which cover smoking particularly well. In discussion of smoking resources, it is important to note there is a lack of formal guidelines regarding tobacco smoking, presumably as it is well-known that no level of tobacco smoking is advisable.

Many websites discuss the harms of smoking although frequently with a narrowed focus to a specific group of health outcomes (e.g. cardiovascular disease). The three websites we selected provide a good broad reflection of the health hazards associated with smoking. This is often the information found on pages discussing smoking. Each of the websites we discuss provide an additional novel way to engage with smoking in addition to generic health information. *Help to Quit*[16] provides a tool for people to calculate the amount of financial savings they would make in tax alone and outline health benefits as well as the harms of smoking. *Make Smoking History* again points out the health and financial benefits of quitting, but also identifies the health effects of second-hand smoke on others. Finally, the *Quit*[18] website provide both health risks of smoking and benefits of quitting, but also provide an "Other reasons for quitting" page which highlights other possible motivating factors including sections on regaining control, freeing yourself from the hassles of smoking, being a role model, protecting others, quitting for surgery, and following doctors' advice.

Each of the websites we selected also offer resources to help people prepare for changing their smoking behaviour. The *Help to Quit* website provides a wide range of information to support people in changing, including information on different methods of quitting, likely symptoms of withdrawal and possible ways to respond, a selection of questions that may be useful to ask a doctor about quitting, and a wide range of tips to help make a quitting attempt successful. The website also provides a "Find a Doctor" map tool, although this appears only partly effective. The *Make Smoking History* website provides a wide range of information and suggestions on how to mentally approach an attempt to quit smoking, and information to help a person be prepared for the potential challenges quitting entails. The *Quit* website also provides tips on how to prepare for an effort to quit and information on different methods of quitting. Of particular use could be the "Coaching Selection Guide", which helps people to select support services they may wish to access as they attempt to quit.

Only limited online support for people actively changing their smoking habits was identified. *Quit* offers tools to monitor progress while quitting, although these have very limited interactive content. However there is a "Quit Now: My QuitBuddy" smartphone application available which is presented on the Government's website and appears affiliated with *Quit*.

There is a clearly publicised, dedicated helpline – 13 78 48 (13 QUIT) – for people to gain support or information about tobacco smoking. This is operated through the *Quit* channels and also offers a callback service.

In contrast to diet and alcohol online resources, smoking resources are easily identifiable through a regular internet search.

[16] https://www.helptoquit.com.au/
[17] https://makesmokinghistory.org.au/

Physical activity

Guidelines for physical activity are clearly stated for both the general population and some age groups on the Department of Health[19] website. These guidelines are repeated elsewhere including in text form on the Heart Foundation[20] website, and in an accessible infographic on a helpsheet produced by National Seniors Australia[21].

Alongside the guidelines, each of the above resources provide information about the health benefits of physical activity. This is best served by the Department of Health website, as they justify their guidelines, while it is given brief mention by the Heart Foundation and National Seniors Australia.

In regards to materials supporting people in preparing to change their behaviour, the *Healthy Weight Guide*[22] website is particularly useful as it provides interactive content, including some tools, in an accessible online form. The Department of Health website also provides effective planning tools and useful advice on preparing to change physical activity behaviour. However, this content is not interactive and although an online version of their activity change booklet is available the presentation of content in planning sections is less clear. The Heart Foundation provides wide-ranging and useful information to support people in considering different ways to improve their physical activity although content is not interactive. Nonetheless, one particularly useful feature of their website is their link to walking groups, which are only available in limited locations but do offer an effective entry-level physical activity for people with a group nearby.

For those actively seeking to change behaviour, the *Healthy Weight Guide* website again appears to be the strongest resource. As they offer interactive tools for both planning and monitoring physical activity online, this is the most readily accessible internet based resource. Comparatively, the Department of Health, via their "Choose Health: Be Active – A Physical Activity Guide for Older Australians" booklet offers similarly useful planning and monitoring tools. However, for these to be used effectively, a person must download and print the brochure for manual use.

Our search identified no suitable and readily available personalised services for people wishing to speak to someone about their physical activity.

Sadly, the highest quality resources for physical activity are not necessarily easy to identify. Many informative websites are available for physical activity in the realm of individual health conditions although those examining physical activity more generally are harder to locate. The Department of Health guidelines appear on the first page of Google searches (i.e. the first 10 results) for "physical activity and Australia" and "exercise and Australia", while the Healthy Weight Guide and National Seniors resources do not appear within the first 10 pages (i.e. the first 100 results) of either search. Interestingly, the Heart Foundation consumer page for physical activity does not appear within the first 10 pages of a Google search, but a page of resources for health professionals does. Regardless, promotion of effective resources regarding physical activity could be improved considerably for online searches.

Social activity

Social activity resources have a poor online presence, either absent or difficult to locate. There are no identifiable formal guidelines for social activity, and it is difficult to locate information on general health benefits associated with social activity.

We were able to identify *Meetup*[23] as a resource for assisting people to prepare to increase social activity. *Meetup* provides information about local groups throughout Australia and is designed to help people with similar interests form and join social groups. Unfortunately, *Meetup* is not well promoted for internet searches, failing to appear in the first 10 pages (first 100 results) of a Google search for "social activity and Australia".

We were unable to identify any online resources to support people in actively changing their social activity or wishing to discuss social activity personally.

[19] http://www.health.gov.au/internet/main/publishing.nsf/Content/pasb
[20] https://www.heartfoundation.org.au/active-living
[21] https://nationalseniors.com.au/sites/default/files/0714827PAC_PAF_FactSheet_PhysicalActivity_FN%20(4)_0.pdf
[22] http://healthyweight.health.gov.au/wps/portal/Home/get-active/
[23] https://www.meetup.com/cities/au/

Cognitive activity

Guidelines for cognitive activity are not readily identifiable online. Further, resources related to cognitive activity and general health were not readily identifiable. Thus, we opted to review resources relating to cognitive activity as a protective factor against dementia.

Alzheimer's Australia[24] has minimal information on their website about the benefits of cognitive activity for protecting against dementia, with content largely contained to helpsheets. However, the *Your Brain Matters*[25] website, a satellite project of Alzheimer's Australia, identifies five steps to protecting against dementia and one of these is engaging in mentally stimulating activities. They consequently elaborate on this factor in much more detail on this website.

The *Your Brain Matters* website is also very effective at promoting behaviour change, with a number of suggestions for methods people may wish to use to increase their cognitive activity. While the Alzheimer's Australia website may be relatively poor in this regard, the organisation does offer the *Brainy App*[26] application for smart phone and tablet devices. This resource includes both suggestions for behaviour change and self-assessment tools for a number of risk factors for dementia, including cognitive activity.

Many different resources are available to support people as they engage in increasing cognitive activity. In particular, anecdotally, there is a booming market in commercial "brain training" programs marketing themselves as a way to improve cognition. The *Your Brain Matters* website offers links to a number of these and other websites containing mentally-stimulating activities, while there are some simple mentally-stimulating games contained on the *Brainy App* offered by Alzheimer's Australia. There is a missed opportunity within the Australian research community to capitalise on the interest in brain training programs. In the UK, Cambridge Brain Sciences[27] host a portal of brain training games where people can participate in a limited number of activities for no cost, or with full access for a monthly fee (currently 10USD). However, this program also collects research data (from consenting users) which may be used in scientific studies to further understanding within this in-demand field.

There were no clearly identifiable resources found in our search to inform people about cognitive activity. The *Your Brain Matters* website is easily identifiable for online searches, appearing on the first page of results (i.e. within the first 10 results) for Google searches into both "cognitive activity and Australia" and "mental activity and Australia". However, other websites are not as readily identifiable. Neither of the aforementioned resources listed in the first 10 pages (i.e. first 100 results) on a Google search.

Obesity

Guidelines on body mass – in the form of both body mass index (BMI) and waist circumference – are readily available via the Australian Institute of Health and Welfare[28] (AIHW) and Department of Health[29] websites.

The guidelines published on AIHW and Department of Health websites are accompanied by information on the adverse effects of being overweight or obese. In addition, the *Healthy Weight Guide*[30] provide information on both the disease risks associated with being overweight or obese, and the benefits of losing weight.

Finding non-commercial resources devoted to either preparing or undertaking weight loss holistically (i.e. not through only either physical activity or diet individually), can be difficult online. We identified the *Healthy Weight Guide* as a resource that did this particularly well. This website has tools to plan and prepare for change as well as monitoring tools to help support a person as they actively change their lifestyle to address their weight. Both the Department of Health and AIHW websites offer online tools for people to calculate their BMI, although neither provides further support for planning or intervention toward weight.

Our search did not identify any personalised support services for weight.

[24] https://www.fightdementia.org.au/
[25] https://yourbrainmatters.org.au/brain_health/evidence/mental_activity
[26] https://brainyapp.com.au/
[27] https://www.cambridgebrainsciences.com/
[28] http://www.aihw.gov.au/body-weight/
[29] http://www.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-strateg-hlthwt-obesity.htm
[30] http://healthyweight.health.gov.au/wps/portal/Home/get-started/are-you-a-healthy-weight/

While AIHW and Department of Health websites appear on the first (covering the first 10 results) and second (covering results 11-20) pages of our Google search for "obesity and Australia", the *Healthy Weight Guide* did not appear within the first 10 pages (i.e. first 100 results), suggesting the typical internet user is likely to have difficulty identifying this high quality resource for planning and supporting active change to weight.

Cholesterol

Cholesterol guidelines are identified on the Australian Institute of Health and Welfare[31] (AIHW) and CSIRO[32] websites. In the case of the AIHW this identifies what they statistically classify as abnormal levels, while the CSIRO more explicitly talk about safe levels of cholesterol.

In regards to discussing general health concerns, most resources are reasonably poor for cholesterol. However, in regards to cardiovascular health and the different forms of lipids typically discussed as cholesterol, online resources perform much better. The Heart Foundation[33] website is particularly effective at this, although for the full breadth of content the user must access PDF documents attached alongside website content. The CSIRO website covers similar content but in less detail, while the AIHW website provides statistical data on cholesterol in Australia.

The Heart Foundation website is particularly effective at supporting people to plan changes to lifestyle factors that may affect cholesterol with a self-assessment tool for actions to respond to concerns about cholesterol. *Health Direct*[34] also offers complex advice on how to lower cholesterol with additional links to further information.

Unfortunately, further resources that support people to actively changing their lifestyle in order to improve their cholesterol levels, and to provide personalised feedback, were not identified in our search.

Many reliable cholesterol resources appear early in a standard internet search. For example, of the websites we mention for cholesterol, all but the AIHW can be found on the first page (presenting the first 10 results) of a Google search for "cholesterol and Australia". The AIHW website appears on the third page of our search, result 39.

Diabetes

As diabetes is a disease itself, there are no formal guidelines for individuals. There are, however, guidelines available for health professionals regarding management of patients presenting with diabetes although this is beyond the current report's focus.

There are still many online resources discussing diabetes. The Department of Health[35] website and *Health Direct*[36] provide a good brief overview of diabetes, while for a broader explanation of diabetes, Diabetes Australia[37] offer extensive general information on diabetes, as well as specific information on Type 1, Type 2, and gestational diabetes.

Unfortunately, we were unable to identify many comprehensive resources supporting people to prepare for lifestyle changes that may reduce risk of diabetes. The strongest resource we identified was the Diabetes Australia website, which offered some brief suggestions on reducing risk of diabetes, but also offered website visitors access to a quick risk profile self-assessment.

We were unable to identify any programs designed to guide people through changing their lifestyle to reduce risk of diabetes, although there are some functions to the Diabetes Australia application for smart phones and tablets that may partly service this purpose.

[31] http://www.aihw.gov.au/risk-factors/abnormal-blood-lipids/
[32] https://www.csiro.au/en/Research/Health/Healthier-foods/Cholesterol-facts
[33] https://www.heartfoundation.org.au/your-heart/know-your-risks/blood-cholesterol
[34] https://www.healthdirect.gov.au/how-to-lower-cholesterol
[35] http://www.health.gov.au/internet/main/publishing.nsf/Content/chronic-diabetes
[36] https://www.healthdirect.gov.au/diabetes
[37] https://www.diabetesaustralia.com.au/what-is-diabetes

For people wishing to discuss diabetes personally, Diabetes Australia offer a helpline which is promoted on their website. This service connects callers to their local Diabetes Australia office and focuses on offering support to people with diabetes seeking information on managing and treating their condition. However, personal correspondence has indicated they are willing to discuss lifestyle factors associated with diabetes for the purposes of redirecting callers to more appropriate support services.

The resources we identified for diabetes are easily accessible via an internet search, all three appearing within the first two pages (i.e. first 20 results) of a Google search for "diabetes and Australia".

Mental health

Mental health is a well-supported lifestyle factor, although it must be noted that with many options available to consumers, identifying high quality resources may be a challenge. As with diabetes, no formal guidelines are available for mental health. Reliable general information on mental health can be found via sources including *Beyond Blue*[38], *Black Dog Institute*[39], *Mind Health Connect*[40], *Mind Spot*[41], *SANE Australia*[42], and the *Suicide Call Back Service*[43]. In the case of the *Suicide Call Back Service*, the information focuses only on suicidality, although the other resources listed tend to be more inclusive of a wider range of mental health phenomena.

Resources are also readily available to support people in preparing and planning to change behaviours associated with mental health. The Department of Veterans' Affairs operate the *High Res*[44] website on which visitors can find a number of comprehensive tools, including tools to plan activities designed to boost mental health resilience. *Beyond Blue* offers some brief self-assessment tools as well as information on some of the different treatment options available for mental health disorders. Similar tools are available on the *Black Dog Institute* and *Mind Health Connect* websites. *Lifeline*[45] and the *Suicide Call Back Service* provide information on how a person may wish to gain support as they seek to improve their mental health. Finally, *Mind Spot* and *Mood Gym* offer self-assessment tools after registration within their guided programs.

There are also several high quality online programs to support people in making changes to improve their mental health. The *High Res* website has many tools accessible online, both with and without a login – by logging in, users can access more suggestions for making improvements to their lifestyles and track their activity. *Mind Spot* offers an eight-week online treatment course which includes occasional support from dedicated counselling services. The *Black Dog Institute* offers the "My Compass" portal where people can take self-assessments, track symptoms, and learn management strategies. Finally, *Mood Gym* offers an online portal introducing people to psychological models for promoting mental health in learning modules.

Personalised services are particularly well served for mental health. Many people are aware of the telephone support offered by *Lifeline*, while *Beyond Blue* and *SANE* also offer helpline services. For people wishing to discuss suicidality specifically, the *Suicide Call Back Service* is specifically designed to respond to these queries. *Lifeline*, *Beyond Blue*, and *SANE* all also offer web-based chat services, while *Beyond Blue* and *SANE* also offer online peer-support forums.

There is a mix in how accessible the different mental health resources are to the typical internet user. Most of our selected resources were identified by one or more of our Google searches – "mental health and Australia"; "depression and Australia"; or "anxiety and Australia" – and typically within the first page of results (first ten results). Only *High Res* and the *Suicide Callback Service* failed to appear in the first ten pages (first 100 results) of each of our searches. However, only *Beyond Blue*, *Mind Health Connect*, and *SANE* appeared within the first ten pages (first 100 results) of all three searches. This suggests that people are likely to have ready access to valuable mental health resources online, although some of the best tools may still be made more accessible.

[38] https://www.beyondblue.org.au/home
[39] https://www.blackdoginstitute.org.au/mental-health-wellbeing
[40] http://www.mindhealthconnect.org.au/
[41] https://mindspot.org.au/
[42] https://www.sane.org/mental-health-and-illness/81-mental-health-and-mental-illness
[43] https://www.suicidecallbackservice.org.au/
[44] https://at-ease.dva.gov.au/highres/
[45] https://www.lifeline.org.au/
[46] https://moodgym.anu.edu.au/

Summary and conclusions

Overall, the lifestyle factors discussed in our earlier literature review are well-supported by resources available online. However, many of the resources are unlikely to be easily accessible to the typical internet user, and difficult to identify by a standard internet search. For this reason, it is worrying to consider the possible number of high quality resources available that we were unable to identify.

For most lifestyle factors, resources covered a breadth of different types of content to support people seeking different types of information and support. However, only alcohol and mental health had identifiable resources for each category of resources. Conversely, social activity and cholesterol appeared the poorest-resourced lifestyle factors – cholesterol lacked any identifiable intervention or personalised support resources, while only preparation resources were identified for social activity. For smoking, the *Quit* website was effective in offering wide-reaching support for everything except publication of guidelines.

Mental health was serviced by some particularly strong resources. *Beyond Blue*, the *Black Dog Institute*, and *Mind Spot* all offered content supporting all available categories (noting that no formal guidelines were expected of specific health conditions).

While personalised support services were typically few for all lifestyle factors, there are two broad areas identifiable as poorly serviced: those relating to an active lifestyle and associated with healthy weight. No personalised support services were identifiable for physical, social, or cognitive activity, highlighting a clear deficiency in some of the support services offered. However, more alarmingly – considering the notoriety of healthy weight as an important factor to good health – no personalised services were identifiable for obesity, diet, or physical activity. While such services may be more difficult to construct than other resources, these are areas which are of considerable importance where additional or redirected resources may be an effective way to improve the prospects of healthy ageing at a population level.

CONCLUSION

This report has focused on healthy ageing through the lens of modifiable risk factors related to chronic health conditions that make up the bulk of burden of diseases in Australia, particularly in late life. The purpose of the literature review was to examine the current Australian guidelines surrounding lifestyle factors associated with healthy ageing, and to review the evidence since the publication of these reviews, to explore if the guidelines remain current and relevant. Whilst this review has identified further important research on the mechanisms involved in the chronic conditions associated with the lifestyle factors, it can be concluded that the current Australian guidelines on diet, alcohol consumption, smoking, and physical activity remain appropriate and applicable. The review has, however, highlighted that guidelines surrounding the optimal amount and type of social and cognitive activities necessary for optimal health and ageing well comprise a significant gap in the literature, and are yet to be determined through evidence.

A further objective of this review was to ascertain the accessible resources available relating to modifiable lifestyle factors and healthy ageing. The resources identified were websites and online applications, reflecting the capacity of the internet to deliver easily accessible, immediate and comprehensive resources to the individual. Excellent, evidence-based online resources were found for a number of lifestyle factors. However, many personalised services, especially those directed towards active lifestyle, and in support of healthy weight, were found to be lacking. Whilst there are many resources in the community to improve social connectivity, this space would benefit from a singular, easily identifiable site that provides links and connections to the organisations and activities available. Finally, while there is a plethora of commercial brain-training applications and sites, there is also a notable lack of evidence-based, freely accessible resources that provide assessment, interventions, and evidence based cognitive activities.

It is important to note that this report is not an exhaustive or systematic review of chronic conditions and their modifiable risk factors. Nor is it a systematic review of all available online resources, or an objective, gold-standard evaluation of those resources. Such reviews are outside the scope of the current report. Nonetheless, by identifying a consistent set of lifestyle risk factors that contribute to mechanisms underlying chronic conditions that make up a large proportion of the burden of disease in Australia, this report provides insight into several factors that increase the likelihood of both population and individual healthy ageing. In addition, the information garnered from the selected online resources identifies appropriate and quality sites that can inform the development of a free, online portal of resource links for the National Seniors Australia website.

REFERENCES

1. Australian Institute of Health and Welfare (2016). *Australian Burden of Disease Study: Impact and Causes of Illness and Death in Australia 2011*. Retrieved from Canberra:
2. Australian Institute of Health and Welfare (2014). *Leading types of ill health*. Retrieved from Canberra:
3. Levey, A. S., Coresh, J., Balk, E., Kausz, A. T., Levin, A., Steffes, M. W., . . . Eknoyan, G. (2003). National Kidney Foundation Practice Guidlines for Chronic Kidney Disease: Evaluation, classification, and stratification. *Annals of Internal Medicine, 139*, 137-147.
4. Barnes, D. E., & Yaffe, K. (2011). The projected impact of risk factor reduction on Alzheimer's disease prevalence. *Lancet Neurology, 10*, 819-828.
5. National Health and Medical Research Council (2013). *Australian Dietary Guidelines*. Retrieved from Canberra: https://www.nhmrc.gov.au/guidelines-publications/n55
6. National Health and Medical Research Council (2009). *Australian Guidelines to Reduce Health Risks from Drinking Alcohol*. Retrieved from Canberra: https://www.nhmrc.gov.au/guidelines-publications/ds10
7. Department of Health (Australia) (2014). *Physical Activity and Sedentary Behaviour*. Retrieved from http://www.health.gov.au/internet/main/publishing.nsf/Content/pasb:
8. Hariharan, D., Vellanki, K., & Kramer, H. (2015). The Western diet and chronic kidney disease. *Current Hypertention Reports, 17*, 1-9.
9. Australian Institute of Health and Welfare (2012). *Risk Factor Trends: Age Patterns in Key Health Risks over Time*. Retrieved from Canberra: http://www.aihw.gov.au/publication-detail/?id=10737422803
10. Al-Khudairy, L., Flowers, N., Wheelhouse, R., Ghannam, O., Hartley, L., Stranges, S., & Rees, K. (2017). Vitamin C supplementation for the primary prevention of cardiovascular disease. *Cochrane Database of Systematic Reviews, CD011114*, 1-52.
11. Middleton, L. E., & Yaffe, K. (2009). Promising strategies for the prevention of dementia. *Archives of Neurology, 66*, 1210-1215.
12. Hosseini, B., Saedisomeolia, A., & Skilton, M. R. (2017). Association between micronutrients intake/status and carotid intima media thickness: A systematic review. *Journal of the Academy of Nutrition and Dietetics, 117*, 69-82.
13. Zhao, D., Yang, J., & Yang, L. (2017). Insights for oxidative stress and mTOR signaling in myocardial ischemia/reperfusion injury under diabetes. *Oxidative Medicine and Cellular Longevity, 2017*, 1-12.
14. Jun, M., Venkataraman, V., Razavian, M., Cooper, B., Zougas, S., Ninomiya, T., . . . Perkovic, V. (2012). Antioxidants for chronic kidney disease. *Cochrane Database of Systematic Reviews, 10*, 1-62.
15. Bae, J.-M. (2016). Reinterpretation of the results of a pooled analysis of dietary carotenoid intake and breast cancer risk by using the interval collapsing method. *Epidemiology and Health, 38*, 1-4.
16. Chen, P., Zhang, W., Wang, X., Zhao, K., Singh Negi, D., Zhuo, L., . . . Zhang, X. (2015). Lycopene and risk of prostate cancer: A systematic review and meta-analysis. *Medicine, 94*, 1-14.
17. Peng, L., Liu, X., Lu, Q., Tang, T., & Yang, Z. (2015). Vitamin E intake and pancreatic cancer risk: A meta-analysis of observational studies. *Medical Science Monitor, 21*, 1249-1255.
18. Al-Khudairy, L., Hartley, L., Clar, C., Flowers, N., Hooper, L., & Rees, K. (2015). Omega 6 fatty acids for the primary prevention of cardiovascular disease. *Cochrane Database of Systematic Reviews, 11*, 1-57.
19. Hartweg, J., Perera, R., Montori, V. M., Dineen, S. F., Neil, A. H. A. W. N., & Farmer, A. J. (2008). Omega-3 polyunsaturated fatty acids (PUFA) for type 2 diabetes mellitus. *Cochrane Database of Systematic Reviews, 1*, 1-65.
20. Ganguly, R., & Pierce, G. N. (2015). The toxicity of dietary trans fats. *Food and Chemical Toxicology, 78*, 170-176.

21. Buijsse, B., Boeing, H., Drogan, D., Schulze, M. B., Feskens, E. J., Amiano, P., . . . Wareham, N. J. (2015). Consumption of fatty foods and incident type 2 diabetes in populations from eight *European countries. European Journal of Clinical Nutrition, 69*, 455-461.
22. Kurt, A., Andican, G., Siva, Z. O., Andican, A., & Burcak, G. (2016). The effects of n-3 long-chain polyunsaturated fatty acid supplementation on AGEs and sRAGE in type 2 diabetes mellitus. *Journal of Physiology and Biochemistry, 72*, 679-687.
23. Hooper, L., Martin, N., Abdelhamid, A., & Davey Smith, G. (2015). Reduction in saturated fat intake for cardiovascular disease. *Cochrane Database of Systematic Reviews, 6*, 1-168.
24. Mas, E., Barden, A., Burke, V., Beilin, L. J., Watts, G. F., Huang, R.-C., . . . Mori, T. A. (2016). A randomized controlled trial of the effects of n-3 fatty acids on resolvins in chronic kidney disease. *Clinical Nutrition, 35*, 331-336.
25. Yang, B., Shi, M.-Q., Li, Z.-H., Yang, J.-J., & Li, D. (2016). Fish, long-chain n-3 PUFA and incidence of elevated blood pressure: A meta-analysis of prospective cohort studies. *Nutrients, 8*, 1-12.
26. Cheng, P., Huang, W., Bai, S., Wu, Y., Yu, J., Zhu, X., . . . Xie, P. (2015). BMI affects the relationship between long chain N-3 polyunsaturated fatty acid intake and stroke risk: A meta-analysis. *Scientific Reports, 5*, 1-11. doi:10.1038/srep14161
27. Alhazmi, A., Stojanovski, E., McEvoy, M., & Garg, M. L. (2012). Macronutrient intake and development of type 2 diabetes: A systematic review and meta-analysis of cohort studies. *Journal of the American College of Nutrition, 31*, 243-258. doi:10.1080/07315724.2012.10720425
28. Han, J., Jiang, Y., Meng, Q., Xi, Q., Zhuang, Q., Han, Y., . . . Wu, G. (2015). Dietary fat intake and risk of gastric cancer: A meta-analysis of observational studies. *PLos ONE, 10*, 1-18.
29. Wu, S., Ding, Y., Wu, F., Li, R., Hou, J., & Mao, P. (2015). Omega-3 fatty acids intake and risks of dementia and Alzheimer's disease: A meta-analysis. *Neuroscience and Biobehavioral Reviews, 48*, 1-9.
30. Zhao, J., Lyu, C., Gao, J., Du, L., Shan, B., Zhang, H., . . . Gao, Y. (2016). Dietary fat intake and endometrial cancer risk: A dose response meta-analysis. *Medicine, 95*, 1-8.
31. Jiang, L., Hou, R., Gong, T.-T., & Wu, Q.-J. (2015). Dietary fat intake and endometrial cancer risk: Dose-response meta-analysis of epidemiological studies. *Scientific Reports, 5*, 1-11.
32. Hooper, L., Summerbell, C. D., Thompson, R., Sills, D., Roberts, F. G., Moore, H. J., & Davey Smith, G. (2012). Reduced or modified dietary fat for preventing cardiovascular disease. *Cochrane Database of Systematic Reviews, 5,* 1-220.
33. Aune, D., Norat, T., Romundstad, P., & Vatten, L. J. (2013). Dairy products and the risk of type 2 diabetes: A systematic review and dose-response meta-analysis of cohort studies. *The American Journal of Clinical Nutrition*, 98, 1066-1083.
34. Yakoob, M. Y., Shi, P., Willett, W. C., Rexrode, K. M., Campos, H., Orav, E. J., . . . Mozaffarian, D. (2016). Circulating biomarkers of dairy fat and risk of incident diabetes mellitus among men and women in the United States in two large prospective cohorts. *Circulation, 133*, 1645-1654.
35. Weggemans, R. M., Zock, P. L., & Katan, M. B. (2001). Dietary cholesterol from eggs increases the ratio of total cholesterol to high-density lipoprotein cholesterol in humans: A meta-analysis. *The American Journal of Clinical Nutrition, 73*, 885-891.
36. Djoussé, L., & Gaziano, J. M. (2009). Dietary cholesterol and coronary artery disease: A systematic review. *Current Artherosclerosis Reports, 11*, 418-422.
37. Tajima, R., Kodama, S., Hirata, M., Horikawa, C., Fujihara, K., Yachi, Y., . . . Sone, H. (2014). High cholesterol intake is associated with elevated risk of type 2 diabetes mellitus - A meta-analysis. *Clinical Nutrition, 33*, 946-950.

38. Wang, J., Wang, W.-J., Zhai, L., & Zhang, D.-F. (2015). Association of cholesterol with risk of pancreatic cancer: A meta-analysis. *World Journal of Gastroenterology, 21*, 3711-3719.
39. McDonnell, D. P., Chang, C.-Y., & Nelson, E. R. (2014). The estrogen receptor as a mediator of the pathological actions of cholesterol in breast cancer. *Climacteric, 17*, 60-65.
40. Hartley, L., May, M. D., Loveman, E., Colquitt, J. L., & Rees, K. (2016). Dietary fibre for the primary prevention of cardiovascular disease. *Cochrane Database of Systematic Reviews, 1*, 1-90.
41. Kim, Y., & Je, Y. (2016). Dietary fibre intake and mortality from cardiovascular disease and all cancers: A meta-analysis of prospective cohort studies. *Archives of Cardiovascular Disease, 109*, 39-54.
42. Yao, B., Fang, H., Xu, W., Yan, Y., Xu, H., Liu, Y., . . . Zhao, Y. (2014). Dietary fiber intake and risk of type 2 diabetes: A dose-response analysis of prospective studies. *European Journal of Epidemiology, 29*, 79-88.
43. Liu, L., Wang, S., & Liu, J. (2015). Fiber consumption and all-cause, cardiovascular, and cancer mortalities: A systematic review and meta-analysis of cohort studies. *Molecular Nutrition & Food Research, 59*, 139-146.
44. Zhang, Z., Xu, G., Ma, M., Yang, J., & Liu, X. (2013). Dietary fiber intake reduces risk for gastric cancer: A meta-analysis. *Gastroenterology, 145*, 113-120.
45. Dahl, W. J., & Stewart, M. L. (2015). Position of the Academy of Nutrition and Dietetics: Health implications of dietary fiber. *Journal of the Academy of Nutrition and Dietetics, 115*, 1861-1870.
46. Priebe, M., van Binsbergen, J., de Vos, R., & Vonk, R. J. (2008). Whole grain foods for the prevention of type 2 diabetes mellitus. *Cochrane Database of Systematic Reviews, 1*, 1-33.
47. Chiavaroli, L., Mirrahimi, A., Sievenpiper, J. L., Jenkins, D. J. A., & Darling, P. B. (2015). Dietary fiber effects in chronic kidney disease: A systematic review and meta-analysis of controlled feeding trials. *European Journal of Clinical Nutrition, 69*, 761-768.
48. Huang, T.-B., Ding, P.-P., Chen, J.-F., Yan, Y., Zhang, L., Liu, H., . . . Yao, X.-D. (2014). Dietary fiber intake and risk of renal cell carcinoma: evidence from a meta-analysis. *Medical Oncology, 31*, 1-10.
49. Lei, Q., Zheng, H., Bi, J., Wang, X., Jiang, T., Gao, X., . . . Li, J. (2016). Whole grain intake reduces pancreatic cancer risk: A meta-analysis of observational studies. *Medicine, 95*, 1-9.
50. Threapleton, D. E., Greenwood, D. C., Evans, C. E. L., Cleghorn, C. L., Nykjaer, C., Woodhead, C., . . . Burley, V. J. (2013). Dietary fibre intake and risk of cardiovascular disease: Systematic review and meta-analysis. *BMJ, 347*, 1-12.
51. World Health Organization (2003). *Diet, Nutrition and the Prevention of Chronic Diseases: Report of a Joint WHO/FAO Expert Consultation*. Retrieved from Geneva: http://www.who.int/dietphysicalactivity/publications/trs916/en/
52. Rippe, J. M., & Angelopoulos, T. J. (2016a). Added sugars and risk factors for obesity, diabetes, and heart disease. *International Journal of Obesity, 40*, S22-S27.
53. Meier, T., Senftleben, K., Deumelandt, P., Christen, O., Riedel, K., & Langer, M. (2015). Healthcare costs associated with an adequate intake of sugars, salt and saturated fat in Germany: A health econometrical analysis. *PLoSOne, 10*, 1-21.
54. Kim, Y., & Je, Y. (2016). Prospective association of sugar-sweetened and artificially sweetened beverage intake with risk of hypertension. *Archives of Cardiovascular Disease, 109*, 242-253.
55. Huang, C., Huang, J., Tian, Y., Yang, X., & Gu, D. (2014). Sugar sweetened beverages consumption and risk of coronary heart disease: A meta-analysis of prospective studies. *Atherosclerosis, 234*, 11-16.
56. Cai, X., Wang, C., Wang, S., Cao, G., Jin, C., Yu, J., . . . Ding, F. (2015). Carbohydrate intake, glycemic index, glycemic load, and stroke: A meta-analysis of prospective cohort studies. *Asia-Pacific Journal of Public Health, 27*, 486-496.

57. Karalius, V. P., & Shoham, D. A. (2013). Dietary sugar and artificial sweetener intake and chronic kidney disease: A review. *Advances in Chronic Kidney Disease, 20*, 157-164.
58. Mullie, P., Koechlin, A., Boniol, M., Autier, P., & Boyle, P. (2016). Relation between breast cancer and high glycemic index or glycemic load: A meta-analysis of prospective cohort studies. *Critical Reviews in Food Science and Nutrition, 56*, 152-159.
59. Roberts, R. O., Roberts, L. A., Geda, Y. E., Cha, R. H., Pankratz, V. S., O'Connor, H. M., . . . Petersen, R. C. (2012). Relative intake of macronutrients impacts risk of mild cognitive impairment or dementia. *Journal of Alzheimer's Disease, 32*, 329-339.
60. Nagle, C. M., Olsen, C. M., Ibiebele, T. I., Spurdle, A. B., & Webb, P. M. (2013). Glycemic index, glycemic load and endometrial cancer risk: Results from the Australian National Endometrial Cancer Study and an updated systematic review and meta-analysis. *European Journal of Nutrition, 52*, 705-715.
61. National Health and Medical Research Council (2006). *Calcium*. Retrieved from Canberra:
62. Dickinson, H. O., Nicolson, D., Cook, J. V., Campbell, F., Beyer, F. R., Ford, G. A., & Mason, J. (2006). Calcium supplementation for the management of primary hypertension in adults. *Cochrane Database of Systematic Reviews, 2*, 1-51.
63. Reid, I. R. (2013). Cardiovascular effects of calcium supplements. *Nutrients, 5*, 2522-2529.
64. Pannu, P. K., Calton, E. K., & Soares, M. J. (2016). Calcium and vitamin D in obesity and related chronic disease. *Advances in Food and Nutrition Research, 77*, 57-100.
65. Huncharek, M., Muscat, J., & Kupelnick, B. (2009). Colorectal cancer risk and dietary intake of calcium, vitamin D, and dairy products: A meta-analysis of 26,335 cases from 60 observational studies. *Nutrition and Cancer, 61*, 47-69.
66. Anderson, J. J. B., & Klemmer, P. J. (2013). Risk of high dietary calcium for arterial calcification in older adults. *Nutrients, 5*, 3964-3974.
67. Yang, Y., Wang, X., Yao, Q., Qin, L., & Xu, C. (2013). Dairy product, calcium intake and lung cancer risk: A systematic review with meta-analysis. *Scientific Reports, 6*, 1-8.
68. Reid, I. R., Bristow, S. M., & Bolland, M. J. (2015). Cardiovascular complications of calcium supplements. *Journal of Cellular Biochemistry, 116*, 494-501.
69. Tian, D.-Y., Tian, J., Shi, C.-H., Song, B., Wu, J., Ji, Y., . . . Xu, Y.-M. (2015). Calcium intake and the risk of stroke: An up-dated meta-analysis of prospective studies. *Asia Pacific Journal of Clinical Nutrition, 24*, 245-252.
70. Wang, X., Chen, H., Ouyang, Y., Liu, J., Zhao, G., Bao, W., & Yan, M. (2014). Dietary calcium intake and mortality risk from cardiovascular disease and all causes: A meta-analysis of prospective cohort studies. *BMC Medicine, 12*, 158-167.
71. Aburto, N. J., Ziolkovska, A., Hooper, L., Elliott, P., Cappuccio, F. P., & Meerpohl, J. J. (2013). Effect of lower sodium intake on health: Systematic review and meta-analyses. *BMJ, 346*, 1-20.
72. Stolarz-Skrzypek, K., & Staessen, J. A. (2015). Reducing salt intake for prevention of cardiovascular disease - Times are changing. *Advances in Chronic Kidney Disease, 22*, 108-115.
73. Adler, A. J., Taylor, F., Martin, N., Gottlieb, S., Taylor, R. S., & Ebrahim, S. (2014). Reduced dietary salt for the prevention of cardiovascular disease. *Cochrane Database of Systematic Reviews, 12*, 1-70.
74. He, F. J., Li, J., & MacGregor, G. A. (2013). Effect of longer-term modest salt reduction on blood pressure. *Cochrane Database of Systematic Reviews, 4*, 1-104.
75. Hooper, L., Bartlett, C., Davey Smith, G., & Ebrahim, S. (2004). Advice to reduce dietary salt for prevention of cardiovascular disease. *Cochrane Database of Systematic Reviews, 1*, 1-62.

76. McMahon, E. J., Campbell, K. L., Bauer, J. D., & Mudge, D. W. (2015). Altered dietary salt intake for people with chronic kidney disease. *Cochrane Database of Systematic Reviews, 2*, 1-68.
77. Graudal, N., Jürgens, G., Baslund, B., & Alderman, M. H. (2014). Compared with usual sodium intake, low- and excessive-sodium diets are associated with increased mortality: A meta-analysis. *American Journal of Hypertension, 27*, 1129-1137.
78. Clifton, P. M., & Keogh, J. B. (2015). Salt restrictions in diabetes. *Current Diabetes Reports, 15*, 1-6.
79. Jones-Burton, C., Mishra, S. I., Fink, J. C., Brown, J., Gossa, W., Bakris, G. L., & Weir, M. R. (2006). An in-depth review of the evidence linking dietary salt intake and progression of chronic kidney disease. *American Journal of Nephrology, 26*, 268-275.
80. D'Elia, L., Galletti, F., & Strazzullo, P. (2014). Dietary salt intake and risk of gastric cancer. In V. Zappia, S. Panico, G. Russo, A. Budillon, & F. Della Ragione (Eds.), *Advances in Nutrition and Cancer* (pp. 83-95). Berlin: Springer.
81. Kasdagly, M., Radhakrishnan, S., Reddivari, L., Veeramachaneni, D. N. R., & Vanamala, J. (2014). Colon carcinogenesis: Influence of Western diet-induced obesity and targeting stem cells using dietary bioactive compounds. *Nutrition, 30*, 1242-1256.
82. Myles, I. A. (2014). Fast food fever: Reviewing the impacts of the Western diet on immunity. *Nutrition Journal, 13*, 1-17.
83. Blondin, S. A., Mueller, M. P., Bakun, P. J., Choumenkovitch, S. F., Tucker, K. L., & Economos, C. D. (2016). Cross-sectional associations between empirically-derived dietary patterns and indicators of disease risk among university students. *Nutrients, 8*, 1-17.
84. Li, F., Hou, L.-N., Chen, W., Chen, P.-L., Lei, C.-Y., Wei, Q., . . . Zheng, S.-B. (2015). Associations of dietary patterns with the risk of all-cause, CVD and stroke mortality: A meta-analysis of prospective cohort studies. *British Journal of Nutrition, 113*, 16-24.
85. McEvoy, C. T., Cardwell, C. R., Woodside, J. V., Young, I. S., Hunter, S. J., & McKinley, M. C. (2014). A Posteriori dietary patterns are related to risk of type 2 diabetes: Findings from a systematic review and meta-analysis. *Journal of the Academy of Nutrition and Dietetics, 114*, 1759-1775.
86. Shin, S., Saito, E., Inoue, M., Sawada, N., Ishihara, J., Takachi, R., . . . Tsugane, S. (2016). Dietary pattern and breast cancer risk in Japanese women: The Japan Public Health Centre-based Prospective Study (JPHC Study). *British Journal of Nutrition, 115*, 1769-1779.
87. Fabiani, R., Minelli, L., Bertarelli, G., & Bacci, S. (2016). A Western dietary pattern increases prostate cancer risk: A systematic review and meta-analysis. *Nutrients, 8*, 1-16.
88. D'Alessandro, A., De Pergola, G., & Slivestris, F. (2016). Mediterranean diet and cancer risk: An open issue. *International Journal of Food Sciences and Nutrition, 67*, 593-605.
89. De Lorenzo, A., Bernardini, S., Gualtieri, P., Cabibbo, A., Alfonso Perrone, M., Giambini, I., & Di Renzo, L. (2017). Mediterranean meal versus Western meal effects on postprandial ox-LDL, oxidative and inflammatory gene expression in health subjects: A randomized controlled trial for nutrigenomic approach in cardiometabolic risk. *Acta Diabetologica, 54*, 141-149.
90. Kontogianni, M. D., & Panagiotakos, D. B. (2014). Dietary patterns and stroke: A systematic review and re-meta-analysis. *Maturitas, 79*, 41-47.
91. Rees, K., Hartley, L., Flowers, N., Clarke, A., Hooper, L., Thorogood, M., & Stranges, S. (2013). 'Mediterranean' dietary pattern for the primary prevention of cardiovascular disease. *Cochrane Database of Systematic Reviews, 8*, 1-55.
92. van de Rest, O., Berendsen, A. A. M., Haveman-Nies, A., & de Groot, L. C. P. G. M. (2015). Dietary patterns, cognitive decline, and dementia: A systematic review. *Advances in Nutrition, 13*, 154-168.

93. Clare Morris, M., Tangney, C. C., Wang, Y., Sacks, F. M., Bennett, D. A., & Aggarwal, N. T. (2015). MIND diet associated with reduced incidence of Alzheimer's disease. *Alzheimer's and Dementia, 11*, 1007-1014.
94. Schwingshackl, L., & Hoffmann, G. (2015). Adherence to Mediterranean diet and risk of cancer: An updated systematic review and meta-analysis of observational studies. *Cancer Medicine, 4*, 1933-1947.
95. Rifai, L., & Silver, M. A. (2016). A review of the DASH diet as an optimal dietary plan for symptomatic heart failure. *Progress in Cardiovascular Diseases, 58*, 548-554.
96. Larsson, S. C., Wallin, A., & Wolk, A. (2016). Dietary Approaches to Stop Hypertension diet and incidence of stroke: Results from 2 prospective cohorts. *Stroke, 47*, 986-990.
97. Chiu, S., Bergeron, N., Williams, P. T., Bray, G. A., Sutherland, B., & Krauss, R. M. (2016). Comparison of the DASH (Dietary Approaches to Stop Hypertension) diet and a higher-fat DASH diet on blood pressure and lipids and lipoproteins: A randomized controlled trial. *American Journal of Clinical Nutrition, 103*, 341-347.
98. Shirani, F., Salehi-Abarhouei, A., & Azadbakht, L. (2013). Effects of Dietary Approaches to Stop Hypertension (DASH) diet on some risk for developing type 2 diabetes: A systematic review and meta-analysis on controlled clinical trials. *Nutrition, 29*, 939-947.
99. Boggs, D. A., Ban, Y., Palmer, J. R., & Rosenberg, L. (2015). Higher diet quality is inversely associated with mortality in African-American women. *The Journal of Nutrition, 145*, 547-554.
100. Schwingshackl, L., & Hoffmann, G. (2015). Diet quality as assessed by the Healthy Eating Index, the Alternate Healthy Eating Index, the Dietary Approaches to Stop Hypertension score, and health outcomes: A systematic review and meta-analysis of cohort studies. *Journal of the Academy of Nutrition and Dietetics, 115*, 780-800.
101. Jones-McLean, E., Hu, J., Greene-Finestone, L. S., & de Groh, M. (2015). A DASH dietary pattern and the risk of colorectal cancer in Canadian adults. *Health Promotion and Chronic Disease Prevention in Canada, 35*, 12-20.
102. Anic, G. M., Park, Y., Subar, A. F., Schap, T. E., & Reedy, J. (2016). Index-based dietary patterns and risk of lung cancer in the NIH-AARP diet and health study. *European Journal of Clinical Nutrition, 70*, 123-129.
103. Benisi-Kohansal, S., Shayanfar, M., Mohammad-Shirazi, M., Tabibi, H., Sharifi, G., Saneei, P., & Esmaillzadeh, A. (2016). Adherence to the Dietary Approaches to Stop Hypertension-style diet in relation to glioma: A case-control study. *British Journal of Nutrition, 115*, 1108-1116.
104. Rehm, J., Mathers, C., Popova, S., Thavornchaoensap, M., Teerawattananon, Y., & Patra, J. (2009). Global burden of disease and injury and economic cost attributable to alcohol use and alcohol-use disorders. *Lancet, 373*, 2223-2233.
105. Anstey, K. J., Mack, H. A., & Cherbuin, N. (2009). Alcohol consumption as a risk factor for dementia and cognitive decline: Meta-analysis of prospective studies. American Journal of Geriatric Psychiatry, 17, 542-555.
106. Fernandez-Solà, J. (2015). Cardiovascular risks and benefits of moderate and heavy alcohol consumption. *Nature Reviews Cardiology, 12*, 576-587.
107. Jayasekara, H., MacInnis, R. J., Room, R., & English, D. R. (2016). Long-term alcohol consumption and breast, upper aero-digestive tract and colorectal cancer risk: A systematic review and meta-analysis. *Alcohol and Alcoholism, 51*, 315-330.
108. Barone, E., Corrado, A., Gemignani, F., & Landi, S. (2016). Environmental risk factors for pancreatic cancer: An update. *Archives of Toxicology, 90*, 2617-2642.
109. Praud, D., Rota, M., Rehm, J., Shield, K., Zatonski, W., Hashibe, M., . . . Boffetta, P. (2016). Cancer incidence and mortality attributable to alcohol consumption. *International Journal of Cancer, 138*, 1380-1387.
110. Zhang, X., Shu, L., Si, C., Yu, X., Gao, W., Liao, D., . . . Zheng, P. (2015). Dietary patterns and risk of stroke in adults: A systematic review and meta-analysis of prospective cohort studies. *Journal of Stroke and Cerebrovascular Diseases, 24*, 2173-2182.

111. Huang, J., Wang, X., & Zhang, Y. (2017). Specific types of alcoholic beverage consumption and risk of type 2 diabetes: A systematic review and meta-analysis. *Journal of Diabetes Investigation, 8*, 56-68.
112. Knott, C., Bell, S., & Britton, A. (2015). Alcohol consumption and the risk of type 2 diabetes: A systematic review and dose-response meta-analysis of more than 1.9 million individuals from 38 observational studies. *Diabetes Care, 38*, 1804-1812.
113. Handing, E. P., Andel, R., Kadlecova, P., Gatz, M., & Pederson, N. L. (2015). Midlife alcohol consumption and risk of dementia over 43 years of follow-up: A population-based study from the Swedish twin registry. *Journals of Gerontology: Medical Sciences, 70*, 1248-1254.
114. Mostofsky, E., Chahal, H. S., Mukamal, K. J., Rimm, E. B., & Mittleman, M. A. (2016). Alcohol and immediate risk of cardiovascular events: A systematic review and dose-response meta-analysis. *Circulation, 133*, 979-987.
115. Cheungpasitporn, W., Thongprayoon, C., Kittanamongkolchai, W., Brabec, B. A., O'Corragain, O. A., Edmonds, P. J., & Erickson, S. B. (2015). High alcohol consumption and the risk of renal damage: A systematic review and meta-analysis. *QJM, 108*, 539-548.
116. Park, J.-E., Choi, T.-Y., Ryu, Y., & Cho, S.-I. (2015). The relationship between mild alcohol consumption and mortality in Koreans: A systematic review and meta-analysis. *BMC Public Health, 15*, 1-12.
117. Sabia, S., Elbaz, A., Britton, A., Bell, S., Dugravot, A., Shipley, M., . . . Singh-Manoux, A. (2014). Alcohol consumption and cognitive decline in early old age. *Neurology, 82*, 332-339.
118. Chen, W. Y., Rosner, B., Hankinson, S. E., Colditz, G. A., & Willett, W. C. (2011). Moderate alcohol consumption during adult life, drinking patterns, and breast cancer risk. *JAMA, 306*, 1884-1890.
119. Kar, D., Gillies, C., Zaccardi, F., Webb, D., Seidu, S., Tesfaye, S., . . . Khunti, K. (2016). Relationship of cardiometabolic parameters in non-smokers, current smokers, and quitters in diabetes: A systematic review and meta-analysis. *Cardiovascular Diabetology, 15*, 1-15.
120. Lafortune, L., Martin, S., Kelly, S., Kuhn, I., Remes, O., Cowan, A., & Brayne, C. (2016). Behavioural risk factors in mid-life associated with successful ageing, disability, dementia and frailty in later life: A rapid systematic review. *PLos ONE, 11*, 1-34.
121. Linneberg, A., Jacobsen, R. K., Skaaby, T., Taylor, A. E., Fluharty, M. E., Jeppesen, J. L., . . . Husemoen, L. L. N. (2015). Effect of smoking on blood pressure and resting heart rate: A Mendelian randomisation meta-analysis in the CARTA Consortium. *Circulation: Cardiovascular Genetics, 8*, 832-841.
122. Fu, Q., Colgan, S. P., & Shelley, C. S. (2016). Hypoxia: The force that drives chronic kidney disease. *Clinical Medicine & Research, 14*, 15-39.
123. Koyanagi, Y. N., Matsuo, K., Ito, H., Wakai, K., Nagata, C., Nakayama, T., . . . Sasazuki, S. (2016). Cigarette smoking and the risk of head and neck cancer in the Japanese population: A systematic review and meta-analysis. *Japanese Journal of Oncology, 46*, 580-595.
124. Pan, A., Wang, Y., Talaei, M., Hu, F. B., & Wu, T. (2015). Relation of active, passive, and quitting smoking with incident diabetes: A meta-analysis and systematic review. *Lancet Diabetes & Endicrinology, 3*, 958-967.
125. Feodoroff, M., Harjutsalo, V., Forsblom, C., Thorn, L., Waden, J., Tolonen, N., . . . Groop, P.-H. (2016). Smoking and progression of diabetic nephropathy in patients with type 1 diabetes. *Acta Diabetologica, 53*, 525-533.
126. Anstey, K. J., von Sanden, C., Salim, A., & O'Kearney, R. (2007). Smoking as a risk factor for dementia and cognitive decline: A meta-analysis of prospective studies. *American Journal of Epidemiology, 166*, 367-378.
127. Ordonez-Mena, J. M., Schottker, B., Mons, U., Jenab, M., Freisling, H., Bueno-de-Mesquita, B., . . . Brenner, H. (2016). Quantification of the smoking-associated cancer risk with rate advancement periods: Meta-analysis of individual participant data from cohorts of the CHANCES consortium. *BMC Medicine, 14*, 1-15.

128. Masaoka, H., Matsuo, K., Ito, H., Wakai, K., Nagata, C., Nakayama, T., . . . Sasazuki, S. (2016). Cigarette smoking and bladder cancer risk: An evaluation based on a systematic review of epidemiologic evidence in the Japanese population. *Japanese Journal of Clinical Oncology, 46*, 273-283.

129. Brenner, D. R., Yannitsos, D. H., Farris, M. S., Johansson, M., & Friedenreich, C. M. (2016). Leisure-time physical activity and lung cancer risk: A systematic review and meta-analysis. *Lung Cancer, 95*, 17-27.

130. Nee, P. N., Thornton, A. J., & Hamling, J. S. (2016). Epidemiological evidence on environmental tobacco smoke and cancers other than lung or breast. *Regulatory Toxicology and Pharmacology, 80*, 134-163.

131. Frazer, K., Callinan, J. E., McHugh, J., van Baarsel, S., Clarke, A., Doherty, K., & Kelleher, C. (2016). Legislative smoking bans for reducing harms from secondhand smoke exposure, smoking prevalence and tobacco consumption (Review). *Cochrane Database of Systematic Reviews, 2*, 1-194.

132. Ohara, T., Ninomiya, T., Hata, J., Ozawa, M., Yoshida, D., Mukai, N., . . . Kiyohara, Y. (2015). Midlife and late-life smoking and risk of dementia in the community: The Hisayama study. *Journal of the American Geriatrics Society, 63*, 2332-2339.

133. Forbes, D., Forbes, S. C., Blake, C. M., Thiessen, E. J., & Forbes, S. (2015). Exercise programs for people with dementia. *Cochrane Database of Systematic Reviews, 4*, 1-80.

134. Latino-Martel, P., Cottet, V., Druesne-Pecollo, N., Pierre, F. H. F., Touillaud, M., Touvier, M., . . . Ancellin, R. (2016). Alcoholic beverages, obesity, physical activity and other nutritional factors, and cancer risk: A review of the evidence. *Critical Reviews in Oncology/Hematology, 99*, 308-323.

135. Wen, H., & Wang, L. (2017). Reducing effect of aerobic exercise on blood pressure of essential hypertensive patients: A meta-analysis. *Medicine, 96*, 1-6.

136. Anderson, C. A. M., Nguyen, H. A., & Rifkin, D. E. (2016). Nutrition interventions in chronic kidney disease. *Medical Clinics of North America, 100*, 1268-1283.

137. Huai, P., Han, H., Reilly, K. H., Guo, X., Zhang, J., & Xu, A. (2016). Leisure-time physical activity and risk of type 2 diabetes: A meta-analysis of prospective cohort studies. *Endocrine, 52*, 226-230.

138. Young, J., Angevaren, M., Rusted, J., & Tabet, N. (2015). Aerobic exercise to improve cognitive function in older people without cognitive impairment. Cochrane Database of Systematic Reviews, 4, 1-145.

139. Yen, S. H., Knight, A., Krishna, M. B. V., Muda, W. M. W., & Rufai, A. A. (2016). Lifetime physical activity and breast cancer: A case-control study in Kelantan, Malaysia. *Asian Pacific Journal of Cancer Prevention, 17*, 4083-4088.

140. Kyu, H. H., Bachman, V. F., Alexander, L. T., Mumford, J. E., Afshin, A., Estep, K., . . . Forouzanfar, M. H. (2016). Physical activity and risk of breast cancer, colon cancer, diabetes, ischemic heart disease, and ischemic stroke events: Systematic review and dose-response meta-analysis for the Global Burden of Disease Study 2013. *BMJ, 354*, 1-10.

141. Cheema, B. S., Chan, D., Fahey, P., & Atlantis, E. (2014). Effect of progressive resistance training on measures of skeletal muscle hypertrophy, muscular strength and health-related quality of life in patients with chronic kidney disease: A systematic review and meta-analysis. *Sports Medicine, 44*, 1125-1138.

142. Yalamanchi, S. V., Stewart, K. J., Ji, N., Golden, S. H., Dobs, A., Becker, D. M., . . . Kalyani, R. R. (2016). The relationship of fasting hyperglycemia to changes in fat and muscle mass after exercise training in type 2 diabetes. *Diabetes Research and Clinical Practice, 122*, 154-161.

143. Mustafa, M., Carson-Stevens, A., Gillespe, D., & Edwards, A. G. K. (2013). Psychological interventions for women with metastatic breast cancer. *Cochrane Database of Systematic Reviews, 6*, 1-72.

144. Kuiper, J. S., Zuidersma, M., Oude Voshaar, R. C., Zuidema, S. U., van der Huevel, E. R., Stolk, R. P., & Smidt, N. (2015). Social relationships and risk of dementia: A systematic review and meta-analysis of longitudinal cohort studies. *Ageing Research Reviews, 22*, 39-57.

145. Magrin, M. E., D'Addario, M., Greco, A., Miglioretti, M., Sarini, M., Scrignaro, M., . . . Crocetti, E. (2015). Social support and adherence to treatment in hypertensive patients: A meta-analysis. *Annals of Behavioral Medicine, 49*, 307-318.

146. Bookwala, J., Marshall, K. I., & Manning, S. W. (2014). Who needs a friend? Marital status transitions and physical health outcomes in later life. *Health Psychology, 33*, 505-515.

147. Yang, C. Y., Boen, C., Gerken, K., Li, T., Schorpp, K., & Mullan Harris, K. (2016). Social relationships and physiological determinants of longevity across the human life span. *PNAS, 113*, 578-583.

148. Altevers, J., Lukaschek, K., Baumert, J., Kruse, J., Meisinger, C., Emeny, R. T., & Ladwig, K. H. (2016). Poor structural social support is associated with an increased risk of type 2 diabetes mellitus: Findings from the MONICA/KORA Augsburg cohort study. *Diabetic Medicine, 33*, 47-54.

149. Holt-Lunstad, J., Smith, T. B., & Layton, J. B. (2010). Social relationships and mortality risk: A meta-analytic review. *PLoS Medicine, 7*, 1-20.

150. Ibrahim, N., Teo, S. S. L., Che Din, N., Gafor, A. H. A., & Ismail, R. (2015). The role of personality and social support in health-related quality of life in chronic kidney disease patients. *PLoSOne, 10*, 1-11.

151. Satterwhite Mayberry, L., Harper, K. J., & Osborn, C. Y. (2016). Family behaviors and type 2 diabetes: What to target and how to address in interventions for adults with low socioeconomic status. *Chronic Illness, 12*, 199-215.

152. Bahar-Fuchs, A., Clare, L., & Woods, B. (2013). Cognitive training and cognitive rehabilitation for mild to moderate Alzheimer's disease and vascular dementia. *Cochrane Database of Systematic Reviews, 6*, 1-103.

153. Ortega, V., McDonald, K. R., Poliakoff, E., Hindle, J. V., Clare, L., & Leroi, I. (2015). Cognitive training interventions for dementia and mild cognitive impairment in Parkinson's disease. *Cochrane Database of Systematic Reviews, 11*, 1-15.

154. Landau, S. M., Marks, S. M., Mormino, E. C., Rabinovici, G. D., Oh, H., O'Neil, J. P., . . . Jagust, W. J. (2012). Association of lifetime cognitive engagement and low [beta]-amyloid deposition. *Archives of Neurology, 69*, 623-629.

155. Valenzuela, M., Brayne, C., Sachdev, P., Wilcock, G., & Matthews, F. (2011). Cognitive lifestyle and long-term risk of dementia and survival after diagnosis in a multicenter population-based cohort. *American Journal of Epidemiology, 173*, 1004-1012.

156. Goghari, V. M., & Lawlor-Savage, L. (2017). Comparison of cognitive change after working memory training and logic and planning training in healthy older adults. *Frontiers in Aging Neuroscience, 9*, 1-12.

157. Martin, M., Clare, L., Altgassen, A. M., Cameron, M. H., & Zehnder, F. (2011). Cognitive-based interventions for healthy older people and people with mild cognitive impairment. *Cochrane Database of Systematic Reviews, 1*, 1-53.

158. Curioni, C., Andre, C., & Veras, R. (2006). Weight reduction for primary prevention of stroke in adults with overweight or obesity. *Cochrane Database of Systematic Reviews, 4*, 1-21.

159. Profenno, L. A., Porstensson, A. P., & Faraone, S. V. (2010). Meta-analysis of Alzheimer's disease risk with obesity, diabetes, and related disorders. *Journal of Biological Psychiatry, 67*, 505-512.

160. Aune, D., Sen, A., Norat, T., Janszky, I., Romunstad, P., Tonstad, S., & Vatten, L. J. (2016). Body mass index, abdominal fatness, and heart failure incidence and mortality: A systematic review and dose-response meta-analysis of prospective studies. *Circulation, 133*, 639-649.

161. Guo, Y., Yue, X.-J., Li, H.-H., Song, Z.-X., Yan, H.-Q., Zhang, P., . . . Li, T. (2016). Overweight and obesity in young adulthood and the risk of stroke: A meta-analysis. *Journal of Stroke and Cerebrovascular Diseases, 25*, 2295-3004.

162. Liu, J., Chen, Z., Li, W., Xu, G., Liu, J., Yi, B., . . . Zhang, H. (2016). Obesity indices for prediction of chronic kidney disease: A cross-sectional study in 26 655 Chinese adults. *Journal of Central Southern University (Medical Sciences), 41*, 445-454.
163. Liu, H., Zhang, Y., Ai, M., Wang, J., Jin, B., Teng, Z., . . . Li, L. (2016). Body mass index can increase the risk of gallbladder cancer: A meta-analysis of 14 cohort studies. *Medical Science Monitor Basic Research, 22*, 146-155.
164. Liu, Z., Zhang, T.-T., Zhao, J.-J., Qi, S.-F., Du, P., Liu, D.-W., & Tian, Q.-B. (2015). The association between overweight, obesity and ovarian cancer: A meta-analysis. *Japanese Journal of Clinical Oncology, 45*, 1107-1115.
165. De Ridder, J., Julian-Almarcegui, C., Mullee, A., Rinaldi, S., Van Herck, K., Vicente-Rodriguez, G., & Huybrechts, I. (2016). Comparison of anthropometric measurements of adiposity in relation to cancer risk: A systematic review of prospective studies. *Cancer Causes & Control, 27*, 291-300.
166. Chen, C.-C., Liu, K., Hsu, C.-C., Chang, H.-Y., Chung, H.-C., Liu, J.-S., . . . Hsiung, C. A. (2017). Healthy lifestyle and normal waist circumference are associated with a lower 5-year risk of type 2 diabetes in middle-aged and elederly individuals: Results from the health ageing longitudinal study in Taiwan (HALST). Medicine, 96, 1-9.
167. Hidayat, K., Du, X., Chen, G., Shi, M., & Shi, B. (2016). Abdominal obesity and lung cancer risk: Systematic review and meta-analysis of prospective studies. *Nutrients, 8*, 1-13.
168. Emdin, C. A., Khera, A. V., Natarajan, P., Klarin, D., Zekavat, S. M., Hsiao, A. J., & Kathiresan, S. (2017). Genetic association of waist-to-hip ratio with cardiometabolic traits, type 2 diabetes, and coronary heart disease. *JAMA, 317*, 626-634.
169. Gao, B., Zhang, L., & Zhao, M. (2016). Underweight but metabolically abnormal phenotype: Metabolic features and its association with cardiovascular disease. *European Journal of Internal Medicine, 29*, 46-51. doi:10.1016/j.jejim.2015.11.020
170. Bucholz, E. M., Krumholz, H. A., & Krumholz, H. M. (2016). Underweight, markers of cachexia, and mortality in acute myocardial infarction: A prospective cohort study of elderly medicare beneficiaries. *PLoS Medicine, 13*, 1-18. doi:10.1371/journal.pmed.1001998
171. Qizilbash, N., Gregson, J., Johnson, M. E., Pearce, N., Douglas, I., Wing, K., . . . Pocock, S. J. (2015). BMI and risk of dementia in two million people over two decades: A retrospective cohort study. *Lancet Diabetes & Endicrinology, 3*, 431-436. doi:10.1016/S2213-8587(15)00033-9
172. Kim, D. H., Gim, J.-A., Yeo, S. H., & Kim, H.-S. (2017). Integrated late onset Alzheimer's disease (LOAD) susceptibility genes: Cholesterol metabolism and trafficking perspectives. *Gene, 597*, 10-16.
173. Australian Bureau of Statistics (2013). *Australian Health Survey: Biomedical results for Chronic Diseases, 2011-12 - Australia*. Retrieved from Canberra:
174. Smart, N. A., Marshall, B. J., Daley, M., Boulos, E., Windus, J., Baker, N., & Kwok, N. (2011). Low-fat diets for acquired hypercholesterolaemia. *Cochrane Database of Systematic Reviews, 2*, 1-23.
175. Yao, X., & Tian, Z. (2015). Dyslipidemia and colorectal cancer risk: A meta-analysis of prospective studies. *Cancer Causes & Control, 26*, 257-268.
176. Xue-Shan, Z., Juan, P., Qi, W., Zhong, R., Li-hong, P., Zhi-han, T., . . . Lu-shan, L. (2016). Imbalanced cholesterol metabolism in Alzheimer's disease. *Clinica Chimica Acta, 456*, 107-114.
177. Hwang, Y.-C., Hayashi, T., Fujimoto, W. Y., Kahn, S. E., Leonetti, D. L., McNeely, M. J., & Boyko, E. J. (2015). Differential associations between HDL subclasses and the development of type 2 diabetes in a prospective study of Japanese Americans. *Diabetes Care, 38*, 2100-2105.

178. Touvier, M., Fassier, P., His, M., Norat, T., Chan, D. S. M., Blacher, J., . . . Latino-Martel, P. (2015). Cholesterol and breast cancer risk: A systematic review and meta-analysis of prospective studies. *British Journal of Nutrition, 114*, 347-357.

179. Singh, S., Singh, P. P., Singh, A. G., Murad, M. H., & Sanchez, W. (2013). Statins are associated with a reduced risk of hepatocellular cancer: A systematic review and meta-analysis. *Gastroenterology, 144*, 323-332.

180. Anstey, K. J., Lipnicki, D. M., & Low, L.-F. (2008). Cholesterol as a risk factor for dementia and cognitive decline: A systematic review of prospective studies with meta-analysis. T*he American Journal of Geriatric Psychiatry, 16,* 343-354.

181. Palmer, S. C., Navaneethan, S. D., Craig, J. C., Johnsons, D. W., Perkovic, V., Hebrant, J., & Strippoli, G. F. M. (2014). HMG CoA reductase inhibitors (statins) for people with chronic kidney disease not requiring dialysis. *Cochrane Database of Systematic Reviews, 5*, 1-139.

182. Grimley Evans, J., & Areosa Sastre, A. (2003). Effect of the treatment of Type II diabetes mellitus on the development of cognitive impairment and dementia. *Cochrane Database of Systematic Reviews, 1*, 1-24.

183. Zhu, B., Wu, X., Wu, B., Pei, D., Zhang, L., & Wei, L. (2017). The relationship between diabetes and colorectal cancer prognosis: A meta-analysis based on the cohort studies. *PLos ONE, 12*, 1-20.

184. Zhao, X.-B., & Ren, G.-S. (2016). Diabetes mellitus and prognosis in women with breast cancer: A systematic review and meta-analysis. *Medicine, 95*, 1-7.

185. Lee, S. J., Kim, J. H., Park, S. J., Ock, S. Y., Kwon, S. K., Choi, Y. S., & Kim, B. K. (2017). Optimal glycemic target level for colon cancer patients with diabetes. *Diabetes Research and Clinical Practice, 124*, 66-71.

186. Ding, Y., Sun, X., & Shan, P.-F. (2017). MicroRNAs and cardiovascular disease in diabetes mellitus. *Biomed Research International, epub ahead of print 12 February 2017*, 1-8.

187. Lo, C., Toyama, T., Hirakawa, Y., Jun, M., Cass, A., Hawley, C., . . . Zoungas, S. (2015). Insulin and glucose-lowering agents for treating people with diabetes and chronic kidney disease. *Cochrane Database of Systematic Reviews, 8*, 1-17.

188. Mongraw-Chaffin, M., LaCroix, A. Z., Sears, D. D., Garcia, L., Phillips, L. S., Salmoirago-Blotcher, E., . . . Anderson, C. A. M. (2017). A prospective study of low fasting glucose with cardiovascular disease events and all-cause mortality: The Women's Health Initiative. *Metabolism, 70*, 116-124.

189. Zhang, J., Chen, C., Hua, S., Liao, H., Wang, M., Xiong, Y., & Cao, F. (2017). An updated meta-analysis of cohort studies: Diabetes and risk of Alzheimer's disease. *Diabetes Research and Clinical Practice, 124*, 41-47.

190. Li, T., Wu, H. M., Wang, F., Huang, C. Q., Yang, M., Dong, B. R., & Liu, G. J. (2011). Education programmes for people with diabetic kidney disease. *Cochrane Database of Systematic Reviews, 6*, 1-40.

191. Hirakawa, Y., & Inagi, R. (2017). Glycative stress and its defense machinery glyoxalase 1 in renal pathogenesis. *International Journal of Molecular Sciences, 18*, 1-11.

192. Ricci, G., Pirillo, I., Tomassoni, D., Sirignano, A., & Grappasonni, I. (2017). Metabolic syndrome, hypertension, and nervous system injury: Epidemiological correlates. *Clinical and Experimental Hypertension, 39*, 8-16.

193. Cameron, A. J., Magliano, D. J., Zimmet, P. Z., Welborn, T., & Shaw, J. E. (2007). The Metabolic Syndrome in Australia: Prevalence using four definitions. *Diabetes Research and Clinical Practice, 77*, 471-478.

194. Tie, H.-T., Shi, R., Li, Z.-H., Zhang, M., Zhang, C., & Wu, Q.-C. (2015). Risk of major adverse cardiovascular events in patients with metabolic syndrome after revascularization: A meta-analysis of eighteen cohorts with 18457 patients. *Metabolism: Clinical and Experimental, 64*, 1224-1234.

195. Tune, J. D., Goodwill, A. G., Sassoon, D. J., & Mather, K. J. (2017). Cardiovascular consequences of metabolic syndrome. T*ranslational research, 183*, 57-70.
196. Esposito, K., Ciardiello, F., & Giugliano, D. (2014). Unhealthy diets: A common soil for the association of metabolic syndrome and cancer. *Endocrine, 46*, 39-42.
197. World Health Organization (2014). *Mental Health: A State of Wellbeing*. Retrieved from http://www.who.int/features/factfiles/mental_health/en/:
198. Mensah, G. A., & Collins, P. Y. (2015). Understanding mental health for the prevention and control of cardiovascular diseases. *Global Heart, 10*, 221-224.
199. Tong, A., Wang, X., Li, F., Xu, F., Li, Q., & Zhang, F. (2016). Risk of depressive symptoms associated with impaired glucose metabolism, newly diagnosed, and previously diagnosed diabetes: A meta-analysis of prospective cohort studies. *Acta Diabetologica, 53*, 589-598.
200. Semenkovich, K., Brown, M. E., Svrakic, D. M., & Lustman, P. J. (2015). Depression in type 2 diabetes mellitus: Prevalence, impact, and treatment. *Drugs, 75*, 577-587.
201. Whitworth, S. R., Bruce, D. G., Starkstein, S. E., Davis, W. A., Davis, T. M. E., & Bucks, R. S. (2016). Lifetime depression and anxiety increase prevalent psychological symptoms and worsen glycemic control in type 2 diabetes: The Fremantle Diabetes Study Phase II. *Diabetes Research and Clinical Practice, 122*, 190-197.
202. Almeida, O. P., Alfonso, H., Yeap, B. B., Hankey, G. J., & Flicker, L. (2013). Cardiovascular diseases do not influence the mental health outcome of older men with depression over 6 years. *Journal of Affective Disorders, 144*, 248-252.
203. Cherbuin, N., Kim, S., & Anstey, K. J. (2015). Dementia risk estimates associated with measures of depression: A systematic review and meta-analysis. *BMJ Open, 5*, 1-14.
204. Cooper, C., Sommerlad, A., Lyketsos, C. G., & Livingston, G. (2015). Modifiable predictors of dementia in mild cognitive impairment: A systematic review and meta-analysis. *American Journal of Psychiatry, 172*, 323-334.
205. Klainin-Yobas, P., Ng, S. H., Maria Stephen, P. D., & Lau, Y. (2016). Efficacy of psychosocial interventions on psychological outcomes among people with cardiovascular diseases: A systematic review and meta-analysis. *Patient Education and Counseling, 99*, 512-521.
206. Farrokhi, F., Abedi, N., Beyene, J., Kurdyak, P., & Vanita Jassal, S. (2014). Association between depression and mortality in patients receiving long-term dialysis: A systematic review and meta-analysis. *American Journal of Kidney Diseases, 63*, 623-635.
207. Batelaan, N. M., Seldenrijk, A., Bot, M., van Balkom, A. J. L. M., & Penninx, B. W. J. H. (2016). Anxiety and new onset of cardiovascular disease: Critical review and meta-analysis. *The British Journal of Psychiatry, 208*, 223-231.
208. Hayes, C. (2008). Role of physical activity in diabetes management and prevention. *Journal of the American Dietetic Association, 108*, s19-s23.
209. LaValley, S. A., Kiviniemi, M. T., & Gage-Bouchard, E. A. (2017). Where people look for online health information. *Health Information & Libraries Journal, 34*, 146-155.

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