Deloitte Access Economics

Value of Accredited Exercise Physiologists in Australia

Exercise & Sports Science Australia

October 2015

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21 October 2015

Dear Katie

Value of accredited exercise physiologists in Australia

Please find attached our final report, which finds large benefits in terms of avoided health system costs, avoided productivity costs and the years of life saved from exercise interventions, as delivered by accredited exercise physiologists, in diabetes, depression, heart failure and other chronic diseases. It is a concern that accredited exercise physiologists appear to be a largely underutilised resource, despite these clearly established benefits and the high prevalence rates of chronic diseases in Australia.

Yours sincerely,

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Lead Partner | Health Economics and Social Policy | Deloitte Access Economics
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Contents

Charts

Tables

Glossary

ABS	Australian Bureau of Statistics
ACSM	American College of Sports Medicine
AHS	Australian Health Survey
AIHW	Australian Institute of Health and Welfare
AR-DRG	Australian Refined Diagnosis Related Group
BCR	benefit-cost ratio
BDI	Beck Depression Index
BEACH	Bettering the Evaluation of Health and Care
BMI	body mass index
CHF	chronic heart failure
CI	confidence interval
COPD	chronic obstructive pulmonary disease
CVD	cardiovascular disease
DALY	disability adjusted life year
DVA	Department of Veterans' Affairs
ESSA	Exercise & Sports Science Australia
FEP	first episode psychosis
GDP	gross domestic product
GP	general practitioner
HAQ	Health Assessment Questionnaire
HbA1c	glycated haemoglobin (A1c)
HRQOL	health-related quality of life
HRSD	Hamilton Rating Scale for Depression
ICER	incremental cost effectiveness ratio
IFG	impaired fasting glucose
IGT	impaired glucose tolerance
IHPA	Independent Hospital Pricing Authority
MD	mean difference
MET	metabolic equivalent unit
MLWHF	Minnesota Living with Heart Failure questionnaire
NICE	National Institute for Health and Clinical Exercise

NPV	net present value
NRAS	National Registration and Accreditation Scheme
OBPR	Office of Best Practice Regulation
PQOL	Perceived Quality of Life scale
PTSD	post-traumatic stress disorder
QALY	quality adjusted life year
RCT	randomised controlled trial
SF-36	Short Form 36 Health Survey
SMD	standard mean difference
TAU	treatment as usual
VAS	transformed Visual Analog Scale rating personal
VSLY	value of a statistical life year
WHO	World Health Organization
WHOQOL	World Health Organization Quality of Life scale
WOMAC	Western Ontario and McMaster Universities osteoarthritis index

Executive summary

The value of exercise in the prevention and management of a large range of chronic diseases is well evidenced in the literature. However, rates of exercise among those who have chronic diseases are far lower than in the rest of the population (AIHW, 2015).

Accredited exercise physiologists have three important contributions to make in this regard. First, they utilise their behavioural change skills to encourage people with chronic disease to undertake some moderate exercise rather than little or none. Second, they tailor the exercise regime to that person's age, gender, motivation levels and comorbidities, to produce optimum health outcomes. Finally, accredited exercise physiologists appear to be successful in producing lasting lifestyle modification. Once accredited exercise physiologists have demonstrated the benefits of exercise, people with chronic diseases can maintain exercise activities on their own for many subsequent years (Knowler et al, 2009).

Despite these benefits, only a very small proportion of people with chronic diseases or at risk of chronic disease are referred to accredited exercise physiologists for treatment. Almost 50% of Australians have some form of chronic disease[1], and as many as 13 million Australians are at risk of chronic disease due to overweight and obesity (Cheema et al, 2014). However, it has been estimated that less than 1% of people at risk of chronic disease due to overweight or obesity are referred to an accredited exercise physiologist (Cheema et al, 2014).

Exercise & Sports Science Australia (ESSA) commissioned Deloitte Access Economics to estimate the benefits of employing accredited exercise physiologists to manage three particular groups of chronic conditions:

- type 2 diabetes (including pre-diabetes);
- mental illness (including physical comorbidities); and
- cardiovascular and other chronic diseases managed in community settings.

There is a significant body of evidence which establishes the benefits of exercise supervised by university qualified exercise physiologists. However, there is insufficient evidence to estimate the benefits of accredited exercise physiologists compared with their unaccredited counterparts. In the literature, most interventions which assess the efficacy of exercise interventions are delivered by unaccredited university qualified exercise physiologists. Also, the great majority of these studies have been conducted in clinical settings, rather than the community settings where most accredited exercise physiologists work.

Accordingly, for the modelling conducted in this report, it has been assumed that accredited exercise physiologists are at least as effective as the average university qualified exercise physiologist in motivating people with chronic disease to commence and maintain exercise activities. It has also been assumed that efficacy results translate from clinical settings to community interventions. Most clinical trials provide interventions to a group of

[1] http://www.aihw.gov.au/media-release-detail/?id=60129552034

people on a one size fits all basis. In practice, in the community accredited exercise physiologists provide mostly one on one coaching with individually tailored regimes, but over a fewer number of sessions than is found in typical clinical trials.[2] The exception is pre-diabetes, where there have been sufficient community studies to allow their efficacy to be directly estimated.

From the extensive literature available, exercise interventions are estimated to cost around $5,611 per QALY for pre-diabetes and $5,135 per QALY for type 2 diabetes. Additionally, exercise interventions as delivered by accredited exercise physiologists are estimated to save up to $1,977 in health system costs for people with pre-diabetes annually, and up to $5,107 in health system costs for people with type 2 diabetes annually.[3] Further, avoided productivity impacts of type 2 diabetes for people with pre-diabetes are estimated to be $1,520 per person annually.

The total direct annual costs avoided for pre-diabetes are $3,497 per person. The total direct annual costs avoided for type 2 diabetes are $5,107 per person. Combining the direct costs with the burden of disease avoided annually, the **total annual wellbeing gains due to accredited exercise physiologists in Australia for people with pre-diabetes and type 2 diabetes are estimated to be $6,115 and $7,967 per person with pre-diabetes and type 2 diabetes** respectively, noting that no productivity estimates were able to be made for type 2 diabetes.

Costs of delivering this care are relatively cheap in comparison. For an accredited exercise physiologist to deliver an intervention similar to the Life! diabetes prevention program[4], which comprises 6 sessions lasting up to 1.5 hours, the cost would be approximately $635 per person.[5] Similarly, a program similar to the Healthy Eating Activity and Lifestyle (HEAL) program would cost approximately $525 per person. This comprises 2 sessions for 8 weeks and 2 individual sessions. The average cost of a program on either a group or individual basis is largely dependent on the program design; however, **the average cost of accredited exercise physiologists delivering an exercise intervention for people with pre-diabetes or type 2 diabetes is estimated to be $580**.

> The benefit-cost ratio (BCR) with reference to direct health care expenditure and the average cost of exercise interventions, as delivered by accredited exercise physiologists, per person with pre-diabetes is 6.0 to 1. For people with type 2 diabetes, the BCR is 8.8 to 1.

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[2] Medicare rebates allow for up to five sessions with university qualified exercise physiologists, which is lower than the average number of sessions in clinical trials (for example, the average number of sessions in the clinical trials on treating depression which were reviewed for this report is 33.0 – see Table 3.2).

[3] Health system savings occur as a result of health system costs that are avoided – for example, costs associated with visits to general practitioners, specialists, emergency departments, hospitalisations and day clinics (see Section 2.8.2 and Section 2.8.3).

[4] This program is delivered by Accredited Exercise Physiologists.

[5] Assuming that Accredited Exercise Physiologist interventions are primarily delivered on an individual basis.

It is possible that group programs based on the Medicare Benefits Scheme may be more cost effective than the interventions based on the Life! and HEAL programs, although no effectiveness data was found for such a program. Literature suggests that group-based interventions are more cost effective than individual-based interventions due to lower costs (Li et al, 2015).

In contrast to diabetes, we located few studies addressing the cost effectiveness of exercise interventions – that are representative of services provided by accredited exercise physiologists – to improve mental health conditions. However for clinical depression[6], the most common mental condition treated by university qualified exercise physiologists[7], there are a large number of meta-analyses demonstrating that exercise is highly effective.

The incremental cost per case of depression remitted is calculated using reported clinical recovery outcomes and exercise dosage information, and the cost of these interventions was calculated as being delivered by accredited exercise physiologists. The benefits per recovery are calculated using the health system, productivity and other financial costs of depression established by Deloitte Access Economics (2013). Assuming community interventions are 50%[8] as effective as clinical trials (as observed in the literature) it is estimated that exercise interventions, as delivered by accredited exercise physiologists, will result in benefits of $2,239 per person at a cost of $824 per person.

Thus, the incremental benefit to cost ratio of exercise interventions delivered by accredited exercise physiologists for depression is 2.7 to 1.

Chapter 3 also contains an overview of efficacy and cost effectiveness evidence in relation to other mental illnesses and for weight loss in people with psychosis.

Literature pertaining to cost effectiveness of exercise interventions for cardiovascular diseases (CVD) is also limited. However, the efficacy of such interventions is well established by a large number of meta-analyses. This study uses data on the effectiveness of exercise in preventing deaths among older people who had chronic heart failure (CHF) in combination with exercise dosage data to calculate the cost to deliver these incremental exercise interventions using accredited exercise physiologists. These results are then translated to a community setting by applying the 50% ratio relative to a clinical trial setting, to the CHF mortality rates in the Australian population. Under the Commonwealth Government's value for a year of life saved of $187,495[9] the estimated deaths averted results in total per person benefits of $11,847 at a cost of $1,903 per person.

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[6] Clinical depression refers to a Major Depressive Disorder as defined by the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders Fifth Edition (DSM-V).

[7] It has been reported that the majority of mental health cases dealt with by university qualified exercise physiologists are for depression (Stanton, 2013).

[8] See Section 2.6.1. This is calculated by dividing the results from community interventions by the results from clinical trial interventions [0.25/0.51 = 50%].

[9] Office of Best Practice Regulation (2014) figures inflated to 2015 values.

> The benefit to cost ratio is estimated to be 6.2 to 1 for accredited exercise physiologist cardiovascular interventions delivered in community settings.[10]

Clinical exercise interventions were also found to be cost effective for chronic back pain, osteoarthritis and rheumatic diseases, as discussed in Chapter 4.

Table i provides a summary of the benefits and costs for each condition.

Table i: Estimated benefits and costs of accredited exercise physiologist exercise interventions per person

Condition	Benefits ($)				Costs ($) (E)	BCR
	Health system (A)	Productivity & other financial (B)	BoD (C)	Total wellbeing (D = A + B + C)		
Pre-diabetes	1,977	1,520	2,617	6,115	580	**6.0^**
Type 2 diabetes	5,107	NE	2,860	7,967	580	**≥ 8.8^**
Mental health (depression)	330	1,909	NE	2,239	824	**2.7^**
Chronic disease (cardiovascular)	NE	NE	11,847	11,847	1,903	**6.2#**

Note: BoD is 'burden of disease', NE is 'not estimated due to lack of available data', ^ BCRs for pre-diabetes, type 2 diabetes and mental health (depression) are reported as the ratio of financial benefits (health system and lost productivity savings) to costs # The BCR for chronic disease is relative to the burden of disease. BCRs which contain NE elements are reported on a "greater than or equal to" basis, as it is assumed that the NE components would add to the benefits.
Source: Deloitte Access Economics calculations.

> Overall, exercise interventions delivered by accredited exercise physiologists are estimated to be efficacious and highly cost effective in the Australian health care setting for people with pre-diabetes and type 2 diabetes, depression, and cardiovascular disease.

There is a "plethora of evidence"[11] for the efficacy of exercise interventions in treating a number of conditions, which should be sufficient to increase referral rates to accredited exercise physiologists. However, there is still a dearth of community based studies in a number of conditions where exercise prescription delivered by accredited exercise physiologists is beneficial, which should be rectified.

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[10] Due to data restrictions, this is a "burden of disease" saving only. That is, it does not include any financial benefits such as reduced health system expenditure, or reduced absenteeism. For most conditions, burden of disease costs are considerably larger than financial costs.

[11] Stanton (2013) page 8.

1 Background

1.1 Physical activity

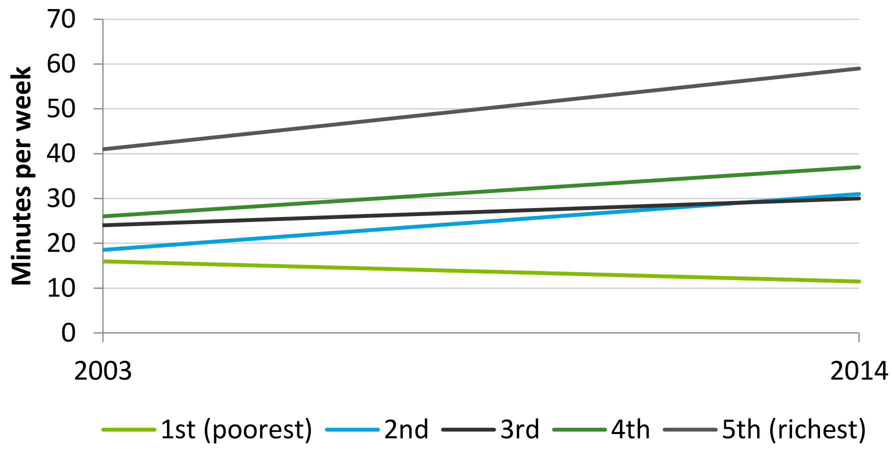
There is now irrefutable evidence that physical inactivity plays a major role in the pathogenesis of many chronic diseases that result in reduced life expectancy (Gillam, 2015). Stanton (2013) observes that "physical activity and exercise [delivered by an accredited exercise physiologist] assist[s] in the management of a plethora of chronic health conditions including obesity, hypertension and diabetes". Medibank Private (2007) estimated that 30 minutes of physical activity a day could save the Australian health system $1.5 billion annually. Carek et al (2011) observe that physical activity has been consistently shown to be associated with improved physical health, life satisfaction, cognitive functioning, and psychological well-being. Conversely, physical inactivity appears to be associated with the development of psychological disorders.

There are a range of options for advice and support for exercise for those that are motivated to participate in exercise. However, there are still issues with getting those who most need tailored exercise to be physically active. The AIHW (Begg et al, 2007) reports that there is a high degree of correlation between chronic diseases and physical inactivity. That is, people with chronic diseases tend not to exercise, and have low motivation to do so. Consultations undertaken during the development of this report[12] indicated that people with chronic disease typically only participate in exercise programs if they do not have to pay anything (if then).

There is a high degree of correlation between chronic disease and low socioeconomic status (ABS, 2010). In the United States, a country with some behavioural similarities to Australia in this regard, there is a strong correlation between income and exercise levels. Moreover, this disparity is increasing, with the top four income quintiles increasing their exercise effort over time, while the poorest income quintile is increasingly undertaking less physical activity (see Chart 1.1).

[12] Deloitte Access Economics consulted with six Accredited Exercise Physiologists to inform the development of this report.

Chart 1.1: Exercise minutes per week, by income level, United States, 2003-2014



Note: exercise included working out, weightlifting, using cardiovascular equipment, yoga and aerobics.
Source: United States Bureau of Labor Statistics, American Time Use Survey (http://www.bls.gov/tus/)

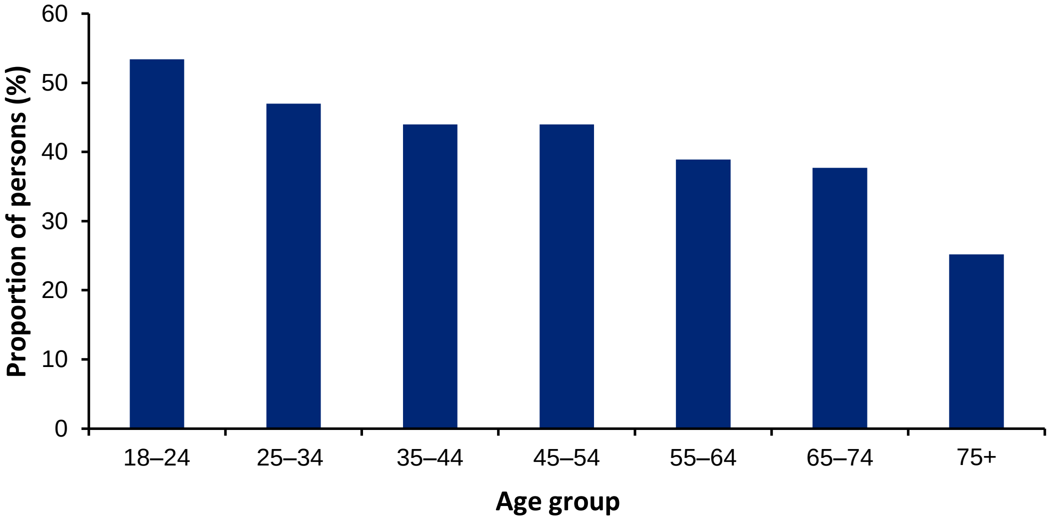
1.1.2 Physical activity in Australia

Exercise is defined as physical activity that is planned, structured, repetitive, and undertaken to improve or maintain aspects of physical fitness (Cheema et al, 2014). The Department of Health's Physical Activity and Sedentary Behaviour Guidelines for Adults (18-64 years) (Brown et al, 2012) defines sufficient physical activity as *"150 to 300 minutes of moderate intensity physical activity or 75 to 150 minutes of vigorous intensity physical activity, or an equivalent combination of both moderate and vigorous activities, each week"* (page 2). The guidelines recommend that exercise be spread over most days of the week, and that weight resistance exercise be undertaken on at least two days each week.

Doing some physical activity is better than none, whereby activity at the lower end of the scale provides significant health benefits such as reduced risk of type 2 diabetes and cardiovascular disease, as well as other psychological and musculoskeletal conditions or injuries. Higher levels of activity are considered necessary to prevent weight gain and some cancers.

The 2011-12 AHS (ABS, 2013) contains data on the proportion of Australian adults who engage in sufficient activity as defined by the national guidelines. The results show that a substantial proportion of Australians are not sufficiently active. The proportion of people meeting the physical activity guidelines declines with age, from 54% in people aged 18-24 years to 26% in those aged 75 years and over (Chart 1.2).

Chart 1.2: Proportion of persons meeting physical activity guidelines, 2011-12



Source: Deloitte Access Economics calculations using ABS (2013b; 2013d).

1.2 What is an accredited exercise physiologist?

Australia is one of only a few countries where allied healthcare professionals with specialised university education and training in exercise prescription and delivery (such as accredited exercise physiologists) provide services within a government-run healthcare system (Cheema et al, 2014).

The manipulation of key exercise training variables (i.e., frequency, intensity, duration, specificity, progressive overload) is required to optimise improvements in physical fitness, and the application of appropriate behaviour change strategies is needed to foster long-term adherence. Further, to maximise outcomes for a given individual, exercise needs to be prescribed and delivered with regard for the functional and disease-related limitations, as well as any domestic, social, and occupational constraints. It is therefore important to integrate accredited exercise physiologists, who have specialist training and expertise in the many factors involved in exercise prescription and delivery, within the healthcare system (Cheema, et al 2014).

Accredited exercise physiologists are four-year university degree qualified allied health professionals specialising in the delivery of exercise for the prevention and management of chronic diseases and injuries, such as cardiovascular disease, diabetes, osteoporosis, mental illness, cancer, arthritis and pulmonary disease. Interventions are exercise-based and include health and physical activity education, advice and support and lifestyle modification with a strong focus on achieving behavioural change and restoring optimal physical function, health or wellness. Most commonly, accredited exercise physiologists work in private clinics, workplace occupational rehabilitation, hospitals, and the community health setting. Accredited exercise physiologists are eligible to register with Medicare Australia, the Department of Veterans' Affairs (DVA) and WorkCover and are recognised by most private health insurers.

1.3 How many accredited exercise physiologists are there?

There are over 3,540 accredited exercise physiologists in Australia in 2015[13]. Of the 39 universities in Australia, 23 offer courses in clinical exercise physiology (Cheema et al, 2014).

1.4 Who uses accredited exercise physiologist services?

Under Medicare, patients with a ''chronic medical condition,'' defined as ''a condition that has been, or is likely to be, present for at least six months or is terminal,'' are eligible to receive services under the Chronic Disease Management Plan. Patients can claim a Medicare benefit (rebate) for a maximum of five visits to an Exercise Physiologist (item codes 10953 and 81315[14]) per calendar year. Patients can also access services through the DVA[15], and through private health insurance providers[16].

Patients with a diagnosis of type 2 diabetes are entitled to additional Medicare services provided by Exercise Physiologists (item code 81110). Exercise physiology services for patients with diabetes include one assessment and up to eight group services (e.g. group exercise sessions) per calendar year.

All programs are general practitioner (GP) centred, in that the management plan of the patient is developed and reviewed by the GP, and all referrals for allied healthcare services must come from the GP.

The 2012 Australian Health Survey (AHS) (ABS[17], 2012) shows that 63.4% of Australians are overweight or obese. There were at least 13 million resident Australians who were categorically overweight or obese in 2012. By assuming that each of the 121,926 MBS accredited exercise physiologist services in 2012 were for one overweight or obese individual, Cheema et al (2014) estimated that less than 1% of this at-risk population was referred for exercise physiology services in 2012. Similarly, the AHS showed that over 747,000 resident Australians had known type 2 diabetes in 2012. Patients with diabetes are entitled to one assessment service (Item Code: 81110) per year. There were 5,536 such services in 2012, which indicates that fewer than 0.8% of patients with diagnosed type 2 diabetes were referred for an assessment service in 2012.

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[13] Unpublished data provided by ESSA. Total membership of ESSA is currently 6,270.

[14] Item 81315 is Indigenous-specific

[15] Entitled persons can access services provided by exercise physiologists who are accredited by ESSA (DVA, 2015).

[16] 30 health insurers supply policies which pay benefits for services delivered by an Accredited Exercise Physiologist, which are used for preventing, delaying or ameliorating chronic diseases or injuries (ESSA, 2010).

[17] Australian Bureau of Statistics.

Data from the *Bettering the Evaluation of Health and Care* (BEACH) initiative suggest that GPs only provide exercise counselling at a rate of around 1.2 per 100 encounters (Stanton et al, 2015; Britt et al, 2014). As shown in Section 1.1.2, some of these people may already meet exercise guidelines and still have a condition, or they may see their GP for other reasons such as a general check-up. That said, it is still likely that a substantial proportion of services that may benefit from exercise are not referred, due to a lack of awareness.

1.5 Benefits of accredited exercise physiologists and supervised exercise

The vast majority of studies unearthed in the literature review for this report simply showed the benefits of exercise for the prevention and management of chronic conditions. We were not able to identify any studies that compared the benefits of accredited exercise physiologist led exercise compared to exercise supervised by other health professionals or to unsupervised exercise.

- In this report, the term “accredited exercise physiologist” is only used where the data is specific to accredited exercise physiologists (such as in the ESSA survey) or where the modelling pertains directly to accredited exercise physiologist interventions.
- The term “university qualified exercise physiologist” is used as the generic term in most other circumstances (e.g. where an overseas RCT refers to the use of exercise physiologists who are university qualified). This term is also used for hospital and clinical trials which involved exercise physiologists undertaking tasks that are typically performed by accredited exercise physiologists, but where the specifics of the qualifications are not provided. The great majority of interventions analysed in this report were conducted in hospital and clinical environments, rather than in community settings where accredited exercise physiologists usually provide their services.
- Where it is not clear what type of health professional was involved, the term “supervised exercise” is used, and the absence of this information is noted. Studies which specifically included non-university qualified professionals were excluded from this report.

While there were no comparators, there is evidence that university qualified exercise physiologists are effective in getting people with chronic conditions to exercise. Forsyth et al (2009) detailed a lifestyle intervention conducted in New South Wales. Accredited exercise physiologists developed and implemented a lifestyle intervention aimed at modifying behaviours to improve physical activity in GP referred patients with a mental illness. They report cardiovascular fitness, muscular endurance and psychological well-being improved in 80% of program completers. Wynaden et al (2012) described the patient-perceived outcomes from an Exercise Physiologist[18] coordinated healthy lifestyle program implemented in a West Australian forensic mental health facility. More than 95% of respondents report the program was helpful in improving fitness, physical well-being and mood.

[18] Note that the study did not state whether the Exercise Physiologist was university qualified.

Accordingly, one of the main benefits of university qualified exercise physiologists is in motivating people with chronic conditions to exercise. Gillam (2015) note that accredited exercise physiologists can provide more complete and effective multidisciplinary care, by translating exercise advice offered by physicians in primary care. There are also a number of studies (Daley et al, 2008) that show adherence rates to supervised interventions for chronic conditions are at least as good as those for psychological or pharmacological interventions.

Supervised exercise is likely to be more efficacious than unsupervised exercise (depending on the qualifications of the supervisor). In this respect, supervision by an accredited exercise physiologist is assumed to be at least as effective as supervision by other health professionals. For example:

- A systematic review by Rosenbaum et al (2015) reported that there is clear evidence from trials in other clinical populations such as type 2 diabetes, and reviews in populations with mental illness demonstrating superior outcomes from structured, supervised and progressive exercise compared with non-structured, unsupervised interventions.
- Callaghan et al (2011) showed that a specially designed exercise program was significantly more effective in reducing depression than the regular exercise program.
- Richardson et al (2014) in their analysis of integrating physical activity into mental health services found interventions that target specific groups or that are tailored to the individual, taking into account the participant's age, gender, socioeconomic status, cultural background, health status, barriers to activity, and fitness level, were more effective in increasing levels of physical activity than more generic interventions.
- Stanton and Raeburn (2013) reported that all RCTs included in their review were supervised to some degree, and all supervisors were well trained in the provision of exercise. However, the qualifications of professionals providing supervision was varied, and "the influence of this variable is presently unknown".
- Conn (2010a) reported supervised interventions were more effective than others for treating anxiety. The presence of a supervised physical activity component of the intervention appears important. Supervised physical activity may provide subjects with explicit guidelines for exercise intensity, duration, and frequency. Supervised physical activity may also be associated with social affirmation from others exercising at the same time or from research staff supervising the physical activity. Recommendations to continue exercise at a fitness centre may also be effective because they provide social interaction or because participants continue a pattern of exercise behaviour established during the intervention.
- In a similar vein, a systematic review by Chien et (2010) concluded that home-based exercise training did not improve the health related quality of life (HRQOL) of heart failure patients, whereas supervised exercise[19] did.

The role of the accredited exercise physiologist is as much about being considerate of and addressing the psychosocial needs of the patient, as it is about exercise delivery, for

[19] Note that the study did not specify the qualifications of the supervisors.

example, using targeted goal setting to address barriers to participation – they are specialists in getting the inactive active. For example, Callaghan et al (2011) conducted a randomised controlled trial (RCT) on exercise for people living with depression. Importantly, the exercise sessions were supervised by a qualified exercise therapist[20]. The results confirmed the study hypothesis that **to generate the improvements across a range of outcomes among depressed people who are largely sedentary; exercise must be accompanied by supportive psychosocial interventions**. Overall there was a medium effect size (d = 0.58) with the difference between control and intervention groups being significant (t = 1.781).

Soan et al (2014) report that cardiac rehabilitation programs designed and facilitated by accredited exercise physiologists have been highly successful in:

- changing exercise and physical activity behaviours;
- preventing or delaying subsequent cardiac arrest;
- improving exercise tolerance, muscle atrophy, and circulation;
- improving quality of life; and
- significantly reducing risk factors for comorbidities.

1.6 Accreditation

ESSA is a self-regulating professional association providing standards and regulation of the AEP profession. The National Registration and Accreditation Scheme (NRAS) for health professions commenced in July 2010 providing a national registration framework for professions. The Australian Health Practitioner Regulation Agency is the administering agency for the NRAS. Prior to the NRAS, health practitioners were registered through state based agencies. By providing a national approach to registration and governance, the NRAS reduces the administrative burden for practitioners practicing in different jurisdictions. Currently, only those professions that have historically been registered are included in the NRAS.

While the NRAS provides a national framework for registered professions, the majority of health practitioners (particularly in allied health) self-regulate. That is, the peak professional body for the health profession administers functions equivalent to those of the NRAS boards. These include formally recognising qualifications, administering minimum entry practice standards, assurance of practice standards, providing a code of conduct and investigating complaints.

Protection to the public is provided through practitioner accreditation with their peak professional body. The peak professional body for accredited exercise physiologists is ESSA and the Australian Government has formally recognised ESSA as accrediting and regulating exercise physiology. The ESSA Independent Ethics Committee is assigned to investigate complaints made against ESSA members from the public, regulatory bodies, other members or health care professionals.

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[20] Note that the study did not provide details on the qualifications of the exercise therapists.

One of the main criteria for regulation versus self-regulation of a health profession is risk of harm to the consumer. While accredited exercise physiologists prescribe active exercise treatment as a treatment for health conditions, these treatments are predominantly non-invasive in nature, and therefore the risk of harm to consumers is relatively low. As a result of this low risk of harm to the consumer, the Australia Government has to-date seen no need to regulate the profession. However, public expectation is that all health professionals are registered. Consequently, there is a disparity between public expectation and the legislated approach to regulation of health professions.

To address this disparity, ESSA is one of eight allied health professions (including Dietitians, Speech Pathologists, Credentialled Diabetes Educators, Audiologists, Orthotics and Prosthetics, Sonographers and Perfusionists) that have aligned through the National Alliance of Self-Regulating Health Professions to develop a comprehensive set of standards to standardise governance across self-regulating health professions. In addition, accredited exercise physiologists are required to be accredited with ESSA before they can provide services compensable under Medicare, DVA and other regulatory schemes.

1.6.1 Establishing the benefits of accreditation

The trend toward accreditation has become widespread in the healthcare sector over the last few decades. Benefits of accreditation which are often cited include promoting change, organisational impacts, quality and safety improvements and patient satisfaction.

However, the evidence from the literature is limited. Many included studies showed that accredited services result in higher quality when compared to non-accredited services. However it was uncertain if this was the result of accreditation, self-selection or was due to other extraneous factors, as most of the studies attributed changes to the accreditation process, without robust controls or accounting for confounding factors.

During consultations, it was estimated that ESSA membership fees require ongoing professional development, which costs around $1,015 a year for accredited exercise physiologists. This would represent around 2% of remuneration for a full time accredited exercise physiologist earning a representative income of $60,000. The majority of university qualified exercise physiologists choose to pay these costs, indicating that they value accreditation as being worth at least this much.

That said, the lack of evidence for the benefits of accreditation may be a reflection of the challenges in assessing complex, heterogeneous interventions such as accreditation and certification. That is, the benefits of accreditation may be real and substantial, but just very difficult to verify empirically. More study is required in this area.

Accordingly, while it stands to reason that there are quality and safety benefits for patients in using accredited exercise physiologists over their unaccredited counterparts, lack of robust evidence precludes estimating a parameter for the scale of such benefits in this report.

1.7 Costs of accredited exercise physiologists

ESSA regularly surveys its membership, with approximately 50% of respondents being accredited exercise physiologists. The survey asks a number of questions related to the age, gender, location and business specific questions for accredited exercise physiologists. Insights from this survey include:

- the workforce is relatively young, with a high proportion of workers under the age of 40;
- the gender breakdown is relatively even;
- workers are predominantly located in metropolitan areas, and in line with population size; however, there are more people working in Queensland than in Victoria; and
- a large number of the membership has post-graduate qualifications and work with chronic disease and rehabilitation.

The ESSA workforce survey also identifies information on the charges for clients and hours provided, and salaries and some on cost information. Deloitte Access Economics also consulted with industry experts surrounding the costs of accredited exercise physiologists to help inform this report. These findings are important for the economic implications and the cost benefit analysis of accredited exercise physiologists in Australia.

1.7.1 Fees / charges and hours

The ESSA workforce survey asked the following questions that help to inform the charges for clients:

- what does your employer/business charge for a client one-on-one initial private consultation lasting up to one hour in duration;
- what does your employer/business charge for a client one-on-one follow-up consultation, usually lasting 30-45 minutes in duration;
- what does your employer/business charge each individual participant attending a client group session, lasting up to one hour in duration;
- do you charge a gap fee for individual consults under Medicare; and
- do you charge a gap fee for group sessions conducted for Medicare.

The average gap fee for initial individual consultations under Medicare was $15.90 for all services, and $28.90 for services that did not bulk bill. For the follow-up consultation, these were $12.20 and $24.10 respectively. For group sessions, the average gap fee was $5.80 and $12.50 respectively.

Businesses charged, on average, $84.00 for one-on-one initial private consultations that lasted up to one hour in duration. This was $68.80 for follow-up consultations that usually lasted 30-45 minutes in duration. Businesses charged $21.90 for each individual participant attending a client group session lasting up to one hour in duration. Employers on the other hand charged $73.80, $60.60 and $24.80 for those services, respectively.

Taking an average (weighted based on number of survey respondents), **individual sessions with an accredited exercise physiologist cost approximately $70.59**. Similarly, **group sessions with an accredited exercise physiologist cost approximately $23.99 per person**[21].

1.8 Concepts used in this report

Measurement of health outcomes is often undertaken using the quality-adjusted life year (QALY). QALYs assess the improvement in quality of life obtained through a specific health intervention relative to a situation in which no intervention or a standard alternative intervention is provided.

QALYs and disability adjusted life years (DALYs) are common outcome measures used in economic evaluations such as cost effectiveness analyses. The measures are similar in that they express health in terms of the duration of a health state (healthy life years) and give a weight to the degree of disability (loss of wellbeing) incurred by a disease or injury. DALYs combine mortality and morbidity into a single numerical unit, whereas QALYs do not assess mortality. DALYs are based on expert-determined 'disability weights' whereas QALYs are self-assessed health states. For QALYs, a disability weight of one represents full health, while zero represents death. For DALYs the reverse is the case. Thus QALYs measure health gain and DALYs health loss. The DALY 'burden of disease' approach to valuing healthy life was developed by the World Health Organization (WHO), World Bank and Harvard University in the 1990s, and is estimated in Australia by the Australian Institute of Health and Welfare (AIHW).

The WHO estimates that an intervention (such as diabetes education) is cost effective if it costs three times the gross domestic product (GDP) per capita to save a year of life. Locally, the Department of Prime Minister and Cabinet recommends all government agencies use the value of a statistical life year (VSLY) in cost benefit analysis to estimate the value of a healthy life year as approximately $187,495 in 2015 (OBPR, 2014), which is based on observed marketplace risk valuations, and is also around three times GDP per capita. Interventions which cost less to produce a QALY gain or DALY loss are deemed highly cost effective. Cost effectiveness is typically expressed as an incremental cost effectiveness ratio (ICER), the ratio of change in costs to the change in QALY effects.

1.9 Literature search

To determine the effectiveness of services delivered by accredited exercise physiologists, searches were conducted on PubMed, the Cochrane Database and Google Scholar. The overall search strategy was to concentrate on meta-analysis and systematic reviews to ensure overall effectiveness was established. Then, individual trials within those studies were retrieved to obtain data on costs, exercise inputs, clinical outcomes, health system utilisation and productivity impacts. Table 1.1 provides a summary of terms used in the literature search for each of the streams of mental illness, diabetes and chronic disease.

[21] These prices are inclusive of GST.

Table 1.1: Keywords for literature search

Mental illness	Diabetes	Chronic disease
exercise OR physical activity AND (therapy OR prescription OR training OR physiology / physiologists)	exercise OR physical activity AND (therapy OR prescription OR training OR physiology / physiologists)	exercise OR physical activity AND (therapy OR prescription OR training OR physiology / physiologists)
Depression, anxiety, psychosis, schizophrenia, serious mental illness	type 2 (II) diabetes OR (pre-diabetes OR impaired fasting glucose (IFG) or impaired glucose tolerance (IGT) or impaired glucose regulation)	chronic disease, chronic heart disease (CHD), cardiovascular disease (CVD), osteoarthritis, rheumatoid disease, COPD, chronic pain AND (back OR knee OR neck OR shoulder),
meta-analysis OR systematic review AND (cost OR effectiveness)	meta-analysis OR systematic review AND (cost OR effectiveness)	meta-analysis OR systematic review AND (cost OR effectiveness)

2 Pre-diabetes and type 2 diabetes

Diabetes is a chronic health condition where the body is unable to adequately manage the level of glucose in the blood. There are three main types of diabetes – type 1, type 2 and gestational diabetes – while various other types of diabetes represent a small proportion of cases. Type 2 diabetes is the most common type of diabetes, affecting about 9 in 10 individuals with diabetes.

The benefits of medication, dietary control and exercise in the management and prevention of type 2 diabetes are well understood, and that knowledge continues to increase. However, the use of exercise to manage and prevent type 2 diabetes may be underutilised (O'Hagan et al, 2013). **It is considered that there is no longer an evidence gap, rather there is an implementation gap, with services in Australia slow to implement efficacious interventions for people with pre-diabetes and type 2 diabetes**.

For the purposes of this review, exercise encompasses a range of terms that refer to services provided by accredited exercise physiologists including (but not limited to) exercise prescription, exercise training and exercise therapy.

2.1 Type 2 diabetes

There are an estimated 1.61 million Australians with type 2 diabetes in 2015 (Deloitte Access Economics, 2015). The specific aetiology of type 2 diabetes is not known. Cells in the body do not release enough insulin to manage blood glucose levels, and/or they release insulin that does not allow for sufficient glucose to leave the blood. Diabetes is defined as the presence of high levels of glucose (>7.0 mmol/L[22]) in the blood after fasting.

There are many behavioural and modifiable risk factors for type 2 diabetes, which include unhealthy weight, physical inactivity and unhealthy diet, depression, low birth-weight and metabolic syndrome and genetic predisposition (AIHW, 2008). High body mass contributes approximately 55% of type 2 diabetes cases, while physical inactivity contributes approximately 24% of cases (Begg et al, 2007).

Higher rates of diabetes (not specifically type 2 diabetes) are associated with both remote areas of Australia and specific population sub-groups. Data from the 2012-13 Australian Aboriginal and Torres Strait Islander Health Survey found that Indigenous people were more than three times as likely as non-Indigenous people to have diabetes or high blood glucose levels (ABS, 2013b). Similarly, for females and Indigenous people, remote communities are more likely than non-remote communities to have diabetes (AIHW, 2015b). Income is also associated with diabetes, with higher prevalence rates generally observed in lower socioeconomic status in Australia (AIHW, 2015b).

[22] millimoles per litre.

Diabetes is commonly associated with many other health conditions, including both comorbidities (conditions that are present at the same time as diabetes) and complications (conditions that occur as a result of diabetes). Common complications and comorbidities associated with diabetes include high blood pressure, high cholesterol, heart disease, stroke, depression, vision loss and kidney-related disorders. Approximately 64% of people with diabetes reported that they had at least one of these conditions (AIHW, 2013a).

2.2 Pre-diabetes

Optimal levels of blood glucose are referred to as normoglycaemia. Optimal fasting plasma glucose is a level of <5.6mmol/L[23]. As the level of blood glucose increases, individuals enter the hyperglycaemia phase. The first part of this phase, sometimes referred to as pre-diabetes, is identified by either impaired fasting glucose (IFG) or impaired glucose tolerance (IGT). IFG is defined as fasting plasma glucose of 6.1 to 7.0 mmol/L[24], while IGT is identified by administering glucose orally and checking plasma levels two hours later. As such, the threshold for IGT is higher, at 7.8 to 11.0 mmol/L[25] (Grundy, 2012). While IGT and IFG increase the risk of developing type 2 diabetes, individuals in the IGT/IFG stage may be able to **delay progression to diabetes by adopting life style modification based on modest weight loss and increased physical activity**. Managing pre-diabetes is considered to be the same as the prevention of type 2 diabetes.

2.3 Risk factors for type 2 diabetes and pre-diabetes

The risk factors for type 2 diabetes and pre-diabetes include: impaired glucose regulation, physical inactivity, unhealthy diet, unhealthy weight, tobacco smoking, high blood pressure, high blood cholesterol, and high triglycerides. The risk factors impaired glucose regulation, physical inactivity and unhealthy weight are of interest to this study as exercise interventions are primarily designed to affect these risk factors.

Impaired glucose regulation

Impaired glucose regulation (either IGT or IFG) lies between normoglycaemia and diabetes. Both IGT and IFG represent impaired glucose regulation, and as such are risk factors for the future development of diabetes (Unwin et al, 2002; Nathan et al, 2007), although lifestyle modification can reduce the risk of developing diabetes (Section 2.6.1). The risk factors for developing impaired glucose regulation are similar to risk factors for type 2 diabetes, and addressing these behavioural risk factors reduces the risk of developing diabetes.

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[23] This is a glycated haemoglobin (A1c) (HbA1c) level of <33 mmol/mol (millimoles per mole). Measuring HbA1c can determine average blood glucose levels over a number of months.

[24] HbA1c of 36 to 42 mmol/mol.

[25] HbA1c of 48 to 80 mmol/mol.

The 1999-2000 Australian Diabetes, Obesity and Lifestyle Study (Dunstan et al, 2000) estimated that about one in six Australians aged 25 years and older had either IGT or IFG. IGT was found to be more prevalent (10.6%) than IFG (5.8%). The age-gender prevalence rates applied to the current Australian population aged 25 years and over gives approximately 1.72 million and 0.93 million Australians with IGT and IFG, respectively. The total prevalence estimate of pre-diabetes is 2.65 million Australians in 2015.

Physical inactivity

Regular physical activity is considered to be a key mitigating factor in the development of type 2 diabetes, as it has been found to reduce the risk of developing type 2 diabetes, slow the progression from impaired glucose regulation to type 2 diabetes, and reduce the mortality rate among people with diabetes (Colagiuiri et al, 2009). Regular physical activity also improves blood glucose levels for people with type 2 diabetes, and resistance training is beneficial for managing the health of older people with diabetes as it improves management of blood glucose levels (Dunstan et al, 2002). Physical activity also reduces the risk of diabetes comorbidities, such as obesity, high cholesterol, and cardiovascular disease (AIHW, 2008).

Analysis by the AIHW (2015) found that 70% of people with diabetes did not meet physical activity guidelines in Australia in 2011-12, compared with 52% in the general population.

Unhealthy weight

People who are an unhealthy weight are at significantly higher risk of developing diabetes. Increasing rates of obesity are associated with the rise in the prevalence of type 2 diabetes in recent decades. Unhealthy weight reduces an individual's insulin sensitivity, and reduces the amount of insulin that is released by the pancreas in response to increasing plasma glucose levels. A prolonged reduction in insulin sensitivity and secretion means that plasma glucose levels will increase to the point where an individual has type 2 diabetes. This also means that an individual with type 2 diabetes can improve their insulin sensitivity and secretion by reducing body fat. This can be achieved through a combination of improved diet and/or increased physical activity (Golay & Ybarra, 2005; AIHW, 2008; Eckel et al, 2006; Sharma, 2006).

Body mass index (BMI) and waist circumference can be used to help assess whether an individual is an unhealthy weight. Using a definition of BMI > 25 (NHMRC, 2013), approximately 83% of people with diabetes are an unhealthy weight compared to 60% in the general population. Similarly, 86% of people with diabetes are considered to be at increased risk of developing a chronic condition based on waist circumference of >80cm for women and >94cm for men (NHMRC, 2013; Deloitte Access Economics, 2014).

2.4 Treatment, management and prevention of type 2 diabetes

Exercise training, combined with diet and oral medications, is considered to be an essential component of any treatment plan for people with pre-diabetes and type 2 diabetes, and there is an established need for multiple therapies to effectively manage long-term blood glucose levels (Colagiuri et al, 2009). **It has been recommended that exercise training programs should be designed and delivered by qualified personnel such as accredited exercise physiologists due to the potential risks and likelihood of the presence of comorbidities, among other reasons** (Hordern et al, 2012). Accredited exercise physiologists are well placed to manage the acute and chronic risks of exercise for people with type 2 diabetes.

Currently, exercise recommendations suggest that people with pre-diabetes and type 2 diabetes should accumulate a minimum of 150 minutes per week of at least moderate-intensity and/or 90 minutes per week of at least vigorous intensity cardiorespiratory exercise. Resistance training is also encouraged on top of this (Marwick et al, 2009). Benefits are maximised by training on at least 3 non-consecutive days each week. Individual sessions should last for no less than 10 minutes. More recent recommendations suggest that people with pre-diabetes or type 2 diabetes should undertake around 210 minutes of moderate intensity or 125 minutes of vigorous intensity exercise each week (Hordern et al, 2012).

Recent studies have suggested that training frequency, duration and intensity can affect the outcomes achieved in people with type 2 diabetes and pre-diabetes. For example, Hansen et al (2009) found that high-intensity training can have improved outcomes for measures such as HbA1c reduction compared to low-intensity. However, when energy expenditure is matched in treatment groups, the outcomes are similar. Hansen et al (2010) suggest that the impact of training session duration and volume on clinical outcomes needs further investigation.

2.5 Exercise and insulin resistance

As noted in Section 2.1, cells in people with type 2 diabetes either do not release enough insulin (insulin deficiency), or they release insulin that does not allow for sufficient glucose to leave the blood (insulin resistance). Exercise acts to reduce the insulin resistance, and can modify lipid abnormalities and hypertension (Marcus et al, 2010). There are considered to be two pathways for exercise to increase blood glucose uptake. First, muscle replenishes glycogen (energy) stores by taking glucose from the blood when a person is resting. Second, intramuscular actions break down glycogen through the glycogenolysis process during exercise, which stimulates further blood glucose uptake. This second pathway is separate from the first and remains elevated post-exercise, reducing blood glucose levels for several hours (Colberg et al, 2010). Higher intensity exercise has been shown to rely on increase glucose uptake to fuel muscular activity as glycogen levels are depleted. Further, exercise can also increase muscle mass, which will use more glucose despite the muscle's ability to respond to insulin (Colberg et al, 2010).

Exercise also helps to maintain a healthy weight, which can decrease insulin resistance. That said, exercise appears to improve blood glucose control by reducing the amount of visceral adipose tissue (centrally located body fat), rather than being associated with weight. Visceral adipose tissue is linked to insulin resistance (Hordern et al, 2012).

2.6 Efficacy of exercise for diabetes prevention and management

The benefits of exercise therapy for the prevention, treatment and management of type 2 diabetes and pre-diabetes are well documented.[26] The following sections provide a summary of literature regarding the benefits of exercise for the prevention of type 2 diabetes. The primary outcome considered in the literature is reduced incidence of type 2 diabetes, so that is also the focus of this brief review. However, it is noted that many of these studies also report a number of other parameters such as, but not limited to, BMI, weight, and waist circumference.

2.6.1 Prevention of type 2 diabetes

Lifestyle modification, including exercise training now represents a central strategy in diabetes prevention (Hordern et al, 2012). A number of large, randomised controlled trials of lifestyle modification (including exercise interventions) in pre-diabetic populations have been conducted, with the aim to observe whether structured education on diet and physical activity can reduce the incidence of type 2 diabetes, and improve risk factors associated with both type 2 diabetes and cardiovascular morbidity and mortality. Lifestyle interventions are generally targeted at both physical activity and diet, representing a comprehensive approach to health care.

Clinical trials

There are a few studies that consider exercise interventions alone (rather than combined with diet advice) including the Da Qing Study in China (Pan et al, 1997), and reviews by Gillies et al (2007) and Orozco et al (2008). A review by Jeon et al (2007) is also included here as it describes benefits of exercise generally in preventing type 2 diabetes, however this review was not included in the modelling as it did not discuss exercise interventions prescribed by university qualified exercise therapists.

- Orozco et al (2008) aimed to assess the effects of exercise or exercise and diet for preventing type 2 diabetes. The review included eight trials where a small number of participants were randomised to exercise only intervention, which included delivery from university qualified exercise physiologists, physiotherapists and dietitians. Orozco et al note that exercise combined with diet is effective in reducing the incidence of type 2 diabetes in people with pre-diabetes, finding a **37% risk reduction**. In a meta-analysis combining data from Pan et al (1997) and one other study, **exercise reduced the risk of developing diabetes by approximately 42%**. However, likely due to small sample sizes, they did not observe a statistically significant difference of exercise alone compared to either standard care or diet alone.

[26] Exercise therapy is also beneficial in the treatment and management – and in some cases the prevention – of other types of diabetes including type 1 diabetes and gestational diabetes; however, the benefits for the management of other types of diabetes are beyond the scope of this report.

- Gillies et al (2007) conducted a systematic review and meta-analysis of various pharmacological and lifestyle interventions to prevent diabetes. There were two studies that considered exercise interventions. The review did not note who delivered these interventions; however, the hazard ratio for the risk of developing type 2 diabetes for these studies was 0.49, meaning that the intervention group was **51% less likely to develop diabetes** than the control group.
- Results from the Da Qing Study (Pan et al, 1997) demonstrate exercise prescription is effective at preventing diabetes. The study aimed to determine whether diet and exercise interventions in people with pre-diabetes could delay the development of type 2 diabetes. They randomised individuals diagnosed with IGT to a control group, or one of three intervention groups – diet only, exercise only, or a combination of both. Participants in the exercise intervention were taught and encouraged to increase the amount of physical exercise on an individual basis, to at least 20 minutes a day of moderate exercise. The intervention is similar to services provided by accredited exercise physiologists, although it was not stated if university qualified exercise physiologists were involved in prescribing exercise. Counselling sessions were conducted weekly in the first month, once a month for the next three months, and once every three months thereafter. At 6-year follow up, and after adjusting for fasting plasma glucose and BMI, **the exercise intervention group was 46% less likely to develop type 2 diabetes than the control group**. The lifestyle intervention group was 42% less likely to develop type 2 diabetes than the control group.

Jeon et al (2007) conducted a meta-analysis of cohort studies, finding that the risk of developing type 2 diabetes was 31% lower in participants that undertook regular moderate-intensity activity than in sedentary people. Similarly, in people who walked regularly compared to people who did not, the reduction in risk was 30% lower for those walking regularly. The reduction in risk associated with increased activity levels was independent of BMI. General lifestyle intervention programs that also combine structured education programs covering diet and behaviour modification in addition to exercise also find similar, albeit marginally larger, reductions in the incidence of type 2 diabetes.

- Ramachandran et al (2006) conducted a study in a population of Asian Indians, to determine if lifestyle modifications were as effective for this sub-population with generally higher insulin resistance and prevalence of diabetes compared to other populations, such as in the Da Qing Study. Participants with IGT were randomised to four groups, which involved standard advice, lifestyle modification, metformin or lifestyle modification and metformin. The lifestyle intervention involved advising and encouraging participants to walk briskly for at least 30 minutes per day, or to continue with their physical activity if they already exceeded this. The intervention is similar to services provided by accredited exercise physiologists, although it was not stated if university qualified exercise physiologists were involved in prescribing exercise. The cumulative incidence of diabetes after three years was 55%, 39.3%, 40.5% and 39.5% in the four groups, respectively. The **lifestyle modification reduced the incidence of diabetes by 28.5% compared to the control group**.
- Kosaka et al (2005) undertook a study of lifestyle intervention for Japanese males with IGT. The lifestyle intervention incorporated intensive advice on diet and exercise. Participants were individually informed on aspects of diet, and were advised to undertake more physical activity such as walking 30-40 minutes per day. They were also advised to reduce BMI to 22 or less, with the control group being

advised on a BMI of 24 or less. Advice on the importance of the intervention was repeated every 2-3 months during follow up visits in an outpatient clinic. The intervention is similar to services provided by accredited exercise physiologists, although it was not stated if university qualified exercise physiologists were involved in prescribing exercise. The cumulative incidence of diabetes in the intervention group after 4 years was 3.0%, compared with 9.3% in the control group. The **lifestyle intervention reduced the risk of developing diabetes by 67% compared to the control group** (standard care).

- In the US, the Diabetes Prevention Program (Knowler et al, 2002; Diabetes Prevention Program Research Group, 2012) study randomised people with IGT and IFG to a control group, metformin, or a lifestyle intervention. The goal of the lifestyle intervention was to reduce weight by 7%, and achieve at least 150 minutes of physical activity per week. Participants were provided education over 16 sessions, which covered diet, exercise and behaviour modification. The intervention was delivered by individual case managers, who were generally university qualified exercise physiologists or dietitians. At the end of 24 weeks, 50% of participants in the lifestyle intervention group had achieved the goal of 7% weight loss, which dropped to 38% at the most recent follow-up (average 2.8 years). Further, 74% met physical activity goals of 150 minutes of moderate exercise per week, which dropped to 58% at the most recent follow-up. The **lifestyle intervention reduced the incidence of diabetes by 58% compared to the control group (placebo)**.
- The Finnish Diabetes Prevention Study (Tuomilehto et al, 2001) aimed to determine the feasibility and effects of a program of changes in lifestyle to prevent or delay type 2 diabetes in people with IGT (Tuomilehto et al, 2001). Participants were randomised to a control group and intervention group. The control group participants were given general advice surrounding exercise and diet, while the intervention group received detailed advice on achieving specific goals to reduce weight by 5% or more, including dietary and exercise advice. Exercise advice included individual guidance on increasing physical activity, and supervised resistance training. The intervention is similar to services provided by accredited exercise physiologists, although it was not stated if university qualified exercise physiologists were involved in prescribing exercise. Adherence to tailored exercise advice varied by site, and was around 50% to 85%. The **lifestyle intervention reduced the overall incidence of diabetes by 58%**, the same value found in the US Diabetes Prevention Program for the lifestyle intervention.

As described previously, Pan et al (1997) found that the **lifestyle intervention was 42% less likely to develop type 2 diabetes** in the Da Qing study.The evidence shows that both exercise interventions alone and lifestyle interventions that include exercise significantly reduce the risk of developing type 2 diabetes in pre-diabetes populations. The risk reduction is generally comparable across interventions and study type (Balk et al, 2015). However, randomised controlled trials (and systematic reviews that are dependent on these trials) are unlikely to reflect real world interventions. For example, Lindström et al (2003) highlight that subjects are individually guided to make behavioural changes, with free services (such as organising group exercise competitions and resistance training classes) offered to participants to help them achieve physical activity recommendations.

The real world setting equips patients with the tools necessary to make behavioural changes, but does not necessarily undertake this level of generally free individual guidance. Consequently, and given that exercise interventions alone see similar results to lifestyle interventions in controlled trials, it is assumed that services offered by accredited exercise physiologists are likely to be more reflective of current translational lifestyle interventions in the Australian setting. Further, interventions delivered by accredited exercise physiologists are often combined with advice from diabetes educators and dietitians surrounding diet and healthy eating, and therefore represent lifestyle interventions (see for example Dunbar et al, 2014).

Translational studies

Translational studies are studies that observe implementation of programs in the community setting. These programs aim to implement interventions developed in controlled clinical trials within community settings. They are intended to produce similar benefits as in the clinical trials. A number of translational lifestyle intervention studies have been conducted in Australia and observe similar results to those produced in intensive randomised controlled trials.

- The Greater Green Triangle (GGT) Diabetes Prevention Project was delivered in a primary health care setting in Australia, involving 237 participants aged 40-75 years at risk of developing type 2 diabetes. The intervention was intensive and involved education around diet and physical activity with tasks to complete between sessions. Sessions were conducted fortnightly for 9 weeks (5 sessions), with one follow-up session after 8 months. The intervention was delivered by university qualified exercise physiologists, dietitians and nurses. After 12 months, weight was reduced by 2.5kg (2.7% reduction) in those completing the program, and waist circumference was reduced by 4.2cm (4% reduction). Applying the linear interpolation from Dunbar et al (2014) below, these outcomes correspond with a **potential risk reduction of diabetes between 22% and 43%**, respectively (Laatikainen et al, 2007).
- The lifestyle intervention program Life! is a large-scale diabetes prevention program in Australia. The program is a behaviour change intervention based on the GGT Diabetes Prevention Project, which comprises six group sessions over a period of 8 months. More than 3,100 people had completed the Life! program by the end of 2012. The intervention is intensive and involves education around diet and physical activity with tasks to complete between sessions. Sessions are conducted fortnightly for 9 weeks (5 sessions), and there is a follow-up session after 8 months. The program is group based (8-15 people) and is delivered by a trained facilitator and incorporates one session by an accredited exercise physiologist or physiotherapist and one session by a dietitian. After 8 months, participants reduced weight by 2.4kg and waist circumference by 3.8cm. Based on linear interpolation of these results, and outcomes from the US Diabetes Prevention Program and the Finnish Diabetes Prevention Study, Life! results in a **potential diabetes risk reduction between 21% and 39%** (Dunbar et al, 2014). Janus et al (2012) conducted a smaller trial before state-wide implementation of Life!, finding similar diabetes risk reductions.
- The Sydney Diabetes Prevention Program is a translational study that recruited more than 1,500 participants between 50 and 65 years of age at high risk of developing diabetes. The program is a lifestyle intervention that comprised an individual session and three group sessions designed to achieve behavioural change surrounding diet

and exercise. The intervention was delivered by university qualified exercise physiologists, dietitians, and nurses. Participants were contacted every three months to review progress and offer ongoing advice over the following year (Colagiuri et al, 2010). Recent data suggests that the program achieved a weight reduction of 2.2kg after 12 months. This is likely to result in a similar reduced risk of diabetes as the Life! program (Colagiuri and Johnson, 2014). Applying the linear interpolation from Dunbar et al (2014), this weight reduction **translates into a potential diabetes risk reduction of 19%**.

- Hetherington et al (2015) report on the community-based lifestyle modification program *Healthy Eating Activity and Lifestyle (HEAL)*, which was targeted at reducing risk factors for chronic disease in Australia and has been operating for 12 years in Sydney. While the population is not necessarily defined as pre-diabetes, many of the characteristics that are risk factors for pre-diabetes and type 2 diabetes (for example, overweight, physical inactivity, etc.) are present in this sample of over 2,800 adults. The intervention was designed and delivered by a team of (predominately) university qualified exercise physiologists and dietitians. The program involved education and physical activity sessions for 2 hours a week and running over 8 weeks. An individual consultation was also conducted at the start and end of the program. Hetherington et al (2015) found that weight was reduced by 1kg at follow up, and waist circumference was reduced by an average of 2.5cm across participants. Applying the linear interpolation from Dunbar et al (2014), this **translates into a potential diabetes risk reduction of 9% and 25%** for weight and waist circumference, respectively.
- A systematic review and meta-analysis by Dunkley et al (2014) of 22 translational diabetes prevention programs found a significant reduction in weight for the intervention arms of 2.3kg (2.6%) after 12 months – a similar result to that reported in the Life! program. Other systematic reviews have also found similar results to Dunkley et al and the Life! program (Ali et al, 2012; Cardona-Morrell et al, 2010). Dunkley et al conclude that the real-world lifestyle interventions included in the review lowered diabetes progression rates, based on data from the US Diabetes Prevention Program that indicated that a 1kg reduction in weight is associated with reduced diabetes incidence of approximately 16%.

Summary of efficacy for prevention of type 2 diabetes

Table 2.1 presents a summary of the literature and the main findings for exercise in the prevention of type 2 diabetes. **Overall, exercise interventions delivered by accredited exercise physiologists are estimated to reduce the incidence of type 2 diabetes in high risk populations by 31%, on average**.

Table 2.1: Summary of benefits in pre-diabetes

Study (year)	Brief description	Main finding
Clinical trials – exercise intervention		
Pan et al (1997)	Randomised controlled trial of lifestyle intervention in people with IGT or IFG in China. Intervention personnel were not specified.	Reduced risk of developing type 2 diabetes by 46% compared to the control group.
Gillies et al (2007)	Systematic review and meta-analysis of various interventions including lifestyle. Intervention personnel were not specified.	Of exercise interventions, risk for developing type 2 diabetes was reduced by 51% compared to the control groups.
Orozco et al (2008)	Review of trials including exercise interventions and exercise and diet interventions. Interventions were mostly delivered by university qualified exercise physiologists, physiotherapists and dietitians.	Reduced risk of developing type 2 diabetes by 42% in exercise intervention alone.
Clinical trials – lifestyle intervention		
Pan et al (1997)	Randomised controlled trial of lifestyle intervention in people with IGT or IFG in China. Intervention personnel were not specified.	Reduced risk of developing type 2 diabetes by 42% compared to the control group.
Tuomilehto et al (2001)	Lifestyle intervention in people with IGT in Finland. Control group received standard care, while intervention group received specific advice on exercise and diet goals. Intervention personnel were not specified.	Reduced risk of developing type 2 diabetes by 58% compared to the control group.
Knowler et al (2002)	Lifestyle intervention in people with IGT or IFG in the US. Control group received a placebo. Intervention generally delivered by university qualified exercise physiologists or dietitians.	Reduced risk of developing type 2 diabetes by 58% compared to the control group.
Ramachandran et al (2006)	Lifestyle intervention in sub-population of Asian Indians, encouraging participants to increase physical activity. Intervention personnel were not specified.	Reduced risk of developing type 2 diabetes by 28.5% compared to the control group.
Kosaka et al (2005)	Lifestyle intervention in Japanese males with IGT. Intervention included diet and exercise advice. Control group received usual treatment. Intervention personnel were not specified.	Reduced risk of developing type 2 diabetes by 67% compared to control group.

Study (year)	Brief description	Main finding
Translational study - lifestyle intervention		
Laatikainen et al (2007)	GGT Diabetes Prevention Project delivered in primary health care setting in Australia. Participants took part in a lifestyle intervention with a total of 6 sessions delivered over 8 months. Intervention delivered by university qualified exercise physiologists, dietitians and nurses.	Weight reduced by 2.5kg at follow-up, waist circumference reduced by 4.2cm. Results translate to potential risk reduction of diabetes between 23% and 40%.
Dunbar et al (2014);	Life! program is a large-scale diabetes prevention program consisting of a lifestyle intervention delivered over 6 sessions and 8 months. Intervention was delivered by accredited exercise physiologists and dietitians.	Weight reduced by 2.5kg, waist circumference reduced by 3.8cm at follow-up. Results translate to potential diabetes risk reduction between 21% and 39%.
Colagiuri and Johnson (2014)	Sydney Diabetes Prevention Program lifestyle intervention comprised of 1 individual sessions, 3 group sessions with follow-up calls every 3 months. Intervention was delivered by university qualified exercise physiologists, dietitians, and nurses.	Weight reduced by 2.2kg after 12 months.
Hetherington et al (2015)	Community based lifestyle intervention program for population considered high risk for chronic diseases including type 2 diabetes. Intervention delivered by university qualified exercise physiologists and dietitians.	Weight reduced by 1kg, waist circumference reduced by 2.5cm at follow-up. Results translate to potential diabetes risk reduction between 9% and 25%.
Average	**Risk reduction of developing type 2 diabetes:** • **Exercise intervention in clinical trials – 46%** • **Lifestyle intervention in clinical trials – 51%** • **Lifestyle intervention in community settings (Life!, Sydney DPP and HEAL) – 25%**	

The benefits of lifestyle interventions in the prevention of type 2 diabetes are clear. Importantly, these benefits are sustained for a number of years after the intervention has finished. For example, 13 years after the Finnish Diabetes Prevention Study commenced, lifestyle intervention still reduced the risk of developing type 2 diabetes by 38% compared to the control group (Lindström et al, 2013). Similarly, 20 years after the Da Qing Diabetes Prevention Study commenced, the risk of developing type 2 diabetes for the lifestyle intervention group was still 43% lower than the control group (Li et al, 2008), compared to 51% lower incidence of diabetes during the active intervention period (6 years follow up). In the US Diabetes Prevention Program, the risk of developing diabetes was still 34% lower 10 years after commencing the study, although this study offered the original lifestyle intervention to the control group after conclusion of the active intervention period, which may have reduced the difference in the benefits (Knowler et al, 2009).

For reductions in complications, there was no conclusive evidence that lifestyle interventions also lead to reduced cardiovascular disease or mortality due to cardiovascular disease or all-cause mortality, although the hazard risk ratio was less than one in each case for the Da Qing Diabetes Prevention Study (Li et al, 2008). While there is no conclusive evidence for people with diabetes, there are known reductions in complications in people with diabetes, discussed further in Section 2.6.2. These studies demonstrate the importance of equipping patients with the skills that enable them to reduce their risk of developing type 2 diabetes over the long-term.

The evidence overwhelmingly suggests that lifestyle interventions, as delivered by accredited exercise physiologists, can achieve improved outcomes in terms of reduced diabetes and/or risk factors. Even in real world settings, interventions delivered by university qualified exercise physiologists are able to achieve outcomes that are similar – albeit, slightly reduced – compared to controlled trial interventions (Dunbar et al, 2014; Janus et al, 2012).

To determine benefits specifically due to accredited exercise physiologists, it would be ideal to use translational data on exercise alone from Australia. As the Da Qing and other studies showed, exercise interventions can substantially reduce the risk of developing diabetes without intensive diet advice. That said, in addition to specialised exercise prescription and facilitating behavioural change, accredited exercise physiologists provide general health education, advice, and support to enhance health and well-being, which can include some dietary advice. Furthermore, services are often combined with dietitians and diabetes educators to provide a comprehensive approach to care such as in the Life! and HEAL programs. **Evidence also suggests that services provided by accredited exercise physiologists are likely more effective than non-university qualified professionals or unsupervised exercise alone** (Section 1.5). For the purpose of the modelling, the benefits provided by accredited exercise physiologists are based on the benefits observed in large scale translational studies, as delivered by both accredited exercise physiologists and university qualified exercise physiologists – although it is noted that this may be a conservative assumption.

This means a simple average of the outcomes observed in the Life! program, Sydney Diabetes Prevention Program and HEAL program are used to model the benefits of diabetes prevention programs. That is, **the risk of developing diabetes compared to those that do not receive intervention is reduced by 25%**.

2.6.2 Managing type 2 diabetes

A number of exercise guidelines have been published for managing type 2 diabetes, including guidelines that are endorsed by the National Health and Medical Research Council (Colagiuri et al, 2009). Hordern et al (2012) has provided the most recent recommendations for exercise guidelines as discussed in Section 2.4. Controlled trials and community-based studies often see exercise rates that differ widely from the recommended guidelines, although benefits are thought to accrue as a result of reducing sedentary behaviour rather than specifically meeting the guidelines (Jeon et al, 2007). Sedentary behaviour (or physical inactivity) is considered to be a modifiable risk factor for the development and management of type 2 diabetes (Jeon et al, 2007; Horden et al, 2012; Colagiuri et al, 2009).

Benefits of exercise training

Recent controlled trials and systematic reviews have demonstrated the benefits of exercise training in managing type 2 diabetes. Benefits of exercise training for people with type 2 diabetes include improved glycaemic control (improved HbA1c levels), body composition, cardiorespiratory fitness and risk, and physical functioning and well-being (Hordern et al, 2012). A summary of the benefits of exercise training in managing type 2 diabetes is presented below. It is noted that lifestyle interventions can further improve benefits for people with type 2 diabetes.

- Hordern et al (2011) aimed to assess the effects of a four-week exercise training program on the acute response of blood glucose to a single exercise session in patients with type 2 diabetes. Patients received four weeks of exercise training under the guidance of an accredited exercise physiologist. HbA1c was not measured at follow-up; however, the study showed that people with type 2 diabetes should exercise as it lowers blood glucose levels, but also that blood glucose levels become more responsive to exercise over time. After four weeks of exercise training the ability of an exercise session to lower blood glucose levels was improved, suggesting that multiple sessions should be undertaken each week.
- Church et al (2010) conducted a randomised controlled trial to assess the effects of exercise training on HbA1c levels in patients with type 2 diabetes. The study included aerobic, resistance and combination training groups. The intervention involved supervised exercise although it was not specified who provided this. Compared with the control group (usual treatment), the **combination training group reduced HbA1c by -0.34%**.
- Gordon et al (2008) reviewed 20 studies considering resistance training in type 2 diabetes. Supervised resistance training was observed to be more effective than unsupervised training, although the professionals involved were generally not reported for either supervised or unsupervised. Of the studies included that reported HbA1c outcomes, the **reduction in HbA1c ranged between 0.5% and 1.2%** in most cases. HbA1c returned towards baseline after 6 months. Conn et al (2007) conducted a meta-analysis of 103 studies. The intervention included diabetes self-management including recommendations to increase exercise in people with type 2 diabetes. A number of studies included exercise prescription and supervised exercise training, although it was not reported who provided the intervention. The meta-analysis found an overall mean weighted effect size for two-group comparisons of 0.29, which is consistent with a **reduction in HbA1c of 0.45%** (7.38% for treatment vs 7.83% for control subjects). Conn et al found a bigger effect size in studies that focussed on exercise only (effect size of 0.45) than interventions targeting multiple health behaviours (effect size of 0.22).
- Thomas et al (2006) conducted an extensive analysis and review of exercise as a treatment for type 2 diabetes. The review considered 14 clinical trials where exercise was explicitly prescribed as a treatment, although it was not mentioned who prescribed the exercise training. Outcomes reported included HbA1c, visceral adipose tissue, body mass, triglycerides, maximal exercise capacity, systolic blood pressure, diastolic blood pressure, and fasting plasma glucose concentration. Each outcome was compared to no exercise treatment. **Exercise interventions significantly improved glycaemic control as indicated by a decrease in HbA1c of 0.6%**. There was no significant difference between groups in whole body mass,

which the authors suggest may be due to an increase in muscle mass with exercise. There were no adverse effects associated with exercise reported in any of the included studies. **The prescribed exercise interventions significantly increased insulin response reducing the need for other forms of treatment including medications**.

- Snowling and Hopkins (2006) conducted a meta-analysis of the effects of different modes of exercise training on glucose control and risk factors for complications of diabetes. There were 27 studies included in the meta-analysis where exercise training included aerobic, resistance and combined training that was generally prescribed or included specific exercise guidelines (although it was not specified who provided the exercise interventions). The **mean reduction in HbA1c was 0.8%** for combined exercise training that lasted longer than 12 weeks. Resistance training alone reduced HbA1c by 0.5%, and aerobic training alone reduced HbA1c by 0.7%. The HbA1c reduction in trials lasting less than 12 weeks was 0.4%. The authors note that exercise interventions alone can produce outcomes similar to other diabetes interventions such as long-term drug or insulin therapy.
- Boule et al (2001) conducted a systematic review of the effect of exercise for people with type 2 diabetes, focussing on HbA1c outcomes and body mass. They reviewed 14 studies, which were predominately aerobic training exercises. The interventions included supervised exercise and were prescribed. The weighted mean **HbA1c after intervention was found to be 0.66% lower between exercise groups and control groups**, in absolute terms. Body mass was similar in both groups after intervention. Boule et al conclude that exercise training reduces HbA1c to the extent that it should reduce risk of complications of diabetes.

O'Hagan et al (2013) observe that exercise intervention is an effective treatment for type 2 diabetes. Exercise interventions result in stabilisation of plasma glucose in the acute phase and improvements in body composition, insulin resistance and HbA1c with exercise training. Further, Marwick et al (2009) conclude that exercise training in patients with type 2 diabetes is beneficial and suggest that exercise training should be implemented long-term.

There is sufficient data available examining the reduction in HbA1c due to exercise interventions (the primary outcome linked to health expenditure, cost effectiveness and complication outcomes), although no translational studies for managing type 2 diabetes were identified. **The average HbA1c reduction across the meta-analyses was 0.63%** (Table 2.2). This reduction is sufficient to realise reductions in complications of diabetes (Thomas et al, 2006).

Table 2.2: Summary of benefits in type 2 diabetes

Study (year)	Brief description	Main finding
Boule et al (2001)	Systematic review and meta-analysis of 14 studies, predominately aerobic training exercises interventions. Interventions were supervised exercise that was prescribed. Outcomes compared to no exercise intervention.	HbA1c reduced by 0.66% between exercise and control groups.
Thomas et al (2006)	Systematic review and meta-analysis of 14 studies. Outcomes compared to no exercise intervention. Interventions were prescribed by not specified personnel.	HbA1c reduced by 0.6% between exercise and control groups.
Conn et al (2006)	Systematic review and meta-analysis of 103 studies, interventions including diabetes self-management and recommendations to increase exercise. Intervention generally prescribed and supervised although this was not specified further.	HbA1c reduced by 0.45%. There was a bigger effect size in studies that focussed on exercise alone.
Snowling and Hopkins (2006)	Systematic review and meta-analysis of 27 studies considering various forms of exercise training (aerobic, resistance and combined training). Interventions were prescribed by unspecified personnel.	HbA1c reduced by 0.8%. The study found that interventions delivered over a longer duration has larger effects. Combined training was the most effective intervention.
Gordon et al (2008)	Review of 20 studies considering resistance training in type 2 diabetes.	Supervised training more effective than unsupervised training. HbA1c reduced by between 0.5% and 1.2% across studies.
Church (2010)	Randomised controlled trial including aerobic, resistance and combination training, compared with usual treatment. Supervised exercise, but personnel not specified.	Combination training reduced HbA1c by 0.34% compared with the control group.
Hordern et al (2011)	Controlled trial of a four-week exercise training program on acute blood glucose. Delivered by an accredited exercise physiologist.	HbA1c reduction not measured at follow-up.
Average of meta-analyses		**HbA1c reduced by 0.63%**

Comorbidities and the impact of HbA1c reductions

There are a number of common complications of diabetes. These include retinopathy, nephropathy, neuropathy, coronary heart disease, myocardial infarction and stroke (Fowler, 2008). Complications of diabetes are broadly grouped into microvascular conditions (retinopathy, nephropathy and neuropathy) and macrovascular complications (coronary heart disease, myocardial infarction and stroke).

A Canadian study (Health Quality Ontario, 2009) estimated the impact of reduction in HbA1c levels on mortality and the risk of microvascular and macrovascular disease. It found that intensive blood glucose and blood pressure control lower the risk of microvascular and macrovascular complications in people with type 2 diabetes. In particular, it found that a **1% reduction in HbA1c has been associated with a 10% reduction in diabetes-related mortality and a 25% reduction in microvascular end-points**. Further, results indicated that intensive blood pressure control was associated with a 32% reduction in risk of mortality from diabetes-associated conditions, two-thirds of which are cardiovascular diseases. Tight blood pressure control was also associated with a 34% reduction in the risk of macrovascular disease (including myocardial infarction, sudden death, stroke, and peripheral vascular disease), 44% reduction in the risk of stroke and 37% reduction in the risk of microvascular disease.

Further, a local Baker IDI Heart and Diabetes Institute study (2012) modelled the impact of tighter glycaemic control (as defined by a HbA1c reduction from 8% to 7%) over a five year period. A significant reduction in co-morbidities was seen including a **reduction in end stage kidney disease by 40%, of amputations by 20%, of advanced eye disease by 42% and of myocardial infarction by 15%**. Although during a five year period as considered in the study, only a small number of people would develop each of these complications, the study found that improvement in glycaemic control had significant impacts on quality of life, health costs and productivity.

In addition to the common physical comorbidities, mental health conditions are also more common in people with type 2 diabetes. A review by van der Heijden et al (2013) looked at the effects of exercise training on quality of life, symptoms of depression, symptoms of anxiety and emotional well-being in people with type 2 diabetes. There were 20 randomised controlled trials included in the study, with three classifications of exercise training, including aerobic, resistance and combined training. The interventions were prescribed although the personnel involved were not specified. Quality of life was assessed in 16 studies, although there were mixed results surrounding the benefits of exercise interventions for quality of life symptoms. Conflicting results were also found for symptoms of depression and emotional well-being. van der Heijden et al conclude that the effects of exercise training on mental health outcomes in people with type 2 diabetes are conflicting, and suggestive of a need for further research into the role of exercise training in reducing and preventing mental health conditions in people with type 2 diabetes. It is possible that this study may not have found and observed the effects of more comprehensive interventions provided by accredited exercise physiologists or university qualified exercise physiologists as studies that also included a dietary component as part of the intervention were excluded.

Delaying the onset of diabetes does not appear to have benefits of reduced complications later in life in people with pre-diabetes (Li et al, 2008); rather, observed benefits of reduced complications are noted as part of managing type 2 diabetes through a reduction in HbA1c (blood glucose levels).

Table 2.3 presents a summary of the outcomes observed in the literature.

Table 2.3: Summary of comorbidity and the impact of HbA1c reductions

Study (year)	Brief description	Main findings
Health Quality Ontario (2009)	Estimated the impact of reduction in HbA1c levels on mortality and the risk of microvascular and macrovascular complications of diabetes.	1% reduction in HbA1c has been associated with a 10% reduction in diabetes-related mortality and a 25% reduction in microvascular end-points.
Baker IDI Heart and Diabetes Institute study (2012)	Modelled the impact of a reduction in HbA1c levels from 8% to 7% over a 5 year period.	Reduction in the cumulative incidence of end stage kidney disease by 40%, of amputations by 20%, of advanced eye disease by 42% and of myocardial infarction by 15%, over five years.
van der Heijden et al (2013)	Review of 20 studies examining the effects of prescribed exercise training on quality of life, symptoms of depression, anxiety and emotional well-being in type 2 diabetes. Intervention personnel were not specified.	Mixed results surrounding benefits of prescribed exercise training for quality of life, depression and emotional well-being. Authors suggest further research needs to be conducted in people with type 2 diabetes.
Average		**Reduction in microvascular end-points of 28%, reduction in macrovascular end-points of 14%.**

Based on findings by Health Quality Ontario (2009) and Baker IDI Heart and Diabetes Institute (2012), the average reduction in microvascular and macrovascular endpoints was 28% and 14%, respectively. As these reductions are based on an HbA1c reduction of 1%, they are multiplied by the average HbA1c reduction of 0.63% (Table 2.2), resulting in a **reduction in microvascular and macrovascular endpoints of 18% and 8%**, respectively.

2.6.3 Summary of efficacy of exercise for diabetes prevention and management

There is clear evidence to demonstrate that lifestyle interventions, as delivered by accredited exercise physiologists, are effective for the prevention and management of type 2 diabetes. Benefits include, but are not limited to, improved insulin sensitivity, reduction in weight and waist circumference (known risk factors for type 2 diabetes), improved glucose management, reductions in blood pressure, total cholesterol, and triglycerides (Hordern et al, 2012; Colagiuri et al, 2009). These benefits lead to reductions in complications due to diabetes (Colagiuri et al, 2009).

The primary outcomes reported for the prevention and management of type 2 diabetes are the risk of incidence and HbA1c outcomes, respectively. Table 2.4 summarises the primary outcomes observed in the literature of physical activity and lifestyle interventions as prevention and management for type 2 diabetes.

Table 2.4: Summary of exercise intervention benefits for the prevention and management of type 2 diabetes

Study	Population	Type of study	Main findings
Average of translational studies (Life!, Sydney Diabetes Prevention Program, and HEAL)	People with pre-diabetes, or at risk of chronic disease.	Large-scale community based translational programs. Generally involves university qualified exercise physiologists in interventions combined with dietitians.	Incidence of diabetes reduced by approximately 25% at follow-up (approximately 1 year).
Average of meta-analyses by Boule (2001), Thomas (2006), Conn (2007), Snowling & Hopkins (2006).	People with type 2 diabetes.	Meta-analyses of controlled clinical trials. Involves exercise prescription and or supervised exercise in interventions although personnel were generally identified.	The average HbA1c reduction across the meta-analyses was 0.63% (range 0.45% to 0.8%).
Health Quality Ontario (2009) and Baker IDI Heart and Diabetes Institute (2012)	People with type 2 diabetes	Diabetes model	Based on a 1% reduction in HbA1c, the average reduction in microvascular endpoints was 28%, and the average reduction for macrovascular endpoints was 14%.

2.7 Cost effectiveness and costs in the literature

As noted in Section 2.6, there is clear evidence to demonstrate that lifestyle interventions, as delivered by accredited exercise physiologists, are effective for the prevention and management of type 2 diabetes. Benefits accrue across the improved insulin sensitivity, reduction in weight (a known risk factor for type 2 diabetes), improved glucose management, reductions in blood pressure, total cholesterol, triglycerides and heart disease risk. Reductions in risk factors lead to substantial reductions in the incidence of diabetes – the primary outcome considered in the literature for prevention of type 2 diabetes. Consequently, **it is expected that there would also be substantial cost savings for individuals and society as a whole, through a reduced need for health care services and improved quality of life for people with type 2 diabetes or pre-diabetes**. The following sections provide a brief summary of the literature which provides evidence surrounding cost effectiveness of exercise interventions.

2.7.1 Prevention of type 2 diabetes

Early intervention in people with pre-diabetes produces significant long term savings in healthcare costs. A number of cost effectiveness studies have been published in Australia and internationally. The majority of these studies use diabetes progression models to evaluate costs over a set period (often lifetime). There is limited evidence available on the cost effectiveness of lifestyle interventions within trials (rather than modelled, and evidence is further limited when concerning exercise interventions for cost effectiveness.

Only one study (Bertram et al, 2010) was found in the literature search that modelled the cost effectiveness ratio for exercise interventions alone delivered by accredited exercise physiologists in the Australian setting. Results presented include the incremental cost effectiveness ratio (ICER), number of disability adjusted life years (DALYs) averted, intervention costs and healthcare cost savings over the lifetime of Australians alive in 2003. For exercise interventions that involve pre-diabetes screening followed up with training delivered by an accredited exercise physiologist, **the ICER was 30,000 (23,000 to 89,000) per DALY averted**. The exercise intervention resulted in 14,000 DALYs averted, and the total intervention costs were $430 million. The total cost savings from the exercise intervention, delivered by an accredited exercise physiologist, were estimated to be $180 million. Bertram et al (2010) based their results on the clinical effectiveness findings in Gillies et al (2007) which compared various interventions to prevent or delay type 2 diabetes in people with impaired glucose regulation. As noted in Section 2.6.1, Gillies et al (2007) found that the risk of developing diabetes was reduced by 51% in exercise interventions.

Palmer et al (2012) analysed lifetime incremental costs and QALYs for lifestyle interventions using Australian cost data and incidence reduction based on the US Diabetes Prevention Program. This intervention was delivered by individual case managers, who were generally university qualified exercise physiologists or dietitians (Knowler et al, 2002). They found that lifestyle interventions have cost savings compared to usual care, and have an incremental QALY gain of 0.39 compared to usual care. **The lifestyle intervention was cost effective in an Australian setting as it was dominant over usual care (both cost saving and life saving)**.

An earlier study by Palmer et al (2004) found that intensive lifestyle changes in people with pre-diabetes, which involves physical activity for 30 minutes per day and a loss of 5-7% of initial body weight, have been estimated to result in a reduction in lifetime healthcare costs by around $1,100[27] per person within the Australian healthcare setting. Again, this intervention was delivered by individual case managers, who were generally university qualified exercise physiologists or dietitians (Knowler et al, 2002). Palmer et al found that lifestyle interventions could improve quality of life, and gain 0.08 additional life years per person with pre-diabetes. Again, **the intervention was cost effective in the Australian setting as it was dominant compared with usual care (both cost saving and life saving)**.

A number of other studies have also been conducted which show that lifestyle modifications are cost effective in preventing type 2 diabetes. Li et al (2015) assessed the effect of lifestyle Interventions in people with pre-diabetes to reduce the risk of developing type 2 diabetes. Interventions were delivered by a range of personnel, and included "health professionals" which contains university qualified exercise physiologists. This review expands on an earlier review by Li et al (2010) which found that interventions to

[27] Reported value was a lifetime reduction in health system costs of £636 compared to the control group. This was converted using the exchange rate reported in Palmer et al (2004) of $1 = €0.5611.

prevent and control diabetes are cost saving and highly cost effective with strong evidence to support this. The current review analyses incremental cost effectiveness ratios (ICERs) for 22 studies, mostly comprising lifestyle interventions. The outcomes are reported in Table 2.5. The review presents data on DALYs averted, QALYs gained, and life years gained. **An average of the DALYs averted and QALYs gained across all studies was found to be 0.21, with an average ICER of $32,987**. This demonstrates that lifestyle interventions are cost effective to prevent type 2 diabetes.

Data from Li et al (2015) also showed that group-based interventions (average ICER $24,400) were substantially more cost effective than individual-based settings (average ICER $1,819). However, this is largely dependent on the study design and intervention. Other reviews have also found that group-based interventions may be as effective as individual-based interventions (no significant differences between intervention – Balk et al, 2015), which would also be suggestive that group-based interventions are more cost effective if costs are lower for these programs.

Li et al (2015) also found interventions involving "Health professionals", which can include university qualified exercise physiologists, cost more than interventions with unqualified personnel as is expected, although no cost effectiveness data for each type of intervention personnel were provided.[28]

[28] The data reported in Li et al (2015) did not provide sufficient information to establish the type of personnel used to deliver the intervention in each study reported in Table 2.5. Consequently, this is not reported here. Most of the studies that provided costs involved "Health professionals", which can include university qualified exercise physiologists or other professions with a university qualification.

Table 2.5: Summary of lifestyle intervention outcomes

Lead author, Year, Country	Intervention and setting	Assumed effectiveness outcome	QALY/DALY outcomes	ICER (health system perspective, 2015 AUD)
Within trial				
DPP research group, 2003, United States	Lifestyle intervention, clinical trial	Incidence reduction of 58%	0.072 QALYs gained	78,078
DPP research group, 2012, United States	Lifestyle intervention, clinical trial	0.12 QALYs gained	0.12 QALYs gained	24,406
Irvine, 2011, United Kingdom	Lifestyle intervention, clinical trial	0.012 QALYs gained	0.012 QALYs gained	62,142
Sagarra, 2014, Spain	Lifestyle intervention, clinical trial	Incidence reduction of 36.5%, 0.012 QALYs gained	0.012 QALYs gained	8,254
Modelled effects				
Segal, 1998, Australia	Diabetes model based on lifestyle intervention	Incidence reduction of 70% reducing to 30%	-	-
Caro, 2004, Canada	Diabetes model based on lifestyle intervention	Incidence reduction of 58% at 5 years, 22% at 10 years	-	-
Palmer, 2004, Australia, France, Germany, Switzerland and United Kingdom	Diabetes model based on lifestyle intervention	Incidence reduction of 58%, assumed effect would not persist after 3 years	-	-
Eddy, 2005, United States	Diabetes model based on lifestyle intervention	Incidence reduction of 58% for intervention, 15% reduction after 30 years	0.159 QALYs gained	145,936
Herman, 2005, United States	Diabetes model based on lifestyle intervention	Incidence reduction of 58% for intervention, 24% reduction at end-lifetime	0.57 QALYs gained	2,780
Ackerman, 2006, United States	Diabetes model based on lifestyle intervention	Incidence reduction of 58% for intervention period	0.59 QALYs gained	3,188
Hoerger, 2007, United States	Diabetes model based on lifestyle intervention	Incidence reduction of 58% for intervention period	0.04 QALYs gained	21,800
Jacobs-van der Bruggen, 2007, Netherlands	Diabetes model based on lifestyle intervention	Incidence reduction not reported, BMI reduced and physical activity increased.	1.17 QALYs gained	12,899

Lead author, Year, Country	Intervention and setting	Assumed effectiveness outcome	QALY/DALY outcomes	ICER (health system perspective, 2015 AUD)
Lindgren, 2007, Sweden	Diabetes model based on lifestyle intervention	Incidence reduction of 58% for intervention period	0.2 QALYs gained	20,588
Gillies, 2008, United Kingdom	Diabetes model based on lifestyle intervention	Hazard ratio -0.649 from review	0.09 QALYs gained	22,105
Bertram, 2010, Australia	Diabetes model based on lifestyle intervention and exercise interventions	Relative risk 0.49, 10% decay from end of intervention.	0.05 DALYs averted	32,644
Smith, 2010, United States	Diabetes model based on lifestyle intervention	Reduced metabolic risk 16.2% at year 1, 19% at year 3.	0.01 QALYs gained	8,462
Neumann, 2011, Germany	Diabetes model based on lifestyle intervention	Based on Diabetes Prevention Program in Germany - number not reported.	0.025 QALYs gained	-
Palmer, 2012, Australia	Diabetes model based on lifestyle intervention	0.39 QALYs gained	0.39 QALYs gained	-633
Feldman, 2013, Sweden	Diabetes model based on lifestyle intervention	Incidence reduction not reported	0.095 QALYs gained	6,321
Png and Yoong, 2014, Singapore	Diabetes model based on lifestyle intervention	Incidence reduction not reported	0.05 QALYs gained	27,129
Colagiuri and Walker, 2008, Australia	Diabetes model based on lifestyle intervention	Incidence reduction 60% for IFG, 30% for IGT	0.21 DALYs averted	78,098
Zhuo, 2012, United States	Diabetes model based on lifestyle intervention	Incidence reduction 40-50% before year 3, 10-15% after	0.03 QALYs gained	12,904
Average outcome			**0.21 QALYs gained / DALYs averted**	**32,987 per QALY gained / DALY averted**

Source: Adapted from Li et al (2015).

2.7.2 Managing type 2 diabetes

A literature search was conducted to examine cost effectiveness data for exercise interventions in managing type 2 diabetes. Identified literature is summarised below. Coyle et al (2012) assessed the cost effectiveness of programs with supervised, facility-based exercise training to improve glycaemic control in type 2 diabetes. Three intervention groups were considered (resistance, aerobic or combined exercise training) and compared to usual treatment. The interventions were supervised exercise interventions provided by “exercise specialists”, although the personnel were not further defined. The combined exercise program cost $40,050, while no program cost $31,075. QALYs in the exercise program were 8.94 compared with 8.70 with no program. Incremental QALYs gained were 0.24. **The incremental cost per QALY gained for the combined exercise was $37,872 compared with no exercise program**. The combined exercise program was cost effective for all scenarios considered. Coyle et al conclude that providing training in both resistance and aerobic exercise was the most cost effective of the alternatives compared, and that based on previous funding decisions, exercise training for individuals with diabetes can be considered an efficient use of resources.

Brun et al (2008) evaluated the effects of targeted, moderate endurance training on healthcare cost, body composition and fitness in 25 people with type 2 diabetes. The participants were randomised to intervention, which consisted of 8 sessions and vigorous training twice a week for 30-45 minutes at home. The intervention was a supervised exercise intervention, although the qualifications of the personnel were not further defined. The control group received usual care. Both groups were followed for a year, and **the total healthcare cost was reduced by 50% per day in the intervention group**. This was a result of reduced hospitalisations and reduced need for medications. Brun et al conclude that exercise training can improve the cost effectiveness of treatment and patient’s health.

Nguyen et al (2007) conducted a retrospective analysis of claims data in the US for people receiving an exercise intervention. The exercise intervention was a community-based physical activity program. This program was a supervised exercise intervention, although it was not specified if the personnel were university qualified or not. After participating in the program, those who attended more than one session per week reduced total health care costs by approximately 41% compared to those in the control group and those participating in less than one session per week. There was an observed reduction in hospital admissions for participants (approximately 35% reduction).

As noted in Section 2.6.1, accredited exercise physiologists do provide comprehensive lifestyle interventions in addition to specialised exercise prescription. So, while there was limited cost effectiveness data for exercise training in people with type 2 diabetes, there are a number of programs assessing cost effectiveness for lifestyle interventions. For example, Colagiuri and Walker (2008) estimated that the cost per DALY of a lifestyle intervention aimed at improving nutrition and exercise in Australia was $50,000, which is cost effective. The authors hypothesised that if 175,000 newly diagnosed people with diabetes aged 45-74 years underwent a lifestyle program, 36,009 DALYs would be averted. This intervention was based on data from the Finnish Diabetes Prevention Program (Tuomilehto et al, 2001) and the US Diabetes Prevention Program (Knowler et al, 2002) where the US Diabetes Prevention Program intervention included university qualified exercise physiologists. **The evidence suggests that exercise programs for managing type 2**

diabetes are cost effective and can result in substantial reductions in health system costs. Based on the literature, the cost effectiveness of exercise programs for managing type 2 diabetes is likely between $37,800 to $50,000 per QALY gained or DALY averted.

2.7.3 Summary of cost savings and cost effectiveness in the literature

The evidence available in the literature suggests that exercise interventions, as delivered by accredited exercise physiologists, are cost effective to both prevent and manage type 2 diabetes. The main findings are summarised in Table 2.6.

Table 2.6: Summary of cost savings and cost effectiveness for pre-diabetes and type 2 diabetes

Study	Population	Type of study / intervention	Main findings
Li et al (2015)	Pre-diabetes	Systematic review and meta-analysis of lifestyle interventions. Included data from university qualified exercise physiologists, although costs/outcomes not specific to this group.	0.21 QALYs or DALYs averted, ICER of $32,987 per QALY gained / DALY averted
Bertram et al (2010)	Pre-diabetes and type 2 diabetes	Modelled exercise intervention delivered by accredited exercise physiologists to prevent/manage type 2 diabetes.	ICER of $30,000 per DALY averted for exercise intervention.
Brun et al (2008)	Type 2 diabetes	Clinical trial of a supervised exercise intervention. Intervention personnel were not described further.	Health care costs reduced by up to 50% compared to no exercise intervention.
Coyle et al (2012)	Type 2 diabetes	Modelled facility based supervised exercise intervention based on clinical trial. Intervention personnel were not described further.	ICER of $37,872 compared with no exercise intervention.
Colagiuri and Walker (2008)	Type 2 diabetes	Modelled lifestyle intervention based on Finnish Diabetes Prevention Program and US Diabetes Prevention Program, which included university qualified exercise physiologists.	ICER of $50,000 compared with no lifestyle intervention.
Nguyen et al (2007)	Type 2 diabetes	Retrospective analysis of claims data for exercise intervention.	Participants attending more than 1 session a week had approximately 41% lower total health care costs compared with control and those attending less than 1 session a week.

2.8 Health system cost savings

To estimate the health system expenditure benefits associated with accredited exercise physiologists, there are two components required – the reduction in the number of services utilised due to an appropriately prescribed exercise intervention, and the average cost per service.

The 2011-12 AHS (ABS, 2013) is a large, comprehensive health survey conducted in Australia. The survey is designed to collect a range of information regarding health issues such as current health status, risk factors for conditions, actions taken to help treat or manage conditions, and various lifestyle decisions. The survey also aims to identify socioeconomic circumstances associated with health, although that is beyond the scope of this analysis.

Regarding diabetes and health service utilisation, the AHS asks participants to identify service utilisation in the previous two weeks for the following topics:

- number of GP consultations;
- number of specialist consultations;
- number of admissions to hospital as an inpatient;
- number of visits to outpatient clinics;
- number of visits to emergency/casualty department; and
- number of visits to day clinics.

The AHS also provides data on type of actions taken to help manage diabetes, which is broken down by type of diabetes. The actions taken can include using insulin, taking supplements, diet modification, losing weight, exercising and 'other actions'. It is possible to use this survey to identify health service utilisation by whether they exercise to help manage their diabetes. This is compared to people with diabetes who do not use exercise to help manage their diabetes (considered to be usual care). It is also possible to compare health service use amongst people with type 2 diabetes (Section 2.8.2) and with the general population (Section 2.8.3). These comparisons provide an estimate of the additional health service use for people with type 2 diabetes and pre-diabetes, respectively.

To derive the average cost of each health service, the following sources are used:

- **Admitted to hospital as inpatient:** The AIHW (2013) reports the per separation hospital inpatient expenditure was $7,567 in 2008-09. Inflating this to 2014-15, the per separation hospital inpatient expenditure is $8,756.
- **Visited outpatient clinic** and **visited day clinic:** The Independent Hospital Pricing Authority (IHPA) classification system for non-admitted patient services (including outpatient and day clinics) are referred as the Tier 2 Non-Admitted Care Services. Diabetes related tier 2 class names[29] have cost weights which are applied to the National Weighted Average Unit – $5,007 in 2014-15 (IHPA, 2015). Taking an average of these cost weights indicates that the average cost of outpatient and day clinic services are approximately $305.
- **Visited emergency department:** IHPA National Hospital Cost Data Collection (NHCDC) for 2011-12 provided emergency department costs related to four Australian Refined Diagnosis Related Group (AR-DRG) codes associated with diabetes (K60A, K60B, K01A and K01B). A weighted average of the emergency department costs was $723 in 2014-15 (IHPA, 2014).

[29] Diabetes related Tier 2 class names include the non-admitted service events 10.01, 20.34, 20.40, 40.15, 40.23, and 40.46.

- **Specialist consultation:** This is assumed to be the same as a specialist, referred consultation to which no other Medicare Item applies (Medicare Item 104). This was $85.55 in 2015 (Department of Health, 2015).
- **GP consultations:** This is assumed to be the same as a general practitioner attendance to which no other Medicare Item applies (Medicare Item 23), which was $37.05 in 2015 (Department of Health, 2015).

The average cost of health services are summarised in Table 2.7.

Table 2.7: Health system expenditure averted due to exercise in people with type 2 diabetes, 2015

Health service	Average cost ($)
GP consultations	37.05
Specialist consultations	85.55
Admitted to hospital as inpatient	8,756.22
Visited outpatient clinic	304.93
Visited emergency department	722.88
Visited day clinic	304.93

Source: Deloitte Access Economics.

2.8.2 Health system savings in people with type 2 diabetes

By comparing health service utilisation for those implementing exercise into their daily routine to help manage their diabetes with those that do not, it is possible to estimate the number of services averted due to implementing exercise (noting that other actions may be taken in conjunction with exercise). The number of visits averted per person with type 2 diabetes by service type is reported in Table 2.8. The total costs averted per person per annum are derived by multiplying the average cost and the visits averted per person per annum.

Table 2.8: Health system expenditure averted due to exercise in people with type 2 diabetes, 2015

Health service	Average cost ($)	Visits averted per person with T2D per annum	Total costs averted per person with T2D per annum ($)
GP consultations	37.05	2.68	99.28
Specialist consultations	85.55	0.00	-0.12
Admitted to hospital as inpatient	8,756.22	0.54	4,767.85
Visited outpatient clinic	304.93	-0.11	-34.70
Visited emergency department	722.88	0.33	239.44
Visited day clinic	304.93	0.12	35.49
Total			**5,107.24**

Source: Deloitte Access Economics calculations.
Note: T2D is 'type 2 diabetes'.

The total costs averted per person with type 2 diabetes receiving exercise intervention, as delivered by an accredited exercise physiologist, are estimated to be $5,107 annually.

2.8.3 Health system savings in people with pre-diabetes

Estimates of health system savings for exercise in people with pre-diabetes would ideally be captured by comparing health system use for those receiving exercise as an intervention, and those who are not. However, no Australian literature was found that provided estimates of health service usage for these groups. There was also no Australian data on the effects of an exercise intervention in people with pre-diabetes. As a proxy for health system savings, it is assumed that people with pre-diabetes that are receiving an exercise intervention would be similar to the general population excluding diabetes.

The AHS reports HbA1c rates for approximately 30% of the total sample. This data can be used to determine people who are at risk of developing diabetes, have diabetes, or have no indication of diabetes. The health service use for each of these groups can also be obtained. The number of visits averted per person with pre-diabetes is taken as the difference between service use amongst the general population with no indication of diabetes and the service use amongst those at risk of diabetes as indicated by their HbA1c. The number of visits averted by service type is reported in Table 2.9.

The relevant costs of being admitted to hospital and an emergency department are derived as the average cost of admissions in the general population as indicated by IHPA (2015). The total costs averted per person per annum are derived by multiplying the average cost and the visits averted per person per annum.

Table 2.9: Health system expenditure averted due to exercise in people with pre-diabetes, 2015

Health service	Average cost ($)	Visits averted per person with pre-diabetes per annum	Total costs averted per person with pre-diabetes per annum ($)
GP consultations	37.05	6.5	239.81
Specialist consultations	85.55	1.9	161.53
Admitted to hospital as inpatient	4,914.00	0.3	1,456.18
Visited outpatient clinic	304.93	0.1	31.54
Visited emergency department	222.00	0.0	3.22
Visited day clinic	304.93	0.3	85.00
Total			**1,977.27**

Source: Deloitte Access Economics calculations.

The total costs averted per person with pre-diabetes receiving exercise intervention, as delivered by an accredited exercise physiologist, are estimated to be $1,977 annually.

As a comparison, one study in the Netherlands analysed economic costs in a population of people at risk of developing type 2 diabetes and cardiovascular disease. Participants were randomised to a control group and an intervention group which received a lifestyle modification advice. The intervention was delivered in primary care, and found that healthcare costs were reduced by approximately 10%, although this was not significant (van Wier et al, 2013). While less than the reduction observed in comparing pre-diabetes and the general population (approximately 55% reduction), this can likely be attributed to lower per unit cost of services in this study. For example, applying the per unit costs (converted to Australian dollars in 2015 using purchasing power parity) reported in van Wier et al (2013) to the number of AHS visits averted indicates that total costs are approximately 20% lower, rather than 55%.

2.8.4 Cost savings from reduced co-morbidities

Literature summarised in Section 2.6.3 found that HbA1c is reduced by approximately 0.63% due to exercise interventions in people with type 2 diabetes. Thomas et al (2006) note that this reduction is clinically significant. Consequently, the average reductions in comorbidities from Health Quality Ontario and the Baker IDI Heart and Diabetes Institute study are applied here (but reduced by the average HbA1c reduction 0.63%) to give an idea of the expected savings per person due to reduced complications of diabetes. This estimate cannot be considered separately from the data reported in Sections 2.8.2 and 2.8.3 as the AHS reports on all admissions to hospital, not just those for type 2 diabetes.

The expected reduction for microvascular and macrovascular complications is multiplied by the expected prevalence of each condition amongst people with diabetes to get the number of cases averted. Cases averted were then multiplied by the cost of treating each case to estimate the health cost savings in 2015.

The health system costs per person for chronic kidney disease, amputations and myocardial infarction were calculated using the IHPA cost weights associated with each condition (IHPA, 2015). Chronic kidney disease was calculated as the weighted average of health system costs for AR-DRG codes L09A, L09B and L09C. Amputations were assigned the health system cost related to the AR-DRG code F13B. Myocardial infarction was assigned a weighted average of health system costs related to AR-DRG codes F62A and F62B.

Table 2.10: Costs of secondary complications averted due to exercise, 2015

Complication	Prevalence amongst people with diabetes (A)	Health system costs per person per annum (B)	Expected cost per person (C = A * B)	Reduction from glycaemic control^ (D)	Expected savings (E = C * D)
Visual loss (incl. retinopathy)	10.7%	$5,167*	$552.86	18%	$98.52
Chronic kidney disease	6.0%	$5,926	$355.57	8%	$30.12
Amputations	4.1%	$11,126	$456.18	8%	$38.64
Coronary heart disease	10.0%	$27,327	$2,732.68	8%	$231.49
Myocardial Infarction	10.0%	$8,087	$808.75	8%	$68.51
Stroke	5.0%	$2,237*	$111.84	8%	$9.47
Total					**$476.77**

Source: IHPA (2014; 2015), Baker IDI Heart and Diabetes Institute (2012), Health Quality Ontario (2009), AIHW (2008), AIHW (2008a), * indicates total health system costs from previous Deloitte Access Economics, 2013. ^ microvascular reductions of 28% are reduced by 0.63%/1% to give the reduction due to exercise interventions, similarly, macrovascular reductions of 14% are reduced by 0.63%/1% to give the reduction due to exercise interventions – see section 2.6.2.

The expected cost savings due to a reduction in complications of diabetes are expected to be around $477 per person annually. Again, it is noted that these are not additional to the health system costs previously reported using data from the AHS.

2.8.5 Summary of health system cost savings for people with type 2 diabetes and pre-diabetes

Health system impacts for people with type 2 diabetes and pre-diabetes impose a large burden on society. Expenditure for diabetes exceeded $1.5 billion in 2008-09 (AIHW, 2013). However, this does not include the large burden on the health system imposed by diabetes related complications. For example, diabetes is considered the primary reason for admission to hospital in just 5% of admissions where diabetes is listed as a secondary diagnosis (AIHW, 2015a).

> For people with type 2 diabetes receiving an exercise intervention, the expected annual saving in health system expenditure is $5,107 per person annually. For people with pre-diabetes, the expected annual saving in health system expenditure is $1,977 per person annually.

2.9 Productivity cost savings

Productivity losses are the cost of production lost when people with illnesses and disorders are unable to work because of their condition. They may work less than they otherwise would (either being employed less, being absent more often or being less productive while at work) or they may die prematurely.

Absenteeism costs are shared by the worker and the employer based on access to sick leave. Presenteeism costs are borne largely by employers. Other productivity costs of illness are incurred by the worker (lost income if they reduce their working hours) and the government (taxation revenue forgone).

Previous work undertaken by Deloitte Access Economics (2014) estimated the productivity costs associated with diabetes in Australia. The study estimated the productivity losses for people with diabetes associated with reduced employment, premature death, absenteeism, presenteeism and informal care. A number of sources were used to impute productivity losses including a literature review, and analysis of the Survey of Disability Ageing and Carers (Deloitte Access Economics, 2014). The loss per person with diabetes is presented in Table 2.11.

By way of comparison, work by the American Diabetes Association (2013) found the economic costs of diabetes in the US in 2012 to be 288 million days, or 12.9 per person with diabetes in the US (estimated 22.3 million). Although the American Diabetes Association used different parameters to estimate productivity losses – such as not estimating productivity losses due to premature death or informal care, but estimating losses of reduced productivity for those not in the labour force due to reduced leisure time – they found productivity losses to equal approximately 12.9 days per person with diabetes, which is comparable with the work by Deloitte Access Economics (2014).

Table 2.11: Indirect costs of type 2 diabetes in Australia, 2015

Cost component	Annual loss per person with diabetes (days)
Reduced labour force participation due to disability	3.3
Workdays absent (absenteeism)	0.7
Reduced performance at work (presenteeism)	8.2
Premature death	0.6
Informal care	0.4
Total	**13.2**

Source: Deloitte Access Economics (2014).

2.9.2 Productivity cost savings for people with type 2 diabetes

The productivity impacts associated with type 2 diabetes are substantial. There are estimated to be 13.2 days lost per person with diabetes annually, although no studies were identified that connected the activities of accredited exercise physiologists with improved productivity outcomes in people with type 2 diabetes.

As an indication of the likely savings in productivity losses, a study by van Wier et al (2013) found productivity losses were reduced by approximately 25% per person due to a lifestyle intervention delivered in primary care for people at risk of developing diabetes and cardiovascular diseases. Combined with the estimates presented in Table 2.11, and the average weekly earnings (weighted by general employment rates) as reported by the ABS (2015), **the per person savings in productivity losses may be as high as $760 annually**. The result in van Wier et al (2013) was close to being statistically significant at the 5% significance level.

As this study was not in a type 2 diabetes population, no estimates of the productivity savings for people with type 2 diabetes are included in the analysis.

2.9.3 Productivity cost savings for people with pre-diabetes

To estimate the avoided productivity impacts due to prevention of type 2 diabetes, the average daily earnings are multiplied by days lost for each productivity component to estimate the loss per person with diabetes in dollar terms. Further, to be conservative, it is assumed that productivity losses associated with pre-diabetes are only half of the productivity costs associated with type 2 diabetes.

Average daily earnings are derived from average weekly earnings and weighted by general employment rates for the population as reported by the ABS (2015). The average daily earnings are approximately $238 per person.

The total productivity loss avoided per person with pre-diabetes is estimated to be $1,520 annually (Table 2.12).

Table 2.12: Indirect costs of type 2 diabetes avoided yearly in Australia, 2015

Cost component	Annual loss per person with diabetes (days)	Annual loss per person ($)
Reduced labour force participation due to disability	3.3	376
Workdays absent (absenteeism)	0.7	84
Reduced performance at work (presenteeism)	8.2	946
Premature death	0.6	73
Informal care	0.4	40
Total	**13.2**	**1,520**

Source: ABS (2015) and Deloitte Access Economics (2014).

As a comparison, van Wier et al (2013) found productivity losses were reduced by A$1,502[30] (or 25%) per person due to a lifestyle intervention delivered in primary care for people at risk of developing diabetes and cardiovascular diseases.

2.9.4 Summary of productivity cost savings for people with type 2 diabetes and pre-diabetes

Productivity impacts for type 2 diabetes are substantial annually. It is estimated that diabetes will reduce productivity by 13.2 days per person with diabetes. While there was no literature that estimated the improvement in productivity impacts after intervention by

[30] Converted to 2015 Australian dollars using purchasing power parity.

an accredited exercise physiologist, **the productivity loss avoided as a result of exercise intervention in people with pre-diabetes is estimated to be $1,520 per person annually**. **The productivity savings in people with type 2 diabetes may be as high as $760 per person annually**.

2.10 Wellbeing savings

There were two primary studies that reported on the QALYs gained or DALYs averted in people with type 2 diabetes (Section 2.7.2). Coyle et al (2012) estimated that a combined exercise program would result in an incremental QALY gain of 0.24 per person with type 2 diabetes. Colagiuri and Walker (2008) modelled a lifestyle intervention, finding 0.21 incremental DALYs averted per person. To model the wellbeing savings in people with type 2 diabetes, the average **exercise intervention is likely to result in 0.23 QALYs gained or DALYs averted per person with type 2 diabetes** (average of Coyle et al, 2012 and Colagiuri and Walker, 2008).

There were a number of studies that reported on the QALYs gained or DALYs averted in people with pre-diabetes (Section 2.7.1). The majority of studies considered do not separate outcomes for exercise interventions alone. Bertram et al (2010) estimated the DALYs averted for exercise intervention delivered by accredited exercise physiologists. The DALYs averted were 0.05 per person with pre-diabetes. Taking an average of outcomes reported by Li et al (2015) showed that **the average QALYs gained or DALYs averted were 0.21 per person with pre-diabetes**. The results from Li et al (2015) are used to model the wellbeing savings for people with pre-diabetes.

These gains both occur over the remaining lifetime in the studies reported. The average gain of 0.23 and 0.21 QALYs/DALYs per person was multiplied by the VSLY ($187,495 as in Section 1.8) to estimate the lifetime burden of disease savings. The average age of an Australian with diabetes (64.4 years[31]) was subtracted from their life expectancy (79.8 years[32]) to estimate the number of years over which savings would be considered (14.8 years).

[31] Weighted average age of individuals with diabetes mellitus who responded to the AHS (ABS, 2013)

[32] Average of male and female life expectancy (ABS, 2013) in 2014 minus expected life expectancy reduction due to diabetes – 6.8 years for females with age of onset at 55 years, 5 years for males with age of onset at 55 years (Roper et al, 2001).

> The annual per person lifetime burden of disease savings resulting from Australians receiving exercise interventions, as delivered by an accredited exercise physiologist, is estimated to be $2,860 and $2,617 for a person with type 2 diabetes and pre-diabetes, respectively.

2.11 Benefits of accredited exercise physiologists to people with pre-diabetes and type 2 diabetes in Australia

Exercise interventions are very cost effective. The World Health Organisation (WHO) considers an intervention to be "highly cost effective" if it saves one QALY for less than gross domestic product (GDP) per capita. In Australia, GDP per capita is around $67,000. Exercise interventions are estimated to cost around $5,373 per QALY gained depending on the population and intervention frequency (pre-diabetes – $5,611 per QALY or type 2 diabetes – $5,135 per QALY).

Exercise interventions are estimated to save:

- up to $1,977 in health system costs for people with pre-diabetes annually;
- up to $5,107 in health system costs for people with type 2 diabetes annually.

Additionally, avoided productivity impacts of type 2 diabetes for people with pre-diabetes are estimated to be $1,520 annually. There was insufficient data available to estimate the productivity impacts from exercise interventions in people with type 2 diabetes.

> The total direct annual costs avoided for pre-diabetes are $3,497 per person. The total direct annual costs avoided for type 2 diabetes are $5,107 per person.
>
> Combining the direct costs with the burden of disease avoided annually, the total annual wellbeing gains due to accredited exercise physiologists in Australia for people with pre-diabetes and type 2 diabetes are estimated to be $7,967 and $6,115 per person with pre-diabetes and type 2 diabetes, respectively – noting that this excludes lost productivity savings for people with type 2 diabetes.

Costs of delivering this care to people with pre-diabetes and type 2 diabetes are relatively cheap in comparison. For an accredited exercise physiologist to deliver an intervention similar to the Life! diabetes prevention program[33], which comprises 6 sessions lasting up to 1.5 hours, the cost would be approximately $635 per person receiving the intervention. This assumes that accredited exercise physiologist interventions are primarily delivered on an individual basis.

[33] This program involves Accredited Exercise Physiologists.

Similarly, a predominately group-based program similar to the Healthy Eating Activity and Lifestyle (HEAL) program, which comprises 2 sessions for 8 weeks and 2 individual sessions at program commencement and follow-up, would cost approximately $525 per person receiving the intervention. The average cost of a program on either a group or individual basis is largely dependent on the program design; however, the average cost is estimated to be $580.[34]

The BCR with reference to direct health care expenditure and the average cost of exercise interventions per person with pre-diabetes is 6.0 to 1. When the burden of disease is accounted for, the indicated BCR becomes 10.5 to 1. For people with type 2 diabetes, the BCRs are 8.8 to 1 and 13.7 to 1, respectively.

The BCR in people with type 2 diabetes is likely to be conservative as no estimation of the productivity impacts could be made for this group.

Overall, exercise interventions delivered by accredited exercise physiologists are estimated to be efficacious and highly cost effective in the Australian health care setting for both people with pre-diabetes and type 2 diabetes.

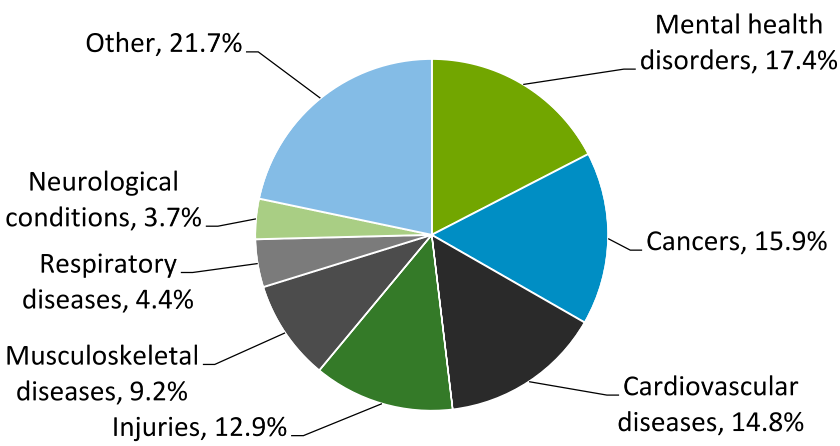
[34] Programs for people with type 2 diabetes that are based on Medicare Items for 1 individual session and up to 8 group sessions with an Accredited Exercise Physiologists will cost less than this, although no cost benefit estimates are provided for this program due to a lack of effectiveness (benefits) data.

3 Mental illness

Mental illness is one of the major causes of morbidity in Australia. There are many gold standard studies (meta-analysis and systemic reviews) that demonstrate exercise is effective in combatting mental illness. Unfortunately, there are very few that report clinical outcomes. Most meta-analyses report standardised mean differences across a large range of mental health indices. The literature search was unable to find a single study of exercise in mental illness that included any cost data. Thus, it is difficult to conduct cost-benefit analysis.

Mental health disorders are the leading cause of disability among people of working age in the developed world (Chart 3.1). The AHS shows that almost one in ten Australians suffer from long term depression (9.7%).[35] Approximately 7.3 million Australians will be affected by mental illness during their lifetime (AIHW 2013).

Chart 3.1: DALYs by cause in people under 70, high income countries, 2012



Source: World Health Organization (2015).

People with serious mental illness face a 'scandal of premature mortality'. Life expectancy is up to 15 years less for people with serious mental illness than for the rest of the population (Rosenbaum et al, 2015).

A number of meta-analyses have clearly demonstrated that exercise has strong anti-depressive and anxiolytic benefits for both the general population and those with mental illness (for example, Jayakody et al, 2013 and Cooney, 2013).

Longitudinal studies show an association between physical activity and reduced risk of developing a mental disorder. For example, a population-based study of 7,076 Dutch adults found that engaging in physical exercise reduced the risk of developing a mood or anxiety

[35] The AHS reports on "mood (affective) disorders" which also includes bipolar disorder / manic depression

disorder over the 3-yr follow-up period, even when controlling for sociodemographic characteristics and physical illnesses (ten Have et al, 2011).

Consistent with the relationship between physical activity and mental health is that individuals with a mental disorder are at higher risk of chronic physical conditions such as heart disease, diabetes, arthritis, and asthma (Teesson et al, 2011; De Hert et al, 2009). De Hert et al (2009) observed that the prevalence of modifiable risk factors such as obesity, smoking, hypertension, dyslipidaemia and metabolic syndrome range between approximately 20 – 80% depending on the risk factor, and the relative risk of schizophrenia or bipolar disorder in these people are generally between 1.5 and 2 times greater (although it can be higher) than people without these risk factors. Some treatments may contribute to these risk factors, with up to 86% of patients treated with antipsychotic medication experiencing a significant gain in weight (Álvarez-Jiménez et al, 2008).

As Lancet Psychiatry (2014) noted, awareness must be raised among psychiatrists and physicians; diabetes and other cardiometabolic complications must be monitored; respiratory health must be checked and smoking cessation encouraged. Exactly how this should be done is less clear. Whereas there is a firm evidence base for specific interventions, there is little consensus about the best way of delivering them. Helping someone to manage their diabetes can be difficult enough: helping someone when their diabetes is complicated with mental illness is likely to be harder. Eating a healthy diet, doing exercise, monitoring food intake, even taking prescribed drugs, day in, day out, require high levels of motivation. When getting out of bed is a challenge, taking a brisk walk feels like being asked to run a marathon.

Bartels (2015) found that adults with serious mental illness represent the single greatest and least recognised health disparity in the nation, reflected in a 13- to 30-year reduced life expectancy. The primary cause of this epidemic of early mortality is cardiovascular disease associated with disproportionately high rates of obesity and tobacco use. As a result, health care costs are two to three times greater in adults with serious mental illness compared with general patient populations.

Despites this, Bartels (2015) suggests that organisations dealing with behavioural health issues have been slow in providing evidence-based health behaviour interventions aimed at preventing chronic health conditions associated with early mortality. Bartels (2015) suggests this is due to negativity regarding the ability of people with mental illness to embrace health behaviour change.

3.1 Current treatment in Australia

The AIHW estimates some 15 million, or more than 12% of GP encounters, are mental health-related, with more than 2 million Medicare-subsidised mental health services provided by Australian GPs in 2011–2012. PBS data shows a 95% increase in antidepressant medication prescriptions between 2001 and 2011.

In Australia, it has been observed that around one in three nurses working in mental health report that they consult with accredited exercise physiologists surrounding the physical health of their patients with mental health disorders (Stanton et al, 2015).

This is substantially different than in the UK, where it has been reported that around 80% of GPs utilise exercise referral schemes in the treatment of patients with depression when they can (Stanton et al, 2015).

The NSW state government has been proactive, incorporating exercise as a routine component of care within the new Mental Health Intensive Care Unit (MHICU) at Prince of Wales Hospital, Sydney. This is an innovative and substantial step forward for the care of people with serious mental illness and ESSA contends this contemporary model be replicated across the nation.

3.2 Exercise recommendations for mental disorders

There have been a range of recommendations surrounding the use of exercise in the treatment of people with mental disorders. The literature search mostly uncovered evidence that discussed depression, although other mental disorders relating to psychosis or anxiety were also found. Where possible we have made the distinction between mental disorders generally (which may include depressive symptoms), clinical diagnoses of depression referred to as depression, and other mental disorders.

Stanton et al (2015) note that the components of exercise interventions for people with depression that are likely to lead to positive outcomes are similar to the recommendations made for the general population. That is, three to four sessions a week of around 30 to 40 minutes at moderate intensity.

Similarly, Firth et al (2015) conducted a systematic review and meta-analysis of exercise interventions in people with schizophrenia. They observed that mental health symptoms were reduced significantly by interventions that consisted of approximately 90 minutes of moderate to vigorous exercise each week. This amount of exercise not only reduced symptoms, but improved functioning and reduced comorbid disorders.

To date, only one systematic review of RCTs has been performed specifically to establish recommendations for exercise program variables in the treatment of patients with mental illness. Perraton et al (2010) analysed 14 papers meeting their strict inclusion criteria specifically looking at exercise recommendations in the treatment of depression. Their review concluded that 30 minutes of supervised aerobic exercise performed three times weekly for at least eight weeks is likely to be effective in treating the symptoms of clinical depression.

Stanton and Reaburn (2013) in their review of exercise program variables for the treatment of depression examined exercise frequency, intensity, session duration, exercise type, exercise mode, intervention duration, delivery of exercise, level and quality of supervision and compliance in high quality RCTs published since 2007. Most programs were performed three times weekly and of a moderate intensity. Intervention duration ranged from four to twelve weeks, with an average duration of 9.3 weeks.

The National Institute for Health and Clinical Exercise (NICE, 2009) guidelines for the treatment and management of depression in adults recommend that physical activity programs be implemented for people with persistent subthreshold depressive symptoms or mild to moderate depression. These interventions should be delivered in groups with support from a competent practitioner, such as an accredited exercise physiologist, and consist typically of three sessions per week of moderate duration (45 minutes to 1 hour) over 10 to 14 weeks (average 12 weeks).

Vancampfort et al (2015) advocate that individuals who are unable or unwilling to meet the goal of 150 minutes of moderate physical activity could still benefit from engaging in some physical activity. The risk for premature mortality significantly increases when adults sit for more than 7 hours a day. Therefore, people with severe mental illness should be advised to sit less and to break up sitting time throughout the day rather than focusing on compliance with general population guidelines. For example, people with severe mental illness might be advised to reduce prolonged sitting by standing or strolling for 1–2 minutes at least once an hour. Although seemingly trivial, adopting small, incremental lifestyle changes can better position sedentary people with severe mental illness to transition to brief bouts of moderate intensity exercise. Such an approach would not be constrained by socioeconomic, environmental, and organisational barriers. Although, implementation of such interventions requires a shift in culture and system reform, from the design of mental health facilities through to changing staff attitudes.

3.3 Aetiology

The mechanisms explaining the benefits of exercise for people with mental illness are not fully understood (Stanton et al, 2015). However, one mechanism proposed to explain the mood enhancing effect of exercise involves an increase in brain-derived neurotrophic factor that leads to increased neuronal survival. This may reduce stress reactivity, thus leading to a reduction in allostatic load. A second potential mechanism is through psychological means. Several recent reviews have alluded to the benefits of exercise in reducing anxiety sensitivity, providing distraction to ruminating thoughts, improved body image changes, social reinforcement, experience of mastery, shift of external to more internal locus of control, and improved coping strategies.

Conn (2010) notes that it is not clear how physical activity acts to reduce symptoms of depression (and therefore mental health disorders). Biochemical or physiological explanations include endogenous opiates, endocannabinoids, brain neurotransmitters, anti-inflammatory cytokines, cerebral blood flow, and hypothalamic–pituitary–adrenal axis function. Hypothesised psychological mechanisms include distraction and enhanced self-efficacy, self-esteem, behavioural activation, sense of achievement/mastery, and self-determination. The relationship between physical activity and symptoms of depression may be reciprocal. People who experience reduced symptoms of depression may be more likely to continue exercise performance.

3.4 Efficacy of exercise on depression

The majority of mental health cases dealt with by university qualified exercise physiologists are for cases of depression (Stanton, 2013), although in recent years changing roles mean that university qualified exercise physiologists deal with a large number of other mental health disorders. That said, the majority of literature found discussed the efficacy of exercise on cases of depression. Consequently, this section and the section on cost effectiveness (Section 3.5) primarily deal with the effects of exercise, as delivered by university qualified exercise physiologists, in cases of depression. Some of the evidence referenced in this section comes from accredited exercise physiologists in Australia in recent years – for example, Rosenbaum, Stanton and a number of their colleagues are accredited exercise physiologists.

It is noted that exercise training can have large benefits in reducing symptoms of depression generally (rather than reducing symptoms of depression in clinical depression alone) in a number of conditions and has been found to have a similar effect as pharmacotherapy in certain conditions (Herring et al, 2012).

There have been several meta-analyses conducted since 2000 on the efficacy of exercise for depression, all of which show that exercise has an antidepressant effect compared with control conditions that ranges from moderate ($g = –0.40$; Krogh et al., 2011) to very large ($g = –1.39$; Stathopoulou et al., 2006)[36].

There were also meta-analyses conducted before 2000, but Daley (2008) observes that while these reviews reported very positive results regarding the effects of exercise for managing depression, these conclusions were often based predominately on observational studies and poor quality controlled trials. Accordingly, the literature search for this report concentrated mostly on publications since that date.

Table 3.1: Meta-analysis of effects of exercise on depression

Author	Year	Effect size*
North	1990	0.72
Craft & Landers	1998	0.94
Lawlor & Hopker	2001	1.10
Stathopoulou	2006	1.39
Mead	2009	0.82
Rethorst	2009	0.80
Krogh	2011	0.40
Bridle (old)	2012	0.34
Cooney (Cochrane)	2013	0.62
Joesfsson	2014	0.77
Rosenbaum	2014	0.80
Average		**0.79**

Note: *usually difference in means between intervention and control, divided by standard deviation. Measured in many different ways.

A highly influential meta-analysis by Lawlor and Hopker (2001) found exercise was as effective as cognitive therapy in the reduction of depressive symptoms in cases of depression. This review predominately included exercise interventions that were one-on-one supervised exercise or supervised group exercise.

[36] Hedges's *g* is a measure of effect size computed by using the square root of the Mean Square Error from the analysis of variance testing for differences between two groups.

The meta-analysis by Stathopoulou et al (2006) included 11 randomised controlled trials of exercise interventions. A large effect size ($g = –1.39$) was found for the treatment of depression with exercise compared with control.

Daley (2008) in her systematic review translated the effect sizes from preceding meta-analyses of exercise and depression to a binominal effect size to allow for interpretation in terms of clinical significance. **The effect sizes (between -0.72, 0.94 and 1.1) reflect an increase in success rate due to exercise of between 67, 71 and 74% respectively,** where a 50% reduction in symptoms is taken as the cut-off for a therapeutic response. Another important observation from Daley's review is that, while drop-out from exercise programs has been identified as a concern in people with depression, at approximately 20% this rate is similar to, and in some cases, better than antidepressant medication to treat depression.

Rethorst et al (2009) performed a rigorous search strategy resulting in an inclusion of 58 randomised trials. The main purpose was to provide Level 1, Grade A evidence for the effect of exercise on depression, something that previously had not been done before. The authors found an overall large effect size ($d = -0.80$), indicating a significant reduction in depression for exercise treatment compared with control conditions. The reduction in depression scores was significantly larger for the clinical population ($d = -1.03$) than for the nonclinical population ($d = -0.59$), thus suggesting that clinically depressed patients benefit more from exercise than nonclinical persons. Furthermore, Rethorst et al (2009) surprisingly found that adequate allocation concealment and intention-to-treat analysis were associated with larger effect sizes, and that clinical interviews did not reveal any differences in effect sizes compared with self-report assessments of depression. This may suggest that the methodological problems that have been widely debated may have had less impact on the results than expected.

A Cochrane review in the same year (Mead et al, 2009) of 28 exercise intervention trials also obtained a large overall effect size ($d = –0.82$) that indicated a significant reduction of depression scores in people with depression for the exercise condition compared with the control condition. These interventions were mostly supervised exercise, although they did not specify who delivered the exercise. Of note, while aerobic exercise indicated a moderate clinical effect, mixed and resistance exercise indicated large effect sizes.

Krogh et al (2011) aimed at determining if exercise should be provided by healthcare services for clinically depressed adults. Thirteen trials were finally included in the main analysis resulting in an overall effect size of $g = –0.40$. Another Cochrane review (Cooney et al, 2013) assessed 35 RCTs (1,356 participants) comparing mostly supervised exercise interventions with no treatment or a control intervention. The pooled standard mean deviation (SMD) for the primary outcome of depressive symptoms at the end of treatment was -0.62, indicating a moderate clinical effect. **The authors converted this to an outcome of 0.6 points lower on the Hamilton Depression Rating Scale** by re-expressing the SMD against the control group from the most representative study (Bloomenthal et al, 2007).

- Seven trials compared exercise with psychological therapy (189 participants), and found no significant difference.

- Four trials (n = 300) compared exercise with pharmacological treatment and found no significant difference.[37]
- Three trials reported on by Cooney et al (2013) included quality of life, but no statistically significant differences were observed between intervention and control outcomes.

Josefsson et al (2014) in their meta-analysis found that previous studies had erred by including studies with 'placebo' controls such as meditation and relaxation exercises, because these have an anti-depressive effect. Correcting for this, their analysis of 13 studies, which involved mostly supervised exercise, showed a significant large overall effect favouring exercise intervention. The pooled standardised mean difference (Hedges's g,) was –0.77 indicating a large effect size in favour of exercise compared with the control condition, and it was also significant ($p < 0.001$).

Rosenbaum et al (2014) conducted a meta-analysis on effects from 39 trials of physical activity on depressive symptoms (primary objective), symptoms of schizophrenia, anthropometric measures, aerobic capacity, and quality of life (secondary objectives) in people with mental illness. While participants in this study did not strictly have a diagnosis of depression (participants could also have schizophrenia, generalised anxiety disorder and bipolar disorder), the authors found a large effect of physical activity on depressive symptoms (standardised mean difference (SMD) = 0.80). Outcomes appeared to have some degree of dose independence, as the effect size in trial interventions that met American College of Sports Medicine (ACSM) guidelines for aerobic exercise did not differ significantly from those that did not meet these guidelines. A large effect was also found for schizophrenia symptoms (SMD = 1.0), and moderate effects were found for quality of life (SMD = 0.64).

- Trials included a range of exercise interventions from 'laboratory-based' settings to pragmatic approaches aimed at increasing physical activity. The review also revealed some areas for attention in future studies. A number of interventions identified failed to follow established principles of physical activity and exercise prescription, suggesting design and implementation by those who lacked expertise in exercise prescription. This issue can be addressed by greater involvement of accredited exercise physiologists in mental health program development.

In addition to appearing to be as efficacious as CBT or anti-depressant medication in combatting depression, exercise is associated with a wide range of additional physical benefits: stress reduction, decreased blood pressure, reduced risks for coronary artery diseases, weight reduction, increased oxygen uptake, and improvements in cognitive functioning such as learning and memory. In addition, no negative side effects have thus far been reported - as opposed to antidepressant medication (Josefsson et al, 2014).

Bridle et al (2012) conducted a meta-analysis of nine trials of exercise interventions in older people. Exercise was associated with significantly lower depression severity (SMD = 0.34). They concluded that, for older people who present with clinically meaningful symptoms of

[37] Mota-Pereira et al (2011) conducted an RCT with patients with treatment-resistant depression, and found that 26% of the exercise group went into remission after 12 weeks of exercise, while none of the control group did.

depression, prescribing structured exercise tailored to individual ability will reduce depression severity.

While the above results clearly establish that exercise interventions have a strong effect on reducing depression and/or symptoms of depression, it is difficult to place an economic value on effect sizes. Even for those meta-analyses that report mean differences in particular measures of depression, it is not straightforward to place an economic valuation of say, a reduction of six points on the Beck Depression Inventory (BDI).

Box 1: Depression scales

There are two main subjective methods of assessing depression - the Beck Depression Inventory (BDI)[38] and the Hamilton Rating Scale for Depression (HRSD)[39]. While based on different psychological theories, both are highly correlated in practice.

The BDI is one of the most widely used psychometric tests for measuring the severity of depression. It consists of 21 questions, where a value of 0 to 3 is assigned for each answer and then the total score is compared to a key to determine the depression's severity. The standard cut-off scores are as follows:

- 0–9: indicates minimal depression
- 10–18: indicates mild depression
- 19–29: indicates moderate depression
- 30 or higher: indicates severe depression.

The HRSD is considered the gold standard for rating depression. There are 17 questions to be rated and each is scored on a 3 or 5 point scale, depending on the item. A score of 0-7 is considered to be normal.

- 0–6: indicates minimal depression
- 7–17: indicates mild depression
- 18–24: indicates moderate depression
- 25 or higher: indicates severe depression.

3.5 Cost effectiveness of exercise in depression

The study by Rethorst et al (2009), in addition to being arguably the highest quality study to date, and having an effect size squarely in the mid-range where most studies cluster, also has the advantage of reporting clinical outcomes. The study included examination of clinical significance for 16 trials with clinically depressed patients, which found 9 of 16 exercise treatment groups were classified as recovered at post-treatment, with another three groups classified as improved.

[38] http://www.pearsonclinical.com/psychology/products/100000159/beck-depression-inventoryii-bdi-ii.html

[39] http://healthnet.umassmed.edu/mhealth/HAMD.pdf

- The authors use a two-step method for analysing clinical significance by examining a change in score from pre-test to post-test. The first step is to establish a cutoff point that must be crossed in moving from the depressed population to the general population. The second criterion used to establish clinical significance is a change in score greater than a pre-established reliable change index (RCI). Individuals can be classified as 'recovered' if they pass both criteria. Previous studies in depression treatment have shown that the substantial majority (77%) of individuals attaining such a recovery threshold are still in recovery two years later (McGlinchey et al, 2002).
- From the literature, the cutoff point for the BDI is (14.3) and the RCI (8.5). Six of the nine interventions that used the BDI both crossed over the cutoff and exceeded the required RCI, indicating that the average score of the sample could be classified as 'recovered' following treatment. Of the three interventions that did not reach `recovered' criteria, two met the criteria for `improvement' by crossing the cutoff point, but not exceeding the required RCI. Only one intervention could be classified as `unchanged' at post-treatment. The average score for this study fell just short of meeting both criteria, with a post-treatment score of 14.6 and an RCI of 7.2.
- Similarly, for the HSRD the cut-off point was (11.8) and the RCI (7.7). Three of the seven interventions crossed over the cutoff and exceeded the required RCI, indicating that the average score of the sample could be classified as 'recovered' following treatment. Of the four treatment groups that did not reach 'recovered' criteria, one met the criteria for 'improvement' by crossing the cutoff point, but not exceeding the required RCI. The two interventions that could be classified as 'unchanged' and one of the ‘improved’ at post-treatment were in the arms of multi-intervention studies that used lower intensity exercise than the arms that showed 'recovery'.

Some caution must be taken in interpreting the clinical significance results. A group treatment score reaching the 'recovered' criteria does not indicate that all participants in that group had reached the 'recovered' criteria. Nor does it mean that none of the participants in the other arms reached recovery. However, assuming a normal distribution of depression scores, the majority of participants in these groups would have reached 'recovered' criteria.

Table 3.2: Results of exercise interventions with recorded clinical outcomes

Study	Year	Measure	Control	Pre	Post	Pre	Post	weeks	freq/w	sessions	duration (min)	Status
				Exercise		Control						
Martinsen*	1985	BDI	occupational therapy	25.2	12.1	31.5	22.8	9	3	27	60	Recovered
Epstein	1986	BDI	psychotherapy	25.3	9.0	22.0	16.3	8	3	24	30	Recovered
McNeil	1991	BDI	wait list	16.6	11.1	15.2	14.7	6	3	18	40	Improved
Veale*	1992	BDI	TAU	22.9	13.9	26.7	17.8	12	3	36	43	Recovered
Singh	1997	BDI	education	21.3	9.8	18.4	13.8	10	3	30	45	Recovered
Mutrie	1998	BDI	wait list	22.4	9.5	23.0	21.4	4	3	12	30	Recovered
		BDI	wait list	21.9	14.6			4	3	12	20	Absent
Singh	2001	BDI	education	21.0	9.2	18.4	11.0	20	3	60	45	Recovered
Singh	1997	HRSD	education	12.3	5.4	11.4	8.5	10	3	30	45	Improved
Singh	2005	HRSD	usual GP	18.0	8.5	18.7	14.4	8	3	24	60	Recovered
Dunn	2005	HRSD	placebo	19.3	11.7	20.5	14.0	12	3	36	43	Improved
		HRSD	placebo	19.2	12.8			12	5	60	43	Absent
		HRSD	placebo	19.1	9.0			12	3	36	43	Recovered
		HRSD	placebo	19.1	10.0			12	5	60	43	Recovered
Average				**20.3**	**10.5**	**20.6**	**15.5**	**9.9**	**3.3**	**33.2**	**42.1**	

Notes: * both arms received treatment as usual (TAU)
Source: Adapted from Rethorst et al (2009).

From the meta-analysis by Rethorst et al (2009), the average number of sessions for interventions that successfully treated depression was 34 (status of "Recovered" in Table 3.2).

Assuming that these trials had been supervised by accredited exercise physiologists, the average cost per person per session would have been $23.99, as this is the weighted average of current rates for group sessions reported in the ESSA survey (Section 1.7). If so, **the cost of the average intervention would be $824 per participant** (=$23.99 * 34).

- In practice, it is unlikely that participants would be willing to attend so many sessions, as they would have to start paying for them after the Medicare subsidy ceased (although other payers such as private health insurance may offer additional sessions). However, it is plausible that a much smaller number of individually tailored one on one sessions with an accredited exercise physiologist could achieve the same results, in terms of behavioural modification, as a large number of one size fits all group exercises.

It is not feasible from the available data to estimate costs for the control group, which means we cannot conduct full cost effectiveness analysis. For example, while in most cases the control was wait list or placebo with low costs, in a few cases both arms received treatment as usual (plus exercise for the intervention arm). It is possible that the costs of psychological and pharmacological interventions in those trials may have been far larger than the exercise costs.

However, the incremental cost effectiveness of exercise can still be conducted. That is, we can say how many more people recovered in the groups that had exercise as an addition, and what that additional exercise would have cost had it been delivered by accredited exercise physiologists.

- The average effect size (as opposed to clinical outcome) for the control groups was not statistically different from zero. This implies the cost effectiveness and the incremental cost effectiveness for exercise would have been similar.

On the benefits side, Deloitte Access Economics (2013) estimated the financial costs per case of depression were $9,622 per year.[40] Translating this to 2015 dollars indicates that **each case of depression averted through exercise, as delivered by accredited exercise physiologists, saves society $10,062 per year**.[41]

[40] This estimate understates the actual likely cost, as it was based on depression in youth and young adults. As this group earn less than most people, the costs of lower productivity and employment caused by their depression will also be correspondingly lower than for the average worker.

[41] This only includes financial costs, not the costs of the reduced stock of healthy life (DALYs)

Table 3.3: Costs of depression, per person per annum, 2015

Category	$
Health system expenditure	1,482
Productivity	7,269
Other financial costs	1,311
Total financial costs	**10,062**

Source: Deloitte Access Economics (2013).

However, the results from Rethorst et al (2009) only showed that the average participant recovered from depression due to exercise. To err on the side of caution, we assume that this means that for every 100 intervention participants, 50 more reached recovery than in the same sized control arm. Allowing for this averaging of differences in outcomes between the two arms, the benefit per intervention becomes $5,031 (=$10,062 *.50). This does not take account of the fact that some individuals in control groups may have 'recovered', despite the overall control group not achieving this status.

As the cost of depression is based on a full year, this assumes that the results demonstrated at the end of trials are sustainable thereafter, at least for a year. This is not implausible, as accredited exercise physiologists specialise in behavioural modification. McGlinchey et al (2002) found that for people with depression classified as 'recovered' using the same definition employed by Rethorst et al, 77% were still classified as recovered at two year follow up. Assuming a linear relapse rate, this implies that 89% would still be in recovery at one year follow up.

Adjusting the cost of the intervention for patients assumed to still be in recovery at one year follow up reduces the benefits to $4,458 (=$5,031*.89). However, as this is still far smaller than the cost of a year of depression, the BCR is 5.41 to 1 (=$4,458/824).

The literature search did not find any studies of accredited exercise physiologist exercise interventions for depression in community settings. However, in exercise interventions for diabetes (2.6.1) the evidence shows that community interventions are only around 50% as effective as clinical trials are.

Allowing for translational effects, the total annual savings due to exercise interventions, as delivered by accredited exercise physiologists, are estimated to be $2,239 (=$4,458 * 0.50) per person with a mental health condition receiving the intervention.

As the costs of these services are substantially lower than this ($824 per person), **the estimated BCR of accredited exercise physiologist interventions for exercise in the community is 2.7 to 1**.

It is important to note that this reflects exercise as an incremental benefit. Exercise is not a panacea for depression, but in conjunction with psychological and pharmacological interventions, it can be very effective.

The AIHW (Begg et al, 2007) calculates the disability weight of depression as 0.127. All else being equal, this implies that a case of depression averted by exercise will avert 0.127

QALYs over the course of the following year. This will understate QALYs gained as it makes no allowance for mortality considerations.

However, indicatively, if the exercise intervention costs $824 and saves 0.127 QALYs, then the implied cost is **$6,485 per QALY,** which is highly cost effective.

3.6 Other mental illnesses

3.6.1 Psychosis

The AIHW (Begg et al, 2007) estimates that schizophrenia affects around 4 in 1000 Australians (0.44%).

A Cochrane review has confirmed the effectiveness of exercise in the treatment of schizophrenia (Gorczynski and Faulkner 2010). Three randomised controlled trials met the inclusion criteria. Trials assessed the effects of exercise on physical and mental health. Overall numbers leaving the trials were similar. Two trials compared exercise to standard care and both found exercise to significantly improve negative symptoms of mental state (Mental Health Inventory Depression mean differences of 17.50 and 8.50). Physical health improved significantly in the exercise group compared to those in standard care (MD 79.50), but there was no apparent effect on peoples' weight or BMI.

Similarly, Firth et al (2015) conducted a systematic review and meta-analysis of exercise interventions in people with schizophrenia. They found that psychiatric symptoms were significantly reduced by interventions involving around 90 minutes of moderate to vigorous exercise each week. The SMD was reported to be 0.72. Further, they found that exercise significantly improved functioning, comorbid disorders and neurocognition. They suggest that supervised exercise in a group setting could maximise adherence.

3.6.2 Anxiety

The AHS reports that 3.8% of the Australian population suffer from anxiety.

Jayakody et al (2013) in an analysis of 8 RCTs conclude that exercise seems to be effective as an adjunctive treatment for anxiety disorders but they found exercise was less effective compared with antidepressant treatment.

DeBoer et al (2012) in their review of exercise interventions for anxiety note that studies have provided reliable evidence of fewer anxiety symptoms, lower stress and greater well-being among individuals who engage in regular physical activity. Likewise, individuals who exercise regularly are significantly less likely to meet diagnostic criteria for panic disorder, agoraphobia, social phobia, generalised anxiety disorder or specific phobias. Furthermore, among those who do have anxiety disorders, higher physical activity is associated with better social functioning and vitality. Laboratory challenge studies have extended these findings by demonstrating that acute exercise confers anti-panic and anxiolytic effects.

Conn (2010) conducted a meta-analysis of anxiety outcomes after physical activity interventions. The overall effect of exercise interventions on anxiety outcomes in two-group studies was 0.229. Interventions to increase physical activity on average resulted in statistically significant improved anxiety outcomes among healthy adults. In contrast, control subjects did not experience improvement as indicated by effect sizes from 0.005 to 0.048, which were not significantly different from 0.

Smits et al (2008) observes that there have been several large-scale studies providing evidence for the negative association between physical activity and anxiety. Data from four national health surveys conducted in the United States and Canada over a ten year period covering approximately 55,000 persons between ages 10 and 74 supported the hypothesis that physical activity is associated with fewer symptoms of anxiety, even after controlling for education and physical health status. Interestingly, the strength of this relationship varied as a function of age and sex, where a stronger link was observed among women and among those over age 40.

Exercise interventions were also found to be beneficial for post-traumatic stress disorder (PTSD). A study by Wolff et al (2011) reviewed the available literature on the effect of exercise interventions for PTSD. The three studies identified (Newman and Motta, 2007; Diaz and Motta, 2008; Manger and Motta, 2005) reported positive effects of aerobic exercise and moderate walking on PTSD severity, and the associate depressive and anxious symptoms in children, adolescents and adults. However, Wolff et al note that all of these studies had severe methodological limitations such as small sample sizes, a lack of clinical diagnoses, and no control groups. Motta et al (2012), in their study on the role of exercise in reducing childhood and adolescent PTSD, conclude that “despite the lack of an empirically supported rationale, the available data suggest that exercise, particularly aerobic exercise, can be of value in reducing PTSD in children and adolescents”.

Rosenbaum et al (2011) have published the design of the Randomised Exercise Augmentation for PTSD (REAP) study, which will investigate the effects of a structured and progressive exercise program on PTSD symptoms, functional ability, body composition, physical activity levels, sleep patterns and medication usage. The results of this study have not yet been published.

Studies also show therapeutic benefits of exercise for other mental illnesses including panic disorder, and obsessive compulsive disorder (Stanton et al, 2015). Gerber & Pühse (2009) report that exercise protects against stress-induced health complaints.

3.7 Physical comorbidities

Curtis et al (2015) undertook a prospective, controlled study in two early psychosis community services. The aim of the intervention was to evaluate the effectiveness of a lifestyle and life skills intervention in reducing clinically significant weight gain after initiating antipsychotic medications. The intervention was delivered within 4 weeks of commencing medications. Intervention participants (n = 16) received a 12-week individualised intervention delivered by accredited exercise physiologists, nurses and dietitians. The accredited exercise physiologist was responsible for the exercise program included in the intervention, which was individually tailored. The intervention was successful in reducing clinically significant weight gain (defined as greater than 7% of baseline weight). Approximately 13% (2/16) of the intervention group experienced clinically significant weight gain, while 75% (9/12) of the standard care group experienced this level of weight gain.

Rosenbaum et al (2015) conducted a systematic review of interventions to increase physical activity and exercise among youth experiencing first-episode psychosis (FEP). They included 11 eligible studies describing 12 interventions (n = 351; 14–35 years) incorporating health coaching (n = 5), exercise prescriptions based on physiological parameters (e.g. heart rate) (n = 3), supervised, individually tailored programs (n = 2), an Internet-delivered intervention and a yoga intervention. Considerable heterogeneity in the design, implementation and assessment of interventions was found. One-third of the interventions were supervised by university qualified exercise professionals such as accredited exercise physiologists. The relatively small number of studies identified was another important finding given the overwhelming evidence regarding the metabolic changes that occur in young people with FEP following initial exposure to antipsychotic medications. The authors concluded that it remains unclear as to the optimal strategies to engage and maintain physical activity in young people with FEP.

Vancampfort et al (2015) note that interventional studies on the long-term effects of reducing sedentary behaviour and increasing light activities is currently lacking in people with serious mental illnesses. An important major challenge is that, to date, research has not assessed low-level physical activity accurately on a large scale in people with mental illness. Accelerometers provide objective measurement of physical activity and are particularly useful for measuring light-intensity physical activities, which may be interspersed throughout the day, and thus more difficult to recall accurately than moderate to vigorous physical activity. In most mental healthcare settings, clinicians will not have access to these devices. Interviews and questionnaires are, in contrast, cheaper and easier to use but often prone to systematic errors because of poor recall, in particular in people with serious mental illness.

3.7.1 Cost effectiveness of exercise interventions for weight loss in psychotic illness

Our literature review found two studies that assessed cost effectiveness of exercise interventions to treat physical comorbidities in mental health. Neither was cost effective in term of dollars per QALY, although one had large reductions in hospital costs compared to TAU.

Verhaeghe et al (2014) provided what, as far as was known to the authors, the first health economic evaluation of an exercise intervention targeting physical activity weight loss among individuals with psychotic illnesses. The authors reported an ICER of €27,096 per QALY in men, and €40,139 in women from their RCT. Projecting their results into the future with Markov modelling, and assuming further increases in quality of life from weight reduction, **resulted in €3,357 per QALY for men, and €3,766 for women**.

Meenan et al (2015) presented results from a 12-month RCT in the US that used improved diet, moderate restriction of calories, and physical activity (20 minutes twice weekly) for participants who were taking anti-psychotic medication. Costs per participant ranged from $4,365 to $5,687. Costs to reduce weight by one kilogram ranged from $1,623 to $2,114; costs to reduce fasting glucose by 1 mg/dL ranged from $467 to $608. Medical hospitalisation costs were reduced by $137,500. The authors observed no statistically significant difference in EQ-5D scores between intervention and control participants. However the mean EQ-5D score was 0.02 higher for the intervention group, which was modestly suggestive of a possible improvement in quality of life from weight loss and/or control of diabetes risk factors. This suggested an ICER of $233,000 per QALY, which is not cost effective.

4 Cardiovascular and other chronic diseases

Non-communicable diseases, including cardiovascular diseases, cancers, diabetes mellitus, and chronic kidney disease currently account for nearly two thirds (63%) of the global annual death toll (Cheema et al, 2014).

Empirical investigations conducted over the past several decades have consistently shown that exercise regimens involving potent methods of aerobic and resistance training can prevent and reverse overweight-obesity, cardiovascular diseases and type 2 diabetes. Exercise can also prevent the risk factors that contribute to these illnesses, including hypertension, dyslipidaemia, insulin resistance, systemic inflammation, and endothelial dysfunction. Effective exercise regimens can also improve immune system function and cancer-specific biomarkers, and hence exercise is known to reduce the risk of many cancers (Cheema et al, 2014).

The AHS reported that only 32% of Australians aged 18 years or more completed sufficient exercise for health benefits. Indeed, the AIHW reports that physical inactivity is the second largest cause of lifestyle-related chronic disease, as measured by DALYs (Begg et al, 2007).

While the focus of this report is on exercise for management of chronic disease, rather than prevention, **epidemiological data show that low exercise capacity is a strong predictor of all cause mortality. Indeed, the association is stronger than that for smoking, hypertension, hyperlipidaemia, and diabetes** (Coombes et al, 2013). Exercise capacity is commonly reported in units termed metabolic equivalents (METs), where 1 MET is the resting metabolic rate. An increase in exercise capacity by 1 MET is associated with a reduction in the risk of mortality by 17% in women and 12% in men in the general population (Coombes et al, 2013). By way of comparison, highly trained endurance athletes have exercise capacity values of around 25 METs.

Sofi et al (2008) conducted a meta-analysis that demonstrated significant protection against the occurrence of coronary heart disease resulting from moderate-to-high levels of physical activity. For individuals who practised a moderate level of physical activity, the relative risk of coronary heart disease was 0.88 (95% CI 0.83–0.93), $P < 0.0001$).

NICE (2006) conducted a review of exercise referrals as a means of preventing chronic diseases (specifically, CHD, stroke, diabetes and colon cancer episodes avoided). Where costs were defined as only including the costs of the intervention, all the interventions had a cost per QALY gained significantly less than £30,000 when compared separately with usual care. When costs are defined to include the healthcare costs avoided through avoiding health states, all the interventions are dominant when compared separately with usual care.

There is strong evidence for the efficacy in combating cardiovascular diseases (CVD), and reasonable evidence for a number of other conditions including chronic pain and arthritis. Most of this evidence is derived from laboratory trials, whereas the vast majority of accredited exercise physiologists work in community settings. Based on the approach taken for type 2 diabetes, it has been assumed that the results in the community are 50% as effective as the results in clinical experiments.

4.1 Cardiovascular diseases

Patients with CHF experience marked reductions in their exercise capacity which has detrimental effects on their activities of daily living, health-related quality of life (HRQOL), and ultimately their hospital admission rate and mortality. Exercise training is often a component of evidence based rehabilitation programs offered to patients with CHF.

4.1.1 Efficacy of exercise interventions in CVD

A Cochrane review by Heran et al (2011) found that in coronary heart disease, exercise-based cardiac rehabilitation **reduced cardiac deaths**. This systematic review included 47 studies with 10,794 patients randomised to exercise-based cardiac rehabilitation or usual care[42]. In medium to longer term (i.e. 12 or more months follow-up) exercise-based cardiac rehabilitation reduced overall and cardiovascular mortality (relative risk 0.87 and 0.74 respectively). Cardiac rehabilitation did not reduce the risk of total myocardial infarction, coronary artery bypass graft or percutaneous transluminal coronary angioplasty. A meta-analysis was not undertaken for health-related quality of life, but in 7 out of 10 trials reporting health related quality of life using validated measures, there was evidence of a significantly higher level of quality of life with exercise-based cardiac rehabilitation than usual care.

A Cochrane systematic review by Rees et al (2004) on the effect of exercise-based interventions on people with heart failure demonstrated a clear **improvement in short-term exercise capacity.**

The ExTraMATCH Collaborative Group (Piepoli et al, 2004) conducted an individual patient data meta-analysis. This review reported a **reduction in the mortality** of CHF patients who received exercise based intervention (hazard ratio: 0.65).

A meta-analysis by van Tol et al (2006), published a meta-analysis supporting the improvements in exercise capacity seen in Rees et al. The authors also reported an **improvement in quality of life** as measured by the Minnesota Living with Heart Failure (MLWHF) questionnaire.

In 2007, Haykowsky et al published a meta-analysis demonstrating the positive effect of exercise-based intervention on cardiac remodelling in patients with CHF. There were 14 trials that reported ejection fraction data in 812 patients. Aerobic training significantly improved ejection fraction (weighted mean difference 2.59%). Aerobic training is an inexpensive and effective non-drug, non-device, non-surgical intervention that helps to reverse or slow the progression of ventricular remodelling and improves VO_2 peak in clinically stable individuals with systolic dysfunction.

[42] Note that the studies included a mix of "supervised or unsupervised inpatient, outpatient, or community- or home-based intervention including some form of exercise training".

Another Cochrane review, by Davies et al (2010) examined the effect of exercise training on clinical events and health-related quality of life (HRQOL) of patients with heart failure. There were 19 RCTs with a minimum follow-up of six months included, with a total of 3,647 patients. **Heart failure-related hospitalisations were lower** (relative risk: 0.72) and HRQOL improved (standardised mean difference: 20.63) with exercise therapy[43]. However, effects on HRQOL were independent of exercise intervention dose.

Table 4.1: Exercise interventions for chronic heart failure

Lead author	Year	Duration (min)	freq/w	Supervised weeks*	Sessions	Dose (hours)
Belardinelli	1999	60	2.1	60.0	128.0	128.0
Dubach	1997	160	4.0	8.0	32.0	85.3
Giannuzzi	1997	30	3.0	8.0	24.0	12.0
Hambrecht	1995	50	7.0	3.0	21.0	17.5
Kiilavuori	2000	30	3.0	12.0	36.0	18.0
McKelvie	2002	30	3.0	12.0	36.0	18.0
Zanelli	1997	30	2.0	8.0	16.0	8.0
Wielenga	1999	30	2.7	12.0	32.0	16.0
Willenheimer	1998	30	2.0	16.0	32.0	16.0
Average		**50**	**3.2**	**15.4**	**39.7**	**35.4**

Note: * excludes follow on unsupervised home exercise conducted in some trials.
Source: ExtraMATCH (2004).

4.1.2 Cost effectiveness of exercise interventions in CVD

In the systematic review by Roine et al (2009), three out of four studies comparing an exercise intervention with usual care found the **exercise intervention to be cost effective for coronary artery disease**.[44]

- Arthur et al (2000) reported that costs of the exercise intervention were more than offset by the cost savings realised by the reduced length of stay – finding net cost savings of approximately $133 per patient per day.
- Briffa et al (2005) reported an incremental cost per QALY saved of $42,535 for exercise in rehabilitation of CVD.
- Yu et al (2004) found that use of exercise in rehabilitation cost $640 per QALY gained.
- Conversely, Blumenthal et al (2002) found that where mental stress was the underlying cause of ischaemia, stress management was more beneficial than exercise and was associated with lower medical costs.

Hambrecht et al (2004) reported exercise to be more cost effective than stent angioplasty. Exercise training also resulted in significantly higher event-free survival (88% vs. 70%).

Georgiou et al (2001) reported that for heart failure patients, **exercise interventions were more cost effective compared to usual care by $1,773 per life-year saved**.

[43] Note that one study (out of a total of 19 studies) contained an exercise intervention which was unsupervised.

[44] All of these studies except for Blumenthal et al (2002) were supervised, although it was not specified who conducted the supervision.

4.1.3 Cost benefit analysis for exercise interventions in CVD

In the ExtraMATCH (2004) meta-analysis of exercise in CHF, at two year follow up 88 out of the original 395 exercise participants had passed away (22%), compared with 105 out of 406 control participants (26%). This represented a significant (p = 0.015) reduction in mortality, with a relative risk of 0.86 (=22%/26%). The authors note "These results would imply a number needed to treat of 17 to prevent one death in two years".

If the mortality rates for the control group had applied to the intervention group, there would have been 14 more deaths by the two year follow up. By inference, 7 deaths which would otherwise have occurred in the intervention group in the first year were averted by exercise. The average age of intervention participants was 60 years, thus at the one year follow up, their average age would have been 61. At this age, each death averted represents an expected saving of 17 life years (from the West Standard Life Tables).

The Commonwealth Government's Office of Best Practice Regulation (OBPR, 2014) requires that a year of life saved be valued at $182,000 in regulatory models. Updating this value of a statistical life year (VSLY) to 2015 dollars yields $187,495. However, the OBPR also requires that future benefits (costs) be discounted at 7% to convert them into net present values (NPV). **Thus, the benefits of 17 years of future life saved is $1.96 million in today's terms. For the seven lives saved in the first year, this amounts to $13.9 million**.

ExtraMATCH (2004) provides no estimates of costs for either the exercise or the control arms. However, it does show that the average intervention participant received 39.7 supervised exercise sessions[45] (Table 4.1). Had these interventions been run by accredited exercise physiologists, the group rate charge would have been $23.99 per hour (Section 1.7) or $1,903 per participant. **Thus for the total 395 people in the exercise group, the total cost of accredited exercise physiologists would have been $751,767. Compared to the life years saved benefits of $12.2 million, this represents a BCR of 17.6 to 1**. The per person costs of this intervention are estimated to be $1,903, while the per person benefits are estimated to be $35,096.

- It is important to note that these are the incremental benefits of exercise. There was insufficient information in the studies cited to estimate the costs of standard care for either the intervention or control arms. (All CHF patients will receive at least standard care: those in the intervention arms received exercise in addition to standard care). Thus it was not possible to estimate full, as opposed to incremental, cost effectiveness. These results should not be taken to infer that exercise alone is sufficient treatment for CHF.

Translation to community results

There are at least two steps required to attempt to translate clinical trials into accredited exercise physiologist community interventions. The first step is to compare whether the age-matched Australian community with CHF has the same mortality rates as those involved in the international trials. If initial mortality rates are lower, so too will be the

[45] Note that the study did not specify the qualifications of the supervisors.

benefits of the interventions. The second step is to make an efficacy adjustment for interventions conducted outside clinical settings.

Mortality in those with CHF does appear to be lower in the Australian community. There are an estimated 67,926[46] people aged between 50 and 69 currently living with CHF in Australia. In this 50 to 69 year old cohort, there will be an expected 5,904 deaths from CHF in 2015.[47] The mortality rate for this cohort, at 8.9% is thus around two-thirds (67.2%) lower than that for the control group in ExtraMATCH of 12.9% in the first year.

- This group was chosen because its weighted average age is virtually the same as that of the intervention groups in ExtraMATCH (2004). The average age of people with CHF in Australia is 74, but as mortality rates are higher and exercise ability lower at this age, it is not possible to extrapolate trial results to the whole population.

If we assume initially that community interventions result in the same relative risk reduction as the clinical trials, the lower rate of mortality will still be expected to translate into fewer deaths averted. That is, the BCR will fall to 12.4 to 1 (=18.4:1 *67%). In this situation, the per person benefits are estimated to be $23,591.

The second adjustment is to reduce the efficacy of the intervention to allow for it being conducted in a community setting. The literature search for this report found no translational studies for exercise benefits in CHF. Accordingly, the same reduction in efficacy as observed for diabetes interventions (50% from section 2.6.1) is assumed to apply here.

> Overall, the total annual lifetime burden of disease savings resulting from exercise interventions in people with CHF, as delivered by accredited exercise physiologists, are estimated to be $11,847 per person.
>
> As the costs associated with accredited exercise physiologists delivering this intervention are substantially lower than this ($1,903 per person), **the estimated BCR of accredited exercise physiologist interventions in people with CHF is 6.2 to 1**.

This estimate can really only be considered as illustrative in the absence of real world translation research with long-run follow up. If the behaviour modification does not endure beyond the first two years, the person who did not die in the first year may stop exercising and then die two years later, reducing the number of life years saved. Conversely, if the behavioural modification does endure, the person who would otherwise have died in year three may live instead, increasing the number of life years saved. **However, long run evidence from diabetes indicates that exercise lifestyle interventions are mostly still in place at ten year follow up** (section 2.6).

[46] Applying 5 year age-gender prevalence rates from Begg et al (2007) to the 2015 population.

[47] Applying 5 year age-gender mortality rates from Begg et al (2007) to the 2015 population.

4.2 Other chronic diseases

The available evidence on the efficacy of exercise in other chronic diseases is mixed. For some diseases, exercise is highly cost effective, for others it is not as effective as usual care. However, for the great majority of chronic diseases, there appears to be little or no evidence either way.

4.2.1 Musculoskeletal disorders

Chronic back pain

Exercise appears to be more effective than standard treatment for chronic back pain, but not strongly so. A Cochrane review (Hayden et al, 2005) conducted a meta-analysis of pain outcomes from 23 exercise interventions for chronic back pain. At earliest follow up, pain outcomes were significantly improved in groups receiving exercises relative to other comparisons, with a mean of approximately 7 points (pooled weighted mean improvement of 7.29 points (95% CI: 3.67 to 10.91)). Effects were similar over longer follow-up, although confidence intervals increased.

Another Cochrane review (Van Tulder et al, 2000) also found strong evidence that exercise therapy[48] is more effective than the usual care by general practitioners for chronic back pain. However, it was unclear whether any specific type of exercise (flexion, extension, or strengthening exercises) is more effective than another.

A meta-analysis by Kool et al (2004) found strong evidence that exercise significantly reduces absenteeism in non-acute back pain.

Roine et al (2009) reported fourteen studies dealing with back pain patients, the majority with chronic back pain. Nine of them reported that exercise saved costs, compared to three in which the exercise intervention was found not cost effective.

The results for cost-efficacy are similar to those for effectiveness. Our literature search found three studies where exercise was compared to usual care and results were presented in $/QALY. In all three studies, exercise was reported to be more cost effective than usual care.

[48] The exercise therapy interventions included a mix of supervised interventions, and interventions which were home-based (and thus assumed to be unsupervised).

Table 4.2: Exercise interventions for chronic back pain

Lead author	Year	Country	n	Control	Intervention	$/QALY*
UK BEAM trial team	2004	UK	1287	8 * 1hr sessions over 8 weeks	TAU	15,066
Van der Roer	2008	Netherlands	114	10 individual and 20 intensive group sessions	guidelines	10,594
					Average $ QALY	**$12,830**

Note:* converted to current Australian dollars using purchasing power parity.
Source: Roine et al (2009)

Wright et al (2005) found a back program with exercise (consisting of exercise, manipulation, joint and tissue mobilization, and so on) to lead to earlier return to work and thus to be cost-saving compared to usual care. By contrast, manipulative treatment together with stabilising exercises was less cost effective than physician consultation alone regarding both healthcare use and work absenteeism (Niemisto et al, 2005).

Osteoarthritis

A meta-analysis by Hernández-Molina et al (2008) on hip osteoarthritis pain found that therapeutic exercise, especially with an element of strengthening, is an efficacious treatment (effect size 0.46 (95% CI 0.64, 0.28; P < 0.0001)).

Our literature review found four studies that reported $/QALY for osteoarthritis. Coupe et al (2007) found no significant difference in outcomes between graded activity levels and usual care. However, the graded activity group cost €773 less per participant, leading to an ICER of €51,385 per QALY for the exercise intervention.

Patrick et al (2001) found that Mean Current Health Desirability Rating (CHDR) was improved under exercise therapy for osteoarthritis compared to TUA. Based on the CHDR measure, the ICER was $10,958 per QALY. However, confidence intervals around this ratio suggested a wide variety of cost effectiveness, which did not allow the authors to reject the null hypothesis. On the other hand, the disability measure of the Health Assessment Questionnaire (HAQ) and the physical domain score of Perceived Quality Of Life scale (PQOL) did have significant improvements in the treatment group.

Cochrane et al (2005) found that group-based exercise in water over 1 year can produce significant reduction in pain and improvement in physical function in older adults with lower limb OA, and may be a useful adjunct in the management of hip and/or knee OA. Wide variation in both the individual costs and the utility measures, combined with small effect sizes, limited the power of the project to detect a difference between the groups on QALY-based analyses, but the water-exercise program produced a favourable cost–benefit outcome, using reduction in Pain score on the Western Ontario and McMaster Universities OA index (WOMAC) pain as the measure of benefit. Analysing quality of life using the Short Form 36 (SF36) resulted in an ICER of £4,895 per QALY compared to TAU.

Richardson et al (2006) found that a supervised exercise program[49] for knee osteoarthritis lead to a slight increase in QALYs by 0.023 per participant compared to a home based exercise program. As the supervised program was also slightly cheaper (£440 versus £445), it thus dominated the unsupervised program.

Table 4.3: Exercise interventions for osteoarthritis

Lead author	Year	Country	n	Intervention	Control	$/QALY*
Coupe	2007	Netherlands	200	8 * 1hr sessions over 8 weeks	TAU	104,727
Patrick	2001	USA	249	8 * 2hr group sessions over 6 weeks	TAU	21,034
Cochrane	2005	UK	312	10 individual and 20 intensive group sessions	TAU	14,024
Richardson	2006	UK	214		home exercise	dominates
					Average $ QALY	**46,595**

Note:* converted to current Australian dollars using purchasing power parity.
Source: Roine et al (2009).

Knee pain

Exercise therapy, education and weight loss are the cornerstones of long-term osteoarthritic knee pain management (Bjordal et al, 2007).

The Osteoarthritis Research Society International (Zhang et al, 2010) examined 64 systematic reviews, 266 randomised controlled trials and 21 economic evaluations. The study concluded that both strengthening and aerobic exercise are associated with relief of pain in the knee.

A Cochrane review (Fransen et al, 2015) concluded that there is high-quality evidence for therapeutic exercise providing benefit in terms of reduced knee pain from osteoarthritis that is sustained for at least six months after cessation of formal treatment. There was also moderate-quality evidence for improvement in physical function among people with knee OA. The magnitude of the treatment effect was comparable with estimates reported for non-steroidal anti-inflammatory drugs.

In one study from Roine et al (2009) that dealt with chronic knee pain, supervised exercise appeared to be an effective intervention (Roush, 2000). Additionally, this study found that exercise resulted in improved clinical outcomes at reduced cost compared to TAU.

Miller and Block (2014) reported an intervention that combined physical rehabilitation, combined with hyaluronic acid intervention to increase lubrication within the knee at the same time. The study reported gains of $12,800 per QALY compared to normal care, which is highly cost effective. Participants had gained 0.138 QALYs at one year follow up, and

[49] Note that the study did not specify the qualifications of the supervisors.

WOMAC pain scores in the intervention group had improved by 45% from a baseline score of 50.

4.2.2 Rheumatic diseases

Roine et al (2009) reported that in three of the four studies on rheumatology, exercise was cost effective. Of these, one (Bakker et al, 1994) was cost effective due to a net 9% reduction in costs over TAU (no HRQOL measures).

The three studies that included $/QALY pose some issues for analysis. The most recent (Bulthuis et al, 2008) reported that exercise dominated TAU. However, the middle study (Van den Hout et al, 2005) found that TAU dominated exercise. The earliest (Van Tubergen et al, 2002) reported two exercise interventions, with quite different results. While both reported net gains in $/QALY over TAU, the second cost more than the first while yielding less than half the additional QALYs. Dividing average incremental QALYs gained (lost) across the four interventions, by average incremental costs (savings) in current AUD yielded an average cost of $44,944 per QALY. This meets the WHO highly cost effective criteria.

However, the fourth study (Van den Hout et al, 2005) where participants had 75 minute high-intensity exercise sessions twice a week for two years was not as cost effective as usual care. Bakker et al (1994) reported that supervised exercise[50] produced significantly better results than unsupervised exercise for mobility, fitness and global health.

Metsios et al (2011) reported that exercise is effective in the management of rheumatoid arthritis, with vigorous physical activity levels correlating significantly with both the number of hospital admissions and their length of stay.

Table 4.4: Exercise interventions for rheumatic disorder

Lead author	Year	Country	n	Intervention	Control
Van Tubergen (a)	2002	Netherlands	120	Spa and exercise therapy, 5 days a week for 3 weeks	TAU
Van Tubergen (b)	2002	Netherlands	120	As above (different spa)	TAU
Van den Hout	2005	Netherlands	309	Long-term intensive exercise program comprising of high-intensity, 75-min sessions twice a week for 2 years	TAU
Bulthuis	2008	Netherlands	85	3-week intensive sessions, twice a day for 75-min	home exercise

Source: Roine et al (2009).

[50] Note that the study did not specify the qualifications of the supervisors.

Table 4.5: Exercise interventions for rheumatic disorder, average $ per QALY

Lead author	Year	Incremental QALYs gained	Incremental cost, pp*	$/QALY*
Van Tubergen (a)	2002	0.17	$2,585	
Van Tubergen (b)	2002	0.08	$3,027	
Van den Hout	2005	-0.04†	$9,486	
Bulthuis	2008	0.09	-$1,480	
Average		**0.08**	**$3,404**	**44,944**

Note:* converted to current Australian dollars using purchasing power parity. †QALYs as measured by transformed Visual Analog Scale rating personal (VAS). QALYs as measured by SF-36 showed a gain of 0.01, but not statistically significant.
Source: Roine et al (2009).

4.2.3 Chronic kidney disease

Chronic kidney disease is one of the most potent known risk factors for cardiovascular disease (CVD). Koufaki et al (2013) note that studies of exercise intervention in chronic kidney disease show a huge variability in exercise training, assessment protocols utilised, inconsistency in reporting procedures, as well as relatively short duration of interventions and extremely small sample sizes. A general conclusion can be reached that a mixed cardiovascular and resistance training program of four to six months, does result in significant improvements in cardiorespiratory fitness. However, this level of improvement does not consistently and meaningfully translate into enhanced CV risk profile, renal function, or quality of life.

Koufaki et al (2015) report that even when prevalent comorbidities such as diabetes, hypertension and CVD are controlled for, people with low physical activity levels are 10 times more likely to develop chronic kidney disease.

4.2.4 Chronic obstructive pulmonary disease

Results reported in Roine et al (2009) concerning the cost effectiveness of exercise interventions in chronic obstructive pulmonary disease (COPD) patients were equivocal with three RCTs comparing exercise to usual care reporting only slight, but non-significant improvements in outcomes.

One study was found where pulmonary rehabilitation was highly cost effective (Griffiths et al, 2001); however, this intervention was not strictly a lifestyle intervention that would be provided by a university qualified exercise physiologist or accredited exercise physiologist as it included a multidisciplinary approach to managing COPD. That said, this intervention may be indicative of the cost savings afforded by accredited exercise physiologists as it primarily included “educational activities, exercise periods, and sessions addressing the psychosocial aspects of chronic disability” (Griffiths et al, 2001).

4.3 Cost benefits analysis for other chronic diseases

Converting the QALYs saved from Table 4.2, Table 4.3 and Table 4.5 shows large benefit to cost ratios for exercise interventions in the management of back pain, osteoarthritis and rheumatologic disorders. However, in the absence of a body of meta-analyses to compare the results of these individual RCTs against, this study does not attempt to translate these findings into community benefits. That is, if all people in Australia with these conditions were able to access Accredited Exercise Physiology treatment.

Table 4.6: Benefits of exercise interventions compared to usual practice for selected chronic conditions.

Condition	$/QALY	VSLY	BCR
Chronic back pain	12,830	$187,495	14.6
Osteoarthritis	46,595	$187,495	4.0
Rheumatologic disorders	44,944	$187,495	4.2

5 Conclusions

Overall, exercise interventions delivered by accredited exercise physiologists are estimated to be efficacious and highly cost effective in the Australian health care setting.

The total annual wellbeing gains due to accredited exercise physiologists in Australia for people with pre-diabetes and type 2 diabetes are estimated to be $6,115 and $7,967 per person with pre-diabetes and type 2 diabetes respectively, noting that no productivity estimates were able to be made for type 2 diabetes. **The BCR with reference to direct health care expenditure and the average cost of exercise interventions, as delivered by accredited exercise physiologists, per person with pre-diabetes is 6.0 to 1. For people with type 2 diabetes, the BCR is 8.8 to 1**.

For clinical depression, there are a large number of meta-analyses demonstrating that exercise is highly effective. Assuming community interventions are 50%[51] as effective as clinical trials (as observed in the literature for type 2 diabetes) it is estimated that exercise interventions, as delivered by accredited exercise physiologists, will result in benefits of $2,239 per person at a cost of $824 per person. Thus, the incremental **benefit to cost ratio of exercise interventions delivered by accredited exercise physiologists for depression is 2.7 to 1.**

Literature pertaining to cost effectiveness of exercise interventions for CVD is also limited. However, the efficacy of such interventions is well established by a large number of meta-analyses. Under the Commonwealth Government's value for a year of life saved of $187,495[52] the estimated deaths averted results in total per person benefits of $11,847 at a cost of $1,903 per person. This results in a **benefit to cost ratio of 6.2 to 1 for accredited exercise physiologist cardiovascular interventions in community settings.**[53] Clinical exercise interventions were also found to be cost effective for chronic back pain, osteoarthritis and rheumatic diseases, as discussed in Chapter 4.

Table 5.1 provides a summary of the benefits and costs for each condition.

[51] See Section 2.6.1. This is calculated by dividing the results from community interventions by the results from clinical trial interventions [0.25/0.51 = 50%].

[52] Office of Best Practice Regulation (2014) figures inflated to 2015 values.

[53] Due to data restrictions, this is a "burden of disease" saving only. That is, it does not include any financial benefits such as reduced health system expenditure, or reduced absenteeism. For most conditions, burden of disease costs are considerably larger than financial costs.

Table 5.1: Estimated benefits and costs of accredited exercise physiologist exercise interventions per person

Condition	Benefits ($)				Costs ($) (E)	BCR
	Health system (A)	Productivity & other financial (B)	BoD (C)	Total wellbeing (D = A + B + C)		
Pre-diabetes	1,977	1,520	2,617	6,115	580	**6.0^**
Type 2 diabetes	5,107	NE	2,860	7,967	580	**≥ 8.8^**
Mental health (depression)	330	1,909	NE	2,239	824	**2.7^**
Chronic disease (cardiovascular)	NE	NE	11,847	11,847	1,903	**6.2#**

Note: BoD is 'burden of disease', NE is 'not estimated due to lack of available data', ^ BCRs for pre-diabetes, type 2 diabetes and mental health (depression) are reported as the ratio of financial benefits (health system and lost productivity savings) to costs # The BCR for chronic disease is relative to the burden of disease. BCRs which contain NE elements are reported on a "greater than or equal to" basis, as it is assumed that the NE components would add to the cost.
Source: Deloitte Access Economics calculations.

These findings indicate that the use of **accredited exercise physiologists can provide substantial benefits across a range of conditions**. As such, there should be continued use of accredited exercise physiologists and the interventions that they provide.

Stanton (2013) observes that "it appears accredited exercise physiologists are a vastly underutilised resource" in the multidisciplinary care for those with chronic diseases generally. Consultations revealed that a large proportion of group sessions that accredited exercise physiologists run are currently for people with type 2 diabetes. Given the extensive evidence currently available, government, private health insurers and primary health care should work together to overcome any potential barriers to accessing services provided by accredited exercise physiologists in people with chronic disease in Australia.

For example, it has been observed that GP referrals can act as a barrier to accessing accredited exercise physiologist services. Stanton (2013) notes that most accredited exercise physiologists believe people with a mental illness are less likely to be referred to an accredited exercise physiologist due to perceptions by GPs that adherence to exercise interventions would be poor.

Rosenbaum et al (2014) concur that referral to accredited exercise physiologists by GPs for people living with chronic disease needs to become standard practice, with sufficient funding to ensure such referrals are likely to lead to implementation of effective, individualised interventions. In particular they consider that it is time to 'activate and integrate' to overcome motivational obstacles regarding the physical health of those experiencing mental illness.

However, it is noted that this is not the only barrier preventing access to accredited exercise physiologist services, and a number of changes are likely needed in the health system to engage the accredited exercise physiologist workforce more completely.

Finally, given the large number of people with chronic diseases who are regular visitors to their GPs, it would be valuable to include a question in BEACH surveys on whether the patient has been previously referred to an accredited exercise physiologist.

> The evidence in this report suggests a high return on investment for exercise physiology in treating people with chronic conditions, notably pre-diabetes and type 2 diabetes, mental illness and chronic heart failure. The continued uptake and availability of Medicare funded services, and other schemes such as increased funding through private health insurers and referral schemes, would be valuable in providing individualised, evidence based accredited exercise physiologist services for people with chronic conditions.

References

Acil, A. A., Dogan, S., & Dogan, O. 2008, 'The effects of physical exercises to mental state and quality of life in patients with schizophrenia'. *Journal of psychiatric and mental health nursing*, 15(10), 808-815.

Ali MK, Echouffo-Tcheugui JB, Williamson DF. 2012 'How effective were lifestyle interventions in real-world settings that were modeled on the Diabetes Prevention Program?'. *Health Affairs, 31*(1), 67-75.

Álvarez-Jiménez M, González-Blanch C, Crespo-Facorro B, et al 2008, 'Antipsychotic-induced weight gain in chronic and first-episode psychotic disorders: A systematic critical reappraisal. *CNS Drug*s. 22:547-563.

American Diabetes Association. 2013 'Economic costs of diabetes in the US in 2012'. *Diabetes care, 36*(4), 1033-1046.

Arthur HM, Daniels C, McKelvie R, et al 2000, 'Effect of a preoperative intervention on preoperative and postoperative outcomes in low-risk patients awaiting elective coronary artery bypass graft surgery. A randomized, controlled trial'. *Ann Intern Med.* 133:253-262.

Australian Bureau of Statistics 2010, *Australian Social Trends: Health and Socioeconomic disadvantage*, Cat No 4102.0.

Australian Bureau of Statistics 2012, *Australian Health Survey: First Results, 2011-12*. Cat. No. 4364.0

Australian Bureau of Statistics 2013, *Microdata: Australian Health Survey, National Health Survey, 2011-12*, Cat. no. 4324.0.55.001, ABS, Canberra.

Australian Bureau of Statistics 2013a, *Deaths, Australia, 2012*, Cat. no. 3302.0, ABS, Canberra.

Australian Bureau of Statistics 2013b, *Australian Aboriginal and Torres Strait Islander Health Survey: First Results, Australia, 2012-13*, Cat. no. 4727.0.55.001, ABS, Canberra.

Australian Bureau of Statistics 2015, *Average weekly earnings, Australia, May 2015,* Cat. no. 6302.0, ABS, Canberra.

Australian Institute of Health and Welfare 2008, *Diabetes: Australian facts 2008*, AIHW, Canberra.

Australian Institute of Health and Welfare 2013, *Mental health services—in brief 2013*. AIHW, Canberra.

Australian Institute of Health and Welfare 2013a, *Diabetes expenditure in Australia, 2008-09*. AIHW, Canberra.

Australian Institute of Health and Welfare 2013b, *Diabetes and disability: impairments, activity limitations, participation restrictions and comorbidities*, AIHW, Canberra.

Australian Institute of Health and Welfare 2015, *Cardiovascular disease, diabetes and chronic kidney disease – Australian facts: Risk factors*, AIHW, Canberra.

Australian Institute of Health and Welfare 2015a, *Hospital care for diabetes,* available at http://www.aihw.gov.au/diabetes/hospital-care/, accessed on 20 August 2015.

Australian Institute of Health and Welfare 2015b, *How many Australians have diabetes?*, http://www.aihw.gov.au/how-common-is-diabetes/, accessed on 22 September 2015.

Baker IDI Heart and Diabetes Institute. 2012. 'Diabetes: the silent pandemic and its impact on Australia'. Diabetes Australia, Juvenile Diabetes Research Foundation.

Bakker C, Hidding A, Van Der Linden S, et al 1994, 'Cost effectiveness of group physical therapy compared to individualized therapy for ankylosing spondylitis. A randomized controlled trial'. *J Rheumatol*. 21:264-268.

Balamurugan A, Ohsfeldt R, Hughes T, Phillips M. 2006 'Diabetes Self-management Education Program for Medicaid Recipients A Continuous Quality Improvement Process'. *The Diabetes Educator, 32*(6), 893-900.

Bartels, S. J. 2015, 'Can behavioral health organizations change health behaviors? The STRIDE study and lifestyle interventions for obesity in serious mental illness. *American Journal of Psychiatry*. 172:1.

Begg, S, Vos, T, Barker, B, Stevenson, C, Stanley, L., &, Lopez, A. 2007, *The burden of disease and injury in Australia*, *2003*. Australian Institute of Health and Welfare AIHW.

Belardinelli R, Georgiou D, Cianci D, Purcaro A. 1999 'Randomized, controlled trial of long term moderate exercise training in chronic heart failure: effects on functional capacity, quality of life, and clinical outcome'. *Circulation*;99

Bertram MY, Lim SS, Barendregt JJ, Vos T. 2010 'Assessing the cost-effectiveness of drug and lifestyle intervention following opportunistic screening for pre-diabetes in primary care'. *Diabetologia, 53*(5), 875-881.

Bertram MY, Vos T. 2010 'Quantifying the duration of pre-diabetes'. *Australian and New Zealand journal of public health, 34*(3), 311-314.

Bjordal, J. M., Johnson, M. I., Lopes-Martins, R. A., Bogen, B., Chow, R., & Ljunggren, A. E. 2007, 'Short-term efficacy of physical interventions in osteoarthritic knee pain. A systematic review and meta-analysis of randomised placebo-controlled trials'. *BMC musculoskeletal disorders, 8*(1), 51.

Blumenthal JA, Babyak M,Wei J, et al. 2002, 'Usefulness of psychosocial treatment of mental stress-induced myocardial ischemia in men' *Am J Cardiol*. 89:164-168.

Bridle, C., Spanjers, K., Patel, S., Atherton, N. M., & Lamb, S. E. 2012, 'Effect of exercise on depression severity in older people: systematic review and meta-analysis of randomised controlled trials. The British Journal of Psychiatry, 201(3), 180-185.

Briffa TG, Eckermann SD, Griffiths AD, et al. 2005, 'Cost effectiveness of rehabilitation after an acute coronary event: A randomised controlled trial'. *Med J Aust*. 183:450-455.

Britt H, Miller GC, Charles J, 2008, *General Practice Activity in Australia 2007-2008*. Australian Institute of Health and Welfare, Canberra

Britt H, Miller GC, Henderson J, et al. 2014, *A decade of Australian general practice activity 2004-05 to 2013-14*, General practice series no. 37. Sydney: Sydney University Press, 2014.

Broocks A, Bandelow B, Pekrun Cl, et al. 1998 'Comparison of aerobic exercise, clomipramine, and placebo in the treatment of panic disorder. *Am JPsychiatr;* 155(5): 603-9

Brubakk, K., Vist, G. E., Bukholm, G., Barach, P., & Tjomsland, O. 2015, 'A systematic review of hospital accreditation: the challenges of measuring complex intervention effects'. *BMC health services research*, 15(1), 280.

Brun JF, Bordenave S, Mercier J, et al. 2008 'Cost-sparing effect of twice-weekly targeted endurance training in type 2 diabetics: a one-year controlled randomized trial'. *Diabetes & metabolism, 34*(3), 258-265.

Bulthuis Y, Mohammad S, Braakman-Jansen LM, et al. 2008 'Cost-effectiveness of intensive exercise therapy directly following hospital discharge in patients with arthritis: Results of a randomized controlled clinical trial'. *Arthritis Rheum*.;59:247-254.

Callaghan P, Khalil E, Morres I, Carter T. 2011, 'Pragmatic randomised controlled trial of preferred intensity exercise in women living with depression'. *BMC Public Health 11*(1): 465.

Cardona-Morrell M, Rychetnik L, Morrell SL, et al. 2010 'Reduction of diabetes risk in routine clinical practice: are physical activity and nutrition interventions feasible and are the outcomes from reference trials replicable? A systematic review and meta-analysis'. *BMC public health, 10*(1), 653.

Carek, P. J., Laibstain, S. E., & Carek, S. M. 2011, 'Exercise for the treatment of depression and anxiety'. *The International Journal of Psychiatry in Medicine*, 41(1), 15-28.

Carr JL, Klaber Moffett JA, Howarth E, et al. A randomized trial comparing a group exercise programme for back pain patients with individual physiotherapy in a severely deprived area. Disabil Rehabil. 2005;27:929-937.

Castaneda C, Layne JE, Munoz-Orians L, et al. 2002 'A randomized controlled trial of resistance exercise training to improve glycemic control in older adults with type 2 diabetes'. *Diabetes care, 25*(12), 2335-2341.

Cheema, B. S., Robergs, R. A., & Askew, C. D. 2014, 'Exercise physiologists emerge as allied healthcare professionals in the era of non-communicable disease pandemics: a report from Australia, 2006–2012'. *Sports Medicine*, 44(7), 869-877.

Chien CL, Lee CM, Wu YW, Chen TA, Wu YT 2010, 'Home-based exercise increases exercise capacity but not quality of life in people with chronic heart failure: a systematic review'. *Australian Journal of Physiotherapy* 54:87–93.

Church TS, Blair SN, Cocreham S, et al. 2010 'Effects of aerobic and resistance training on hemoglobin A1c levels in patients with type 2 diabetes: a randomized controlled trial'. *Jama, 304*(20), 2253-2262.

Clarke P, Leal J, Kelman C, et al. 2008 'Estimating the cost of complications of diabetes in Australia using administrative health-care data'. *Value in health, 11*(2), 199-206.

Cochrane T, Davey RC, Matthes Edwards SM. 2005 'Randomised controlled trial of the cost-effectiveness of water-based therapy for lower limb osteoarthritis'. *Health Technol Assess*.;9: iii-iv, ix-xi, 1-114.

Colagiuri S, Cull CA, Holman RR. 2002 'Are lower fasting plasma glucose levels at diagnosis of type 2 diabetes associated with improved outcomes? UK Prospective Diabetes Study'. *Diabetes care, 25*(8), 1410-1417.

Colagiuri S, Dickinson S, Girgis S, Colagiuri R. 2009 'National evidence based guideline for blood glucose control in type 2 diabetes'. Canberra: Diabetes Australia and the NHMRC.

Colagiuri S, Johnson G. 2014 'Case for action-proposal to NHMRC: A comprehensive type 2 diabetes prevention program'. Available at: www.nhmrc.gov.au/research/research-translation/research-translation-faculty/ideas-research-translation-faculty-cases.

Colagiuri S, Vita P, Cardona-Morrell M, et al. 2010 'The Sydney Diabetes Prevention Program: a community-based translational study'. *BMC Public Health, 10*(1), 328.

Colagiuri S, Walker AE. 2008 'Using an economic model of diabetes to evaluate prevention and care strategies in Australia'. *Health Affairs, 27*(1), 256-268.

Colberg SR, Sigal RJ, Fernhall B, et al. 2010 'Exercise and type 2 diabetes the American College of Sports Medicine and the American Diabetes Association: joint position statement executive summary'. *Diabetes care, 33*(12), 2692-2696.

Conn VS, Hafdahl AR, Mehr DR, et al. 2007 'Metabolic effects of interventions to increase exercise in adults with type 2 diabetes'. *Diabetologia, 50*(5), 913-921.

Conn, V. S. 2010, 'Anxiety outcomes after physical activity interventions: meta-analysis findings'. *Nursing research*, 59(3), 224.

Coombes, J. S., Law, J., Lancashire, B., & Fassett, R. G. 2013, "Exercise Is Medicine" Curbing the Burden of Chronic Disease and Physical Inactivity. *Asia-Pacific Journal of Public Health*, 1010539513481492.

Cooney, G. M., Dwan, K., Greig, C. A., Lawlor, D. A., Rimer, J., Waugh, F. R., Mead, G. E. 2013, 'Exercise for depression'. *Cochrane Database Syst Rev,* 9(9).

Coupe VM, Veenhof C, van Tulder MW, et al. 2007, 'The cost effectiveness of behavioural graded activity in patients with osteoarthritis of hip and/or knee'. *Ann Rheum Dis.;*66:215-221.

Coyle D, Coyle K, Kenny GP, et al. 2012 'Cost-effectiveness of exercise programs in type 2 diabetes'. *International journal of technology assessment in health care, 28*(3), 228.

Craft, L. L., & Perna, F. M. 2004, 'The benefits of exercise for the clinically depressed'. *Primary care companion to the Journal of clinical psychiatry*, 6(3), 104.

Curtis, J., Watkins, A., Rosenbaum, S., Teasdale, S., Kalucy, M., Samaras, K., & Ward, P. B. 2015, 'Evaluating an individualized lifestyle and life skills intervention to prevent antipsychotic-induced weight gain in first-episode psychosis'. *Early intervention in psychiatry.* doi:10.1111/eip.12230

Daley, A. 2008, 'Exercise and depression: a review of reviews'. *Journal of Clinical Psychology in Medical Settings*, 15(2), 140-147.

Dall TM, Zhang Y, Chen YJ, et al. 2010 'The economic burden of diabetes'. *Health Affairs, 29*(2), 297-303.

Davies, E. J., Moxham, T., Rees, K., Singh, S., Coats, A. J., Ebrahim, S., & Taylor, R. S. 2010, 'Exercise training for systolic heart failure: Cochrane systematic review and meta-analysis'. *European journal of heart failure*, 12(7), 706-715.

DeBoer, L. B., Powers, M. B., Utschig, A. C., Otto, M. W., & Smits, J. A. 2012, 'Exploring exercise as an avenue for the treatment of anxiety disorders'. *Expert Rev Neurother*. 12(8): 1011–1022. doi:10.1586/ern.12.73.

Deloitte Access Economics 2013, *Potential health benefits of additional preventative health expenditure*, Report for the Department of Health and Ageing.

Deloitte Access Economics 2014, *Productivity impacts of diabetes*, Report for Diabetes Australia, August, Canberra.

Deloitte Access Economics 2015, *The economic impact of diabetic macular oedema in Australia*, report for Bayer Australia Ltd, April, Canberra.

Department of Health 2015, *MBS Online: Medicare Benefits Schedule*, available at http://www.mbsonline.gov.au/internet/mbsonline/publishing.nsf/Content/Home, accessed on 18 August 2015.

Department of Veterans' Affairs 2015, http://www.dva.gov.au/sites/default/files/files/providers/alliedhealth/exercise_physiologists_notes2f.pdf, accessed 22 September 2015.

De Hert M, Dekker JM, Wood D, et al. 2009 'Cardiovascular disease and diabetes in people with severe mental illness position statement from the European Psychiatric

Association (EPA), supported by the European Association for the Study of Diabetes (EASD) and the European Society of Cardiology (ESC)'. *European psychiatry, 24*(6), 412-424.

Di Loreto C, Fanelli C, Lucidi P, et al. 2005 'Make Your Diabetic Patients Walk Long-term impact of different amounts of physical activity on type 2 diabetes'. *Diabetes Care, 28*(6), 1295-1302.

Diabetes Prevention Program Research Group. 2009 'Regression from pre-diabetes to normal glucose regulation in the diabetes prevention program'. *Diabetes Care, 32*(9), 1583-1588.

Diabetes Prevention Program Research Group. 2012 'The 10-Year Cost-Effectiveness of Lifestyle Intervention or Metformin for Diabetes Prevention: An intent-to-treat analysis of the DPP/DPPOS'. *Diabetes Care, 35*(4), 723-730.

Diabetes Prevention Program Research Group. 2012a 'Effect of regression from prediabetes to normal glucose regulation on long-term reduction in diabetes risk: results from the Diabetes Prevention Program Outcomes Study'. T*he Lancet, 379*(9833), 2243-2251.

Diaz AB, Motta R (2008) 'The effects of an aerobic exercise program on posttraumatic stress disorder symptom severity in adolescents'. *Int J Emerg Ment Health 10*(1):49–59 15

Dubach P, Myers J, Dziekan G, Goebbels U, Reinhart W, Muller P, et al. 1997 'Effect of high intensity exercise training on central hemodynamic responses to exercise in men with reduced left ventricular function'. *J Am Coll Cardiol*;

Dunbar JA, Jayawardena A, Johnson G, et al. 2014 'Scaling up diabetes prevention in Victoria, Australia: policy development, implementation, and evaluation'. *Diabetes Care, 37*(4), 934-942.

Dunkley AJ, Bodicoat DH, Greaves CJ, et al. 2014 'Diabetes Prevention in the Real World: Effectiveness of Pragmatic Lifestyle Interventions for the Prevention of Type 2 Diabetes and of the Impact of Adherence to Guideline Recommendations A Systematic Review and Meta-analysis'. *Diabetes Care, 37*(4), 922-933.

Dunn AL, Trivedi MH, Kampert JB, et al. 2005 'Exercise treatment for depression: efficacy and dose response'. *Am Prevent Med;* 28 (I): 1-8

Dunstan DW, Zimmet PZ, Welborn TA, et al. 2002 'The Rising Prevalence of Diabetes and Impaired Glucose Tolerance The Australian Diabetes, Obesity and Lifestyle Study'. *Diabetes care, 25*(5), 829-834.

Eckel RH, Kahn R, Robertson RM, Rizza RA. 2006 'Preventing cardiovascular disease and diabetes: A call to action from the American Diabetes Association and the American Heart Association'. *Circulation, 113*(25), 2943-2946.

Epstein D. 1986 *Aerobic activity versus group cognitive therapy: an evaluative study of contrasting interventions for the alleviation of clinical depression* [dissertation]. Reno (NV): University of Nevada, ESSA 2010, *Private health insurance factsheet*, https://www.essa.org.au/wp-content/uploads/2010/08/Healthfund-factsheet-info-V2.pdf, accessed 22 September 2015.

Firth J, Cotter J, Elliott R, et al. 2015 'A systematic review and meta-analysis of exercise interventions in schizophrenia patients'. *Psychological medicine, 45*(07), 1343-1361.

Forsberg, K. A., Björkman, T., Sandman, P. O., & Sandlund, M. 2010, 'Influence of a lifestyle intervention among persons with a psychiatric disability: a cluster randomised controlled trail on symptoms, quality of life and sense of coherence'. *Journal of clinical nursing*, 19(11-12), 1519-1528.

Forsyth A, Deane FP, Williams P. 2009, 'Dietitians and exercise physiologists in primary care: lifestyle interventions for patients with depression and/or anxiety'. *J Allied Health*. 38(2):e63-8.

Fowler MJ. 2008 'Microvascular and macrovascular complications of diabetes'. *Clinical diabetes, 26*(2), 77-82.

Georgiou D, Chen Y, Appadoo S, Belardinelli R, Greene R, Parides MK, Glied S. 2001, 'Cost-effectiveness analysis of long-term moderate exercise training in chronic heart failure'. *Am J Cardiol* 87:984–988.

Gerber, M., & Pühse, U. 2009, 'Review article: do exercise and fitness protect against stress-induced health complaints? A review of the literature'. *Scandinavian journal of public health*, 37(8), 801-819.

Giannuzzi P, Temporelli PL, Corra U, Gattone M, Giordano A, Tavazzi L. 1997 'Attenuation of unfavorable remodeling by exercise training in postinfarction patients with left ventricular dysfunction: results of the Exercise in Left Ventricular Dysfunction (ELVD) trial'. *Circulation*;

Gillam, I. 2015 'Success story: how exercise physiologists improve the health of Australians'. *British journal of sports medicine*, bjsports-2015.

Gillett M, Royle P, Snaith A, et al. 2012 'Non-pharmacological interventions to reduce the risk of diabetes in people with impaired glucose regulation: a systematic review and economic evaluation'. *Health Technology Assessment, 16*(33).

Gillies CL, Abrams KR, Lambert PC, et al. 2007 'Pharmacological and lifestyle interventions to prevent or delay type 2 diabetes in people with impaired glucose tolerance: systematic review and meta-analysis'. *Bmj, 334*(7588), 299.

Gillison, F. B., Skevington, S. M., Sato, A., Standage, M., & Evangelidou, S. 2009, 'The effects of exercise interventions on quality of life in clinical and healthy populations; a meta-analysis, *Social science & medicine*, 68(9), 1700-1710.

Golay A, Ybarra J. 2005 'Link between obesity and type 2 diabetes'. *Best Practice & Research Clinical Endocrinology & Metabolism, 19*(4), 649-663.

Gorczynski P, Faulkner G 2010, ‘Exercise therapy for schizophrenia’. *Cochrane Database of Systematic Reviews* (5), CD004412. doi:10.1002/14651858.CD004412.pub2

Gordon BA, Benson AC, Bird SR, Fraser SF 2008, ‘Resistance training improves metabolic health in type 2 diabetes: a systematic review’. *Diabetes research and clinical practice, 83*(2), 157-175.

Gordon LA, Morrison EY, McGrowder DA, et al. 2008 ‘Effect of exercise therapy on lipid profile and oxidative stress indicators in patients with type 2 diabetes’. *BMC complementary and alternative medicine, 8*(1), 21.

Griffiths TL, Phillips CJ, Davies S, et al. 2001 ‘Cost effectiveness of an outpatient multidisciplinary pulmonary rehabilitation programme’, *Thorax, 56*: 779-784.

Grundy SM. 2012 ‘Pre-diabetes, metabolic syndrome, and cardiovascular risk’. *Journal of the American College of Cardiology, 59*(7), 635-643.

Hagberg LA, Lindholm L. 2006, ‘Cost-effectiveness of healthcare based interventions aimed at improving physical activity’. *Scand J Publ Health*.;34:641-653.

Hagerman I, Tyni-Lenne R, Gordon A 2005, ‘Outcome of exercise training on the long-term burden of hospitalisation in patients with chronic heart failure. A retrospective study. *Int J Cardiol* 98:487-491.

Hambrecht R, Niebauer J, Fiehn E, Kalberer B, Offner B, Hauer K, et al. 1995 ‘Physical training in patients with stable chronic heart failure: effects on cardiorespiratory fitness and ultrastructural abnormalities of leg muscles’. *J Am Coll Cardiol*;25:1239-49.

Hambrecht R, Walther C, Mobius-Winkler S, et al. 2004, ‘Percutaneous coronary angioplasty compared with exercise training in patients with stable coronary artery disease: A randomized trial. *Circulatio*n. 109:1371-1378.

Hansen D, Dendale P, Jonkers RAM, et al. 2009, ‘Continuous low-to moderate-intensity exercise training is as effective as moderate-to high-intensity exercise training at lowering blood HbA1c in obese type 2 diabetes patients’. *Diabetologia, 52*(9), 1789-1797.

Hansen D, Dendale P, van Loon LJ, Meeusen R. 2010, ‘The impact of training modalities on the clinical benefits of exercise intervention in patients with cardiovascular disease risk or type 2 diabetes mellitus’. *Sports medicine, 40*(11), 921-940.

Hayden, J., Van Tulder, M. W., Malmivaara, A., & Koes, B. W. 2005, ‘Exercise therapy for treatment of non-specific low back pain’. *The Cochrane Library.*

Haykowsky MJ, Liang Y, Pechter D, Jones LW, McAlister FA, Clark AM. 2007, ‘ A meta-analysis of the effect of exercise training on left ventricular remodelling in heart failure patients: the benefit depends on the type of training performed.’ *J Am Coll Cardiol* 19:2329–2336.

Health Quality Ontario 2009, ‘Community-based care for the management of type 2 diabetes: an evidence-based analysis’, *Ontario Health Technology Assessment Series, 9*(10).

Heran, B. S., Chen, J. M., Ebrahim, S., Moxham, T., Oldridge, N., Rees, K. & Taylor, R. S. 2011, ‘Exercise-based cardiac rehabilitation for coronary heart disease’. *Cochrane Database Syst Rev,* 7(7).

Herman WH. 2013 ‘The economic costs of diabetes: is it time for a new treatment paradigm?’. *Diabetes Care, 36*(4), 775-776.

Hernández-Molina, G., Reichenbach, S., Zhang, B., Lavalley, M., & Felson, D. T. 2008, ‘Effect of therapeutic exercise for hip osteoarthritis pain: Results of a meta-analysis’. *Arthritis Care & Research*, 59(9), 1221-1228.

Herring, M. P., Puetz, T. W., O’Connor, P. J., & Dishman, R. K. 2012, ‘Effect of exercise training on depressive symptoms among patients with a chronic illness: a systematic review and meta-analysis of randomized controlled trials’. *Archives of Internal Medicine*, 172(2), 101-111.

Hordern MD, Dunstan DW, Prins JB, et al. 2012 ‘Exercise prescription for patients with type 2 diabetes and pre-diabetes: a position statement from Exercise and Sport Science Australia’. *Journal of Science and Medicine in Sport, 15*(1), 25-31.

Hordern MD, Marwick TH, Wood P, et al. 2011 ‘Acute response of blood glucose to short-term exercise training in patients with type 2 diabetes’. *Journal of Science and Medicine in Sport, 14*(3), 238-242.

Hurley MV, Walsh NE, Mitchell HL, et al. 2007 ‘Economic evaluation of a rehabilitation program integrating exercise, self management, and active coping strategies for chronic knee pain’. *Arthritis Rheum*.57:1220-1229.

Independent Hospital Pricing Authority (IHPA) 2014, *National Efficient Price Determination 2014-15*, IHPA.

Independent Hospital Pricing Authority (IHPA) 2015, *National Hospital Cost Data Collection Australian Public Hospitals Cost Report 2012-2013, Round 17*, http://www.ihpa.gov.au/internet/ihpa/publishing.nsf/Content/NHCDC-lp, accessed 1 September 2015.

Janus ED, Best JD, Davis-Lameloise N, et al. 2012 ‘Scaling-up from an implementation trial to state-wide coverage: results from the preliminary Melbourne Diabetes Prevention Study’. *Trials, 13*(1), 152.

Jayakody, K., Gunadasa, S., & Hosker, C. 2013, ‘Exercise for anxiety disorders: systematic review’. *British journal of sports medicine*. 48:187196 doi:10.1136/bjsports2012091287

Jeon CY, Lokken RP, Hu FB, Van Dam RM. 2007 ‘Physical Activity of Moderate Intensity and Risk of Type 2 Diabetes: A systematic review’. *Diabetes care, 30*(3), 744-752.

Johnson RE, Jones GT, Wiles NJ, et al. 2007 'Active exercise, education, and cognitive behavioral therapy for persistent disabling low back pain: A randomized controlled trial.' *Spine*.;32:1578-1585.

Jolliffe JA, Rees K, Taylor RS, et al 2001, 'Exercise-based rehabilitation for coronary heart disease. *Cochrane Database Syst Rev*.;1:CD001800.

Jolly K, Taylor R, Lip GY, et al 2007,The Birmingham Rehabilitation Uptake Maximisation Study). Home-based compared with hospital-based cardiac rehabilitation in a multi-ethnic population: Cost-effectiveness and patient adherence. *Health Technol Assess.* 11:1-118.

Josefsson, T., Lindwall, M., & Archer, T. 2014, 'Physical exercise intervention in depressive disorders: Meta-analysis and systematic review'. *Scandinavian journal of medicine & science in sports*, 24(2), 259-272.

Kavookjian J, Elswick BM, Whetsel T. 2007 'Interventions for Being Active Among Individuals With Diabetes A Systematic Review of the Literature'. *The Diabetes Educator, 33*(6), 962-988.

Kiilavuori K, Naveri H, Salmi T, Harkonen M. 2000 'The effect of physical training on skeletal muscle in patients with chronic heart failure'. *Eur J Heart Fail*;

Knowler WC, Barrett-Connor E, Fowler SE, et al. 2002 'Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin'. *The New England Journal of medicine, 346*(6), 393.

Kool, J., de Bie, R., Oesch, P., Knusel, O., van den Brandt, P., & Bachman, S. 2004, 'Exercise reduces sick leave in patients with non-acute non-specific low back pain: a meta-analysis'. *Journal of Rehabilitation Medicine*, 36(2), 49-62.

Korthals-de Bos IB, Hoving JL, van Tulder MW, et al. 2003 'Cost effectiveness of physiotherapy, manual therapy, and general practitioner care for neck pain: Economic evaluation alongside a randomised controlled trial'. *BMJ*.;326:911-916.

Kosaka K, Noda M, Kuzuya T. 2005 'Prevention of type 2 diabetes by lifestyle intervention: a Japanese trial in IGT males'. *Diabetes research and clinical practice, 67*(2), 152-162.

Koufaki, P., Greenwood, S. A., Macdougall, I. C., & Mercer, T. H. 2013, 'Exercise therapy in individuals with chronic kidney disease: a systematic review and synthesis of the research evidence'. *Annual review of nursing research*, 31(1), 235-275.

Koufaki, P., Greenwood, S., Painter, P., & Mercer, T. 2015, 'The BASES expert statement on exercise therapy for people with chronic kidney disease'. *Journal of sports sciences*, 1-6.

Krogh J, Nordentoft M, Sterne JA, Lawlor DA. 2011, 'The effect of exercise in clinically depressed adults: systematic review and meta-analysis of randomized controlled trials'. *J Clin Psychiatry* 72: 529–538.

Laatikainen T, Dunbar JA, Chapman A, et al. 2007 'Prevention of type 2 diabetes by lifestyle intervention in an Australian primary health care setting: Greater Green Triangle (GGT) Diabetes Prevention Project'. *BMC public health, 7*(1), 249.

Lancet Psychiatry 2014, 'Physical and mental health: activate and integrate'. http://www.thelancet.com/pdfs/journals/lanpsy/PIIS2215-0366(14)70322-0.pdf

Lavretsky, H., Alstein, L. L., Olmstead, R. E., Ercoli, L. M., Riparetti-Brown, M., Cyr, N. S., & Irwin, M. R. 2011. 'Complementary use of tai chi chih augments escitalopram treatment of geriatric depression: a randomized controlled trial'. *The American Journal of Geriatric Psychiatry*, 19(10), 839-850.

Lawlor DA, Hopker SW 2001, 'The effectiveness of exercise as an intervention in the management of depression: systematic review and meta-regression analysis of randomised controlled trials'. *BMJ* 2001: 322: 763–767.

Lee CMY, Colagiuri R, Magliano DJ, et al. 2013 'The cost of diabetes in adults in Australia'. *Diabetes research and clinical practice, 99*(3), 385-390.

Lewis JS, Hewitt JS, Billington L, et al. 2005 'A randomized clinical trial comparing two physiotherapy interventions for chronic low back pain'. *Spine*.;30:711-721.

Li G, Zhang P, Wang J, et al. 2008 'The long-term effect of lifestyle interventions to prevent diabetes in the China Da Qing Diabetes Prevention Study: a 20-year follow-up study'. *The Lancet, 371*(9626), 1783-1789.

Li R, Qu S, Zhang P, Chattopadhyay S, et al. 2015 'Economic evaluation of combined diet and physical activity promotion programs to prevent type 2 diabetes among persons at increased risk: a systematic review for the Community Preventive Services Task Force'. *Annals of internal medicine*.

Li R, Zhang P, Barker LE, et al. 2010 'Cost-effectiveness of interventions to prevent and control diabetes mellitus: a systematic review'. *Diabetes care, 33*(8), 1872-1894.

Lindström J, Peltonen M, Eriksson JG, et al. 2013 'Improved lifestyle and decreased diabetes risk over 13 years: long-term follow-up of the randomised Finnish Diabetes Prevention Study (DPS)'. *Diabetologia, 56*(2), 284-293.

Manger TA, Motta RW (2005) 'The impact of an exercise program on posttraumatic stress disorder, anxiety, and depression'. *Int J Emerg Ment Health 7*(1):49–57

Marcus RL, Addison O, Kidde JP, et al. 2010. 'Skeletal muscle fat infiltration: impact of age, inactivity, and exercise'. *The journal of nutrition, health & aging, 14*(5), 362-366.

Marks GC, Coyne ET, Pang GJ. 2001 'Type 2 diabetes costs in Australia-the potential impact of changes in diet, physical activity and levels of obesity'.

Martinsen E, Medhus A, Danvik L 1985 'Effects of aerobic exercise on depression: a controlled study' *BMI;* 291 (6488): 109

Marwick TH, Hordern MD, Miller T, et al. 2009 'Exercise training for type 2 diabetes mellitus impact on cardiovascular risk: a scientific statement from the American Heart Association'. *Circulation, 119*(25), 3244-3262.

McGlinchey, J. B., Atkins, D. C., & Jacobson, N. S. 2002, 'Clinical significance methods: Which one to use and how useful are they? *Behavior Therapy*, 33(4), 529-550.

McKelvie RS, Teo KK, Roberts R, McCartney N, Humen D, Montague T, et al. 2002 'Effects of exercise training in patients with heart failure: the Exercise Rehabilitation Trial (EXERT)'. *Am Heart J*;

McNeil K, LeBlanc EM, Joyner M. 1991 'The effect of exercise on depressive symptoms in the moderately depressed elderly'. *Psychol Aging*; 6(3): 487-8

Mead GE, Morley W, Campbell P, Greig CA, McMurdo M, Lawlor DA. 2009, 'Exercise for depression'. *Cochrane Database Syst Rev* Art. No: CD004366. doi: 1002/14651858. CD004366.pub4

Medibank Private 2007, *The cost of physical inactivity*. http://www.medibank.com.au/Client/Documents/Pdfs/pyhsical_inactivity.pdf.

Meenan, R. T., Stumbo, S. P., Yarborough, M. T., Leo, M. C., Yarborough, B. J. H., & Green, C. A. 2015, 'An Economic Evaluation of a Weight Loss Intervention Program for People with Serious Mental Illnesses Taking Antipsychotic Medications'. *Administration and Policy in Mental Health and Mental Health Services Research*, 1-12.

Metsios, G. S., Stavropoulos-Kalinoglou, A., Treharne, G. J., Nevill, A. M., Sandoo, A., Panoulas, V. F., ... & Kitas, G. D. 2011, 'Disease activity and low physical activity associate with number of hospital admissions and length of hospitalisation in patients with rheumatoid arthritis'. *Arthritis Res Ther*, 13(3), R108.

Miller, L. E., & Block, J. E. 2014, 'An 8-Week Knee Osteoarthritis Treatment Program of Hyaluronic Acid Injection, Deliberate Physical Rehabilitation, and Patient Education is Cost Effective at 2 Years Follow-up: The OsteoArthritis Centers of America SM Experience'. *Clinical medicine insights. Arthritis and musculoskeletal disorders*, 7, 49

Mota-Pereira, J., Silverio, J., Carvalho, S., Ribeiro, J. C., Fonte, D., & Ramos, J. 2011, 'Moderate exercise improves depression parameters in treatment-resistant patients with major depressive disorder'. *Journal of psychiatric research*, 45(8), 1005-1011.

Motta RW, McWilliams ME, Schwartz JT, Cavera RS 2012, 'The Role of Exercise in Reducing Childhood and Adolescent PTSD, Anxiety, and Depression', *Journal of Applied School Psychology*, 28(3): 224-238.

Mumford, V., Forde, K., Greenfield, D., Hinchcliff, R., & Braithwaite, J. 2013, 'Health services accreditation: what is the evidence that the benefits justify the costs? *International journal for quality in health care,* 25(5), 606-620.

Muth ND, Vargo K, Bryant CX 2015, 'The Role of the Fitness Professional in the Clinical Setting'. *Current sports medicine reports, 14*(4), 301-312.

Mutrie N. ‘Exercise as a treatment for depression within the UK Health Service’. 1988 Paper presented at Proceedings of the Sport, Health, Psychology and Exercise Symposium. London: The Sports Council,

Nathan DM, Davidson MB, Defronzo RA, et al. 2007 ‘Impaired fasting glucose and impaired glucose tolerance implications for care’. *Diabetes care, 30*(3), 753-759.

National Health and Medical Research Council (NHMRC), 2013, *Eat for health: Australian Dietary Guidelines*, NHMRC, Canberra.

Newman CL, Motta RW (2007) The effects of aerobic exercise on childhood PTSD, anxiety, and depression. *Int J Emerg Ment Health 9*(2):133–158

Nguyen HQ, Ackermann RT, Berke EM, et al. 2007 ‘Impact of a managed-Medicare physical activity benefit on health care utilization and costs in older adults with diabetes’. *Diabetes care, 30*(1), 43-48.

NICE 2006, *Modelling the Cost-Effectiveness of Physical Activity Intervention*s. https://www.nice.org.uk/guidance/ph2/documents/physical-activity-economics-modelling-report2

NICE 2009, *Depression: the treatment and management of depression in adults (update)* NICE clinical guideline 90. www.nice.org.uk/CG90.

Niemisto L, Rissanen P, Sarna S, et al. 2005 ‘Cost-effectiveness of combined manipulation, stabilizing exercises, and physician consultation compared to physician consultation alone for chronic low back pain: A prospective randomized trial with 2-year follow-up’. *Spine*.;30:1109-1115.

Nieuwland W, Berkhuysen MA, van Veldhuisen DJ, et al. 2000, ‘Differential effects of high-frequency versus low-frequency exercise training in rehabilitation of patients with coronary artery disease’. *J Am Coll Cardiol.* 36:202-207.

O’Hagan C, De Vito G, Boreham CA. 2013 ‘Exercise prescription in the treatment of type 2 diabetes mellitus’. *Sports medicine*, *43*(1), 39-49.

Office of Best Practice Regulation (OBPR) 2014, *Best practice regulation guidance note: Value of statistical life*.

Orozco LJ, Buchleitner AM, Gimenez-Perez G, et al. 2008 ‘Exercise or exercise and diet for preventing type 2 diabetes mellitus’. *The Cochrane Library*.

Palmer AJ, Roze S, Valentine WJ, et al. 2004 ‘Intensive lifestyle changes or metformin in patients with impaired glucose tolerance: modeling the long-term health economic implications of the diabetes prevention program in Australia, France, Germany, Switzerland, and the United Kingdom’. *Clinical therapeutics, 26*(2), 304-321.

Palmer AJ, Tucker DMD. 2012 ‘Cost and clinical implications of diabetes prevention in an Australian setting: a long-term modeling analysis’. *Primary care diabetes, 6*(2), 109-121.

Pan XR, Li GW, Hu YH, et al. 1997 ‘Effects of diet and exercise in preventing NIDDM in people with impaired glucose tolerance: the Da Qing IGT and Diabetes Study’. *Diabetes care, 20*(4), 537-544.

Patrick DL, Ramsey SD, Spencer AC, et al. 2001 ‘Economic evaluation of aquatic exercise for persons with osteoarthritis’. *Med Care*.;39:413-424.

Perraton LG, Kumar S, Machotka Z. Exercise parameters in the treatment of clinical depression: a systematic review of randomized controlled trials. J Eval Clin Pract 2010; 16:597–604.

Piepoli MF, Davos C, Francis DP, Coats AJ, 2004, ‘Exercise training meta-analysis of trials in patients with chronic heart failure ExTraMATCH (Exercise training meta-analysis of trials in patients with chronic heart failure. *BMJ*; 328:189.

Ramachandran A, Snehalatha C, Mary S, et al. 2006 ‘The Indian Diabetes Prevention Programme shows that lifestyle modification and metformin prevent type 2 diabetes in Asian Indian subjects with impaired glucose tolerance (IDPP-1)’. *Diabetologia, 49*(2), 289-297.

Rees K, Taylor RS, Singh S, Coats AJS, Ebrahim S. 2004, ‘Exercise based rehabilitation for heart failure’. *Cochrane Database Syst Rev*;CD003331

Rethorst CD, Wipfli BM, Landers DM. 2009, ‘The antidepressive effects of exercise a meta-analysis of randomized trials’. *Sports Med* 39: 491–511

Richardson G, Hawkins N, McCarthy CJ, et al. 2006 ‘Cost effectiveness of a supplementary class-based exercise program in the treatment of knee osteoarthritis’ *Int J Technol Assess Health Care*.;22:84-89.

Richardson, C. R., Faulkner, G., McDevitt, J., Skrinar, G. S., Hutchinson, D. S., & Piette, J. D. 2014, ‘Integrating physical activity into mental health services for persons with serious mental illness’. *Psychiatric services*.

Roine, E., Roine, R. P., Räsänen, P., Vuori, I., Sintonen, H., & Saarto, T. 2009, ‘Cost-effectiveness of interventions based on physical exercise in the treatment of various diseases: a systematic literature review’. *International journal of technology assessment in health care*, 25(04), 427-454.

Roper NA, Bilous RW, Kelly WF, Unwin NC, Connolly VM 2001, ‘Excess mortality in a population with diabetes and the impact of material deprivation: longitudinal, population based study’, *BMJ*, 322:1389-1393.

Rosenbaum, S., Lederman, O., Stubbs, B., Vancampfort, D., Stanton, R., & Ward, P. B. 2015, ‘How can we increase physical activity and exercise among youth experiencing first-episode psychosis? A systematic review of intervention variables’. *Early intervention in psychiatry. doi:10.1111/eip.12238*

Rosenbaum S, Nguyen D, Lenehan T, Tiedemann A, van der Ploeg HP, Sherrington C 2011, ‘Exercise augmentation compared to usual care for Post Traumatic Stress Disorder: A

Randomised Controlled Trial (The REAP study: Randomised Exercise Augmentation for PTSD)', *BMC Psychiatry*, 11: 115-122.

Rosenbaum, S., Tiedemann, A., Sherrington, C., Curtis, J., & Ward, P. B. 2014, 'Physical activity interventions for people with mental illness: a systematic review and meta-analysis'. *The Journal of clinical psychiatry*, 75(9), 964-974.

Roush MB, Sevier TL, Wilson JK, et al. 2000 'Anterior knee pain: A clinical comparison of rehabilitation methods'. *Clin J Sport Med.*;10:22-28

Sacre JW, Jellis CL, Jenkins C, et al. 2014 'A six-month exercise intervention in subclinical diabetic heart disease: Effects on exercise capacity, autonomic and myocardial function'. *Metabolism, 63*(9), 1104-1114.

Salmon P. 2001, 'Effects of physical exercise on anxiety, depression, and sensitivity to stress: A unifying theory'. *Clinical Psychiatry Review* 21:33-61.

Schuch, F. B., Vasconcelos-Moreno, M. P., Borowsky, C., & Fleck, M. P. 2011, 'Exercise and severe depression: preliminary results of an add-on study'. *Journal of affective disorders*, 133(3), 615-618.

Sharma AM. 2006 'The obese patient with diabetes mellitus: from research targets to treatment options'. *The American journal of medicine, 119*(5), S17-S23.

Singh N, Clements KM, Fiatrone-Singh MA. 2001, 'The efficacy of exercise as a long-term antidepressant in elderly sub jects: a randomized controlled trial'. *Gerontol*; 56A (8): M497-504

Singh NA, Clements KM, Fiatarone MA. 1997 'A randomized controlled trial of progressive resistance training in de-pressed elders.' *Gerontol*; 52A (1): M27-35

Singh NA, Stavrinos TM, Scarbek Y, et al. 2005 'A randomized controlled trial of high versus low intensity weight training versus general practitioner care for clinical depression in older adults.' *Gerontol*; 60A (6): 768-76

Skrinar, G. S., Huxley, N. A., Hutchinson, D. S., Menninger, E., & Glew, P. 2005. 'The role of a fitness intervention on people with serious psychiatric disabilities'. *Psychiatric Rehabilitation Journal,* 29(2), 122.

Smits, J. A., Berry, A. C., Tart, C. D., & Powers, M. B. (2008, 'The efficacy of cognitive-behavioral interventions for reducing anxiety sensitivity: A meta-analytic review'. *Behaviour Research and Therapy,* 46(9), 1047-1054.

Snowling NJ, Hopkins WG. 2006 'Effects of different modes of exercise training on glucose control and risk factors for complications in type 2 diabetic patients a meta-analysis'. *Diabetes care, 29*(11), 2518-2527.

Soan, E. J., Street, S. J., Brownie, S. M., & Hills, A. P. 2014, 'Exercise physiologists: essential players in interdisciplinary teams for noncommunicable chronic disease management'. *Journal of multidisciplinary healthcare*, 7, 65.

Sofi, F., Capalbo, A., Cesari, F., Abbate, R., & Gensini, G. F. 2008, 'Physical activity during leisure time and primary prevention of coronary heart disease: an updated meta-analysis of cohort studies'. *European Journal of Cardiovascular Prevention & Rehabilitation*, 15(3), 247-257.

Stanton, R. 2013, 'Accredited exercise physiologists and the treatment of people with mental illnesses'. *Clinical Practice*, 2(2), 5-9.

Stanton, R., & Reaburn, P. 2014. 'Exercise and the treatment of depression: a review of the exercise program variables'. *Journal of Science and Medicine in Sport*, 17(2), 177-182.

Stanton, R., Rosenbaum, S., Kalucy, M., Reaburn, P., & Happell, B. 2015. 'A call to action: exercise as treatment for patients with mental illness. *Australian journal of primary health*, 21(2), 120-125.

Stathopoulou G, Powers MB, Berry AC, Smits JAJ, Otto MW. 2006, 'Exercise interventions for mental health: a quantitative and qualitative review'. *Clin Psychol Sci Pract*: 13: 179–193.

Teesson M, Mitchell PB, Deady M, Memedovic S, Slade T, Baillie A. 2011, 'Affective and anxiety disorders and their relationship with chronic physical conditions in Australia: Findings of the 2007 National Survey of Mental Health and Wellbeing'. *Aust N Z J Psychiatry.*;45:939-946.

ten Have M, de Graaf R, Monshouwer K. 2011, 'Physical exercise in adults and mental health status: Findings from the Netherlands Mental Health Survey and Incidence Study (NEMESIS)'. *J Psychosom Res*. 71:342-348

Testa MA, Simonson DC. 1998 'Health economic benefits and quality of life during improved glycemic control in patients with type 2 diabetes mellitus: a randomized, controlled, double-blind trial'. *Jama, 280*(17), 1490-1496.

Thomas DE, Elliott EJ, Naughton GA. 2006 'Exercise for type 2 diabetes mellitus'. *Cochrane Database Syst Rev, 3*(3).

Thomas KS, Miller P, Doherty M, et al. 2005; 'Cost effectiveness of a two-year home exercise program for the treatment of knee pain'. *Arthritis Rheum*. 53:388-394.

Torstensen TA, Ljunggren AE, Meen HD, et al. 1998 'Efficiency and costs of medical exercise therapy, conventional physiotherapy, and self-exercise in patients with chronic low back pain. A pragmatic, randomized, single-blinded, controlled trial with 1- year follow-up'. *Spine.*;23:2616-2624.

Tuomilehto J, Lindström J, Eriksson JG, et al. 2001 'Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance'. *New England Journal of Medicine, 344*(18), 1343-1350.

UK Prospective Diabetes Study (UKPDS) Group. 1998 'Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS)'. *The Lancet, 352*(9131), 837-853.

UKBEAM Trial Team United Kingdom 2004 'Back pain exercise and manipulation (UK BEAM) randomised trial: Cost effectiveness of physical treatments for back pain in primary care'. *BMJ*.;329:1381-1385.

Unwin N, Shaw J, Zimmet P, Alberti KGMM 2002 'Impaired glucose tolerance and impaired fasting glycaemia: the current status on definition and intervention'. *Diabetic medicine, 19*(9), 708-723.

Vancampfort, D., Stubbs, B., Ward, P. B., Teasdale, S., & Rosenbaum, S. 2015, 'Integrating physical activity as medicine in the care of people with severe mental illness'. *Australian and New Zealand Journal of Psychiatry*, 49(8), 681-682.

Van Den Hout WB, de Jong Z, Munneke M, et al. 2005 'Cost-utility and cost-effectiveness analyses of a long-term, high-intensity exercise program compared with conventional physical therapy in patients with rheumatoid arthritis'. *Arthritis Rheum*.;53:39-47.

Van der Heijden MMP, Van Dooren FEP, Pop VJM, Pouwer F. 2013 'Effects of exercise training on quality of life, symptoms of depression, symptoms of anxiety and emotional well-being in type 2 diabetes mellitus: a systematic review'. *Diabetologia, 56*(6), 1210-1225.

Van Der Roer N, van Tulder M, van Mechelen W, et al. Economic evaluation of an intensive group training protocol compared with usual care physiotherapy in patients with chronic low back pain. *Spine*. 2008;33:445-451.

van Tol BA, Huijsmans RJ, Kroon DW, Schothorst M, Kwakkel G. 2006, 'Effects of exercise training on cardiac performance, exercise capacity and quality of life in patients with heart failure: a meta-analysis'. *Eur J Heart Fail* 8:841–850.

Van Tulder, M., Malmivaara, A., Esmail, R., & Koes, B. 2000. 'Exercise therapy for low back pain: a systematic review within the framework of the Cochrane collaboration back review group'. Spine, 25(21), 2784-2796.

Van Tubergen A, Boonen A, Landewe R, et al. 2002 'Cost effectiveness of combined spa-exercise therapy in ankylosing spondylitis: A randomized controlled trial'. *Arthritis Rheum*.;47:459-467.

van Wier MF, Lakerveld J, Bot SD, et al. 2013, 'Economic evaluation of a lifestyle intervention in primary care to prevent type 2 diabetes mellitus and cardiovascular diseases: a randomized controlled trial.' *BMC family practice, 14*(1), 45.

Veale D, LeFevre K, Pantelis C, et al. 1992 'Aerobic exercise in the adjunctive treatment of depression: a randomized controlled trial'. 3 *Royal Soc Med.*, 05(9): 541-4

Verhaeghe, N., De Smedt, D., De Maeseneer, J., Maes, L., Van Heeringen, C., & Annemans, L. 2014, 'Cost-effectiveness of health promotion targeting physical activity and healthy eating in mental health care'. *BMC Public Health*, 14, 856.

Visceglia, E., & Lewis, S. 2011, 'Yoga therapy as an adjunctive treatment for schizophrenia: a randomized, controlled pilot study'. *The Journal of Alternative and Complementary Medicine*, 17(7), 601-607.

Vos T, Carter R, Barendregt J, et al. 2010 'Assessing cost-effectiveness in prevention: ACE–prevention'. September.

Wielenga RP, Huisveld IA, Bol E, Dunselman PH, Erdman RA, Baselier MR, et al. 1999 'Safety and effects of physical training in chronic heart failure. Results of the chronic heart failure and graded exercise study (CHANGE)' *Eur Heart J*;20:872-9.

Willenheimer R, Erhardt L, Cline C, Rydberg E, Israelsson B. 1998 'Exercise training in heart failure improves quality of life and exercise capacity'. *Eur Heart J;*774-81.

Wolff E, Gaudlitz K, von Lindenberger BL, Plag J, Heinz A, Ströhle A 2011, 'Exercise and physical activity in mental disorders', *European Archives of Psychiatry and Clinical Neuroscience*, 261(S2): S186-S191.

World Health Organization 2015, *Global Health Observatory (GHO): Disability-adjusted Life Years (DALYs)*, http://www.who.int/gho/mortality_burden_disease/daly_rates/en/, accessed on 22 September 2015.

Wright A, Lloyd Davies A, Williams S, et al. 2005 'Individual active treatment combined with group exercise for acute and subacute low back pain'. *Spine*.;30:1235-1241.

Wynaden D, Barr L, Omari O, Fulton A. 2011, 'Evaluation of service users' experiences of participating in an exercise programme at the Western Australian State Forensic Mental Health Services'. *Int J Ment Health Nurs*. 21(3):229-35.

Yu CM, Lau CP, Chau J, et al. 2004, ' A short course of cardiac rehabilitation program is highly cost effective in improving long-term quality of life in patients with recent myocardial infarction or percutaneous coronary intervention' *Arch Phys Med Rehabil.* 85:1915-1922.

Zanelli E, Volterrani M, Scalvini S, Musmeci G, Campana M, Zappa C, et al. 1997 'Multidisciplinary non-pharmachological intervention prevents hospitalization, improves morbidity rates and functional status in patients with congestive heart failure'. *Eur Heart J*;18(abstract suppl):647.

Zhang, W., Nuki, G., Moskowitz, R. W., Abramson, S., Altman, R. D., Arden, N. K., ... & Tugwell, P. 2010, ' OARSI recommendations for the management of hip and knee osteoarthritis: part III: Changes in evidence following systematic cumulative update of research published through January 2009'. *Osteoarthritis and Cartilage*, 18(4), 476-499.

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