Healthcare expenditure and productivity cost savings resulting from increased intake of grain fibre in Australia.

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FOREWORD

Cardiovascular disease (CVD) and type 2 diabetes (T2D) are some of Australia's biggest health challenges and among the leading causes of morbidity and mortality, reducing not only quality of life, but also the country's productivity. It is not surprising then, that CVD costs the Australian healthcare system more than any other disease in Australia, and both diseases are predicted to cost even more in the coming years with rising rates of T2D combined with an ageing population.

At the same time; 80% of heart disease, stroke and type 2 diabetes is preventable – just by eliminating factors that are modifiable such as an unhealthy diet. Despite the importance of diet in preventing CVD and T2D, Australian diets fall short of recommendations, especially in fruit, vegetable and fibre intakes.

There is scientific evidence that higher dietary fibre intake, particularly from grains, is associated with a substantial reduction in the prevalence of both CVD and T2D. The averted illness and deaths could translate into substantial economic gains including additional productivity gains.

Grain consumption, the largest source of dietary fibre in the Australian diet, is in decline, despite the evidence of the health benefits associated with whole and high fibre grains and the direct association between core grains and fibre intakes among Australian adults. Consequently, dietary fibre intake is lower than recommended. Public health messages that promote consumption of foods that are nutritious and a source of dietary fibre, are positive messages and preferential to those that encourage people to limit particular foods or that penalise individuals.

Increasing the grain fibre intake of Australians is expected to reduce the number of cases of CVD and T2D resulting in substantial healthcare expenditure and productivity cost savings to the Australian government. The estimated potential annual savings if only 5% of the population increased their intake, and by only 2 – 2.5 grams per day of grain fibre, would result in compelling economic and health benefits.

The results of this cost-of-illness analysis present an urgent case for addressing the social, environmental and economic barriers to increasing consumption of grain fibre, and to invest in policies that drive an increase in grain fibre consumption. These may include mass media campaigns, improving the food supply, working with retailers to provide nutrition information at point of sale, promoting high fibre grain foods, and nutrition education in workplaces, schools and communities.

Nutrition Research Australia was commissioned by Kellogg Australia to undertake this research and we commend their thought leadership. It has also been a pleasure to work with Deloitte Access Economics and their Health Economics and Social Policy team to deliver a quality report, which has major implications for both the health of Australians and the health of the economy.

Dr Flavia Fayet-Moore
Nutrition Research Australia

1. EXECUTIVE SUMMARY

An ageing population and growing prevalence of chronic diseases including cardiovascular disease (CVD) and type 2 diabetes (T2D) are putting increased pressure on the Australian healthcare system. Improved health outcomes and economic savings can be realised through dietary changes and lifestyle modifications to reduce the risk of chronic disease.

Consumption of grain fibre (fibre from grain foods) has been shown to reduce the risk of CVD and T2D. However, less than one in five Australian adults meet the suggested dietary target (SDT) for dietary fibre recommended to reduce the risk of chronic disease.

This research assessed the potential savings in healthcare expenditure and productivity costs associated with lower prevalence of CVD and T2D using grain fibre to increase the average daily intake of dietary fibre in Australian adults.

A range of intake scenarios were assessed and consequent reductions in disease prevalence were modelled for 2015–16.

This research demonstrates that if Australian adults use grain fibre to increase their intake of dietary fibre to target intake levels for chronic disease risk reduction (28g for women, 38g for men):

- The potential healthcare expenditure savings would be approximately $1 billion for CVD and over $285 million for T2D in 2015–16. The savings for CVD would represent approximately 0.6% of total Australian health expenditure and savings for T2D would be around 0.2% of health expenditure (AIHW, 2016).
- The potential productivity cost savings were estimated to be approximately $600 million for CVD and $1.4 billion for T2D. The savings for CVD represent approximately 0.04% of gross domestic product (GDP) and for T2D, approximately 0.08% of GDP (ABS, 2017).

The total combined economic savings could potentially reach $3.3 billion. If Australian adults use grain fibre to reach the general recommended levels (25g for women, 30g for men), the potential savings are still substantial at $1.5 billion dollars.

The potential health improvements and economic savings associated with increased intake of grain fibre emphasise the need to evaluate public health strategies for increasing grain fibre intake.

Current situation

There are considerable costs to Australia due to cardiovascular disease (CVD) and type 2 diabetes (T2D). Using data from the Australian Institute of Health and Welfare (AIHW), it was estimated that healthcare expenditure on CVD was $8.8 billion and on T2D, $1.1 billion in 2015–16 (AIHW, 2014; AIHW, 2013).

CVD has the highest level of healthcare expenditure of any disease group in Australia.

By comparison, obesity was estimated to have direct healthcare costs of $3.8 billion in 2014–15 (PWC, 2015). As a result of ageing alone, the number of people with T2D is expected to double, and healthcare expenditure will increase 2.5 times (in real terms) by mid-century (AIHW, 2013).

Considering the substantial costs of these conditions, interventions, including dietary and lifestyle modifications, to reduce the risk of CVD and T2D will be important in addressing rising healthcare spending on these conditions.

In particular, consumption of grain fibre as part of a fibre-rich diet has been associated with a reduced risk of CVD and T2D. However, Australians' average daily intake of dietary fibre is lower than the recommended levels (Table 1). The National Health and Medical Research Council (NHMRC) advises both an adequate daily dietary fibre intake level, as well as a higher 'target intake' level which is recommended for chronic disease risk reduction.

Table 1: Dietary fibre intake of Australian adults and recommended levels (grams per day)

	Average intake	Adequate intake	Target intake
Males	24.8	30	38
Females	21.1	25	28

Source: NHMRC 2014; NHMRC 2016; ABS 2014

Note: 'Adequate intake' is based on the Adequate Intake (AI), which is set at the median for dietary fibre intake in Australia from the 1995 National Nutrition Survey of Australia. 'Target intake' is based on the Suggested Dietary Target (SDT) which is defined as an adequate intake to reduce chronic disease risk. The SDT for dietary fibre is equivalent to the 90th centile of intake for reduction in coronary heart disease risk.

Approach

This research used a cost of illness analysis to estimate the potential healthcare expenditure and productivity cost savings from reduced cases of CVD and T2D that could arise if Australian adults used grain fibre to increase their intake of total dietary fibre.

The analysis involved four steps:

(1) determining levels of dietary fibre intake and prevalence of CVD and T2D in Australia

(2) calculating the potential reduction in CVD and T2D prevalence under several identified scenarios

(3) calculating the healthcare expenditure and productivity costs associated with CVD and T2D

(4) calculating the total expected savings in healthcare expenditure and productivity costs under each scenario ('Results').

The analysis examined a number of scenarios where grain fibre is used to increase adults' average daily intake of dietary fibre to different levels, including:

- A '10% increase' above current average intake
- An increase to 'adequate intake' levels
- An increase to 'target intake' levels

Scenarios were analysed by gender, socioeconomic status (SES), and quartiles of population intake, which provides an estimate of the range of dietary fibre intake levels across the Australian population, from the lowest quartile (bottom 25%) to the highest quartile (top 25%).

Various population uptake rates were modelled, to account for the fact that realised benefits will depend on the share of the Australian adults who actually achieve increases in grain fibre intake. These included universal (100%), optimistic (50%), pessimistic (15%) and very pessimistic (5%) rates of uptake. It is likely that a significant period of time would pass between increases in grain fibre intake and associated reductions in rates of CVD and T2D in the population. Accordingly, the analysis assumed that increases in intake had occurred sufficiently far in the past such that the potential reductions in CVD and T2D were fully realised in 2015–16. All results presented are for the 2015–16 financial year, unless stated otherwise.

Findings

Table 2 shows the potential healthcare expenditure savings for CVD and T2D from increased grain fibre intake, broken down by level of increase and population uptake. As shown in the table, even if just 5% of Australian adults used grain fibre to increase dietary fibre intake to 10% higher levels, the potential savings would be $11.1 million for CVD and $3.0 million for T2D. The universal scenario at target levels is compelling, with more than $1.3 billion dollars saved from healthcare expenditure from CVD and T2D combined.

The potential indirect cost savings from increased productivity are shown in Table 3. This includes costs associated with absenteeism, presenteeism, premature death, and reduced labour force participation by people with CVD and T2D. Universal uptake could potentially deliver just over $2 billion in savings from lost productivity at target levels. Combined at universal levels, the total economic (healthcare and productivity) savings for CVD and T2D combined could potentially reach $3.3 billion dollars.

Table 2: Potential healthcare expenditure savings from increased grain fibre intake, based on level of population uptake (AUD $m)

CVD	Universal (100%)	Optimistic (50%)	Pessimistic (15%)	Very pessimistic (5%)
10% higher	221.5	110.8	33.2	11.1
Adequate	467.3	233.7	70.1	23.4
Target	1,026.5	513.3	154.0	51.3

T2D	Universal (100%)	Optimistic (50%)	Pessimistic (15%)	Very pessimistic (5%)
10% higher	60.7	30.4	9.1	3.0
Adequate	131.0	65.5	19.6	6.5
Target	285.9	143.0	42.9	14.3

Source: Deloitte Access Economics analysis

Note: '10% increase' over current average intake is equivalent to an increase of between 2.1–2.5 grams per day; an increase to 'adequate intake' is 3.9–5.2 grams per day; and an increase 'target intake' is 6.9–13.2 grams per day

Table 3: Potential productivity cost savings from increased grain fibre intake based on level of population uptake (AUD $m)

CVD	Universal (100%)	Optimistic (50%)	Pessimistic (15%)	Very pessimistic (5%)
10% higher	134.8	67.4	20.2	6.7
Adequate	278.8	139.4	41.8	13.9
Target	609.5	304.7	91.4	30.5

T2D	Universal (100%)	Optimistic (50%)	Pessimistic (15%)	Very pessimistic (5%)
10% higher	302.6	151.3	45.4	15.1
Adequate	652.6	326.3	97.9	32.6
Target	1,421.9	710.9	213.3	71.1

Source: Deloitte Access Economics analysis

Note: '10% increase' over current average intake is equivalent to an increase of between 2.1–2.5 grams per day; an increase to 'adequate intake' is 3.9–5.2 grams per day; and an increase 'target intake' is 6.9–13.2 grams per day

Table 4: Potential savings among Australian adults for each 1g increase in intake of grain fibre, based on level of population uptake (AUD $m)

CVD	Universal (100%)	Optimistic (50%)	Pessimistic (15%)	Very pessimistic (5%)
Total direct healthcare expenditure savings	96.5	48.3	14.5	4.8
Total indirect productivity cost savings	58.9	29.5	8.8	2.9

T2D	Universal (100%)	Optimistic (50%)	Pessimistic (15%)	Very pessimistic (5%)
Total direct healthcare expenditure savings	26.5	13.3	4.0	1.3
Total indirect productivity cost savings	132.3	66.1	19.8	6.6

Source: Deloitte Access Economics analysis

As shown in Table 4, on average across the adult population, at universal levels, a one gram daily increase in grain fibre consumption would ultimately result in annual healthcare expenditure savings of $96.5 million for CVD and $26.5 million for T2D, plus productivity cost savings of $58.9 million for CVD and $132.3 million for T2D in 2015–16. Combined this equates to a saving of $314 million for every gram.

A 1g daily increase in grain fibre consumption would result in substantial potential annual healthcare expenditure and productivity savings of $314 million per year.

Given the substantial potential savings, there is a clear case to explore policies targeted towards increasing grain fibre intake in Australia. Successful interventions will be those that reach a large audience, result in sustained behavioural change, and are cost-effective. Potential public health interventions are numerous and could include:

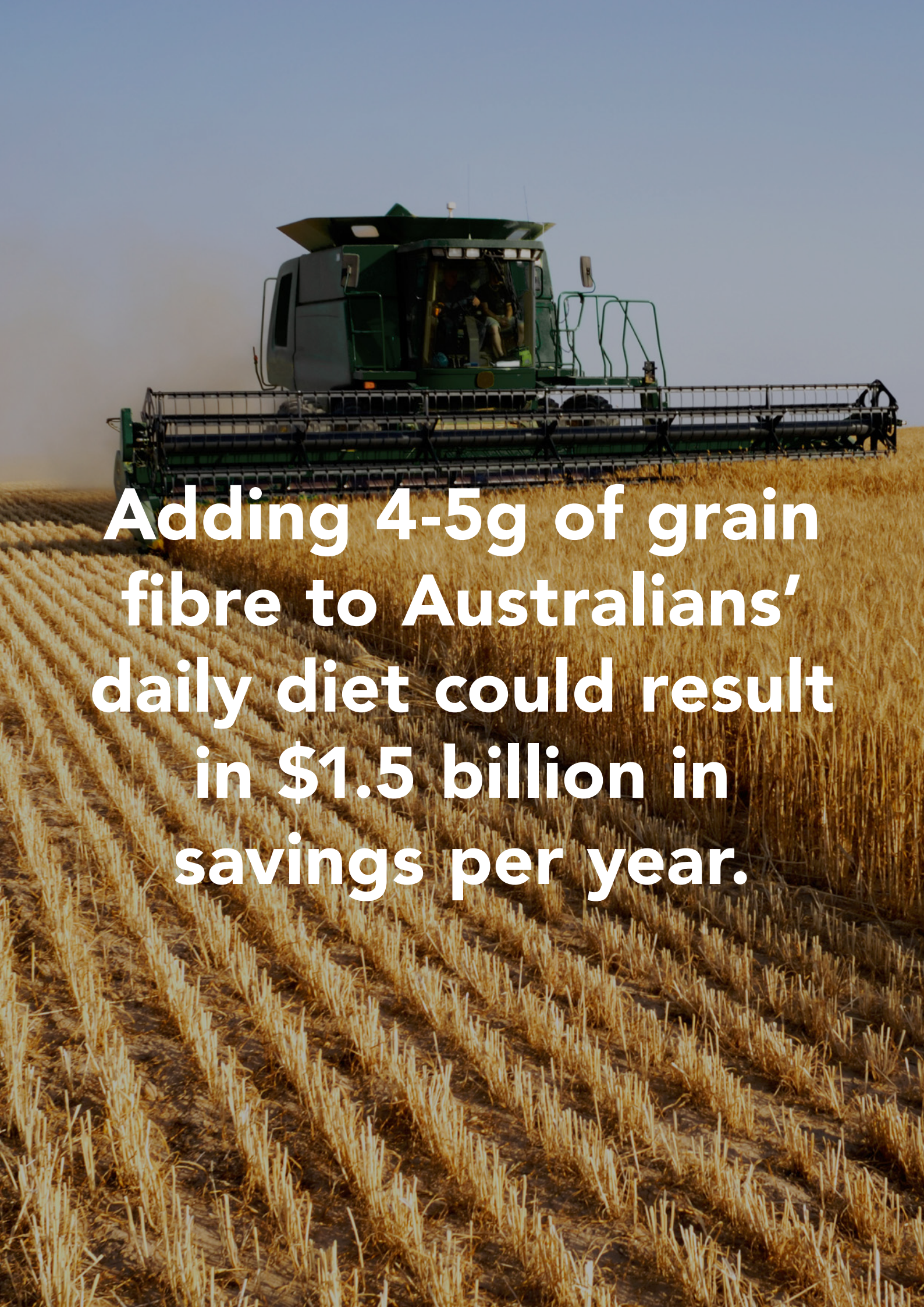
- mass media campaigns
- nutrition education in workplaces, schools and communities
- working with industry to improve the food supply
- promoting high fibre grain foods
- working with retailers to provide nutrition information at point of sale.

The potential benefits estimated in this research need to be compared to the costs of such interventions to government, industry and consumers, on a case-by-case basis. The success of interventions will also depend on how they increase grain fibre intake, along with other nutrients in the diet.

Overall, interventions that involve population-wide approaches and community mass media campaigns, are most likely to be cost saving to the health sector (Cobiac et al, 2013). Intensive nutrition education and delivery of positive health messages have also been shown to be effective at increasing dietary fibre intake at the individual level (Ma et al, 2015), but incur more cost. Notwithstanding, nutrition interventions in workplaces and supermarkets, and the majority of individually targeted behaviour change interventions are considered least likely to be cost-effective (Cobiac et al, 2013).

Future research could include developing dietary targets specific to grain fibre, regularly monitoring population intakes through nutrition surveys to identify at-risk populations, and introducing evidence-based health claims on pack to support the awareness of the benefits of grain fibre.

This report represents an important step in understanding and quantifying the potential health and economic benefits of increasing grain fibre intake. To our knowledge, this is the first such study in Australia. It is hoped the findings of this report will help to establish grain fibre as a key component of future health policy.



Adding 4-5g of grain fibre to Australians' daily diet could result in $1.5 billion in savings per year.

2. BACKGROUND

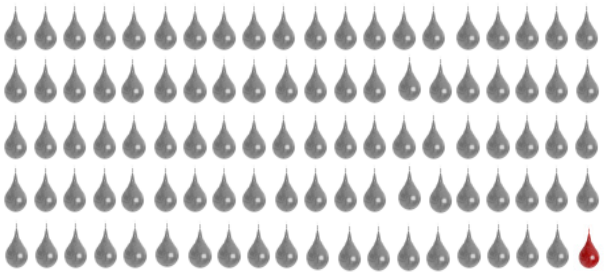
Cardiovascular disease and type 2 Diabetes at a global level

Chronic diseases such as cardiovascular disease, cancer, chronic respiratory diseases and diabetes are the world's biggest killers. The World Health Organisation reported that chronic diseases are responsible for more than 36 million, or nearly two-thirds (63%), of deaths worldwide. That is more than one death due to chronic disease every second (WHO, 2011), and this is expected to rise (WHO, 2013).

Cardiovascular diseases (CVD) are disorders of the heart and blood vessels and include coronary heart disease and stroke. Collectively, CVD are the world's number one killers, with 17.5 million people dying from CVD alone every year and CVD is responsible for 31% of all deaths (WHO, 2016).

Type 2 Diabetes (T2D) occurs when the body cannot effectively use insulin, commonly resulting in hyperglycaemia, or high blood sugar.
Over time, this can cause serious and devastating health consequences, and is a major cause of blindness, kidney failure, heart attack, stroke and lower limb amputation (WHO, 2016b). Worldwide, diabetes and high blood sugar were the direct cause of 1.5 million and 2.2 million deaths, respectively, and 8.5% of all adults worldwide had diabetes in 2014 (WHO, 2016b).

CVD accounts for **a third of all deaths** in Australia.



T2D is the underlying cause of approximately **1 in 100 deaths** in Australia.

Health and economic impact of CVD and T2D in Australia

In Australia, chronic diseases are responsible for a large proportion of mortality, accounting for 90% of all deaths (AIHW, 2014b) despite 80% of premature heart disease, stroke and type 2 diabetes being preventable (WHO, 2008). They are the leading cause of not only mortality, but also morbidity and illness, and are considered our biggest health challenges (AIHW, 2014b).

Almost three in every ten Australian deaths are due to CVD as the underlying cause (AIHW, 2016b), and coronary heart disease and stroke are respectively the number one and number three leading causes of death in Australia (AIHW, 2014c). CVD was responsible for over 1 million hospitalisations in 2014–15, equivalent to 11% of all hospitalisations in Australia (AIHW, 2016b).

Diabetes is the underlying cause of one in every ten deaths in Australia (AIHW, 2016c), responsible for 1 million hospitalisations, or 10% of all hospitalisations in 2014–15 (AIHW, 2016c). T2D is the underlying cause of approximately 1.3% of deaths (ABS, 2016).

Both CVD and T2D appear to be on the rise. The latest 2014–15 Australian Health Survey reported that 5.2% of Australians had CVD and 4.4% had T2D (ABS, 2015); up from 4.7% and 3.8% respectively, from just 3 years earlier (ABS, 2012). If the prevalence of diabetes continues to rise at current rates, one-third of today's young adults will develop diabetes during their lifetime (Baker IDI, 2012).

There is a marked association between socio-economic status (SES) and both CVD and T2D. Those in the lowest SES group had a 43% higher death rate and 24% higher hospitalisation rate from CVD, than those in the highest SES group (AIHW, 2016b). The death and hospitalisation rate from T2D was twice as high in the lowest SES group compared to the highest (AIHW, 2016c).

The differential prevalence of the disease among vulnerable groups is of concern.

Australia's healthcare expenditure is increasing at an alarming rate. Total health expenditure in Australia has more than doubled since 2003 (AIHW, 2015), and is predicted to more than triple from AU$129.7 billion in 2011–12 to AU$416.3 billion in 2031–32 (Nichols et al, 2015). An ageing population, population growth and the rise of chronic diseases are all contributing factors.

CVD and T2D contribute significantly to this health expenditure. In 2008–09, direct healthcare expenditure in Australia was AUD $7.6 billion for CVD (AIHW, 2015) and $0.9 billion for T2D (AIHW, 2013). **The total current health expenditure for all CVD and T2D combined is predicted to reach AUD $58 billion in 2031–32** (Nichols et al, 2015).

Healthcare expenditure on CVD is more than on any other any disease group. In 2008–09, CVD accounted for 12% of all allocated health-care expenditure, with oral health, mental disorders, musculoskeletal conditions, injuries and neoplasms being the next five disease groups ranked in order of allocated health-care expenditure, with each accounting for less than 10% of such expenditure (AIHW, 2014). Furthermore, the proportion of CVD and T2D to current health expenditure is predicted to jump by 261% for CVD and 306% for T2D in the two decades from 2011–12 to 2031–32 (Nichols et al, 2015).

In addition to the direct healthcare expenditure, CVD and T2D also have indirect economic costs related to the loss of productivity that need to be considered. These costs are related to reduced productivity in the workplace through absenteeism, reduced labour force participation and lost wages. Therefore, reducing the risk of CVD and T2D, even by marginal amounts, would have a major impact on improving the health and productivity of Australians.

Reducing the risk of CVD and T2D

Chronic disease is largely preventable. It is thought that up to **80% of heart disease, stroke and T2D could be prevented by eliminating four shared and modifiable risk factors**: tobacco use, unhealthy diet, physical inactivity and the harmful use of alcohol (WHO, 2008). It is well established that these can each be targeted by simple governmental measures, such as the implementation of public awareness programmes (WHO, 2013).

80% of cardiovascular disease and type 2 diabetes are preventable by modifying behaviour, including an improved diet.

The World Health Organisation has developed a 2013–2020 Global Action Plan for the prevention and control of chronic diseases that includes reducing modifiable risk factors and underlying social determinants through the creation of health-promoting environments (WHO, 2013). Modest reductions in modifiable risk factors for CVD and T2D would result in a major improvement on not only health, but also productivity in Australia.

In Australia, there are a range of programs and initiatives to support the prevention of CVD and T2D, including a National Chronic Disease Strategy, building the health workforce capacity, investments in research through the National Health and Medical Research Council (NHMRC) and funding to organisations such as the National Heart Foundation and Diabetes Australia (Australian Government Department of Health, 2016; National Health Priority Action Council, 2006). The Australian Institute of Health and Welfare (AIHW) is funded to support the national monitoring of these diseases and has several population-level prevention initiatives and interventions to reduce the risk factors (AIHW, 2009). However, funding for public health promotion initiatives in Australia is limited and only 2.7% of total health expenditure is spent on public health activities (AIHW, 2016).

The current state of the adult Australian diet

Despite the importance of an adequate diet as a modifiable risk factor for both CVD and T2D, the current Australian diet falls short of national dietary recommendations. At least two-thirds of the population have usual daily intakes of less than the recommended number for each of the five food groups recommended by the Australian Dietary Guidelines: vegetables or legumes/beans; fruit; milk, yoghurt, cheese and alternatives; meats and alternatives; and grain (cereal) foods (ABS, 2016b).

Alarmingly, 96.5% of adult males and 94.8% of adult females did not meet the targets for daily serves of vegetables or legumes/beans and 66.6% of adult males and 75.6% of adult females did not meet their targets for the grain (cereal) food group (ABS, 2016). At the same time, current intakes of discretionary foods and beverages, such as soft drinks, confectionery, hot chips, cakes and biscuits, are high, with more than one-third (34.6%) of the daily energy intake in the adult diet coming from discretionary foods and beverages (ABS, 2014).

As a consequence of the nation's failure to eat according to the Dietary Guidelines, and despite the established health benefits associated with dietary fibre, intake in Australia is sub-par. Results from the latest 2011–12 National Nutrition and Physical Activity Survey reported that on average, men consumed 24.8 grams and women 21.2 grams of dietary fibre per day (ABS, 2014). This is well below the suggested dietary target of 38 grams for men and 28 grams for women to reduce risk of chronic disease (NHMRC, 2006). Furthermore, an unpublished secondary analysis of this survey by Nutrition Research Australia found that less than 1 in 5 adults met these targets, and that less than a third (28%) of adults met the adequate intake levels of 30 grams for men and 25 grams for women (Nutrition Research Australia, 2016).

The leading source of dietary fibre in the Australian diet is grain-based food (fibre from wheat, barley, rye, oats, corn, rice, sorghum, triticale, millet, amaranth, buckwheat, quinoa) – contributing 43.5% of daily fibre intake among adults (ABS, 2014). A recent study reported that greater intake of grain foods as recommended by the Australian Dietary Guidelines, was directly associated with higher daily fibre intakes (Fayet-Moore et al, 2017). However, nearly two-thirds (63.7%) of daily grain (cereal) food intake comes from refined or lower fibre grain foods such as refined breads, grains, flours, rice and crackers (ABS, 2016), as opposed to the whole grain and higher fibre varieties that provide fibre for disease risk reduction.

Grain fibre intake is an important modifiable risk factor of CVD and T2D

The combination of the low adherence to national dietary guidelines and the excess intake of discretionary food items, strengthens the need and urgency for strategies that encourage the consumption of nutrient-dense, health-promoting diets and foods, particularly those that are linked to the greatest reduction in CVD and T2D rates.

Increasing the population's dietary fibre intake is a key diet-related strategy to prevent CVD and T2D in Australia (AIHW, 2009). There is solid scientific evidence that higher dietary fibre intake is associated with a significant reduction in both diseases (Pereira et al, 2005; Schulze et al, 2007; InterAct, 2015; Priebe et al, 2008; Threapleton et al, 2013).

A 2013 meta-analysis of 22 cohort studies (Threapleton et al, 2013) found that total dietary fibre consumption was inversely associated with the risk of cardiovascular disease. It reported a 9% lower risk of CVD per 7 gram increase in daily dietary fibre intake. A similar reduction is observed for T2D. A 2015 meta-analysis of 19 cohort studies reported a 9% lower risk of T2D per 10 gram increase in dietary fibre intake (InterAct, 2015).

When the source of dietary fibre is examined, such as from vegetable or grain foods, the risk reduction is much greater for grain fibre than from fruit or vegetable fibre for T2D (Schulze et al, 2007, InterAct, 2015,) and also possibly for coronary heart disease (Pereira et al, 2005; Threapleton et al, 2013). There was an 8% risk reduction in CVD per 7 gram increase in daily grain fibre intake (Threapleton et al, 2013) and a 25% risk reduction in T2D per 10 gram increase in daily increase in grain fibre intake – while the association between fruit and vegetable fibre and risk of T2D was smaller or non-significant (InterAct, 2015).

Of all the fibres, grain fibre has the greatest potential to help reduce the combined risk of developing cardiovascular disease and type 2 diabetes — more than fruit and vegetable fibre.

While the encouragement of fruit and vegetable consumption has previously been the subject of national health campaigns (Australian Government Department of Health, 2007) and are well-known to be health-promoting, a recent decline in the consumption of grain (cereal) foods has been reported, as well as significant confusion surrounding their health benefits (GLNC, 2014). Targeted intervention strategies around grain (particularly whole grain or high fibre) food consumption may therefore be more susceptible to change.

Grain fibre intake can have economic benefits

Grain foods are also the leading contributor of dietary fibre intake in the Australian diet (ABS, 2014) and can be a dense source of dietary fibre. This means they may hold a greater potential as an effective strategy for increasing total dietary fibre intake at a population level.

Not only are the potential health benefits considered when recommending population strategies to improve diets, but also the financial implications, such as the economic burden for the treatment and management of chronic diseases, and the productivity losses as a direct result of chronic disease.

In Canada, a recent cost-of-illness analysis revealed that the potential economic savings

attributable to a reduction in CVD and T2D following increased intakes of grain fibre up to recommended dietary fibre targets to be between CAD$64.8 million and $1.3 billion in CVD costs and between CAD$35.9 and CAD$718.8 million in T2D costs (Abdullah et al, 2015). In Australia, given the current levels of dietary fibre intake and the high prevalence of mortality and morbidity from CVD and T2D, the economic burden is likely to be substantial. However, no such estimates exist. Due to differences in lifestyle, environment, food availability and habits, dietary targets and a different health care system and associated costs, there is a need for Australian-specific estimates on the economic burden of inadequate fibre intake.

The purpose of this research was to quantify the potential economic savings in terms of healthcare expenditures and productivity costs, which would result from increased grain fibre consumption. These savings are determined using a modelling analysis that estimates the reduced rates of CVD and T2D expected from increasing intakes of grain fibre.

We propose that these potential cost savings are substantial, and call on policy makers within the Australian Government to consider innovative, evidenced-based and cost-effective strategies to increase grain fibre intake at a population level; particularly for those in lower SES groups and with low intakes of dietary fibre. Such strategies are not only likely to bring substantial savings to the Australian economy; they are also expected to save lives.

3. METHODS

A cost of illness analysis was conducted to assess the potential cost savings in both healthcare expenditure and productivity associated with lower prevalence of CVD and T2D resulting from Australian adults using grain fibre to increase their total dietary fibre intake.

Our approach to estimating reductions in health expenditure was based on calculating the average cost per case of CVD and T2D in 2015–16 and applying this to the potential number of cases that could be averted from increased intake of grain fibre.

Based on reductions in risk from published meta-analyses, the number of cases averted was estimated by assuming that Australian prevalence of CVD and T2D would be lower by 1.1% and 2.5%, respectively for each 1 gram increase in grain fibre intake (Threapleton, 2013; InterAct Consortium, 2015).

Potential savings were calculated for total healthcare expenditure as well as, separately, for hospital admitted patient services, out-of-hospital medical expenses, and prescription pharmaceuticals. The analysis also assessed the indirect costs of lost productivity to society arising from CVD and T2D. This included costs associated with absenteeism, presenteeism, premature death, and reduced labour force participation.

Grain fibre was used to increase total dietary fibre intake in Australian adults. The analysis examined savings by gender, SES, quartiles of population intake, as well as various levels of population uptake.

A range of scenarios were assessed for using grain fibre to increase total dietary fibre intake, including a 10% increase, an increase to adequate dietary fibre levels ('adequate intake'), and an increase to dietary fibre levels recommended for reducing the risk of chronic disease ('target intake') as defined by the NHMRC.

In summary, the analysis involved four steps which are described below:

(1) determining levels of dietary fibre intake and prevalence of CVD and T2D in Australia;

(2) calculating the potential reduction in CVD and T2D prevalence under the identified scenarios;

(3) calculating the healthcare expenditure and productivity costs associated with CVD and T2D; and

(4) calculating the total expected cost savings in healthcare expenditure and productivity under each scenario ('Results').

Step 1: Determining dietary fibre intake and prevalence of CVD and T2D in Australia

Dietary fibre intake in Australia

Average intake of dietary fibre was estimated to be 24.8 grams per day for men and 21.1 grams per day for women in 2011–12 based on data from the Australian Bureau of Statistics (ABS, 2014). Intake of dietary fibre by SES was also determined by a secondary analysis of the 2011–12 National Nutrition and Physical Activity Survey (Nutrition Research Australia, 2016). This analysis determined that dietary fibre intake varied by SES, with the lowest quintile consuming, on average, 21.7 grams of dietary fibre per day compared to 24.2 grams per day for those in the highest SES quintile.

Fibre intake was also assessed by quartiles of population fibre intake in our research. This provides an assessment of the range of dietary fibre intake across the Australian population, from the lowest quartile (bottom 25%) to the highest quartile (top 25%). These data were derived from analysis of the results of the 2011–12 National Nutrition and Physical Activity Survey (NRA, 2016).

As shown in Table 5, the lowest quartile consumed, on average, 11.1 and 9.5 grams per day for men and women, respectively. The highest quartile consumed 41.7 and 36.8 grams per day, on average, for men and women, respectively.

Overall, average levels of dietary fibre intake in Australia are lower than both the adequate and target levels. The NHRMC advises that adequate daily dietary fibre intake for Australians is 30 grams per day for men and 25 grams per day for women ('adequate intake') (NHMRC, 2014). For chronic disease risk reduction, the recommended intake is 38 grams per day for men and 28 grams per day for women, defined as 'target intake' levels (NHMRC, 2016).

Given that both men and women in the fourth quartile consume, on average, higher than the target intake level, this group was not considered to contribute to any savings in healthcare expenditure or productivity.

Table 5: Average dietary fibre intake in Australia (grams per day)

	Overall	Quartile 1	Quartile 2	Quartile 3	Quartile 4
Men	24.8	11.1	18.9	26.4	41.7
Women	21.1	9.5	16.4	22.6	36.8

Source: ABS, 2014

Prevalence of CVD and T2D in Australia

Disease prevalence for CVD and T2D in 2015–16 was derived from the Australian Health Survey 2014–15 conducted by the Australian Bureau of Statistics (ABS, 2015). Table 6 shows projected prevalence in 2015–16, which was derived using ABS Australian Demographic Statistics to determine the rate of growth in the Australian population and applying this to the prevalence of CVD and T2D in 2014–15 (ABS, 2016). We applied a rate of growth of 1.75%, which represents the growth in Australia's population from the end of June (quarter 2015) to the end of June (quarter 2016).

Disease prevalence was obtained by socioeconomic status (SES), which is defined by the ABS in terms of people's access to material and social resources as well as their ability to participate in society (ABS, 2009). Table 7 shows disease prevalence by SES, which was derived from the 2014–15 Australian Health Survey (ABS, 2015).

These estimates were used in the analysis to calculate the potential healthcare expenditure and productivity cost savings by SES quintile.

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Table 6: Estimated prevalence of CVD and T2D in Australia, in 2015–16

Prevalence	Persons	RSE (%)*
CVD	**1,206,953**	**3.6**
Males	651,709	5.2
Females	555,244	5.5
T2D	**1,021,362**	**3.9**
Males	559,727	5.3
Females	461,635	5.6

**RSE: Relative standard error of estimate, ABS National Health Survey, 2014–15*

Table 7: Estimated prevalence of CVD and T2D in Australia by SES, in 2015–16

Prevalence	Persons	Males	Females
CVD	**1,206,953**	**651,709**	**555,244**
Quintile 1 (lowest)	317,179	171,265	145,914
Quintile 2	264,786	142,974	121,812
Quintile 3	236,977	127,959	109,019
Quintile 4	190,831	103,042	87,790
Quintile 5 (highest)	197,179	106,469	90,710
T2D	**1,021,362**	**559,727**	**461,635**
Quintile 1 (lowest)	310,681	170,259	140,421
Quintile 2	196,813	107,858	88,956
Quintile 3	218,691	119,847	98,844
Quintile 4	171,060	93,744	77,315
Quintile 5 (highest)	124,117	68,019	56,098

Source: ABS National Health Survey, 2014–15

Step 2: Calculating the potential reduction in CVD and T2D prevalence under the identified grain fibre intake scenarios

Scenarios for increased intake of grain fibre

Three separate scenarios were modelled to evaluate the effects of higher levels of grain fibre consumption. All scenarios assumed that grain fibre is used to increase average intakes of dietary fibre for Australian adult men and women.

The first scenario reflects healthcare expenditure and productivity cost reductions associated with CVD and T2D when grain fibre is used to increase average daily intakes of dietary fibre to adequate intake levels of 30 grams per day and 25 grams per day for men and women respectively, as defined by the NHRMC (2014). This scenario represents increases of 21.0% and 18.5% above the average daily intake by men and women, respectively.

The second scenario evaluated savings in healthcare expenditure and productivity costs when grain fibre is utilised to increase daily intakes of dietary fibre to target intake levels of 38 grams per day for men and 28 grams per day for women, as recommended by the NHRMC (2016) for reducing the risks of chronic disease. This scenario represents increases of 53% and 32.7% above the average daily intake by men and women, respectively.

The third scenario calculated potential healthcare expenditure and productivity cost savings when grain fibre is used to increase total intake of dietary fibre by 10% for men and women. The third '10% higher intake' scenario provides an example of a more conservative increase in grain fibre consumption, which could potentially be an interim target for dietary interventions in the short to medium term.

Table 8 summarises the key parameter values used in the analysis.

Table 8: Scenarios and key parameters used in the analysis

Parameter	Men	Women	Source
Average daily fibre intake (grams per day)	24.8	21.1	ABS, 2014
10% higher intake (grams per day)	27.3	23.2	-
Adequate fibre intake (grams per day)	30.0	25.0	NHMRC, 2014
Target fibre intake (grams per day)	38.0	28.0	NHMRC, 2016
CVD risk reduction per 1 gram grain fibre intake (%)	1.1	1.1	Threapleton et al, 2013
T2D risk reduction per 1 gram grain fibre intake (%)	2.5	2.5	InterAct Consortium, 2015

Estimating the potential reduction in CVD and T2D prevalence

To estimate the reduction in prevalence of T2D from increased grain fibre consumption, we applied estimates of disease risk reduction from InterAct Consortium (2015). The research estimated a 25% reduction in the risk of T2D for a 10 gram average daily increase in grain fibre (RR = 0.75, 95% CI: 0.65-0.86), based on a meta-analysis of prospective studies. Similarly, the risk reduction for CVD was based on data from a systematic review and meta-analysis of cohorts by Threapleton et al (2013). There, grain fibre was found to reduce the risk of CVD by 11% for a 10 gram average daily increase (RR = 0.92, 95% CI: 0.84 to 1.00).

Based on these data, we estimated the number of cases averted by assuming that Australian prevalence of CVD and T2D would be lower by 2.5% and 1.1% respectively for each 1 gram increase in grain fibre intake. It is noted that there is likely to be a time delay between an increase in grain fibre intake and the corresponding reductions in the prevalence of CVD and T2D. The scenarios were modelled assuming that grain fibre intake had been increased so sufficiently in the past that potential reductions in CVD and T2D were fully realised in 2015-16.

Table 9 shows the estimated number of CVD and T2D cases averted under each scenario, together with the estimated reduction in disease prevalence. The number of cases averted was estimated by multiplying the difference in current fibre intake by the estimated prevalence reduction (1.1% for CVD and 2.5% for T2D) and then the estimated prevalence of CVD and T2D (Table 6). The reduction in disease prevalence was then calculated by dividing the estimated number of cases averted by the total prevalence of CVD and T2D.

Table 9: Estimated number of cases averted and reduction in disease prevalence

	10% higher	Adequate	Target
CVD			
Men	17,649 (1.5%)	38,576 (3.2%)	95,927 (7.9%)
Women	12,729 (1.1%)	25,402 (2.1%)	43,725 (3.6%)
Persons	30,378 (2.5%)	63,978 (5.3%)	139,652 (11.6%)
T2D			
Men	34,354 (3.4%)	76,251 (7.5%)	188,197 (18.4%)
Women	23,924 (2.3%)	49,283 (4.8%)	83,906 (8.2%)
Persons	58,278 (5.7%)	125,534 (12.3%)	272,102 (26.6%)

Source: Deloitte Access Economics analysis

Note: '10% increase' over current intake is equivalent to an increase of between 2.1-2.5 grams per day; an increase to 'adequate intake' is 3.9-5.2 grams per day; and an increase 'target intake' is 6.9-13.2 grams per day.

Approximately 64,000 cases of cardiovascular disease and 126,000 cases of type 2 diabetes could be averted with a daily increase of 4-5g of grain fibre

Step 3: Calculating the healthcare expenditure and productivity costs associated with CVD and T2D

Healthcare expenditure

Our approach to estimating reductions in health expenditure was based on calculating the average expenditure per prevalent case for CVD and T2D in 2015–16. The Australian Institute of Health and Welfare (AIHW) provides historical expenditure statistics for both conditions. In 2008–09, CVD and T2D accounted for $7.6 billion (AIHW, 2015) and $0.9 billion (AIHW, 2013) in healthcare expenditure respectively. We then accounted for rates of inflation by multiplying this healthcare expenditure by the growth in the health price index, which is a measure of the change in average health prices from year to year at the national level. Since the health price index was only available up to 2013–14 (AIHW, 2015b), we calculated the average historical growth rate per year over the previous 10 years (2004–05 to 2013–14) as 2.6% and applied this average growth rate for the years 2014–15 and 2015–16. Table 10 shows the estimated healthcare expenditure in 2015–16 from these calculations. The same calculations were also applied for the sub-categories of health expenditure (i.e. hospital-admitted patient services, out-of-hospital medical expenses and prescription pharmaceuticals).

The cost per case was estimated by dividing the total healthcare cost by the number of prevalent cases. As shown in Table 11, the expenditure per case was estimated for total healthcare expenditure as well as, separately, hospital admitted patient services, out of hospital medical expenses, and pharmaceutical expenditure.

Table 10: Estimated healthcare expenditure on CVD and T2D in Australia (AUD $m), 2015–16

Expenditure category	CVD	T2D
Total direct healthcare costs	**8,795.0**	**1,061.6**
Hospital-admitted patient services	5,157.9	629.1
Out-of-hospital medical expenses	1,731.2	202.4
Prescription pharmaceuticals	1,905.9	229.0

Source: AIHW, 2013 and AIHW, 2014

Table 11: Estimated healthcare expenditure per case of CVD and T2D in Australia (AUD $), 2015–16

Expenditure category	Persons	Males	Females
CVD			
Total direct healthcare expenditure	**7,286.96**	**7,555.95**	**6,971.23**
Hospital-admitted patient services	4,273.48	4,810.75	3,642.87
Out-of-hospital medical expenses	1,434.39	1,286.53	1,607.94
Prescription pharmaceuticals	1,579.08	1,458.66	1,720.42
T2D			
Total direct healthcare expenditure	**1,038.31**	**1,077.54**	**990.75**
Hospital-admitted patient services	615.97	657.53	565.57
Out-of-hospital medical expenses	198.15	206.46	188.08
Prescription pharmaceuticals	224.19	213.55	237.10

Source: Deloitte Access Economics analysis

As reported by the AIHW (2013 and 2014), not all healthcare expenditure can be allocated to specific diseases. This is because fixed expenditures, including expenditure on fixed assets and administration, can be common to many diseases.

Therefore, expenditure on both CVD and T2D, as reported by the AIHW, is based on recurrent costs for hospital admitted patient services, out-of-hospital medical expenses, and blood glucose lowering medications. Recurrent expenditure

relates to goods or services that are consumed within a short timeframe.

Expenditure on healthcare in Australia is financed from both government and non-government sources. While expenditure on CVD and T2D reported by the AIHW does not identify the contribution of government and non-government sources, it is noted that government expenditure in 2013–14 contributed to 67.8% of total healthcare expenditure (AIHW, 2015c). Of this, 60.8% was federal government expenditure and 39.2% was expenditure by state and territory governments. Non–government funding for health included individuals (17.8% of total expenditure), private health insurance (8.3%) and other non-government sources, mainly motor vehicle third party insurance and workers compensation (6.1%) (AIHW, 2015c). In considering the results of this analysis, the potential savings could be realised in both the government and non–government sectors.

Indirect (productivity) costs

The analysis also assessed the indirect costs of lost productivity to society arising from mortality and morbidity of CVD and T2D. This included:

- absenteeism, where workers are absent from work due to CVD or T2D;
- presenteeism, representing lost productivity due to people attending work while they are experiencing poor health;
- premature death, resulting in lost productivity and lifetime earnings of workers who die prematurely because of CVD or T2D; and
- reduced labour force participation, which includes lost productivity associated with lower levels of employment due to people having CVD and T2D.

Indirect costs were calculated using data from previous research and modelling by Deloitte Access Economics, which calculated costs of lost productivity and premature death per prevalent case of CVD (Deloitte Access Economics, 2014) and diabetes (types I and II) (Access Economics, 2005). Due to limitations in the availability of data by type of diabetes, the lost productivity costs relate to both type I and II diabetes. It is noted that the prevalence of T2D comprises 86.2% of the total prevalence of diabetes (ABS, 2015), and hence the lost productivity costs per case of diabetes was used to approximate the costs for T2D specifically.

Access Economics (2005) and Deloitte Access Economics (2014) estimated the impact of CVD and diabetes, respectively, on productivity, including reduced employment, absenteeism, and presenteeism. The authors used a human capital approach to estimate productivity losses from people with CVD or diabetes compared to the general population. Employment activity by people with CVD and diabetes were derived using available data from the National Health Survey (ABS, 2002) and the Disability, Ageing and Carers Survey (ABS, 2013), respectively. The productivity loss from people who die prematurely was estimated based on the assumption that if they had lived, the person would have earned an average annual income up until their retirement at the same rate as the age-standardised general population. This represents the discounted lost lifetime earnings.

The costs of presenteeism for CVD were calculated based on previous research on presenteeism for stroke, due to limitations in available data for CVD as a whole (Deloitte Access Economics, 2013). This used a similar methodology to that described previously for diabetes. Stroke contributed to approximately 14.5% of the total prevalence of CVD (ABS, 2015). All lost productivity costs were inflated to 2015–16 figures using growth in the ABS Wage Price Index over the previous years (ABS, 2016b). This was a growth rate of 2.3% for 2014–15 and 2.1% for 2015–16. Table 12 shows the estimated productivity costs of CVD and T2D in Australia in 2015–16.

Table 12: Estimated productivity costs of CVD and T2D in Australia (AUD $m), 2015–16

Cost category	CVD	T2D^
Total indirect costs	**6,212.4**	**5,681.0**
Reduced employment	3,248.9	1,443.7
Premature death	1,937.4	279.9
Absenteeism	141.9	324.3
Presenteeism	884.2*	3,633.1

**Based on presenteeism costs for stroke; Deloitte Access Economics, 2013*
^Based on data for type I and II diabetes.
Source: Access Economics, 2005; Deloitte Access Economics, 2014

The productivity cost savings per case that were averted (Table 13) were calculated by dividing the total estimated productivity costs for CVD and T2D (Table 12) by the prevalence of each disease. It is noted that the Access Economics (2005) report was based on a prevalence estimate for CVD of 3.2 million, based on results of the National Health Survey, 2002. Differences in the prevalence estimate arise from different categorisation of CVD. The present analysis uses the definition of CVD in terms of 'Total heart, stroke and vascular diseases' (ABS, 2015), while the 2005 Access Economics Report includes 'Total diseases of the circulatory system' and includes conditions such as haemorrhoids, varicose veins and cardiac murmurs and sounds (Access Economics, 2005). For the prevalence of diabetes, an estimate of 1.1 million people in 2014 was used based on the results of the 2011-12 National Health, inflated using the ABS Wage Price Index (ABS, 2016b).

Total productivity cost savings from absenteeism, presenteeism, and reduced labour force participation were then calculated by applying the cost per case to the estimated reduction in the prevalence of CVD and T2D. Due to limitations in published data, a cost per prevalent case was not available separately by gender or socioeconomic status.

Table 13: Estimated productivity cost per case of CVD and T2D averted in Australia (AUD $), 2015–16

Cost category	Cost per case ($)
CVD	
Total indirect costs	**45,399.20**
Reduced employment	980.59
Premature death	42,274.30
Absenteeism	42.82
Presenteeism	2,101.49
T2D	
Total indirect costs	**5,178.72**
Reduced employment	1,316.05
Premature death	255.13
Absenteeism	295.63
Presenteeism	3,311.90

Source: Deloitte Access Economics analysis

Costs of premature deaths from CVD and T2D

To quantify the total potential cost savings of premature death from CVD, data were used from a dose response meta analysis conducted by Kim et al (2016), who estimated a 9% reduction in the risk of CVD mortality from a 10 gram per day increase in total dietary fibre intake (RR = 0.91, 95% CI: 0.88 to 0.94). The reduced risk of death from CVD associated with grain fibre intake was reported, by Hajishafiee et al (2016), comparing different levels of grain fibre intake (n=10 studies) (RR=0.82, 95% CI: 0.78-0.86). As Kim et al (2016) reported the relative risk based on dose-response studies, this result was applied to this analysis. However, it is noted that the mortality risk reduction as reported by Kim et al (2016) is for total dietary fibre, not for grain fibre.

The risk reduction reported by Kim et al (2016) was extrapolated to indicate a 0.9% reduced risk of CVD mortality per 1g increase in grain fibre intake. This risk reduction was applied against the number of deaths from CVD, as reported in ABS's Causes of Death, Australia, 2014 publication (ABS, 2016c). The number of deaths with CVD as the underlying cause was 21,633 men and 23,420 women (45,053 persons) in 2014 (ABS, 2016c). The number of deaths from CVD in 2015-16 was derived using ABS Australian Demographic Statistics to determine the rate of growth in the Australian population and applying this to the number of deaths from CVD reported by AIHW in 2014 (ABS, 2016). This provided an estimated 22,012 men and 23,818 women (45,830 persons) who died from CVD in 2015-16.

The cost of premature death derived from Access Economics 2005 was divided by the estimated number of deaths from CVD to provide an estimate of the potential cost per premature death. The cost per death was inflated to 2015-16 using growth in the ABS Wage Price Index (ABS, 2016b). This was estimated to be $42,274.30 per death averted in 2015-16. The potential number of deaths that could be averted with higher fibre intake was calculated by applying a risk reduction of 0.9% per 1 gram increase in dietary fibre intake derived from Kim et al (2016).

There were no published data from systematic literature reviews or meta-analyses available on the reduced risk of death from diabetes associated with increased fibre intake. Instead, the cost of premature deaths averted from increased grain fibre intake was estimated using the relationship between prevalence and mortality of T2D, applied against the number of prevalent cases averted. The productivity cost of premature death from diabetes (both type I and type II) was derived from Deloitte Access Economics (2014) and used to represent the cost of premature death for T2D. Premature death costs per prevalent case were inflated to 2015-16 figures using growth in the ABS Wage Price Index over the previous year (ABS, 2016b) (Table 12). Therefore, the productivity cost of premature death per prevalent case of T2D was estimated to be $255.13 per person. This was applied to the estimated number of cases averted (Table 9), to derive potential productivity cost savings of premature death.

Estimated total cost to the economy of both CVD and T2D is $21.7 billion per annum.

4. RESULTS

Healthcare expenditure savings

Table 14 and Table 15 summarise the potential healthcare expenditure savings for CVD and T2D when grain fibre is utilised to increase average dietary fibre intake to adequate, target and 10% higher levels. It was estimated that healthcare expenditure on CVD could be lowered by $221.5 million from 10% higher intake, $467.3 million from adequate intake levels, and up to $1.03 billion from target intake levels for chronic disease risk reduction. For T2D, potential healthcare expenditure savings were estimated to be $60.7 million, $131.0 million and $285.9 million when grain fibre is utilised to increase intake to 10% higher, adequate and target intake levels, respectively.

Healthcare expenditure savings by gender and quintile of SES

Table 14 and Table 15 also show that, in general, potential healthcare expenditure savings would be greater among the lower SES quintiles (quintiles 1 and 2). However, this relationship is not observed across all groups. For example, in the 10% higher scenario for CVD, higher expenditure savings were realised in the 5th quintile than in the 4th quintile. This arises because the prevalence of both CVD and T2D does not always decrease for higher SES quintiles. For example, the prevalence of CVD is higher in SES quintile 5 than in SES quintile 4. Similarly, the prevalence of T2D was lower in SES quintile 3 than in SES quintile 2. Other than these two examples, the prevalence of CVD and T2D is seen to decrease with higher SES.

Table 14: Healthcare expenditure savings for CVD by gender and SES with increased intake of grain fibre (AUD $m)

Fibre intake	Total	Quintile 1 (lowest SES)	Quintile 2	Quintile 3	Quintile 4	Quintile 5 (highest SES)
Males						
10% higher	**132.8**	33.6	28.5	26.2	21.6	22.8
Adequate	**290.2**	89.0	69.5	56.0	39.4	36.3
Target	**721.7**	202.4	164.2	140.7	107.6	106.8
Females						
10% higher	**88.7**	22.0	19.1	17.6	14.2	15.8
Adequate	**177.1**	59.9	42.9	32.5	26.3	15.5
Target	**304.8**	93.4	70.9	57.6	46.4	36.4
Persons						
10% higher	**221.5**	55.6	47.6	43.8	35.8	38.6
Adequate	**467.3**	148.9	112.4	88.6	65.7	51.8
Target	**1026.5**	295.8	235.1	198.4	154.1	143.2

Source: Deloitte Access Economics analysis

Note: '10% increase' over current average intake is equivalent to an increase of between 2.1-2.5 grams per day; an increase to 'adequate intake' is 3.9-5.2 grams per day; and an increase 'target intake' is 6.9-13.2 grams per day.

Greater healthcare savings for both CVD and T2D are realised in the lowest socioeconomic groups and in males more than females

Table 15: Healthcare expenditure savings for T2D by gender and SES with increased grain fibre intake (AUD $m)

Fibre intake	Total	Quintile 1 (lowest SES)	Quintile 2	Quintile 3	Quintile 4	Quintile 5 (highest SES)
Males						
10% higher	**37.0**	10.9	7.0	8.0	6.4	4.7
Adequate	**82.2**	28.8	17.1	17.1	11.7	7.5
Target	**202.8**	65.5	40.3	42.9	31.9	22.2
Females						
10% higher	**23.7**	6.8	4.5	5.2	4.0	3.2
Adequate	**48.8**	18.6	10.1	9.5	7.5	3.1
Target	**83.1**	29.0	16.7	16.9	13.2	7.3
Persons						
10% higher	**60.7**	17.7	11.5	13.1	10.4	7.9
Adequate	**131.0**	47.4	27.2	26.6	19.1	10.6
Target	**285.9**	94.5	57.0	59.8	45.1	29.5

Source: Deloitte Access Economics analysis

Note: '10% increase' over current average intake is equivalent to an increase of between 2.1-2.5 grams per day; an increase to 'adequate intake' is 3.9-5.2 grams per day; and an increase 'target intake' is 6.9-13.2 grams per day.

Healthcare expenditure savings by quartile of fibre intake

Table 16 and Table 17 show the potential healthcare expenditure savings for men and women by quartile of fibre intake. People in the lowest quartile have the lowest average intake of dietary fibre, and hence this group has the highest potential disease risk reduction and healthcare expenditure savings from increasing consumption to adequate and target intake levels. However, for the 10% higher scenario, the reverse association can be seen since the increased intake of grain fibre is calculated as being 10% higher than the average intake for each quartile. The analysis indicates that potential healthcare expenditure savings for CVD range from $127.9 million for 10% higher intake, up to $1.1 billion where grain fibre is utilised to increase dietary fibre to target intake levels across the population.

For T2D, the potential healthcare expenditure savings ranged from $35.1 million for 10% higher intakes of grain fibre, up to $318.8 million, where grain fibre is utilised to increase total dietary fibre to target intake levels.

Table 16: Healthcare expenditure savings for CVD by quartile of fibre intake with increased intake of grain fibre (AUD $m)

Fibre intake	Total	Quartile 1 (lowest fibre)	Quartile 2	Quartile 3	Quartile 4 (highest fibre)*
Males					
10% higher	**76.4**	15.0	25.6	35.8	—
Adequate	**455.0**	256.0	150.6	48.4	—
Target	**780.0**	364.3	258.9	156.7	—
Females					
10% higher	**51.5**	10.1	17.4	24.0	—
Adequate	**282.9**	165.4	91.7	25.8	—
Target	**378.7**	197.4	123.6	57.7	—
Persons					
10% higher	**127.9**	25.1	43.0	59.8	—
Adequate	**737.9**	421.4	242.3	74.2	—
Target	**1,120.2**	523.2	382.5	214.5	—

Source: Deloitte Access Economics analysis

**People in quartile 4 consume in excess of the adequate and target intake levels of dietary fibre, and hence healthcare expenditure savings are not expected from this group.*

Note: '10% increase' over current average intake is equivalent to an increase of between 2.1-2.5 grams per day; an increase to 'adequate intake' is 3.9-5.2 grams per day; and an increase 'target intake' is 6.9-13.2 grams per day.

Greater healthcare expenditure savings are realised in groups with the lowest fibre intake. Savings are greater for males compared to females

Table 17: Healthcare expenditure savings for T2D by quartile of fibre intake with increased intake of grain fibre (AUD $m)

Fibre intake	Total	Quartile 1 (lowest fibre)	Quartile 2	Quartile 3	Quartile 4 (highest fibre)*
Males					
10% higher	**21.3**	4.2	7.1	10.0	—
Adequate	**126.6**	71.3	41.9	13.5	—
Target	**217.1**	101.4	72.1	43.6	—
Females					
10% higher	**13.8**	2.7	4.7	6.5	—
Adequate	**76.0**	44.4	24.6	6.9	—
Target	**101.7**	53.0	33.2	15.5	—
Persons					
10% higher	**35.1**	6.9	11.8	16.4	—
Adequate	**202.6**	115.7	66.5	20.4	—
Target	**318.8**	154.4	105.3	59.1	—

Source: Deloitte Access Economics analysis

**People in quartile 4 consume in excess of the adequate and target intake levels of dietary fibre, and hence healthcare expenditure savings are not expected from this group.*

Note: '10% increase' over current average intake is equivalent to an increase of between 2.1-2.5 grams per day; an increase to 'adequate intake' is 3.9-5.2 grams per day; and an increase 'target intake' is 6.9-13.2 grams per day.

Healthcare expenditure savings by category of healthcare expenditure

Table 18 shows that hospital-admitted patient services, followed by prescription pharmaceuticals, contributed to the largest expenditure saving for both CVD and T2D. The result follows from the higher relative expenditure of hospital-admitted patient services and prescription pharmaceuticals per case of CVD and T2D. The average expenditure per prevalent case for hospital-admitted patient services for CVD was also higher for males compared to females. For T2D, hospital-admitted patient services, out-of-hospital medical expenses and prescription pharmaceutical expenditures were higher for males compared to females. Consequently, healthcare expenditure savings were higher for males compared to females for both CVD and T2D.

Table 18: Categories of potential healthcare expenditure savings from increased grain fibre intake (AUD $m)

CVD	10% higher	Adequate	Target
Hospital	131.3	278.1	620.8
Males	84.9	185.6	461.8
Females	46.4	92.5	159.3
Out-of-hospital	42.6	89.2	190.6
Males	22.1	48.4	120.3
Females	20.5	40.9	70.3
Pharmaceutical	47.6	100.0	215.2
Males	25.7	56.3	139.9
Females	22.0	43.7	75.2
Total	**221.5**	**467.3**	**1,026.5**

T2D	10% higher	Adequate	Target
Hospital	36.1	78.0	171.2
Males	22.6	50.1	123.7
Females	13.5	27.9	47.5
Out-of-hospital	11.6	25.0	54.6
Males	7.1	15.7	38.9
Females	4.5	9.3	15.8
Pharmaceutical	13.0	28.0	60.1
Males	7.3	16.3	40.1
Females	5.7	11.7	19.9
Total	**60.7**	**131.0**	**285.9**

Source: Deloitte Access Economics analysis

Note: '10% increase' over current average intake is equivalent to an increase of between 2.1-2.5 grams per day; an increase to 'adequate intake' is 3.9-5.2 grams per day; and an increase 'target intake' is 6.9-13.2 grams per day.

Healthcare expenditure savings by population uptake

Analysis was undertaken to assess the potential healthcare expenditure and productivity cost savings if varying shares of the Australian population increased their grain fibre intake. Population uptake analysis was conducted using universal, optimistic, pessimistic and very pessimistic rates of uptake, based on findings from previous research relating to achievable dietary interventions (Abdullah et al, 2015).

Universal fortification assumes a 100% success rate which, while unlikely to be achieved in the short term, provides an indication of the total potential savings that could be realised. The optimistic rate assumed a 50% uptake as a medium-term, pragmatic estimate. The pessimistic and very pessimistic success rates were set at 15% and 5% respectively, and represent a less positive but more realistic short-term estimate. The resulting impact on healthcare expenditure was modelled for the 2015-16 financial year. This included sub-group analysis by gender and socioeconomic status (SES).

Table 19 shows the potential healthcare expenditure savings that could be realised if varying shares of the Australian population increased their grain fibre intake. Under the 'very pessimistic' rate of uptake (based on only 5% of the population increasing their intake of grain fibre), healthcare expenditure savings from reaching target intake levels were estimated to be $51.3 million for CVD and $14.3 million for T2D. The universal (100%) rate of uptake for the target scenario results in savings of $1.03 billion and $285.9 million for CVD and T2D respectively.

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Table 19: Potential healthcare expenditure savings from increased grain fibre intake, based on level of population uptake (AUD $m)

CVD	Universal (100%)	Optimistic (50%)	Pessimistic (15%)	Very pessimistic (5%)
10% higher	221.5	110.8	33.2	11.1
Adequate	467.3	233.7	70.1	23.4
Target	1,026.5	513.3	154.0	51.3
T2D	**Universal (100%)**	**Optimistic (50%)**	**Pessimistic (15%)**	**Very pessimistic (5%)**
10% higher	60.7	30.4	9.1	3.0
Adequate	131.0	65.5	19.6	6.5
Target	285.9	143.0	42.9	14.3

Source: Deloitte Access Economics analysis

Note: '10% increase' over current average intake is equivalent to an increase of between 2.1-2.5 grams per day; an increase to 'adequate intake' is 3.9-5.2 grams per day; and an increase 'target intake' is 6.9-13.2 grams per day.

Healthcare expenditure savings per gram increase in grain fibre consumption

Table 20 shows the potential healthcare expenditure savings for each category of healthcare expenditure for every one gram increase in grain fibre intake, by population uptake. If the entire Australian population increased their intake of grain fibre by one gram per day, total direct healthcare expenditure savings for CVD are estimated to be $96.5 million, and $26.5 million for T2D.

Table 20: Potential healthcare expenditure savings among Australian adults for each 1g increase in intake of grain fibre, based on level of population uptake (AUD $m)

CVD	Universal (100%)	Optimistic (50%)	Pessimistic (15%)	Very pessimistic (5%)
Hospital-admitted patient services	56.7	28.4	8.5	2.8
Out-of-hospital medical expenses	18.8	9.4	2.8	0.9
Prescription pharmaceuticals	21.0	10.5	3.1	1.0
Total direct healthcare expenditures	**96.5**	**48.3**	**14.5**	**4.8**
T2D	Universal (100%)	Optimistic (50%)	Pessimistic (15%)	Very pessimistic (5%)
Hospital-admitted patient services	15.8	7.8	2.4	0.8
Out-of-hospital medical expenses	5.1	2.5	0.8	0.3
Prescription pharmaceuticals	5.7	2.9	0.9	0.3
Total direct healthcare expenditures	**26.5**	**13.3**	**4.0**	**1.3**

Source: Deloitte Access Economics analysis

At universal levels, for every 1 gram of grain fibre consumed, we could potentially save $123 million per year in direct healthcare costs

Productivity cost savings

Table 21 summarises the potential indirect cost savings from increased productivity to society arising from lower prevalence and, consequently, mortality and morbidity of CVD and T2D, arising from higher grain fibre intake.

As shown, the greatest contribution to potential productivity cost savings came from reduced presenteeism for both CVD and T2D, followed by increased employment for T2D and premature deaths averted for CVD, for all levels of increased grain fibre intake.

Table 21: Potential productivity cost savings from increased grain fibre intake (AUD $m)

CVD	10% higher	Adequate	Target
Increased employment	29.8	62.7	136.9
Premature death averted	39.9	78.9	173.1
Absenteeism reduced	1.3	2.7	6.0
Presenteeism reduced*	63.8	134.4	293.5
Total	**134.8**	**278.8**	**609.4**

T2D	10% higher	Adequate	Target
Increased employment	69.0	142.3	242.2
Premature death averted	15.6	34.3	81.0
Absenteeism reduced	17.9	39.0	90.0
Presenteeism reduced	200.1	437.0	1,008.7
Total	**302.6**	**652.6**	**1,421.9**

Source: Deloitte Access Economics analysis

**Based on presenteeism cost savings for stroke.*

Note: '10% increase' over current average intake is equivalent to an increase of between 2.1-2.5 grams per day; an increase to 'adequate intake' is 3.9-5.2 grams per day; and an increase 'target intake' is 6.9-13.2 grams per day.

Productivity cost savings for CVD were calculated to be $134.8 million for a 10% higher intake of grain fibre, $278.8 million from adequate intake levels, and $609.4 million at target intake levels. For T2D, the potential savings from increased productivity range from $302.6 million, $652.6 million and over $1.4 billion for 10% higher, adequate and target intakes respectively.

There are several reasons why the productivity costs for T2D are higher than for CVD. As shown in Table 12, the total productivity costs of CVD ($6.2 billion) and T2D ($5.7 billion) are reasonably similar. However, the prevalence of CVD (3.2 million) is higher than T2D (1.1 million). This means that the productivity costs per case of CVD are lower (excluding premature deaths averted, which used a different methodology). However, the risk reduction for T2D (2.5% per 1 gram grain fibre) is more than two-fold higher than that for CVD (1.1%), therefore the potential number of CVD cases averted is lower. With the lower number of cases averted, multiplied by a lower cost per case, potential savings for CVD are lower than for T2D.

In addition, there are two limitations in the availability of data that could also have contributed to the lower productivity cost savings for CVD compared to T2D. Firstly, as noted previously, the results for presenteeism for CVD are based on calculations for stroke only, therefore this figure may be conservative and not represent the total potential savings from presenteeism for CVD.

A final consideration in comparing these results is the differences in methodologies employed for estimating the costs of premature deaths averted, as noted previously. For CVD, this method was based on literature relating to the reduced risk of death from increased intake of dietary fibre, while for T2D, the method involved estimating a relationship between prevalence and mortality.

Potential productivity cost savings by gender and quintile of SES

Shown in Table 22 and Table 23, productivity cost savings were higher for men compared to women for both CVD and T2D for all levels of increased grain fibre intake. Cost savings were also higher for lower SES groups for nearly all levels of increased grain fibre intake for both CVD and T2D, with small individual exceptions (SES quintiles 4 and 5 for CVD and SES quintiles 2 and 3 for T2D at 10% higher intake levels). As previously noted, this arises due to the relationship between prevalence and SES not being strictly linear.

Table 22: Productivity cost savings for CVD by SES quintiles with increased intake of grain fibre (AUD $m)

Fibre intake	Total	Quintile 1 (lowest SES)	Quintile 2	Quintile 3	Quintile 4	Quintile 5 (highest SES)
Males						
10% higher	**75.9**	19.2	16.3	15.0	12.4	13.0
Adequate	**164.1**	50.3	39.3	31.7	22.3	20.5
Target	**410.3**	115.1	93.3	80.0	61.2	60.7
Females						
10% higher	**58.9**	14.6	12.7	11.7	9.4	10.5
Adequate	**114.7**	38.8	27.8	21.1	17.0	10.0
Target	**199.2**	61.1	46.4	37.6	30.3	23.8
Persons						
10% higher	**134.8**	33.8	29.0	26.7	21.8	23.6
Adequate	**278.8**	89.1	67.1	52.8	39.3	30.6
Target	**609.4**	176.1	139.7	117.7	91.5	84.5

Source: Deloitte Access Economics analysis

Note: '10% increase' over current average intake is equivalent to an increase of between 2.1-2.5 grams per day; an increase to 'adequate intake' is 3.9-5.2 grams per day; and an increase 'target intake' is 6.9-13.2 grams per day.

Table 23: Productivity cost savings for T2D by SES quintiles with increased intake of grain fibre (AUD $m)

Fibre intake	Total	Quintile 1 (lowest SES)	Quintile 2	Quintile 3	Quintile 4	Quintile 5 (highest SES)
Males						
10% higher	**182.9**	53.8	34.6	39.4	31.7	23.4
Adequate	**405.9**	142.3	84.3	84.4	57.6	37.3
Target	**1,001.8**	323.5	199.2	212.0	157.5	109.7
Females						
10% higher	**119.8**	34.5	22.7	26.1	20.4	16.0
Adequate	**246.7**	94.0	51.2	48.1	37.7	15.7
Target	**420.0**	146.8	84.5	85.3	66.8	36.7
Persons						
10% higher	**302.6**	88.3	57.3	65.5	52.1	39.4
Adequate	**652.6**	236.3	135.5	132.5	95.4	52.9
Target	**1,421.9**	470.3	283.7	297.3	224.2	146.4

Source: Deloitte Access Economics analysis

Note: '10% increase' over current average intake is equivalent to an increase of between 2.1-2.5 grams per day; an increase to 'adequate intake' is 3.9-5.2 grams per day; and an increase 'target intake' is 6.9-13.2 grams per day.

Productivity cost savings by quartile of fibre intake

Table 24 and Table 25 show the potential productivity cost savings by population quartiles of dietary fibre intake. For CVD, potential productivity cost savings were estimated to be between $57.0 million for a 10% increase in grain fibre intake, up to $590.2 million if grain fibre was utilised to increase total dietary fibre to target intake levels for all quartiles of current fibre intake. For T2D, a 10% increase in grain fibre was estimated to result in $175.0 million in productivity savings, up to almost $1.6 billion if grain fibre was utilised to increase dietary fibre to target intake levels for all quartiles of intake.

Table 24: Productivity cost savings for CVD by quartile of fibre intake with increased intake of grain fibre (AUD $m)

Fibre intake	Total	Quartile 1 (lowest fibre)	Quartile 2	Quartile 3	Quartile 4 (highest fibre)*
Males					
10% higher	**32.8**	6.4	11.0	15.4	—
Adequate	**211.5**	115.4	75.6	20.5	—
Target	**398.2**	184.6	132.1	81.2	—
Females					
10% higher	**24.2**	4.7	8.2	11.3	—
Adequate	**135.9**	80.0	44.1	11.9	—
Target	**192.0**	100.8	62.7	28.5	—
Persons					
10% higher	**57.0**	11.2	19.2	26.6	—
Adequate	**347.4**	195.4	119.7	32.4	—
Target	**590.2**	285.4	194.8	110.0	—

Source: Deloitte Access Economics analysis

Note: '10% increase' over current average intake is equivalent to an increase of between 2.1-2.5 grams per day; an increase to 'adequate intake' is 3.9-5.2 grams per day; and an increase 'target intake' is 6.9-13.2 grams per day.

**People in quartile 4 consume in excess of the adequate and target intake levels of dietary fibre, and hence, productivity savings are not expected from this group.*

Table 25: Productivity cost savings for T2D by gender and quartile of fibre intake with increased intake of grain fibre (AUD $m)

Fibre intake	Total	Quartile 1 (lowest fibre)	Quartile 2	Quartile 3	Quartile 4 (highest fibre)*
Males					
10% higher	**105.0**	20.7	35.2	49.2	—
Adequate	**625.7**	325.1	207.1	66.5	—
Target	**1,072.6**	501.0	356.0	215.5	—
Females					
10% higher	**69.9**	13.7	23.7	49.2	—
Adequate	**383.9**	224.5	124.4	35.0	—
Target	**513.9**	267.8	167.8	78.4	—
Persons					
10% higher	**175.0**	34.3	58.8	81.8	—
Adequate	**1,009.6**	576.5	331.5	101.6	—
Target	**1,586.5**	768.8	523.8	293.9	—

Source: Deloitte Access Economics analysis

**People in quartile 4 consume in excess of the adequate and target intake levels of dietary fibre, and hence, productivity savings are not expected from this group.*

Productivity cost savings for CVD and T2D, at target levels of fibre intake, could reach $2.1 billion per year.

Productivity cost savings by population uptake

Table 26 shows the potential productivity savings that could be realised if varying shares of the Australian population increased their grain fibre intake. At a very pessimistic level of uptake, if the Australian population increased their intake of grain fibre by 10% more than the current average intake for men and women, $6.7 million for CVD and $15.1 million for T2D, could be saved in productivity costs. If the entire population met the target intake level, up to $609.5 million for CVD and over $1.4 billion for T2D could be saved in productivity costs.

Table 26: Potential productivity cost savings from increased grain fibre intake based on level of population uptake (AUD $m)

CVD	Universal (100%)	Optimistic (50%)	Pessimistic (15%)	Very pessimistic (5%)
10% higher	134.8	67.4	20.2	6.7
Adequate	278.8	139.4	41.8	13.9
Target	609.4	304.7	91.4	30.5
T2D	**Universal (100%)**	**Optimistic (50%)**	**Pessimistic (15%)**	**Very pessimistic (5%)**
10% higher	302.6	151.3	45.4	15.1
Adequate	652.6	326.3	97.9	32.6
Target	1,421.9	710.9	213.3	71.1

Source: Deloitte Access Economics analysis

Note: '10% increase' over current average intake is equivalent to an increase of between 2.1-2.5 grams per day; an increase to 'adequate intake' is 3.9-5.2 grams per day; and an increase 'target intake' is 6.9-13.2 grams per day.

Productivity cost savings per gram increase in grain fibre consumption

Table 27 shows the potential productivity savings among Australian adults for each one gram increase in grain fibre intake. At a very pessimistic level of uptake, $2.9 million in productivity savings for CVD and $6.6 million in productivity savings for T2D could be realised for each additional one gram intake of grain fibre. If all Australian men and women increased their grain fibre intake by one gram, up to $58.9 million in productivity savings for CVD and $132.3 million for T2D could be realised.

Table 27: Potential productivity cost savings among Australian adults for each 1g increase in intake of grain fibre based on level of population uptake (AUD $m)

CVD	Universal (100%)	Optimistic (50%)	Pessimistic (15%)	Very pessimistic (5%)
Increased employment	13.0	6.5	2.0	0.7
Premature death averted	17.4	8.7	2.6	0.9
Absenteeism reduced	0.6	0.3	0.08	0.03
Presenteeism reduced	27.9	14.0	4.2	1.4
Total indirect cost savings	**58.9**	**29.5**	**8.8**	**2.9**
T2D	Universal (100%)	Optimistic (50%)	Pessimistic (15%)	Very pessimistic (5%)
Increased employment	33.3	16.7	5.0	1.7
Premature death averted	6.5	3.3	1.0	0.3
Absenteeism reduced	7.6	3.8	1.1	0.4
Presenteeism reduced	84.8	42.4	12.7	4.2
Total indirect cost savings	**132.3**	**66.1**	**19.8**	**6.6**

Source: Deloitte Access Economics analysis

Sensitivity analysis

As shown in Table 28, the ABS provides relative standard errors of prevalence for each condition by gender, which provide an indication of the level of sampling error in the National Health Survey (ABS, 2015). Sensitivity analyses using the relative standard errors of population prevalence estimate were conducted. Table 28 shows the range of potential healthcare expenditure and productivity cost savings with upper and lower bounds based on the population prevalence estimates.

Table 28: Potential healthcare expenditure and productivity cost savings from increased grain fibre intake using relative standard error estimates of prevalence (AUD $m)

CVD	10% higher	Adequate	Target
Healthcare expenditure	**212.2 – 236.1**	**423.9 – 471.5**	**955.5 – 1,062.1**
Males	127.3 – 141.3	267.0 – 296.3	677.8 – 752.2
Females	84.9 – 94.8	156.9 – 175.2	277.6 – 309.9
Productivity	**128.5 – 143.0**	**255.5 – 284.2**	**568.7 – 625.4**
Males	72.4 – 80.3	151.7 – 168.4	385.1 – 427.4
Females	56.1 – 62.7	103.7 – 115.8	183.5 – 198.0

T2D	10% higher	Adequate	Target
Healthcare expenditure	**58.2 – 64.9**	**116.3 – 129.7**	**263.0 – 292.9**
Males	35.4 – 39.4	74.3 – 82.6	188.5 – 209.6
Females	22.8 – 25.5	42.1 – 47.1	74.5 – 83.3
Productivity	**290.0 – 323.3**	**579.5 – 645.8**	**1,307.5 – 1,456.4**
Males	174.9 – 194.5	366.8 – 407.9	931.2 – 1,035.4
Females	115.1 – 128.7	212.7 – 237.9	376.3 – 421.0

Source: Deloitte Access Economics analysis

Note: '10% increase' over current average intake is equivalent to an increase of between 2.1-2.5 grams per day; an increase to 'adequate intake' is 3.9-5.2 grams per day; and an increase 'target intake' is 6.9-13.2 grams per day.

Summary of total potential cost savings

Overall, the results of this research indicate substantial potential economic (healthcare expenditure and productivity) savings from using grain fibre to increase total dietary fibre intake (Table 29).

By using grain fibre to increase total dietary fibre levels, it was estimated that, in 2015-16, healthcare expenditure savings for CVD would reach **$221.5 million** through a 10% increase, **$467.3 million** from an increase to adequate intake levels, and up to **$1.03 billion** from increasing to target intake levels for chronic disease risk reduction.

For T2D, potential healthcare expenditure savings were estimated to be **$60.7 million**, **$131.0 million** and **$285.9 million** from increasing fibre by 10%, to adequate intake and to target intake levels, respectively.

By using grain fibre to increase total dietary fibre levels, productivity cost savings for CVD were calculated to be **$134.8 million** for a 10% higher intake fibre, **$278.8 million** from increasing to adequate intake levels, and **$609.5 million** from increasing to target intake levels.

For T2D, the potential savings from increased productivity ranged from **$302.6 million**, **$652.6 million** and over **$1.4 billion** by increasing fibre by 10% higher, increasing to adequate intake levels and increasing to target intake levels, respectively.

On average across the population, a one gram daily increase in grain fibre consumption would result in direct healthcare expenditure savings of **$96.5 million** for CVD and **$26.5 million** for T2D, plus productivity savings of **$58.9 million** for CVD and **$132.3 million** for T2D.

Table 29: Potential healthcare expenditure and productivity cost savings for CVD and T2D associated with using grain fibre to increase dietary fibre intakes at universal (100%) uptake (AUD $m)[b]

	Healthcare expenditure savings ($m)		Productivity savings ($m)		Total savings ($m)		
	CVD	T2D	CVD	T2D	CVD	T2D	Total
10% increase	221.5	60.7	134.8	302.6	356.3	363.4	**719.7**
Adequate	467.3	131.0	278.8	652.6	746.1	783.6	**1,529.7**
Target	1,026.5	285.9	609.4	1,421.9	1,635.9	1,707.8	**3,343.7**

Source: Deloitte Access Economics analysis

[b]The savings from the two conditions cannot technically be summed up, due to comorbidity between the conditions, hence the savings will fall short of the simple addition of $1.67 billion and $1.71 billion. For example, for someone who dies and has both CVD and T2D, the premature mortality costs cannot be double counted in the savings.

Note: '10% increase' over current average intake is equivalent to an increase of between 2.1-2.5 grams per day; an increase to 'adequate intake' is 3.9-5.2 grams per day; and an increase 'target intake' is 6.9-13.2 grams per day.

In summary:

- Up to **$1.67 billion** in benefits for CVD and **$1.71 billion** for T2D could ultimately be realised annually if all adult Australians used grain fibre to increase their total dietary fibre to suggested dietary target intake levels.

- This includes **$2.03 billion** in total productivity cost savings for CVD and T2D, and **$1.31 billion** in total healthcare expenditure savings.

- An increase in dietary fibre to the suggested dietary target levels would essentially equate to approximately 7-13g grain fibre per day in addition to the baseline diet or, more simply, 2-3 serves of high fibre grain foods.

- An increase in dietary fibre to the adequate intake would essentially equate to approximately 4-5 grams of grain fibre per day in addition to the baseline diet or, more simply, one serve of high fibre grain food.

- A 10% increase in fibre intake realised here, would essentially equate to approximately 2-2.5 grams of grain fibre per day in addition the baseline diet or, more simply, one serve of grain food containing fibre.

The increases in grain fibre modelled in this report are plausible in the context of the Australian diet, especially where such diets are in line with the Australian Dietary Guidelines. Using grain fibre to reach the targets is a real and cost effective way to increase dietary fibre intake in such a way that disease risk is ultimately reduced.

Limitations

To our knowledge, this analysis is the first study to determine the potential economic savings from increased intake of grain fibre associated with reduced rates of CVD and T2D in Australia. Indeed, this analysis may actually underestimate the total benefit of increasing grain fibre intake due to the potential for risk reductions for other conditions apart from CVD and T2D.

All modelling studies have limitations in comparison to well-designed experimental studies, which need to be considered. In conducting this analysis, it was assumed that there was a linear relationship between grain fibre intake and disease risk reduction. While the risk reduction of increased intake of grain fibre was calculated based on analysis of published data that consistently show an association across many large prospective cohorts after controlling for confounding factors, it is less clear whether a causal linear relationship remains high as well as marginal levels of change at a whole population level.

It was also assumed that potential cost savings would be realised in the present day (2015-16), and therefore the analysis reflects situations where grain fibre intakes were already (historically) at adequate, target or 10% increased levels. In reality, it could take many years or decades for these economic savings to be realised. Conservatively, the healthcare expenditure estimates used for CVD and T2D are based on recurrent expenditure and exclude fixed costs.

Prevalence of CVD and T2D were taken from the 2014-15 Australian Health Survey, and so in calculating the 2015–16 prevalence of these conditions using the population growth rate, it was conservatively assumed that the prevalence rate remained constant. In reality, rates of T2D in particular are projected to rise substantially over coming decades (Baker IDI, 2012). Further, due to the self reported method of data collection, the Australian Health Survey may have underestimated disease prevalence. For example, not all people with T2D are aware they have it, and prevalence may actually be higher than reported.

The research also considered increases in grain fibre intake in isolation from other nutrients, as this was the agreed scope of the study.

If all Australians use grain fibre to increase their fibre intake to target levels it could save the national economy up to $3.3 billion per year in healthcare costs and lost productivity

5. IMPLICATIONS & RECOMMENDATIONS

The Australian healthcare system faces a number of challenges, including an ageing population and increased prevalence of chronic disease, including CVD and T2D. In 2015-16, healthcare expenditure was $8.8 billion for CVD and $1.1 billion for T2D, with a further $11.7 billion in lost productivity.

This report has identified that if Australian adults used grain fibre to increase their total dietary fibre intake, there could be substantial savings to health system expenditure and productivity costs stemming from a reduced risk of CVD and T2D. Specifically, the total potential savings were estimated to be up to $1.67 billion for CVD and $1.71 billion for T2D. Given the potential savings, there is a clear case to explore policies targeted towards increasing grain fibre intake in Australia. Potential public health interventions are numerous and could include media campaigns, nutrition education, improvements to the food supply, and promotion of high fibre foods.

Successful interventions will be those that reach a large audience, result in sustained behavioural change, and are cost-effective. Estimating the cost effectiveness of interventions will be important to compare the potential realisable benefits estimated in this study with the cost and efficacy of interventions in each case, and the timeframes in which they may bring about changes in consumption behaviours, health system costs, and productivity savings.

The case for increasing grain fibre intake in Australia

Australian health expenditure is being pushed higher by an ageing population and increased prevalence of chronic disease. Increasing intake of grain fibre has the potential to improve the health of Australians and ultimately realise healthcare expenditure and productivity savings in the order of $3.34 billion annually[c], from reductions in CVD and T2D alone. The savings are likely to be even higher when considering the benefits of grain fibre in reducing the risk of other conditions such as colorectal cancer, diverticular disease, and weight gain which have not been considered in this report.

This presents a compelling case for considering options to increase grain fibre intake in Australia. Importantly, the realised benefits will depend on the nature and timing of interventions and how grain fibre is increased in the diet along with other nutrients.

> Increasing intake of grain fibre has the potential to improve the health of Australians and ultimately realise healthcare expenditure and productivity savings in the order of $3.34 billion annually[c]

Improvements to nutrition represent an important opportunity to support a healthier population and address the pressure that chronic disease is placing on healthcare expenditure. The typical Australian diet has considerable room for improvement. In particular, fibre intakes in Australia have long fallen short of levels suggested to reduce the risk of chronic disease, such as CVD and T2D. This report has identified that there is a substantial potential to reduce rates of CVD and T2D by increasing grain fibre intake in Australia.

Specifically, this report has shown that increasing grain fibre intake could be an effective focus area for policy-makers because of the potential:

- reductions in rates of CVD and T2D in Australia;
- associated savings for health system expenditure in terms of direct expenditure on hospital-admitted services, out-of-hospital medical expenses, and prescription pharmaceuticals;
- economic savings from increased productivity as a result of increased labour force participation and reductions in absenteeism, presenteeism and premature death.

Notably, the analysis presented in this White Paper only considers savings from CVD and T2D prevention alone. This may underestimate the total healthcare expenditure and productivity savings since it is likely that the benefits of grain fibre also extend to other conditions. For example, a meta-analysis and systematic review of prospective studies found evidence that grain fibre reduces the risk of colorectal cancer (Aune et al, 2011). Similarly grain fibre intake was found to be associated with reduced risk of diverticular disease (Crowe et al, 2014), weight gain (Du et al, 2010 and Koh-Banerjee et al, 2004) and all-cause mortality (Hajishafiee et al, 2016). However, given the substantial costs associated with CVD and T2D, they are likely to represent a significant share of total potential benefits. For example, CVD and T2D were estimated to have direct health expenditure of nearly $10 billion in 2015-16, compared to $3.8 billion for obesity in 2014-15 (PWC, 2015).[d]

Moreover, the analysis in this report did not quantify the burden of disease including the pain and suffering, and overall reduced quality of life for people with CVD and T2D. There is evidence to suggest that the burden of disease for CVD and T2D in Australia may be substantially higher in monetary terms than the healthcare expenditure and productivity costs (Access Economics, 2008). This means that the benefits of increasing grain fibre intake are likely to be even larger than the monetary cost savings presented in this report.

The potential savings from increased intake of grain fibre are also substantial relative to other nutrients. For example, recent research identified that a 10% increase in vegetable consumption was associated with a reduction in healthcare expenditure of around $100 million (Deloitte Access Economics, 2016). By comparison, using grain fibre to increase total dietary fibre intake by 10% (less than 3 grams of grain fibre per day) is estimated to have potential healthcare expenditure savings of $222 million for CVD and $61 million for T2D[e].

Notwithstanding the potential economic savings associated with increased intake of grain fibre, there are a number of important factors that may limit the proportion of these total potential benefits

[c]The savings from the two conditions cannot technically be summed up, due to comorbidity between the conditions, hence the savings will fall short of the simple addition of $1.67 billion and $1.71 billion. For example, for someone who dies and has both CVD and T2D, the premature mortality costs cannot be double counted in the savings.

[d]A direct comparison is not strictly possible due to differences in methodology between this report and the analysis undertaken for obesity. For example, the obesity costs include the direct costs of weight loss interventions and other public interventions.

[e]Differences in modelling methodologies mean that a direct comparison is not possible. The healthcare expenditure savings for vegetables includes savings for CVD and certain cancers.

CVD and T2D were estimated to have direct health expenditure of nearly $10 billion in 2015-16, compared to $3.8 billion for obesity in 2014-15 (PWC, 2015).[d]

that can be realised. The central results presented in this report assume that all Australian adults increase their intake of dietary fibre to target intake levels. However, practical interventions are likely to have a much more moderate reach in the short to medium term. As such, it is important to consider a range of different scenarios for population uptake and increases in fibre intake.

It may also take significant time to realise economic benefits. This includes time associated with implementing interventions, seeing changes in consumer behaviour, and subsequently influencing rates of CVD and T2D. The modelling in this report has not captured these time effects, and instead assumes that changes in grain fibre intake occurred sufficiently far in the past that potential reductions in rates of CVD and T2D would be fully realised by 2015-16.

Moreover, increased grain fibre intake is 'embedded' in foods that may also contain salts, carbohydrates or other ingredients. These foods may increase overall calorific intake, and hence increase a person's body mass index and waist circumference. For instance, one large randomised controlled trial found that increasing wholegrain, and subsequently fibre intake, did not lead to significant changes to markers of cardiovascular risk over 16 weeks (Brownlee et al, 2010). This was potentially due to the intervention also leading to increased intakes of kilojoules and total carbohydrates in some subjects, as well as fibre. This reseach assumes that the additional grain fibre intake is obtained without overall additional calorie intake.

Furthermore, if there is no additional calorie intake, the additional grain fibre intake can displace other foods for which grain fibre is substituted in the diet. This research assumes that the displaced foods are not healthy (risk-reducing) for CVD, T2D or other health conditions but, rather, that the displaced calories are 'empty' calories. If, however, the displaced foods are associated with risk reductions for particular health conditions, then the recognised benefits of increasing grain fibre intake may be reduced. These assumptions are important to consider case by case when analysing and prioritising interventions. For example, substitutional interventions that replace low fibre foods with high fibre foods without changes to other nutrients or increases in energy intake, may be preferred. These may include interventions that replace refined grains with whole grains as a method for increasing intake of dietary fibre.

Overall, reductions in the prevalence of CVD and T2D together with the associated economic benefits, present a compelling case to consider options for increasing grain fibre intake in Australia. However, it is noted that any intervention will have costs, and may have limited effectiveness in changing dietary fibre consumption patterns over prolonged periods.

[d]A direct comparison is not strictly possible due to differences in methodology between this report and analysis undertaken for obesity. For example, the obesity costs include the direct costs of weight loss interventions and other public interventions.

Intervention strategies

Despite the potential health and economic benefits, there are currently no public health strategies to increase intake of grain fibre specifically. There are a number of potential interventions, but further research is required to determine their efficacy and cost-effectiveness in increasing population intakes.

Dietary intervention

The potential health improvements and economic savings associated with increased intake of grain fibre emphasise the need to evaluate public health strategies for increasing grain fibre intake.

This research has identified that larger economic savings result from both higher rates of uptake and larger increases in grain fibre intake. As such, in evaluating interventions it is important to consider the extent to which they reach a large audience, result in sustained increased intake of grain fibre, and are cost-effective. It is also necessary to understand the potential social and economic barriers to higher fibre intake. Potential public health interventions are numerous and could include (Cecchini et al, 2010):

- mass media campaigns;
- nutrition education in workplaces, schools and communities;
- working with industry to provide high fibre grain foods;
- promoting high fibre foods ;
- working with retailers to provide nutrition information at point of sale to help consumers choose high fibre options.

Unfortunately, despite the established benefits of grain fibre, there is little evidence on the effectiveness of different strategies to increase its consumption specifically. There is, however, evidence that certain types of nutrition and health interventions are more likely to reach a large audience and achieve behavioural change.

Overall, population-wide approaches to intervention, such as community mass media campaigns are most likely to be successful (Cobiac et al, 2013). For example, an analysis of mass media health campaigns aimed at improving diet in the United States reported that campaigns were effective at changing the behaviour of about 8% of the population (Snyder et al, 2004).

A focused and coordinated approach is also important for the success of interventions. For instance, a collaborative and strategic approach involving health authorities, non-governmental organisations and the food industry in Denmark was associated with intake of whole grains almost doubling over 10 years (Kyro and Tjonneland, 2016).

In contrast, a recent analysis of Australian interventions reported that nutrition interventions in workplaces and supermarkets, and the majority of individually targeted behaviour change interventions were least likely to be cost effective (Cobiac et al, 2013).

Education

Despite the cost being higher, intensive nutrition education and delivery of positive health messages have also been shown to be effective at increasing dietary fibre intake at the individual level. A randomised trial involving group and individual education sessions was found to achieve increases in dietary fibre of 7.1 grams per day, compared to smaller increases in a control group, who received general dietary advice (Ma et al, 2015).

Education programs and health messages could be targeted at population groups with lower fibre intake, such as lower socio-economic groups,

in order to realise greater benefits. Similarly, interventions could be targeted at men, who have higher target intake levels for dietary fibre than women, and therefore, larger potential healthcare expenditure and productivity savings from increasing intake.[f] It would be beneficial for future research to further explore the dietary behaviours of lower socio-economic groups and men, and identify mechanisms for effectively increasing fibre intake among these populations.

Improving the food supply

Encouraging the food industry to add more grain fibre to the food supply through new product development or renovation will likely be effective for increasing consumption. It has been estimated that improving the nutritional profile of grain products by increasing their fibre content can increase fibre consumption by 11-19% (Combris et al, 2011). Additionally, retailers can provide nutrition information at point of sale displays for high fibre grain foods to help encourage consumption.

Fiscal strategies

Some studies have also investigated the role of price interventions including subsidies in influencing consumer choices towards healthier foods (Cobiac et al, 2013). However, price interventions can be blunt instruments and their effectiveness is highly sensitive to price elasticities and the extent to which consumers will substitute to or away from other food groups. Taxes and subsidies can also be expensive to administer, and can lead to market distortions.

There is evidence that some nutrition interventions may be more effective than others. Further research is necessary to better understand the extent to which various interventions are likely to reach a large population, result in a sustained increase in grain fibre intake, minimise the risk of unintended consequences, and achieve a cost-effective implementation.

Costs of and barriers to intervention

The potential savings from increasing grain fibre intake are substantial, however this report has not accounted for the costs involved in implementing strategies for increasing intake. In addition to the costs to government and industry of implementing health interventions, increasing grain fibre intake may also have a cost to the consumer. It is well established that healthier diets generally cost more than unhealthy diets (Darmon and Drewnowksi, 2015). For example, international evidence suggests that bread products marketed as being whole-grain are likely to cost more than other bread products (Sumanac et al, 2013). Nevertheless, bread and breakfast cereals are still an affordable way to increase whole grain and fibre intake and are easily accessible.

The effectiveness of an intervention may also depend on the context of its implementation. In particular, reductions in chronic disease and subsequent economic savings are likely to be influenced by how grain fibre is increased in the diet, along with other nutrients. Substitional interventions, where high fibre foods are encouraged as a replacement for low fibre foods, will help ensure that total energy is not increased as a result of increasing fibre in the diet.

It will be important to demonstrate that potential interventions are not only effective at increasing fibre intake, but are also cost-effective to government, industry and consumers, within reasonable time periods i.e. estimating the net present value of investment and benefit streams in each case. In addition to the costs of implementing nutrition interventions, a more detailed understanding is required of the barriers to increased fibre intake.

[f]While average daily intake of dietary fibre is higher for men (24.8 grams) than for women (21.1 grams), their target intake levels are also higher (38 grams, compared to 28 grams for women). Therefore the required increase in grain fibre for men to reach target intake levels is higher than for women. As a result, the potential healthcare expenditure and productivity savings for men are also higher.

Potential barriers include:

- Consumer confusion about the dietary fibre content of various foods (Mobley et al, 2014) and perhaps a general lack of knowledge of the health benefits;
- Lack of awareness and misunderstanding of the health benefits of grains, a major carrier of grain fibre (Grains & Legumes Nutrition Council, 2014);
- Limiting intake of grains due to perceptions of gut discomfort and weight gain (Grains & Legumes Nutrition Council, 2014);
- Social and economic barriers – lower socioeconomic status is associated with lower fibre intake, and therefore the largest economic benefits from increasing intake. It has been shown that low income households were less likely to purchase foods that are high in fibre due to their lower levels of dietary knowledge and concerns over higher food costs (Turrell and Kavanagh, 2006);
- Prioritisation – lower priority may be given to increasing fibre in the diet, compared to other foods such as fruits and vegetables;
- Stigma – dietary fibre has been commonly associated with managing regularity, rather than its other nutritional benefits (Mobley et al, 2014), which may mean it is ignored in the diet if regularity is not an issue.

The success of any intervention will be dependent on the social, economic and environmental factors specific to its implementation. Further research is needed to evaluate potential options for increasing grain fibre intake, having regard for evidence from other nutrition interventions and the expected costs and barriers to effective implementation. In addition, consideration needs to be given to the timing of interventions, whether dietary consumption changes are sustained, and the timeframes taken to realise gains.

Policy and research directions

Drawing on the health and economic benefits of increased grain intake, a number of key directions have been identified for future research and policy:

Nutrition labelling

Nutrition labelling can be effective in changing consumer behaviour (Cobiac et al, 2013). Dietary fibre is not currently required to appear on the nutrition information panel on food packaging. Mandatory labelling of dietary fibre content on the nutrition information panel would help consumers to better differentiate between foods which are low or high in fibre.

Investing in the development of a high-level health claim for grain fibre could also be considered. Health claims make it easier for consumers to select foods that are high in fibre and have a positive effect on the availablity of these foods in the marketplace (Kantor et al, 2004; Marquart et al 2003). High-level health claims currently exist for other foods and nutrients, including the claim that increased intake of fruit and vegetables reduces the risk of coronary heart disease (FSANZ, 2013). A similar claim for grain fibre may help to increase consumers grain fibre intake and inform them of its health benefits.

Developing a grain fibre intake target

The National Health and Medical Research Council (NHMRC) provides two recommended levels for dietary fibre intake: adequate intake, and a suggested dietary target for reducing the risk of chronic disease ('target intake'). The analysis in this report highlights the importance of differentiating between these levels, with higher economic savings estimated at target intake compared to adequate intake levels. However, neither level distinguishes between different sources of fibre. A quantitative dietary target specific to grain fibre may be helpful for nutrition education and could support regulatory bodies in communicating health claims relating to grain fibre. It could also assist consumers in understanding those health claims. In particular, this recommendation could support the development of a high level health claim for grain fibre relating to reducing the risk of CVD and T2D as part of a healthy varied diet.

Continual measurement of grain fibre intake in Australia

The Australian Bureau of Statistics' Australian Health Survey (ABS, 2014) records average daily intakes of various nutrients, including dietary fibre. However, there is currently no national data set to record intake of grain fibre specifically. Grain fibre is typically found in food categories distinct from other sources of dietary fibre, such as fruit and vegetable fibre. Furthermore, compared to fruit and vegetable fibre, which is also an important source of health risk reduction, grain fibre has been associated with an even greater risk reduction for T2D and possibly for coronary heart disease. The risk reduction for total CVD is approximately 1.1% per gram of grain fibre compared to around 1% per gram for fruit fibre (Threapleton et al, 2013; InterAct Consortium, 2015). For T2D, the risk reduction per gram of grain fibre is 2.5%, compared to 0.5% for fruit fibre and 0.7% for vegetable fibre.

A national data set specific to grain fibre would enable more detailed tracking of grain fibre intake, a better understanding of its associations with population health outcomes, and better targeting of nutrition interventions to food groups that are rich in grain fibre. Measurement of grain fibre intake could form a part of the ABS Australian Health Survey, which incorporates the National Nutrition and Physical Activity Survey (NNPAS). However it is noted that the last NNPAS took place five years ago in 2011-12 and no more recent statistics are available.

It is important that nutrition surveys occur regularly (at least every five years) and are comprehensive, both in sample size and detail of questions, in order to accurately track nutrition outcomes in Australia.

Taking research beyond CVD and T2D

Apart from healthcare expenditure and productivity costs, chronic diseases such as CVD and T2D also have substantial economic costs due to loss of wellbeing from reduced quality of life and premature death. Undertaking a full burden of disease analysis for fibre inadequacy would enable these costs to be identified.

The benefits of increasing grain fibre intake are also likely to extend beyond CVD and T2D, and include risk reductions for other conditions such as colorectal cancer. Quantifying these costs would provide a more complete view of the total benefits of increasing grain fibre intake, and enable full cost effectiveness analysis to be undertaken that incoporates the benefits of reduced morbidity and mortality, measured in disability adjusted life years (DALYs) averted.

6. CONCLUSION

The Australian healthcare system faces a number of challenges, including an ageing population and increased prevalence of chronic disease. However, the majority of cases of chronic disease are preventable and improvements to nutrition represent an important opportunity to reduce their risk and address the costs of chronic disease.

This report has demonstrated that using grain fibre to increase intake of total dietary fibre by Australian adults to target levels could result in substantial healthcare expenditure and productivity savings - $1.67 billion from reduced risk of CVD and $1.71 billion for T2D. Even if just a small proportion of Australian adults increased their fibre intake, significant savings are still possible.

The economic benefits establish a compelling case for policy-makers to consider options for increasing grain fibre intake in Australia. Possible interventions include media campaigns, nutrition education, working with industry to improve food supply and nutrition information at the point of sale. In evaluating interventions it is important to consider the extent to which they reach a large audience, result in sustained increased intake of grain fibre, and are cost-effective. It is also necessary to understand how interventions increase grain fibre in the diet, along with other nutrients.

This report represents an important step in understanding and quantifying the potential health and economic benefits of increasing grain fibre intake. To our knowledge, this is the first such study in Australia. Importantly, the findings show the need for further research and policy relating to grain fibre. This includes developing dietary targets specific to grain fibre, regularly monitoring population intakes through nutrition surveys, and introducing evidence-based health claims to support consumers in making healthier choices. Future research could also explore the benefits of grain fibre beyond CVD and T2D, including the potential to reduce risks of colorectal cancer, diverticular disease and weight gain.

It is hoped the findings of this report will help to establish grain fibre as a key component of future policies to improve the nutrition and health of Australians.

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