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Review of sexual health issues linked with cardiovascular disease and type 2 diabetes mellitus in Aboriginal and Torres Strait Islander males

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Review of sexual health issues linked with cardiovascular disease and type 2 diabetes mellitus in Aboriginal and Torres Strait Islander males

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The content in this review focuses on sensitive health topics associated with Men's Business. We encourage readers to consider the appropriate dissemination of the information contained in this review for their setting and community.

About this review

The purpose of this review is to summarise the evidence on the links between male sexual health conditions (erectile dysfunction (ED) and low testosterone) and the chronic diseases cardiovascular disease (CVD) and type 2 diabetes mellitus (T2DM), specifically to:

- raise awareness about the links between male sexual health and CVD and T2DM for Aboriginal and Torres Strait Islander males
- encourage the inclusion of sexual health assessments as part of a holistic approach to the healthcare of Aboriginal and Torres Strait Islander males
- encourage healthcare providers to consider sexual health problems and impacts in the management and prevention of CVD and T2DM among Aboriginal and Torres Strait Islander males
- encourage Aboriginal and Torres Strait Islander males, health workers and health professionals to engage in conversations about sexual health problems and impacts, especially with regards to prevention and management.

This review uses information taken from journal articles, research reports, government reports, national data collections and national surveys that are available and can be accessed through the Health*InfoNet*'s publication database https://healthinfonet.ecu.edu.au/key-resources/publications. The accuracy of the identification of Aboriginal and Torres Strait Islander males in health data collections varies across the country. Some information is only considered to be sufficient and complete for certain states and territories. Please note that the statistics presented in this review do not always include all states and territories, see sources for full details.

The Health*InfoNet*, consistent with its nomenclature guide, prefers the term 'Aboriginal and Torres Strait Islander' rather than 'Indigenous Australian' for its publications. Also, some sources may only use the terms 'Aboriginal only' or 'Torres Strait Islander only'. However, when referencing information from other sources, authors may use the terms from the original source. As a result, readers may see these terms used interchangeably in some instances. If they have any concerns, they are advised to contact the Health*InfoNet* for further information.

Introduction

What is sexual health?

The World Health Organization (WHO) defines sexual health as ‘a state of physical, emotional, mental and social well-being in relation to sexuality; it is not merely the absence of disease, dysfunction or infirmity. Sexual health requires a positive and respectful approach to sexuality and sexual relationships, as well as the possibility of having pleasurable and safe sexual experiences, free of coercion, discrimination, and violence. For sexual health to be attained and maintained, the sexual rights of all persons must be respected, protected and fulfilled.’ (World Health Organization, 2020a).

Sexual health encompasses reproductive health, which the WHO defines as ‘a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity, in all matters relating to the reproductive system and to its functions and processes' (World Health Organization, 2020b).

In recent years, some health indicators for Aboriginal and Torres Strait Islander people have improved. While there are ongoing challenges in closing the gap[1] (Australian Indigenous HealthInfoNet, 2021), health and wellbeing programs for Aboriginal and Torres Strait Islander people, and for men specifically, have shown some success when they have incorporated appropriate social and cultural approaches (Thomson, Midford, Debuyst, & MacRae, 2010; Wenitong, 2002). In fact, there is increasing recognition of the importance of addressing cultural as well as social determinants of health for Aboriginal and Torres Strait Islander people (Australian Government Department of Health, 2019; Gee, Dudgeon, Schultz, Hart, & Kelly, 2014; National Aboriginal Community Controlled Health Organisation, 2013).

Aboriginal and Torres Strait Islander people have specific experiences and needs with respect to their health, with high rates of chronic diseases, such as cardiovascular disease (CVD) and type 2 diabetes mellitus (T2DM), and high levels of risk factors for these diseases such as obesity and smoking (Australian Indigenous HealthInfoNet, 2020; Burrow & Ride, 2016; Merone, Burns, Poynton, & McDermott, 2019). Poor access to health services and programs can also be the experience of many Aboriginal and Torres Strait Islander communities, particularly in remote areas (Australian Institute of Health and Welfare, 2020a; Wenitong, Adams, & Holden, 2014).

Several reports and papers draw attention to the fact that Aboriginal and Torres Strait Islander males[2] face health challenges, including a low life expectancy relative to other population groups (Australian Government Department of Health, 2020; Australian Government Department of Health and Ageing, 2010a, 2010b; Australian Institute of Health and Welfare, 2012; Prehn & Ezzy, 2020; Thomson et al., 2010; Wenitong, 2002; Wenitong et al., 2014). To address the health needs of males, gender-specific approaches that encompass the role of males in Aboriginal and Torres Strait Islander communities, are likely to be the most effective (Australian Government Department of Health, 2020; Australian Government

1 ‘Closing the gap’ is a term used to describe the strategies used by various levels of government in Australia to decrease the difference of health outcomes (such as life expectancy and prevalence of disease) for Aboriginal and Torres Strait Islander people and other Australians which has historically been in deficit (Department of the Prime Minister and Cabinet, 2020).

2 The terms 'men' and 'males' are used interchangeably throughout the report. 'Male' is the preferred term as it is inclusive of all males, encompassing young males, uninitiated males of any age, adult men and members of the LGBTIQA+ community including ‘brotherboys’ and ‘sistergirls’. The term 'men' is used where this is the term used in the original source document, and is the term most often used for non-Indigenous adult males.

Department of Health and Ageing, 2010a, 2010b; Australian Institute of Health and Welfare, 2012; Thomson et al., 2010; Wenitong, 2002; Wenitong et al., 2014). In 2002, the first comprehensive report on the health of Aboriginal and Torres Strait Islander males was published, entitled *Indigenous Male Health: A report for Indigenous males, their families and communities, and those committed to improving Indigenous male health* (*Indigenous male health* report) (Wenitong, 2002). This report documented the wide range of health issues experienced by Indigenous males and highlighted the many gaps in knowledge and research on male-specific health (Wenitong, 2002). Importantly, the review included the strengths and successes of many Aboriginal and Torres Strait Islander males and gave examples of programs providing culturally appropriate services that have resulted in improved access to health care (Wenitong, 2002). In 2010, the Australian Indigenous Health*InfoNet*'s *Review of Indigenous male health* (Thomson et al., 2010) also documented the extent and range of health issues experienced by Aboriginal and Torres Strait Islander males and stressed that the social and cultural context of male health and wellbeing must be considered for any health promotion or healthcare program to be successful. Moreover, the review highlighted improvements in some male health outcomes over a period of several years prior to the review, notably for infectious diseases and life expectancy (Thomson et al., 2010).

Despite the many studies and reports on the health of Aboriginal and Torres Strait Islander people, including those that focus on males, there is a lack of information on male sexual health conditions. This was identified as a major gap in the 2002 *Indigenous male health* report (Wenitong, 2002):

> *Diseases specific to males include those of the prostate gland and sex organ, male sexual dysfunction, infertility and testicular cancer. For almost all of these conditions, no documented literature examining prevalence in Indigenous males or Indigenous male perspectives of the illnesses could be found. (p. 16)*

There has been only one in-depth study to date of male sexual health disorders among Aboriginal and Torres Strait Islander males (M. Adams, 2014; M. J. Adams, Collins, Dunne, de Kretser, & Holden, 2013). This 2004-2007 study was undertaken by Dr Michael Adams, an Aboriginal and Torres Strait Islander male, with sponsorship provided by Andrology Australia (now known as Healthy Male). The study found relatively high rates of certain male sexual health problems such as erectile dysfunction (ED), and identified barriers to seeking help for such disorders, including limited awareness of sexual health among Aboriginal and Torres Strait Islander males (M. J. Adams et al., 2013). There is a pressing need for more research to be undertaken in this area.

Given that chronic conditions such as CVD and diabetes are common among Aboriginal and Torres Strait Islander males and they can occur at younger ages than in non-Indigenous males (Burrow & Ride, 2016; Merone et al., 2019), there is much scope for including sexual health conditions in the assessment and treatment of males attending health services. Moreover, there is evidence that lifestyle interventions used for prevention and treatment of CVD and T2DM can also improve sexual health, thus providing an extra dimension to health promotion and prevention programs (Gupta et al., 2011). However, there is often poor knowledge and awareness of male sexual health and the links with general health among both health professionals and Aboriginal and Torres Strait Islander males (M. Adams, 2014), partly due to sensitivities and taboos about sexual matters, resulting in limited opportunities for discussion and intervention (M. Adams, 2014; Wenitong et al., 2014).

Historical, social and cultural context of Aboriginal and Torres Strait Islander male health

When Aboriginal and Torres Strait Islander people are empowered to connect with culture, and the importance of physical, emotional, and spiritual health are realised, health and wellbeing is enhanced. It is becoming more widely acknowledged that the current health status of Aboriginal and Torres Strait Islander people is influenced by the history of colonisation and the associated widespread destruction of culture (Dudgeon, Wright, Paradies, Garvey, & Walker, 2014; Gee et al., 2014; Paradies, 2016; Prehn & Ezzy, 2020). Moreover, the poorer social conditions (relative to non-Indigenous Australians) in which many

Aboriginal and Torres Strait Islander people live today, are a result of the damaging effects of colonisation over several generations and these are inextricably linked to current health (Dudgeon et al., 2014). There are now theoretical and empirical understandings of how the historical trauma related to colonisation cause ill-health among Aboriginal and Torres Strait Islander people, how it acts across generations and interacts with present-day racism to cause further damage to health (Paradies, 2016). Recognising these damaging effects emphasises the resilience of Aboriginal and Torres Strait Islander people and their capacity to overcome extreme disadvantage (Dudgeon et al., 2014; Thomson et al., 2010).

Colonisation has had profound effects on Aboriginal and Torres Strait Islander male identity in particular, resulting from the loss of male roles as traditional leaders, decision makers, father figures and educators (M. Adams, 1998). This has meant that some older Aboriginal and Torres Strait Islander males have lost their authority and status, while young males may no longer have access to these role-models and cultural teachers, thus contributing to poor health and wellbeing over several generations. The loss of male cultural roles can leave Aboriginal and Torres Strait Islander males struggling to find their place in the community (M. Adams, 1998; Prehn & Ezzy, 2020). In response, some males engage in behaviours that are self-destructive and have deep impacts on their physical, emotional and spiritual health (M. Adams, 1998; Thomson et al., 2010). To overcome these challenges, Aboriginal and Torres Strait Islander males are increasingly finding ways to re-connect with their culture and taking their place as decision-makers and role models in their own families and communities as well as in the broader Australian community (M. Adams, 1998; Arney & Westby, 2012; Prehn & Ezzy, 2020).

Current context for Aboriginal and Torres Strait Islander male sexual health

Data from Adams' 2004-2007 study (M. Adams, 2014; M. J. Adams et al., 2013), along with the high rates of CVD and T2DM, suggest that male sexual health conditions are common in Aboriginal and Torres Strait Islander communities. However, seeking or accessing help for assessment and treatment of sexual health can be problematic for Aboriginal and Torres Strait Islander males (M. Adams, 2014; M. J. Adams et al., 2013; Arney & Westby, 2012; Wenitong, 2002; Wenitong et al., 2014). Only about half of the males with moderate to severe ED in the Adams' study reported having sought help or treatment for the condition (M. J. Adams et al., 2013). Barriers to seeking help were identified through focus groups and interviews (M. Adams, 2014; M. J. Adams et al., 2013). Participants reported that often males keep silent about sexual matters and some have feelings of shame and low self-esteem related to their sexual health (M. Adams, 2014; M. J. Adams et al., 2013). Furthermore, they reported that males tend to speak in 'roundabout ways' when discussing sexual health among themselves, and some have fears about lack of confidentiality in communities and the stigma attached to having a sexual health problem, which can create a barrier to speaking with health professionals (M. Adams, 2014; M. J. Adams et al., 2013). Although non-Indigenous Australian males also report barriers to seeking help for sexual health problems (Holden et al., 2005), there can be a 'cultural distance' between Aboriginal and Torres Strait Islander males and healthcare services that makes discussing sexual health with healthcare workers more problematic for Aboriginal and Torres Strait Islander males (M. Adams, 2014). The study also identified a perception that knowledge of sexual health problems was low among males, although many males correctly identified that sexual dysfunction could be related to alcohol abuse, smoking, obesity, heart disease and diabetes (M. Adams, 2014).

It is apparent that the sexual health of Aboriginal and Torres Strait Islander males is 'shrouded in silence' (M. Adams, 2014) (p. 88). Adams concluded that the silence existed across three levels and that changing the context for Aboriginal and Torres Strait Islander male sexual health required action across all levels (M. Adams, 2014). The first level is research: there is little knowledge about the extent of the problem and ways to manage sexual health in Aboriginal and Torres Strait Islander males. The second level is health services, where communicating about sexual health may be difficult for both health professionals and Aboriginal and Torres Strait Islander male patients. This is partly due to reticence to broach sensitive topics and, perhaps, the cultural distance between males and their doctors, particularly if the doctor or health professional is a female or non-Indigenous person. The third level is silence at the community level, where males generally don't talk about their sexual health with their partners or with other males (M. Adams, 2014).

The links between cardiovascular disease and type 2 diabetes and male sexual health conditions

Cardiovascular disease (CVD)

CVD is the broad term used to describe diseases and conditions that affect the heart and blood vessels (World Health Organization, 2017). Specific types of CVD include ischemic heart disease (IHD), heart failure, cerebrovascular disease (including stroke), peripheral vascular disease and rheumatic heart disease (RHD) (World Health Organization, 2016, 2017). The term also encompasses biomedical factors such as hypertension (high blood pressure) and high cholesterol (World Health Organization, 2016).

Most types of CVD (excluding RHD[3]) share a common set of risk factors. These include: smoking, unhealthy diet, physical inactivity, high alcohol use, hypertension, high cholesterol, unhealthy weight, T2DM, chronic kidney disease, depression/social isolation, sex, family history of CVD, ethnicity and age (Agostino et al., 2020; Australian Institute of Health and Welfare, 2015b; World Heart Federation, 2017).

CVD presents a significant burden for Aboriginal and Torres Strait Islander people in terms of prevalence, hospitalisation and mortality (Australian Indigenous HealthInfoNet, 2021; Australian Institute of Health and Welfare, 2016b). Evidence shows that the risk of CVD starts relatively early for Aboriginal and Torres Strait Islander people, and a consensus statement released by leading Australian health organisations in 2020 recommended Aboriginal and Torres Strait Islander people begin having CVD risk assessments at younger ages because of early disease onset (Agostino et al., 2020).

Type 2 diabetes mellitus

Diabetes is a complex chronic condition, characterised by hyperglycemia (high blood sugar levels) due to insulin resistance or deficiency, that can lead to morbidity, disability, reduced quality of life and premature death (Australian Institute of Health and Welfare, 2020b; Diabetes Australia, 2011). Type 2 diabetes (also known as type 2 diabetes mellitus - T2DM) is the most common form of diabetes. It usually develops in adulthood, although recently it has been diagnosed more frequently among children and adolescents (Peña et al., 2020; Shaw & Tanamas, 2012).

This form of diabetes often runs in families, and typically occurs when risk factors such as obesity, poor nutrition, and lack of physical activity are present. T2DM can usually be controlled through lifestyle modifications such as keeping fit, eating well and not smoking, however patients may require insulin treatment over time (Evans, Canuto, Kelly, Caperchione, & Macniven, 2020; The Royal Australian College of General Practitioners & Diabetes Australia, 2020).

As T2DM is often diagnosed at a later age, sometimes signs are dismissed as a part of ‘getting older’. Often people with T2DM have no symptoms at all. Sometimes by the time T2DM is diagnosed, the complications of diabetes may already be present (Diabetes Australia, 2015b). These complications can include diseases of the large blood vessels (macrovascular disease), such as heart disease and stroke (CVD), and diseases of the small blood vessels (microvascular disease), such as kidney disease, eye disease and nerve disease (Baker Heart and Diabetes Institute, 2018; Diabetes Australia, 2015a).

Aboriginal and Torres Strait Islander people experience disproportionately high levels of diabetes, and it is a significant factor in the life expectancy gap between Indigenous and non-Indigenous Australians (Burrow & Ride, 2016; Straw et al., 2019; The Royal Australian College of General Practitioners & Diabetes Australia, 2020). The Royal Australian College of General Practitioners (RACGP) and National Aboriginal Community Controlled Health Organisation (NACCHO) recommend that all Aboriginal and Torres Strait Islander adults

3 Unlike other types of CVD, RHD occurs when acute rheumatic fever (ARF), an illness that affects the heart, joints, brain and skin, leads to permanent damage to the heart valves (Wyber et al., 2020). ARF is caused by an untreated bacterial (group A streptococci or GAS) infection of the throat.

be screened for T2DM (via blood test) on an annual basis (The Royal Australian College of General Practitioners & Diabetes Australia, 2020).

Male sexual health conditions

Over the past 15 to 20 years, evidence for links between male sexual health conditions and chronic disease has accumulated, with implications for a more holistic approach to care for males presenting with either chronic disease or sexual health conditions (Holden, Allan, & McLachlan, 2010). Although nearly all of the studies examining the nature of the relationship between reproductive health and general health are in non-Indigenous male populations, it is likely that the physiological basis of the relationships will apply to all males (M. J. Adams et al., 2013). Moreover, the high prevalence of CVD (Merone et al., 2019) and diabetes (Burrow & Ride, 2016) among Aboriginal and Torres Strait Islander males, along with a relatively young age of onset, suggests that understanding the nature of these relationships and the common risk factors for chronic disease and sexual health conditions can provide opportunities for treatment and prevention. However, this will require healthcare providers and Aboriginal and Torres Strait Islander males to have an awareness of the links between sexual health and general health, and secondly, for males to have access to safe spaces where sensitive sexual health issues can be discussed in a culturally appropriate setting (Wenitong et al., 2014).

Links between reproductive health and general health are illustrated by substantial evidence showing associations between ED and CVD, particularly coronary heart disease (CHD; also known as IHD or coronary artery disease (CAD))[4] (Holden, Allan, et al., 2010), and T2DM (Nehra et al., 2012). Low testosterone (testosterone deficiency or androgen deficiency) has also been the subject of investigation, but due to the need to collect a fasting serum sample to measure circulating total testosterone and the complexity of testosterone assays, there are fewer studies than those related to ED (measured using a questionnaire). Nevertheless, associations between low testosterone and T2DM and obesity are well described (Gianatti & Grossman, 2019; Grossmann & Matsumoto, 2017; Lue, Brant, Shindel, & Bella, 2015). Some studies have also shown that low circulating testosterone levels are associated with greater risk of dying from CVD (or all causes), independent of other CVD risk factors (Meyer & Wittert, 2018; Yeap, 2018; Yeap, Dwivedi, Chih, & Reid, 2019). The focus of this review is therefore ED and low testosterone, and the links between these male sexual health conditions and CVD and T2DM[5] (please see Appendix 1 for further limitations).

Erectile dysfunction

Erectile dysfunction (ED) is defined as a consistent or recurrent inability to maintain a penile erection sufficient for satisfactory sexual activity and intercourse (a clinical diagnosis). ED can have a significant impact on a male's quality of life (and that of his partner) (Healthy Male, 2018d; Shindel, Brandt, Bochinski, Bella, & Leu, 2018), and is a common condition that increases in prevalence with age (see Appendix 2 for more information on the prevalence of ED in Australia). Sexual health conditions are often not talked about by males themselves or by healthcare workers and therefore ED can remain untreated if not specifically addressed (Shoshany, Katz, & Love, 2017).

4 The terms CHD, IHD and CAD are used interchangeably throughout the report. The term chosen, in particular instances, reflects the term used in the source document or dataset; for example, the Australian Bureau of Statistics uses the term IHD.

5 Other male sexual health conditions, such as lower urinary tract symptoms (LUTS), also show associations with chronic conditions, but the evidence on the nature of the associations is not yet clear (Blanker, Bouwman, Voskamp, & Lisman-van Leeuwen, 2016; Bouwman et al., 2015) and is not covered in this review.

Penile erection

A penile erection involves nerves, blood vessels and smooth muscle in the penis to achieve increased blood to flow into the penis, and compression of the veins in the penis to reduce blood flowing out (Healthy Male, 2018d; McMahon, 2019; Shindel et al., 2018). In most instances, arousal arising from thoughts, physical stimulation, smells, sounds or images is needed to achieve an erection. The brain sends messages down the spinal cord to nerves leaving the lower part of the spinal cord. Sensations around the penis, such as touch, can also send messages directly to the spinal cord triggering the nerves in the penis (Healthy Male, 2018d).

Causes of erectile dysfunction

There are various causes of ED, but it is commonly caused by a combination of physical and psychological factors (Table 1). Most cases of ED have a physical cause, with an estimated 80% likely to be due to vascular disease caused by endothelial dysfunction[6] related problems (McMahon, 2019). As an erection requires good blood flow into the penis, males who have a medical condition associated with narrowing of blood vessels, such as heart disease, stroke, high blood pressure and diabetes, have a greater risk of having erection problems (Healthy Male, 2018d).

Table 1: Causes of erectile dysfunction

Type of causal factor	Examples
Psychological	Performance anxiety, depression, relationship problems, social or cultural factors, taboo, previous traumatic sexual experience
Vascular	Atherosclerosis, venous leakage
Endocrine and metabolic conditions and other factors affecting blood vessel function	Diabetes mellitus, hypertension, obesity, end-stage renal failure, thyroid disease, hypogonadism (low testosterone), cigarette smoking
Neurological	Spinal cord injury, multiple sclerosis, pelvic surgery (prostate, bowel), Parkinson's disease
Urological	Peyronie's disease, pelvic or genital trauma or radiotherapy
Medicines, drugs, alcohol	Alcohol and drug abuse; SSRI antidepressants; some medications for hypertension, high cholesterol, prostate cancer.

Sources: Adapted from Heathy Male, 2018 (Healthy Male, 2018d); McMahon, 2019 (McMahon, 2019)

6 Endothelial dysfunction: the endothelium lines the blood vessels and has a role in vasodilation (expansion of blood vessels) and contraction of blood vessels. Alterations of endothelial physiology (endothelial dysfunction) is an early step in the development of atherosclerosis (where plaque or fatty deposits build up in the arteries). It is characterised by a reduction in chemicals that help to dilate blood vessels (vasodilators), particularly nitric oxide, and/or an increase in contracting factors from the endothelium, leading to less dilation of the blood vessels.

Prevalence of erectile dysfunction

Details of the Australian studies that have estimated the prevalence of ED are given in Appendix 2. Studies have included men of varying age ranges and used different definitions of ED, but all showed that ED affects a significant proportion of males across age-groups, and that prevalence increases significantly with age (M. J. Adams et al., 2013; Banks et al., 2013; K. K. Chew, Stuckey, Bremner, Earle, & Jamrozik, 2008; Holden et al., 2005; S. Martin et al., 2012; Schlichthorst, Sanci, & Hocking, 2016; Weber et al., 2013; Wen, Rissel, Cheng, Richters, & de Visser, 2017).

Of the Australian studies, only Adams' 2004-2007 study reported the prevalence of ED specifically among Aboriginal and Torres Strait Islander males (M. J. Adams et al., 2013). In this study of males aged 18 to 74 years in communities across the Northern Territory (NT) and Queensland (Qld) (n=293), 16% of participants reported mild or mild-to-moderate ED and 14% reported moderate-to-severe ED, with increased prevalence across age groups. Notably, moderate-to-severe ED was reported by around 10% of younger Aboriginal and Torres Strait Islander males (in both the 18-24 and 25-34 years age-groups).

Low testosterone (androgen deficiency)

Low testosterone occurs when a man is not able to produce enough testosterone for his body to function normally. It is defined as a lower-than-normal serum testosterone level (normal range is about 8 nmol/L to 27 nmol/L but levels may vary according to the laboratory assay used) (Healthy Male, 2018a; Yeap et al., 2016a).

Androgen deficiency is diagnosed when a male with symptoms of androgen deficiency has low serum testosterone (as described above) in two samples collected in the morning on separate days. Other hormones are tested to see if the cause of the androgen deficiency is a problem in the male's testes or his pituitary gland (a gland located at the base of the brain that controls the production of testosterone by the testes) (Healthy Male, 2018a). Knowing the cause of the problem helps to determine the best treatment.

Androgens and testosterone in males

Androgens, the predominant sex hormones in males, are involved with the development and maintenance of masculine characteristics in reproductive tissues, including the male reproductive tract, secondary sexual characteristics (such as body hair and facial hair) and fertility. Androgens also have a role in building and maintaining muscle and bone (Handelsman, 2020; Healthy Male, 2018a).

Testosterone is the main androgen in males. Most testosterone is produced in the testes, with a small amount produced by the adrenal glands. Testosterone stimulates sperm production in the testes. At puberty, testosterone is needed for the changes that happen when a boy develops adult male characteristics and becomes able to reproduce. Testosterone also affects mood and libido (sex drive) and influences overall health and wellbeing (Grossmann, 2019).

In general, circulating testosterone levels tend to peak in early adulthood and decline gradually across middle- and older-age (Yeap et al., 2019).

Causes of androgen deficiency

Testosterone levels decline slowly as men age, although it is probably due to chronic disease co-morbidities rather than age per se (Sartorius et al., 2012). For men with suspected androgen deficiency, particularly older men, it is important to assess if low testosterone is due to organic causes such as problems in the testes or the pituitary gland (pathological hypogonadism), which is likely to be irreversible and need to be treated with testosterone. If the low testosterone is not pathological but is due to the presence of obesity or chronic disease (functional hypogonadism), it may be helped with lifestyle changes (Grossmann, 2019). Understanding the cause will determine the best treatment and identify any underlying health conditions that may need treatment.

Pathological causes include conditions affecting the hypothalamic-pituitary-testicular (HPT) axis, with complete hypogonadism affecting the production of both testosterone and

sperm, leading to androgen deficiency and infertility (Grossmann, 2019; Yeap et al., 2016a). Klinefelter syndrome[7] and pituitary tumours are common causes. Although Klinefelter syndrome is a chromosomal condition present at birth, it is often not diagnosed until adulthood or later, if at all (estimates suggest fewer than 50% of men with Klinefelter syndrome are diagnosed in their lifetime), thereby many men miss out on the benefits of intervention and testosterone treatment (Herlihy, Halliday, Cock, & McLachlan, 2011).

Functional hypogonadism is more likely to affect older men who are overweight or obese and have chronic conditions such as diabetes, CHD, liver or kidney disease. In these cases, symptoms may be non-specific and overlap with the symptoms of such chronic diseases (Grossmann, 2019; Yeap et al., 2016a). Low testosterone levels in ageing men may be a consequence of potentially reversible effects on the HPT axis due to obesity, chronic disease or medication use, such that weight loss and management of chronic conditions may lead to increased testosterone levels (Grossmann, 2019; Grossmann & Matsumoto, 2017; Yeap et al., 2016a). Obesity is consistently associated with lower circulating testosterone levels and declining testosterone levels over time in longitudinal studies (Grossmann, 2019; Grossmann & Matsumoto, 2017; Yeap et al., 2016a). Conversely, studies of weight loss in obese men have demonstrated that the increase in testosterone is proportional to the amount of weight lost (Grossmann & Matsumoto, 2017).

Prevalence of androgen deficiency

Between 2% and 10% of middle-aged and older men are estimated to have androgen deficiency due to organic causes; however, there is likely to be widespread under-diagnosis. Up to 1 in 10 older men have low testosterone, commonly in association with obesity and chronic disease (Healthy Male, 2018a; Wu et al., 2010). There are no published data on the prevalence of androgen deficiency among Aboriginal and Torres Strait Islander males specifically.

Symptoms of androgen deficiency

The symptoms of androgen deficiency are listed in Table 2 according to stage of life. The variety of presenting symptoms and the fact that many are non-specific mean that androgen deficiency can be difficult to diagnose.

Erectile dysfunction and cardiovascular disease

The significance of the association between ED and CVD has been gaining increasing recognition over the past 15 to 20 years. ED is not only a consequence of CVD, but may also predict the development of CVD in apparently healthy males (Araujo et al., 2010; Banks et al., 2013; K. Chew et al., 2010; Chiles, 2016; Gandaglia et al., 2014; Hackett & Kirby, 2018; Hackett, Krychman, et al., 2016; Holden, McLachlan, et al., 2010; Inman et al., 2009; Jackson, 2013; Katsiki, Wierzbicki, & Mikhailidis, 2015; Miner et al., 2019; Nehra et al., 2012; Pastuszak et al., 2015; Raheem, Su, Wilson, & Hsieh, 2016; Thompson et al., 2005; Uddin et al., 2018; Yao et al., 2018; Zhao et al., 2019) and those with diabetes (Gandaglia et al., 2014; Goldstein, Chambers, Tang, Stecher, & Hassan, 2018; Hackett, Krychman, et al., 2016; Yamada, Hara, Umematsu, Suzuki, & Kadowaki, 2012). ED may indicate undiagnosed or silent CVD (Miner et al., 2019; Osondu et al., 2018), and has been described as the 'canary in the coalmine' or the 'harbinger' of CVD.

There is ongoing research into why endothelial dysfunction in blood vessels of the penis may happen earlier than in blood vessels in other areas of the body, such as the heart or the brain (Musicki et al., 2015). There are still many questions about mechanisms, but the evidence to date supports clinical observations that ED often occurs earlier than CVD (Musicki et al., 2015). In fact, it is thought that ED can occur about three to five years earlier than a CVD event (Jackson, 2013; Raheem et al., 2016), providing an opportunity

7 Klinefelter Syndrome, also known as 47,XXY, is a genetic condition where a male is born with an extra X chromosome. Males with Klinefelter syndrome have small testes, are almost always infertile, and can have other physical characteristics such as breast development and little facial or body hair.

Table 2: Symptoms of androgen deficiency

Stage of life	Possible symptoms
Early childhood	Micropenis (penis does not grow to expected size) Small testes
Early teenage years (puberty)	Late puberty or failure to go through full normal puberty Small testes and penis Poor development of facial, body or pubic hair Poor muscle development Voice does not deepen (larynx underdeveloped) Gynaecomastia (breast development) Poor growth surge (height)
Adulthood	Mood changes (low mood and irritability) Poor concentration Low energy (lethargy, low stamina) Reduced muscle strength Increased body fat Decreased libido (low interest in sex) Difficulty getting and keeping erections (uncommon) Low semen volume Reduced facial or body hair growth Gynaecomastia (breast development) Hot flushes, sweats Osteoporosis (thinning of bones)
Later life	Mood changes (low mood and irritability) Poor concentration Easily fatigued Poor muscle strength Increased body fat Decreased libido (low interest in sex) Difficulty getting and keeping erections Gynaecomastia (breast development) Osteoporosis (thinning of bones)

Source: Healthy Male, 2019 (Healthy Male, 2018a)

More information on these and other male sexual and reproductive health conditions can be found on the Healthy Male website (www.healthymale.org.au).

to not only improve erectile function but also to manage CVD risk (Holden, Allan, et al., 2010). Based on this, clinical guidelines for the treatment of ED generally agree that a cardiovascular assessment should be undertaken to detect undiagnosed CVD or CVD risk factors when a male presents with ED (Burnett et al., 2018; Hackett et al., 2018; McMahon, 2019; Miner et al., 2019; Nehra et al., 2012; Salonia et al., 2020; Shoshany et al., 2017). However, it is still debated as to whether a diagnosis of ED adds to CVD risk estimations based on conventional CVD risk factors, such as the Framingham risk score (Araujo et al., 2010; Shah et al., 2016).

Appendix 2 provides a summary of the extensive evidence of the links between ED and CVD, from both cross-sectional and longitudinal studies in Australian and overseas (mostly European) populations.

The only study in Aboriginal and Torres Strait Islander males showed a strong cross-sectional association between moderate-to-severe ED and self-reported diabetes, heart

disease and high blood pressure (M. J. Adams et al., 2013). Although further evidence of the link between ED and CVD in Aboriginal and Torres Strait Islander males is not yet available, the risk factors for ED that also increase the risk of CVD, including smoking, alcohol, and high cholesterol levels, are common among Aboriginal and Torres Strait Islander males (Australian Indigenous HealthInfoNet, 2021).

Links between ED and CVD in young males

The strong association between ED and CVD in younger men identified in some studies (Banks et al., 2013; K. Chew et al., 2010; Fang, Rosen, Vita, Ganz, & Kupelian, 2015), is noteworthy (see the 'Erectile dysfunction and cardiovascular disease' section in Appendix 2 for a summary of relevant studies). Although younger males have a lower chance of developing ED or CVD than older males, when a young male has ED it is more likely to indicate higher CVD risk (Yao et al., 2018). Moreover, there is evidence that ED in young adult males may signal other systemic health problems (Capogrosso, Montorsi, & Salonia, 2016). This is a powerful message that has the potential to motivate young males to seek help when first experiencing ED, and for health professionals to broach the subject of ED, even with young adult males, so that they have the opportunity for early identification of CVD and potentially access effective treatments sooner.

Erectile dysfunction, type 2 diabetes and cardiovascular disease

Prevalence and determinants of erectile dysfunction in males with diabetes

Along with other sexual health problems, ED is a common complication of diabetes with prevalence about two to three times higher than in males without diabetes (Kouidrat et al., 2017). The prevalence is again higher among males with T2DM than among those with type 1 diabetes. ED prevalence estimates from studies of men with diabetes around the world range from about 35% to 75%, with a meta-analysis of 145 studies showing an overall prevalence of 66% in men with T2DM and 38% in men with type 1 diabetes (Kouidrat et al., 2017). In men with diabetes, ED develops up to 10 to 15 years earlier than in men with no diabetes and the risk of ED increases with age: one estimate suggests up to 95% of 60 to 70-year-old men with diabetes would develop ED (Kamenov, 2015; Kouidrat et al., 2017). The risk of ED in men with diabetes is related to the duration of diabetes, poor glucose control (particularly in younger men) and presence of other co-morbidities and diabetes complications (Kamenov, 2015).

The cross-sectional Australian studies reviewed in Appendix 2 have demonstrated associations between ED and diabetes, as well as other CVD risk factors (Holden, McLachlan, et al., 2010; S. Martin et al., 2012; Weber et al., 2013). Furthermore, a prospective analysis of the FAMAS cohort (a study sample of South Australian men aged 35-80 years at baseline) showed diabetes to be predictive of ED incidence over five years, independent of other factors predictive of ED (such as higher age, lower income, higher abdominal fat mass, low alcohol intake, higher risk of obstructive sleep apnoea, voiding lower urinary tract symptoms and depression) in fully adjusted statistical models (S. A. Martin et al., 2014).

The causes of ED in men with diabetes are more complex than in men without diabetes (Hackett, Krychman, et al., 2016). The process of endothelial dysfunction is accelerated in diabetes, leading to reduced blood flow to the penis (among other effects), making an erection more difficult. Endothelial dysfunction also leads to atherosclerosis and cardiovascular disease (Hackett, Krychman, et al., 2016). Diabetes can cause a reduction in a chemical produced in the body that is needed for the penis to remain erect (cyclic guanosine monophosphate) and nerves in the penis can be affected (Hackett, Krychman, et al., 2016). T2DM is often associated with lower circulating testosterone levels that can increase the risk of ED (Gianatti & Grossman, 2019; Hamilton et al., 2016).

Undiagnosed diabetes in males with erectile dysfunction

ED can be an indicator for undiagnosed diabetes. A recent review suggests between 5% and 12% of men with ED have undiagnosed diabetes (McMahon, 2019), although earlier studies suggest the prevalence of undiagnosed diabetes may be even higher in men with

ED (Kouidrat et al., 2017). A study of men aged 20 years or older in the United States of America (USA), found 12% of the men with ED had undiagnosed diabetes compared with 2.8% of men without ED, with the difference most pronounced in those aged 40-59 years (19% vs 3.3%) (Skeldon, Detsky, Goldenberg, & Law, 2015). The association between ED and undiagnosed diabetes remained after adjustment for traditional CVD risk factors (odds ratio (OR)=2.2) (Skeldon et al., 2015). In an Italian study of 934 men presenting with ED to an andrology unit, of those with a diagnosis of diabetes (n=182), 19% were diagnosed with ED and diabetes at the same time and 13% had been diagnosed with ED before the diabetes was diagnosed (Mazzilli et al., 2015).

Erectile dysfunction and risk of CVD in males with diabetes

At the same time as the hypothesis that ED is a risk marker of CVD in men in the general population was drawing attention, men with diabetes were studied specifically, given their higher risk of ED and CVD, albeit not as extensively. A cross-sectional study of men with uncomplicated T2DM (published in 2004) showed that ED was the risk factor most strongly associated with silent CAD (along with other known CVD risk factors, including smoking and high cholesterol levels) (Gazzaruso et al., 2004). Thus, the presence of ED in men with uncomplicated T2DM should be a prompt to screen for CAD (Gazzaruso et al., 2004).

In a study (published in 2010) of 6,304 men aged 55 to 88 years with T2DM, those with ED at baseline had elevated risks of developing any CVD (HR[8]=1.2), CHD (HR=1.4) and cerebrovascular disease (HR=1.4) over five years, independent of other CVD risk factors, when compared to men without ED (Batty et al., 2010). Meta-analyses of this and other studies showed the odds ratios for men with ED compared to those without were 1.7 for all CVD and 1.7 for CHD (Yamada et al., 2012), stressing the importance of assessing erectile function in men with diabetes, not only because of the effect of ED on quality of life, but also as a marker of silent or future CVD (Yamada et al., 2012).

Testosterone and cardiovascular disease

Assessing the relationship between testosterone and CVD is complicated by the fact that age and obesity are risk factors for both CVD and low circulating testosterone levels. Age and obesity are also risk factors for T2DM, and men with diabetes are more likely to have low testosterone and are at higher risk of CVD (Grossmann, 2019; Yeap et al., 2019). Longitudinal studies have attempted to assess the effects of low testosterone on CVD while accounting for possible confounding by age and obesity, and these are reviewed in Appendix 2.

When considering the links between testosterone levels and CVD, it is important to distinguish between low testosterone (or androgen deficiency) due to pathological causes, and low testosterone associated with ageing or chronic health conditions (functional hypogonadism). It is generally accepted that males diagnosed with androgen deficiency of a pathological cause (due to disorders of the hypothalamus, pituitary or testes) should receive testosterone treatment to relieve the symptoms of androgen deficiency and improve body composition (Yeap et al., 2016a), with the benefits of treatment outweighing any possible CVD risks of the treatment (Yeap et al., 2019). For this review, the focus is on low circulating testosterone levels in middle-aged and older men with functional hypogonadism, in whom treatment with testosterone is not usually recommended; in fact, the benefits and risks of testosterone treatment in this context are currently the subject of debate (Grossmann, 2019; Yeap et al., 2016a).

Low testosterone, cardiovascular disease outcomes and death from CVD or any cause

Study findings have been mixed but overall, there is support for an association between testosterone and CVD as well as death from any cause; however, there is not a consistent association with death due to CVD (Yeap, 2018; Yeap et al., 2019; Yeap et al., 2021).

8 HR = hazard ratio. This gives an estimate of the increased risk of developing CVD in men with ED compared to those without ED. For example, HR=1.2 means that men with ED had 1.2 times the chance of developing CVD compared to men without ED.

Associations with CVD may be linear, with lower testosterone linked to higher risk of CVD, or U-shaped, where both abnormally low and high levels of testosterone are associated with CVD or death from any cause (Yeap, 2018; Yeap et al., 2019). In fact, findings from a Western Australian (WA) study suggest there may be an optimal range of testosterone, with both low and high testosterone associated with a higher risk of death from any cause (Yeap et al., 2014). However, with respect to death due to IHD specifically, only low testosterone levels were associated, suggesting that testosterone may have a protective effect on the heart, although again this is far from conclusive (Yeap et al., 2014).

It is not yet clear whether testosterone levels are an independent risk factor for CVD or a marker of the presence of CVD or other systemic illness (Meyer & Wittert, 2018). However, if low testosterone is a consequence of obesity and lifestyle factors, losing weight and exercising can improve testosterone levels and reduce CVD risk (Meyer & Wittert, 2018; Yeap, 2018; Yeap et al., 2019).

Testosterone and type 2 diabetes

It has long been known that lowered testosterone levels are common in men with T2DM, particularly those who have had the disease for a long period or have complications (Gianatti & Grossman, 2019). It is estimated that between 25% and 50% of men with T2DM have low testosterone (Gianatti & Grossman, 2019). Two Australian studies assessed the prevalence of low testosterone in men with diabetes (Grossmann et al., 2008; Hamilton et al., 2016). A cross-sectional study of a clinic-based population of 580 obese, elderly men with T2DM in Melbourne, Victoria (recruited in 2004-2005) showed 43% had low total testosterone levels with serum testosterone inversely related to age and body mass index (BMI) (Grossmann et al., 2008). In a prospective community-based study of 788 males from WA with diabetes (mean age of 66 years; recruited in 2008-2011), just under 30% had a total testosterone level lower than 10 nmol/L (Hamilton et al., 2016) (normal 8-27 nmol/L). In this study, low testosterone was independently associated with increased waist circumference and serum triglycerides, decreased total serum cholesterol, kidney disease and insulin therapy (Hamilton et al., 2016). A meta-analysis of 20 cross-sectional studies showed that males with diabetes had lower average total testosterone level than males without diabetes, with an estimated mean difference of -2.7 nmol/L (Ding, Song, Malik, & Liu, 2006).

Longitudinal studies demonstrate a higher risk of developing T2DM in males with low testosterone, suggesting that testosterone may have a protective role with respect to developing T2DM (Ding et al., 2006; Gianatti & Grossman, 2019; Gyawali et al., 2018; Hackett & Kirby, 2018). An Australian study of 1,597 community-dwelling men aged 35 to 80 years from South Australia (SA) (initially recruited in 2002-2006) found that baseline testosterone in men without T2DM was inversely associated with developing T2DM over a five-year follow-up (Gyawali et al., 2018). The association was independent of established diabetes risk factors and other related sex hormones (Gyawali et al., 2018).

Insulin resistance is thought to be the mediating factor in lowered testosterone and diabetes (Gianatti & Grossman, 2019; Grossmann et al., 2008). Data suggest the relationship between insulin resistance and low testosterone operates in both directions, such that males with low testosterone have a higher risk of developing T2DM or metabolic syndrome and males with metabolic syndrome or T2DM have a higher risk of developing low testosterone (Ding et al., 2006; Gianatti & Grossman, 2019).

Associations between low testosterone, type 2 diabetes and death

Two Australian studies of men with T2DM have investigated links between testosterone and death, with conflicting results (Hamilton et al., 2016; Tint et al., 2016). In the Melbourne clinic-based study described in the previous section, 531 men with T2DM were followed for a mean 7.6 years during which time 33% died (Tint et al., 2016). Associations with death were identified for lower calculated free testosterone[9] and higher sex hormone binding

9 Free testosterone is the part of total testosterone that is not bound to any other chemical in the blood. It makes up a small proportion of total testosterone as a large proportion of total testosterone is bound to other hormones such as sex hormone binding globulin (SHBG).

globulin (SHBG; a sex hormone), independent of other risk factors. However, associations between low total testosterone and death lost statistical significance after adjustment for a range of other factors related to T2DM, including a measure of insulin resistance (Tint et al., 2016). These findings suggest that studies of total testosterone levels in men with diabetes may be confounded by the effect of insulin resistance and obesity on SHBG, that is in turn strongly correlated with total testosterone (Tint et al., 2016).

In contrast to the findings from the Melbourne clinic study, 788 community-dwelling men with T2DM from the WA study (described in the previous section) were followed for a mean of 4.0 years (Hamilton et al., 2016). A U-shaped relationship between total serum testosterone quintiles[10] and dying from any cause was found. Men in the second, third and fourth quintiles had lower death rates compared to the first (lowest) quintile of total testosterone, while those in the highest quintile had a higher risk of dying compared to the lowest quintile (Hamilton et al., 2016). However, there was no association with free testosterone or SHBG. The same pattern was observed for deaths due to CVD, although there were relatively few CVD deaths and once adjusted for other risk factors the association was not statistically significant (Hamilton et al., 2016).

Extent of cardiovascular disease and diabetes among Aboriginal and Torres Strait Islander males

The measures used here to describe the extent of CVD and diabetes among Aboriginal and Torres Strait Islander males include:

- incidence (where available)
- prevalence
- hospitalisation
- mortality.

It is important to note that some data presented here are derived from the National Aboriginal and Torres Strait Islander Health Survey (NATSIHS) 2018-19 (Australian Bureau of Statistics, 2019). Data from this survey were generally self-reported and not collected in a clinical setting. Moreover, data about people under the age of 15 years were generally reported by a parent or guardian.

Where possible, data are presented disaggregated by sex to give an overview of male health specifically. However, in some cases sex-specific data is not available and overall figures are presented.

Cardiovascular disease

Broadly speaking, CVD refers to all conditions that affect the heart and blood vessels, including but not limited to: ischemic heart disease; cerebrovascular disease (including stroke); hypertension (high blood pressure); pulmonary heart disease and diseases of pulmonary circulation; diseases of the arteries, arterioles and capillaries; some diseases of the veins, lymphatic vessels and lymph nodes; acute rheumatic fever and rheumatic heart disease. The ABS and AIHW generally refer to the WHO International Statistical Classification of Diseases and Related Health Problems (ICD) for classifying conditions reported in their data collections (World Health Organization, 2016). Please refer to ICD-10-CM codes (I00 – I99) for the full list of conditions that fall under the description of CVD. A narrower definition of ‘Heart, stroke and vascular disease’ is used in some data collections, this includes specifically: IHD (including heart attack and angina); cerebrovascular disease (including stroke); heart failure; oedema (fluid retention); and diseases of arteries, arterioles and capillaries.

10 Quintiles of testosterone are when the distribution of testosterone levels in the study population are grouped into five categories such that each quintile category includes 20% of the males in the study.

CVD is a major contributor to the total (fatal and non-fatal) burden of disease in Aboriginal and Torres Strait Islander people and the health gap between Indigenous and non-Indigenous Australians (Australian Institute of Health and Welfare, 2016b; Merone et al., 2019). In the 2018-19 NATSIHS, 14% of Aboriginal and Torres Strait Islander males reported having CVD (Australian Bureau of Statistics, 2019). This included 5.5% of specifically 'heart, stroke and vascular disease' (as described above). When age-standardised, the rate was 9.4% and more than double the rate among other Australians (4.7%) (Australian Bureau of Statistics, 2019). Prevalence of CVD among all Aboriginal and Torres Strait Islander people increased with age (see Table 3).

Table 3. Prevalence of self-reported CVD among Aboriginal and Torres Strait Islander people, 2018-19

Age group (years)	Proportion
0-14	1.9%
15-24	5.1%
25-34	9.1%
35-44	18%
45-54	36%
55+	56%
Total/Average	15%

Source: ABS, 2018-19 NATSIHS (Australian Bureau of Statistics, 2019)

Hypertension (high blood pressure) was self-reported by 8.2% of Aboriginal and Torres Strait Islander males in the 2018-19 NATSIHS (Australian Bureau of Statistics, 2019). However, when blood pressure was measured hypertension was present in 25% of adult males. The prevalence of measured hypertension generally increased with age, although was highest among males in the 45-54 years age group at 40%.

Hospitalisation data for Aboriginal and Torres Strait Islander males was presented in the *Aboriginal and Torres Strait Islander Health Performance Framework Summary Report* for the two-year period 2015-17. In this period, there were 14,696 hospitalisations of Aboriginal and Torres Strait Islander males with a principal diagnosis of 'diseases of the circulatory system'[11], a rate of 18 per 1,000 (Australian Institute of Health and Welfare & National Indigenous Australians Agency, 2020). Of these hospitalisations, IHD (including acute and subsequent myocardial infarctions) was responsible for 40%, followed by pulmonary and other forms of heart disease (32%), other/unspecified diseases of the circulatory system (14%), cerebrovascular diseases (8.3%), acute rheumatic fever (2.5%), hypertension (2.1%) and rheumatic heart diseases (1.1%) (Australian Institute of Health and Welfare & National Indigenous Australians Agency, 2020). Please see Appendix 1 for limitations around hospitalisation data.

In 2019, IHD was the leading cause of death for Aboriginal and Torres Strait Islander males (Australian Bureau of Statistics, 2020). In New South Wales (NSW), Qld, WA, SA and the Northern Territory (NT) combined, there were 257 deaths due to IHD, an age-standardised rate of 145 per 100,000 population. As expected, death rates due to IHD increased with age. Concerningly however, although rates were highest among older people, IHD is recognised as having a substantial impact on younger Aboriginal and Torres Strait Islander males; in 2015-2019, IHD was the leading cause of death for males aged 35-44 years at a rate of 71 per 100,000, and the fourth-leading cause of death for those aged 25-34 years at rate of 15 per 100,000 (Australian Bureau of Statistics, 2020).

11 ICD-10 codes I00-I99.

Diabetes among Aboriginal and Torres Strait Islander males

Diabetes is recognised as one of the most important health problems currently facing Aboriginal and Torres Strait Islander people and can lead to life-threatening health complications (Australian Institute of Health and Welfare, 2015a). The most common form is T2DM which occurs at earlier ages for Aboriginal and Torres Strait Islander people than for non-Indigenous people, and is often undetected and untreated. Complications from diabetes may occur within months of diagnosis while others may develop over several years (Australian Institute of Health and Welfare, 2011).

There are shared risk factors between male sexual health conditions and diabetes. Aboriginal and Torres Strait Islander people with diabetes tend to have high levels of risk factors such as smoking and obesity (Australian Institute of Health and Welfare, 2016a, 2020c), and may show signs of other chronic conditions, including chronic kidney disease, CVD, liver disease and anaemia (Australian Bureau of Statistics, 2014). T2DM is more often linked to ED and low testosterone, although males with type 1 diabetes may also suffer sexual health complications.

The most recent data available for the prevalence of diabetes among Aboriginal and Torres Strait Islander people was collected for the 2018-19 NATSIHS. In this health survey 7.6% of (or 31,770) Aboriginal and Torres Strait Islander males (all ages) reported having diabetes (all types) (Australian Bureau of Statistics, 2019; Australian Institute of Health and Welfare & National Indigenous Australians Agency, 2020). The prevalence of diabetes reported was similar between Aboriginal males and Torres Strait Islander males. When aged standardised[12], the prevalence for Aboriginal and Torres Strait Islander males was 13%, about 2.5 times higher than that for non-Indigenous males (4.9%)[13].

Data obtained in the 2018-19 NATSIHS were subjected to Detailed Microdata analysis by the ABS in 2019 which was used then to report on the prevalence of different types of diabetes. Microdata presented in the *Indicators for the Australian National Diabetes Strategy 2016-2020: data update* (2020) (Australian Institute of Health and Welfare, 2020c), indicate the prevalence of T2DM was around 11% among Aboriginal and Torres Strait Islander adult males in 2018-19. The prevalence was shown to increase with age from 3% among those aged 18-44 years to 35% for those aged 65 years and over (see Table 4).

Table 4. Prevalence of self-reported type 2 diabetes mellitus among Aboriginal and Torres Strait Islander adult males, 2018-19

Age group (years)	Number	Proportion (%)
18-44	4,583*	3.0
45-54	6,849	18
55-64	7,279	27
65+	6,382	35
Total (18+)	25,093	11

Source: AIHW (2020), based on ABS Detailed Microdata analysis of 2018-19 NATSIHS (Australian Institute of Health and Welfare, 2020c)
Note: *Estimate should be used with caution.

Hospitalisation is often required to treat the advanced stages or complications of diabetes (Australian Institute of Health and Welfare, 2015a). Hospital data can therefore provide some indication of the extent of diabetes in a population. However, several factors must be taken into account when interpreting hospital data:

12 Proportions have been age standardised to the 2001 Australian Estimated Resident Population to account for differences in the age structure of the two populations.

13 Non-Indigenous data are from the 2017-18 National Health Survey (NHS).

- the statistics relate to events of hospitalisation rather than to individual patients
- there may be variation in the admission policies and reporting procedures for the management of diabetes across hospitals
- those living in remote locations may not have access to hospitals
- episode of diabetes are only reported when they are serious enough to require hospitalisation (Australian Institute of Health and Welfare, 2018, 2019a; Australian Institute of Health and Welfare & National Indigenous Australians Agency, 2020; Australian Institution of Health and Welfare, 2016).

The most recent data about hospitalisations for T2DM among Aboriginal and Torres Strait Islander males were published in the *Indicators for the Australian National Diabetes Strategy 2016-2020: data update* (2020). In 2017-2018, there were 29,279 hospitalisations of Aboriginal and Torres Strait Islander males for T2DM, including 1,275 hospitalisations for T2DM as a principal diagnosis and 28,004 hospitalisations for T2DM as an additional diagnosis (Australian Institute of Health and Welfare, 2020c) (see Table 5).

Table 5. Hospitalisations for type 2 diabetes mellitus among Aboriginal and Torres Strait Islander males, 2017-18

	Number	Rate (per 1,000 population)
Principal diagnosis	1,275	3
Additional diagnosis	28,004	68
Principal and/or additional diagnosis	29,279	71

Source: AIHW, 2020 (Australian Institute of Health and Welfare, 2020c)
Note: T2DM was categorised as principal and/or additional diagnosis based on 10th edition ICD-10-AM code E11 (World Health Organization, 2016).

The *Aboriginal and Torres Strait Islander Health Performance Framework Summary Report* (2020) provides a comparison between Indigenous and non-Indigenous people hospitalised for a principal diagnosis of T2DM using rate ratios (Australian Institute of Health and Welfare & National Indigenous Australians Agency, 2020). When age standardised[14], the rate of hospitalisations among Aboriginal and Torres Strait Islander males was 5.4 per 1,000 population, approximately four times higher than the rate for non-Indigenous males.

This disparity is also reflected in mortality rates for diabetes, where Aboriginal and Torres Strait Islander males are more than three times more likely to die from diabetes than their non-Indigenous counterparts (Australian Institute of Health and Welfare, 2020c). The rate of deaths[15] from diabetes (all types) for Aboriginal and Torres Strait Islander males in 2018 was 216 per 100,000 population, while for non-Indigenous males the rate was 68 per 100,000 (Australian Institute of Health and Welfare, 2020c).

In 2019, diabetes (all types) was the fifth leading cause of death among Aboriginal and Torres Strait Islander males in Australia[16] (Australian Bureau of Statistics, 2020). The mortality rate increased with age and diabetes was listed in the top five causes of death in all age groups above 45 years. 'Avoidable and preventable deaths' refer to deaths that have arisen from a condition considered to be avoidable given timely and effective health care (Australian Institute of Health and Welfare, 2020c). AIHW analysis of the National Mortality Database indicate that in the five-year period 2014-2018, there were 408

14 Rate ratios published by AIHW were calculated using ABS backcast population estimates and projections based on the 2016 Census.

15 Includes data from NSW, Qld, WA, SA and the NT only.

16 Includes data for NSW, Qld, WA, SA and the NT only. Data for other jurisdictions have been excluded in line with national reporting guidelines (Australian Bureau of Statistics, 2020).

'avoidable and preventable deaths' from diabetes (all types) among Indigenous Australians, at an age-standardised rate of 46 per 100,000 population.

Risk factors for diabetes and cardiovascular disease among Aboriginal and Torres Strait Islander males

Many of the risk factors for ED and low testosterone are also factors that increase the risk of CVD and T2DM. These include being overweight or obese and smoking tobacco, which are both relatively common among Aboriginal and Torres Strait Islander males (Australian Indigenous HealthInfoNet, 2021; Healthy Male, 2018d). Alcohol can also be a risk factor for sexual and chronic conditions. Aboriginal and Torres Strait Islander people are less likely to drink alcohol than other Australians, but those who do drink alcohol are more likely to do so at harmful levels (Australian Institute of Health and Welfare, 2017a, 2017b).

Bodyweight

One way of establishing if a person is overweight or obese is by calculating their Body Mass Index (BMI) using height and weight measurements. By calculating each participant's BMI, the 2018-19 NATSIHS indicated that 71% of Aboriginal and Torres Strait Islander males aged 15 years and over were either overweight (31%) or obese (40%) (Australian Bureau of Statistics, 2019; Australian Institute of Health and Welfare, 2020c). However, it is important to note that the optimal BMI range is based on national standards and may not be accurate for Aboriginal and Torres Strait Islander males due to differences in body shape and other physiological factors (Daniel, Rowley, McDermott, & O'Dea, 2002; Gracey et al., 2007; Li & McDermott, 2010).

Alcohol and tobacco use

The health impacts of alcohol and tobacco use, including increased risk of chronic diseases such as diabetes and CVD, have been well established (Australian Health Ministers' Advisory Council, 2017). Tobacco smoking reduces blood vessel function which is known to be a cause of ED, and alcohol too can be contributing factor. In the 2018-19 NATSIHS, 42% of Aboriginal and Torres Strait Islander males aged 15 years and over reported they were current daily smokers (Australian Bureau of Statistics, 2019).

The NATSIHS also reported that 65% of Aboriginal and Torres Strait Islander adult males reported exceeding the guideline (2009) (National Health and Medical Research Council, 2009) for drinking on a single occasion[17] and 30% reported exceeding the lifetime risk[18] guideline (Australian Bureau of Statistics, 2019). Aboriginal and Torres Strait Islander males were three times more likely to exceed the guideline for lifetime risk than females.

Management and treatment

ED and low testosterone can be both causes and consequences of CVD and T2DM. So, apart from the benefits to a male's sexual health from receiving treatment for a sexual health problem, there can be wider benefits to his general health. It would seem prudent therefore, that a man with CVD or T2DM, or at risk of these conditions, should have sexual health assessments as part of his general health care.

The sexual health impacts of CVD and T2DM in Aboriginal and Torres Strait Islander males have not been well documented; however, the fact that CVD and T2DM are common among Aboriginal and Torres Strait Islander males would suggest that sexual problems are also likely to be common. The extent of assessment and management of sexual problems in Aboriginal and Torres Strait Islander males, whether a consequence of chronic disease

17 Four or less standard drinks on a single day for both males and females (National Health and Medical Research Council, 2009).

18 No more than two standard drinks on any single day (National Health and Medical Research Council, 2009).

or not, is also not known. There are many barriers to discussions about sexual health, either in the community or in the healthcare context, which would suggest that many males with sexual health problems are not being assessed, diagnosed, or treated (M. Adams, 2014; M. J. Adams et al., 2013; Wenitong et al., 2014).

The management and treatment of diabetes and CVD in Aboriginal and Torres Strait Islander people have been reviewed in earlier Health*InfoNet* reviews (Burrow & Ride, 2016; Merone et al., 2019). Here, the focus is on current guidelines for assessment, management and treatment of ED and low testosterone, specifically in the context of CVD and T2DM. It should be noted that the guidance summarised here is general and not tailored to men of particular ethnicity or culture. However, where there are recommendations specific for Aboriginal and Torres Strait Islander males, they are included.

Assessment and management of erectile dysfunction in the context of cardiovascular and disease type 2 diabetes

Assessment of erectile dysfunction

There are no Australian consensus practice guidelines for diagnosing and managing ED in general, or for Aboriginal and Torres Strait Islander males specifically. However, overseas guidelines and expert consensus (Burnett et al., 2018; Hackett et al., 2018; Nehra et al., 2012; Salonia et al., 2020), as well as Australian clinical practice recommendations (Healthy Male, 2018b; McMahon, 2019; Shoshany et al., 2017), all include measurement of glucose levels (for diagnosis of diabetes or impaired glucose tolerance) and CVD risk as essential elements in the assessment of a male presenting with ED.

The discussion of a male's sexual heath is most likely to happen in the context of primary care (Healthy Male, 2018b; Shoshany et al., 2017). Given that there are barriers to discussing sexual health problems for both males and health professionals, it's important for a health professional to take the initiative. The subject of sexual health needs to be and broached with a male patient in a sensitive and straightforward manner, taking into account his ethnic, cultural and personal background (Althof, Rosen, Perelman, & Rubio-Aurioles, 2013; Shoshany et al., 2017). Health professionals can start the conversation about erectile problems with a normalising question so that the male feels he is not alone in having sexual problems, but that it is in fact quite common (Althof et al., 2013; Healthy Male, 2018b; Shoshany et al., 2017). For Aboriginal and Torres Strait Islander males in particular, it is important for the health professional to build trust with the male over a period of time, perhaps over several consultations, and to provide a safe, private and comfortable environment (Wenitong et al., 2014).

Assessments of a male presenting with ED should include a full medical and culturally sensitive sexual history to confirm firstly that the man has ED, and then to determine the onset, severity and duration of the ED, whether he has any other sexual problems, and the impact of the ED on his psychological wellbeing and relationships (McMahon, 2019; Shoshany et al., 2017). A comprehensive medical history may reveal the likely cause of the ED, including certain medications and chronic conditions, but often the cause is not easily identified and may include physical as well as psychological factors. A physical examination should include a genital examination and a cardiovascular examination (Healthy Male, 2018b).

Laboratory testing can be tailored to the male's age and other risk factors, but generally should include screening for diabetes (blood glucose), cholesterol and triglycerides levels, testosterone (for possible androgen deficiency), and possibly further testing for CVD, if indicated (Healthy Male, 2018b; McMahon, 2019; Shoshany et al., 2017). A psychosocial assessment should include an assessment of the male's general psychological wellbeing and effects on his relationship, and determine whether psychological factors are contributing to the ED (Healthy Male, 2018b; McMahon, 2019; Shoshany et al., 2017). Assessing a male with ED for depression may be useful as well as an inquiry about ED in males with depression. As some anti-depressants may cause ED or make it worse, a change of medication may be needed (Shoshany et al., 2017).

Erectile dysfunction and cardiovascular disease

Clinical guidelines on managing ED generally agree that a man presenting with ED that is caused by physical factors should be assessed for risk or presence of CVD, due to the strong links between ED and CVD (Burnett et al., 2018; Hackett et al., 2018; McMahon, 2019; Miner et al., 2019; Nehra et al., 2012; Salonia et al., 2020; Shoshany et al., 2017). The *Princeton III consensus recommendations for the management of erectile dysfunction and cardiovascular disease* state that any man with organic ED should be considered at risk for CVD until examinations and tests show otherwise (Nehra et al., 2012). There are no similar Australian consensus guidelines but one recent summary of international practice guidelines recommends a comprehensive assessment of CVD, amongst other recommendations for managing ED in the Australian context (McMahon, 2019).

For men with existing CVD, ED is probably related to generalised vascular disease that contributes to both conditions simultaneously (Hackett et al., 2018). In men with CHD, psychological factors may also contribute to ED if they, and their partners, are afraid that intercourse could precipitate further coronary episodes (Hackett et al., 2018). An assessment of erectile function in men with CVD should therefore be part of their care.

Erectile dysfunction and type 2 diabetes

As ED may be the first sign of undiagnosed T2DM, a thorough assessment of a male with ED provides an opportunity to diagnose and treat T2DM as well as the ED.

The Royal Australian College of General Practitioners *Management of type 2 diabetes: a handbook for general practice* gives no specific recommendations for assessing or managing ED in males with diabetes (The Royal Australian College of General Practitioners & Diabetes Australia, 2020). However, due to the higher risk of ED (and other sexual problems), increasing risk of ED with duration of disease and poor blood glucose control, and younger age of onset of ED, it would seem prudent for men with T2DM to have regular screening for ED.

Aboriginal and Torres Strait Islander people with T2DM tend to have worse rates of complications and CVD risk profiles than non-Indigenous people (Davis et al., 2012). For males with T2DM, the risk of CVD is higher when ED is present; a diagnosis of ED in a male with diabetes is an opportunity to address both the sexual dysfunction as well as careful regular evaluation and management of CVD or CVD risk factors (Batty et al., 2010; Yamada et al., 2012).

Treatment of erectile dysfunction

Lifestyle modification and management of risk factors, such as smoking, alcohol intake, body weight, physical activity, hypertension and high cholesterol, as well as good management of any co-morbid conditions (particularly diabetes and CVD), should be considered before or with other treatments for ED (Hackett et al., 2018; Healthy Male, 2018b; McMahon, 2019; Shoshany et al., 2017). Increased physical activity, weight loss, and optimal management of diabetes and CVD can probably help prevent and may improve ED (McMahon, 2019). If medications may be contributing to ED (see Hackett et al., 2016 (Hackett, Krychman, et al., 2016)), a change of anti-hypertensive, antidepressant or other medication might be necessary, particularly if the male wants to be sexually active (Healthy Male, 2018b; Shoshany et al., 2017). If androgen deficiency is diagnosed and a cause established, this should be managed with testosterone therapy and may result in an improvement in erectile function (if it is due to the androgen deficiency) and sexual desire (Hackett et al., 2018; Healthy Male, 2018b; Yeap, 2018). This would involve consultation with an endocrinologist (Healthy Male, 2018b).

For psychological problems, depression or relationship issues, psychosexual therapy may be warranted with a specialist counsellor, psychologist or in rare cases, a psychiatrist. Any sexual misinformation should be discussed with the male, and his partner if appropriate, including having realistic expectations of erectile function (for example, age-related changes) and the need for sufficient arousal and lubrication (Healthy Male, 2018b; McMahon, 2019; Shoshany et al., 2017).

Treatments for ED range from non-invasive treatments to surgery (Table 4). The most commonly used treatment is an oral medication (belonging to a class of drug called PDE5 inhibitors), of which there are various types, dosages, dosing regimens and side-effects (Healthy Male, 2018b; McMahon, 2019; Shoshany et al., 2017). The benefits and disadvantages of each type of medicine (including the cost) should be discussed with the male and the one most suited to his needs can be trialled first. Up to 65% of males will respond to oral medication and will be able to have sexual intercourse (McMahon, 2019). However, there are some contraindications, including if the male is taking short or long-acting nitrate medication (most often used for angina), or the recreational use of amyl nitrate (sometimes known as 'poppers' or 'liquid gold') (Healthy Male, 2018b; McMahon, 2019; Shoshany et al., 2017).

If oral medications are not successful, or the patient has a preference to not take them, other treatments can be discussed (listed in Table 6) and referrals can be made to specialists as needed.

Table 6: The main treatments for erectile dysfunction

Non-invasive treatments	Prescribed oral medication External devices: rubber rings, vacuum devices
Injectable treatments	Penile injections
Surgery	Penile prosthesis Vascular surgery (for select patients; not as effective for men with vascular disease (Trost, Munarriz, Wang, Morey, & Levine, 2016)) Treatment of Peyronie's disease

Source: adapted from Healthy Male, 2018 (Healthy Male, 2018b)

Treatment in males with cardiovascular disease

Given that ED and CVD share the same risk factors, lifestyle interventions to reduce risk factor levels will have benefits for both CVD and sexual function. Moreover, the ED may be indicative of silent CVD and this could be uncovered through careful evaluation (McMahon, 2019).

The risk to the heart from sexual activity is low in males with CVD, and most men can have normal sexual activity and use medications for ED (Hackett & Kirby, 2018; McMahon, 2019). Guidelines on managing ED in males with CVD base recommendations for sexual activity on risk groups based on risk factors and diagnosed CVD (McMahon, 2019; Nehra et al., 2012). Only the highest-risk group is recommended not to undertake sexual activity until their CVD is stabilised (Nehra et al., 2012). In general, oral medication can be an effective and safe treatment for ED in males with CVD and there may even be some cardiovascular benefits from their use (Hackett & Kirby, 2018).

Treatment in males with type 2 diabetes

For males with T2DM, treatments for ED include the general lifestyle and risk factor reduction measures described above, specifically aiming to reduce body weight (if overweight), improve control of blood glucose levels and reduce high cholesterol and blood pressure (Kamenov, 2015). As males with T2DM are likely to be taking other medications, an evaluation of medication use should be done, although it is more likely that the ED is due to the diabetes rather than the medication (Hackett & Kirby, 2018). The first treatment is most likely an oral medication, although they are not quite as effective in males with T2DM or pre-diabetes compared to males without diabetes (Boeri et al., 2020; Kamenov, 2015; Lue et al., 2015).

Men with T2DM have a higher risk of low testosterone and if androgen deficiency is confirmed, testosterone treatment may be indicated (Lue et al., 2015), which could improve erectile function (Hackett, Cole, et al., 2016). Treatment of androgen deficiency may also improve the effectiveness of oral medication in males with diabetes (Hackett et al., 2018).

Assessment and management of low testosterone in the context of cardiovascular disease and type 2 diabetes

Assessment of low testosterone

The Endocrine Society of Australia *Position statement on male hypogonadism (part 1): Assessment and indications for testosterone therapy* (Yeap et al., 2016a) and the Healthy Male *Clinical summary guide: Androgen deficiency diagnosis and management* (Healthy Male, 2018a) provide guidance on the assessment of a male with suspected androgen deficiency. If a male presents with symptoms of androgen deficiency, it is important to determine if it is pathological or functional androgen deficiency (as defined above) (Grossmann, 2019; Healthy Male, 2018a; Yeap et al., 2016a). A comprehensive medical history, including information on smoking, medication use and recreational drug use (including androgens and other performance enhancing drugs and supplements) and history of pituitary disease. A review of the reproductive system is also required including pubertal development, fertility, erectile function, sexual desire and history of pelvic surgery or trauma or undescended testes (Yeap et al., 2016a).

A physical examination should include a genital examination to check testicular volume; small testis volume is the defining feature of Klinefelter syndrome (described above and in the Glossary) (Healthy Male, 2018a; Yeap et al., 2016a). If androgen deficiency is suspected laboratory assessment of two morning fasting serum testosterone levels will confirm the diagnosis. Other hormone levels or other tests may be done to look for specific causes of pathological androgen deficiency (Healthy Male, 2018a; Yeap et al., 2016a).

Low testosterone and cardiovascular disease

Assessment of symptoms of low testosterone in males with CVD or CVD risk factors is prudent because of the associations between low testosterone and CVD (Yeap & Wu, 2019). Usually, testosterone levels in these males will be at the lower end of the normal reference range, and management of CVD and obesity may improve the situation without the need for testosterone therapy (Grossmann & Matsumoto, 2017). However, if testosterone levels are very low, an assessment of causes should be done, in addition to managing the CVD (Grossmann & Matsumoto, 2017).

Low testosterone and type 2 diabetes

Given the higher risk of low testosterone associated with diabetes, it is recommended that males with T2DM should be asked routinely about symptoms of low testosterone (as well as ED) (Gianatti & Grossman, 2019). If symptoms of low testosterone are present, a serum testosterone measurement can be done. Males with T2DM and very low testosterone should be assessed for underlying pathological androgen deficiency (Gianatti & Grossman, 2019).

Men without T2DM who have low testosterone level should have their blood glucose levels measured regularly given their increased risk for developing T2DM (Gianatti & Grossman, 2019).

Treatment of low testosterone

Indication for testosterone treatment is dependent on the results of the clinical assessment and laboratory testing (Yeap et al., 2016a). The aim is to restore testosterone to normal levels and alleviate the primary symptom of androgen deficiency (Grossmann & Matsumoto, 2017; Healthy Male, 2018a; Yeap et al., 2016b). In such males, treatment is likely to be life-long. There are some contraindications to testosterone treatment, including advanced prostate cancer (Healthy Male, 2018a; Yeap et al., 2016b). For males wishing to father children, possible effects on fertility and the option of sperm storage should be discussed before starting testosterone treatment (Yeap et al., 2016a).

Monitoring of males undergoing testosterone treatment is essential (Healthy Male, 2018a; Yeap et al., 2016b). Follow-up tests may include testosterone levels, symptoms of low testosterone, PSA testing (guidelines as for other men, unless a known high risk of prostate cancer), CVD risk factors and bone density (Healthy Male, 2018a; Yeap et al., 2016b).

In men with low testosterone but no diagnosis of pathological androgen deficiency, the low testosterone is usually a marker of other illnesses and testosterone treatment is not

generally recommended (Grossmann & Matsumoto, 2017; Healthy Male, 2018a; Yeap et al., 2016a). At present, there is limited evidence that testosterone treatment would be beneficial in these males but treatment of the underlying conditions, in particular obesity, is warranted (Grossmann & Matsumoto, 2017; Yeap et al., 2016a). Weight loss and improvements in other chronic conditions have the potential to improve symptoms and increase testosterone levels (Grossmann, 2019; Grossmann & Matsumoto, 2017).

In some middle-aged and older males, where other measures have not been successful, testosterone treatment may be trialled after counselling about the lack of evidence for the benefits and risks of testosterone treatment, and with careful monitoring for adverse events (Grossmann & Matsumoto, 2017). To obtain subsidised testosterone through the Pharmaceutical Benefits Scheme (PBS) for men aged 40 years or over, the testosterone level must be less than 6 nmol/L and a referral to a specialist is necessary (Healthy Male, 2018a).

Treatment in males with cardiovascular disease

Testosterone treatment in men with CVD and low testosterone should be approached with caution and careful monitoring, unless there is a clear pathological androgen deficiency (Grossmann, 2019; Yeap et al., 2019; Yeap et al., 2016b). Managing existing CVD or CVD risk factors, particularly obesity, is the recommended treatment approach for low testosterone in males with CVD (Grossmann, 2019; Yeap et al., 2019; Yeap et al., 2016b).

Treatment in males with type 2 diabetes

Testosterone treatment can reduce fat mass, increase muscle mass and improves insulin resistance, but randomised controlled trials do not show a consistent benefit to improved blood glucose levels (Gianatti & Grossman, 2019). Asymptomatic men with T2DM and low testosterone levels should be encouraged to lose weight and optimise blood glucose control rather than be offered testosterone treatment (Gianatti & Grossman, 2019; Yeap et al., 2016a). Treatment with standard anti-hyperglycaemic therapies can improve testosterone levels (Gianatti & Grossman, 2019). As for all males with low testosterone that is not pathological, if testosterone treatment is trialled, it should be closely monitored given the uncertainty of the benefits and risks of treatment (Gianatti & Grossman, 2019).

Evidence for sexual health benefits from lifestyle modification

There is an evidence base to support lifestyle modifications for ED and low testosterone. The focus has been on interventions similar to those used in CVD and T2DM prevention and treatment: diet, physical activity, weight loss and cessation of smoking.

Interventions to improve erectile function

A systematic review of six trials of exercise and/or dietary interventions aimed at weight loss, or treatment with cholesterol-lowering medications showed that improvements in CVD risk factors also led to modest improvements in erectile function (Gupta et al., 2011). Improvement in erectile function in men with diabetes may be less than for men without diabetes, possibly due to more vascular disease in men with diabetes (Gupta et al., 2011). Another review found smoking cessation improves erectile function (Hehemann & Kashanian, 2016).

A small study of a Mediterranean diet showed benefits in men with ED and metabolic syndrome, and physical activity has been shown to improve erectile function (Hehemann & Kashanian, 2016). Weight loss of 5% to 10% in overweight or obese nondiabetic or diabetic males can result in improvement in erectile function over a short period of time (Maiorino, Bellastella, & Esposito, 2015). Studies of psychological interventions combined with ED medication showed a greater effect on improving ED than medication alone (Hehemann & Kashanian, 2016).

A recent analysis of a very large follow-up study in the USA (21,469 men) showed that healthy diets were associated with a lower risk of developing ED, particularly in men under the age of 60 years (Bauer et al., 2020). The effect of diet was independent of BMI and physical activity (Bauer et al., 2020).

The mechanisms by which weight loss, a healthy diet and physical activity can improve erectile function include improvements in endothelial dysfunction, insulin resistance and

alleviation of low-grade inflammation associated with diabetes and metabolic syndrome (Maiorino et al., 2015).

Interventions to increase testosterone

A recent large (n=208,677 males aged 40-69 years) study showed associations between lifestyle factors and medical conditions and low testosterone levels, providing support for modifying lifestyle and treating medical conditions to increase testosterone (Yeap et al., 2021). There are few studies of lifestyle interventions to increase testosterone, but weight loss, whether by diet or surgery, can lead to increased testosterone levels that is proportional to the amount of weight lost: 10% weight loss increases testosterone by 2-3 nmol/L; in morbidly obese men with a large amount of weight loss following surgery, testosterone can increase by 10 nmol/L (Corona et al., 2013; Grossmann & Matsumoto, 2017; Yeap et al., 2016a). A systematic review and meta-analysis of 24 trials showed that the rise in testosterone was greater in those who lost more weight and in younger, non-diabetic males with higher levels of obesity (Corona et al., 2013).

Testosterone treatment may add to the benefits of lifestyle interventions in middle-aged and older men (Wittert et al., 2021), and testosterone treatment may help motivate men to stick with diet and exercise programs due to increased energy levels (Grossmann & Matsumoto, 2017). However, as stated earlier, testosterone treatment in men with functional low testosterone is not recommended, except in specific clinical circumstances (Yeap et al., 2016b).

Access to chronic disease and sexual health care in Aboriginal and Torres Strait Islander communities

Guidelines and recommendations for assessment and management of male sexual health conditions and associated chronic diseases, can only be implemented if services and support are available and Aboriginal and Torres Strait Islander males are able and willing to access them. This requires:

- awareness and knowledge of sexual health and the links with chronic disease among males and healthcare providers working with males
- culturally appropriate male-specific primary healthcare services and healthcare providers
- culturally safe spaces to discuss sensitive sexual health issues with the assurance of confidentiality
- access to specialist health practitioners (e.g., endocrinologists, sex therapists) when needed
- access to appropriate treatment
- support for males undergoing treatment and healthy lifestyle interventions
- capacity for ongoing monitoring of sexual health and the effects of treatment within primary healthcare services.

There is a range of barriers to health service access or service delivery to Aboriginal and Torres Strait Islander males, including societal, cultural, logistical, health system, financial and individual factors (M. Adams, 2014; Arney & Westby, 2012; K. Canuto, Brown, Wittert, & Harfield, 2018; K. Canuto, Wittert, Harfield, & Brown, 2018; Davy et al., 2016; Wenitong et al., 2014). Some barriers are relevant to both males and females, while others apply specifically to males and have particular relevance to the sensitive area of sexual health (Table 7) (Arney & Westby, 2012; K. Canuto et al., 2018; K. Canuto et al., 2018; Wenitong et al., 2014).

Table 7: Factors affecting health service access/use for Aboriginal and Torres Strait Islander males

Societal	Illness-related stigma Sex-specific differences in health Racism
Cultural	Traditional gender-related lore, masculinity, and gender roles Language barriers Beliefs about causation of illness (cursed by others, punishment for past wrongdoing)
Logistical	Lack of transport to services Conflict of appointment times and/or inflexible appointment times that do not allow for cultural and family priorities that can occur at short notice
Health system	Limited access to specialist services Complicated referral processes Lack of male health professionals Female health professionals not understanding male needs Medical terminology and jargon Perception services are geared to women and children, men can feel socially excluded Waiting times Culturally inappropriate service/undertrained staff Distrust/discrimination Inadequate or short-term funding for services; complex funding sources
Financial	Hard to meet health service or medication costs
Individual	Lack of knowledge or misinformed perception of illness Previous negative experience with healthcare Lack of knowledge of availability or purpose of local health services Low prioritisation of preventive healthcare Lack of understanding Low self-esteem/lack of confidence Feelings of shame/embarrassment Feelings of invincibility/a need to be strong

Source: Adapted from (Wenitong et al., 2014), (M. Adams, 2014), (K. Canuto et al., 2018), (K. Canuto et al., 2018), (Davy et al., 2016) and (Arney & Westby, 2012)

Attempts to increase male engagement with health services have often focused on changing the behaviour of men to engage with services. However, many of the barriers to access lie outside the individual, so a much broader approach is needed with a focus on how services are delivered and the cultural context of services for males (Arney & Westby, 2012; Prehn & Ezzy, 2020), for management of sexual health problems. Males are motivated to engage with primary health services providing they feel safe and welcomed and have a rapport with staff (K. Canuto et al., 2018; Davy et al., 2016).

Access to chronic disease management

Despite the existence of many recommendations and guidelines for managing CVD and diabetes in Aboriginal and Torres Strait Islander people, barriers to healthcare for these conditions still exist (Burrow & Ride, 2016; Merone et al., 2019). These barriers need to be addressed to ensure Aboriginal and Torres Strait Islander people receive the optimal level of care.

A systematic review of barriers and enablers to primary healthcare interventions for chronic diseases in Aboriginal and Torres Strait Islander people identified five categories of factors that can either inhibit or enable successful interventions: design attributes (such as community engagement, leadership, funding), the chronic disease workforce (such as level of training, exclusion of health workers from decision-making), patient-provider

partnerships (such as healthcare providers empowering patients to be partners in their own care), clinical care pathways (such as referral pathways for comprehensive care), and access (such as culturally safe practices and spaces) (Gibson et al., 2015). These factors are not fixed and can change from being barriers to enablers if addressed appropriately (Gibson et al., 2015).

On the positive side, there are many programs and services designed to improve access and care for CVD and diabetes (Burrow & Ride, 2016; Merone et al., 2019). For example, Aboriginal Community Controlled Health Organisations (ACCHOs) reduce barriers by providing culturally appropriate services, including Aboriginal and Torres Strait Islander Health Workers and Practitioners (ATSIHWPs). There has also been a three-fold increase in uptake of annual health assessments (Medicare MBS item 715) between 2010-11 and 2017-18, which suggests increased service use, although the uptake of health checks remains higher among females than males (Australian Institute of Health and Welfare, 2019b). A recently developed 'Wellbeing Framework' provides practical guidance for primary healthcare to develop chronic disease services that are appropriate for local communities, whether they be urban, rural or remote (Davy C. et al., 2017). A feature of the Framework is its flexibility, allowing services to be designed to respond to individual and community health needs while upholding the specific cultural and social priorities for the community (Davy C. et al., 2017).

Access to medicines

The level of access to treatments for ED and testosterone treatment in Aboriginal and Torres Strait Islander communities has not been documented and access is likely to vary between remote, rural and urban communities. After addressing ED risk factors such as diabetes management, oral medications are the main treatment for ED. There are costs associated with these medications (PDE5 inhibitors), which are not covered by a PBS subsidy for most men, as well as a possible stigma attached to using such treatments (M. Adams, 2014). Similarly, testosterone treatment may not be readily available in some communities and may require access to a specialist endocrinologist, at least when treatment is being started. Certain conditions have to be met before testosterone is covered by the PBS, including the involvement of a specialist (McLachlan, 2015); otherwise the costs of testosterone are substantially higher.

Engaging Aboriginal and Torres Strait Islander males with care and services for sexual health

A substantial proportion of men in the general Australian community are not seeking or receiving help for sexual health problems, for various reasons that include individual and health service factors (K. K. Chew et al., 2008; Holden et al., 2006; Holden et al., 2005; Schlichthorst et al., 2016), suggesting that this is a community-wide problem. However, specific and often more complex barriers exist for Aboriginal and Torres Strait Islander males to seeking and receiving healthcare in general, or for sexual health problems in particular (M. Adams, 2014; Arney & Westby, 2012; K. Canuto et al., 2018; K. Canuto et al., 2018; Davy et al., 2016; Wenitong et al., 2014). There are no published studies describing the implementation and effectiveness of strategies to increase primary healthcare use by Aboriginal and Torres Strait Islander males (K. Canuto et al., 2018).

Involving males from the local community in the design or re-configuration of health services would be a positive first step to providing more culturally appropriate services that cater to the needs of the males in the community (Arney & Westby, 2012; N. Hayman, 2010; Healthy Male, 2018c). Other recommendations for engaging Aboriginal and Torres Strait Islander males in general, or specifically for sexual health, derived from a range of studies and commentaries (M. Adams, 2014; Arney & Westby, 2012; K. Canuto et al., 2018; K. Canuto et al., 2018; Davy et al., 2016; N. Hayman, 2010; Healthy Male, 2018c; Tsey et al., 2014; Wenitong et al., 2014), include:

Health service level

- consultation with the local community to understand their needs and create partnerships
- good policies and practices based on evidence are in place at the establishment of a health service
- linkages to other relevant health services and referral pathways for specialist treatment
- employment of more ATSIHWPs, particularly males
- male healthcare providers are available for male health clinics
- training in male health topics for ATSIHWPs, particularly males, in accredited programs as part of broader primary healthcare training
- support to ATSIHWPs given that their responsibilities often extend beyond the clinic out into the community and for times outside of clinic hours
- education and skills development of staff in health services to change negative views and stereotypes about Aboriginal and Torres Strait Islander male patients
- avoidance of high turnover of staff (often the case in remote communities)
- cultural competency training for staff, in particular the cultural processes around gender and family, including an appreciation of the traditional and localised notions of the complementary nature of the rights, roles and responsibilities of males and females
- orientation of specific services to males
- culturally appropriate waiting rooms (especially for males) with health posters, paintings and artefacts to make it a welcoming and safe place
- confidentiality protocols, particularly in small communities, that are communicated to patients
- male-only times or places to discuss sensitive health issues, including out-of-hours clinics
- minimal waiting times while having a flexible approach so that other priorities that may arise, such as cultural responsibilities, can be attended to
- provision of longer consultations for males to have time to discuss sexual health as well as general health issues
- allowance for second or third consultations so that a relationship can be built with a male patient to allow discussions of a sensitive nature.

Person level

- strong relationships between males and healthcare providers and administration staff (for both non-Indigenous and Aboriginal and Torres Strait Islander staff)
- sustained relationships so that trust can be built over time
- the knowledge and confidence of healthcare providers to sensitively discuss sexual health with males
- encouragement of non-Indigenous healthcare providers to invite ATSIHWPs (preferably males) to work with them and their male patients where appropriate
- non-Indigenous healthcare providers with an understanding of the cultural and historical determinants of Aboriginal and Torres Strait Islander male health as the context of the health status of their patients
- confidentiality in the practice of healthcare providers and reassurance of male patients that confidentiality is a priority
- use of simple, straightforward language by healthcare providers, avoidance of medical jargon and appropriate patient resources to aid understanding and reduce anxiety
- normalisation of sexual health issues to reduce shame and stigma
- word of mouth promotion of the availability and need for males to attend health services.

Holistic approach to male health

The *2010 National Male Health Policy* (the Policy) emphasised the importance of the social determinants of health as drivers of health inequality for males in Australia, and particularly for Aboriginal and Torres Strait Islander males (Australian Government Department of Health and Ageing, 2010b). Since the launch of the Policy, through the *National men's health strategy 2020-2030* (Australian Government Department of Health, 2020) and the *National Aboriginal and Torres Strait Islander Health Plan 2013-2023* (the Health Plan) (Australian Government Department of Health and Ageing, 2013), the Australian Government is increasingly acknowledging that cultural determinants of health are equally important for Aboriginal and Torres Strait Islander people (Australian Government Department of Health, 2017). According to the 2017 *My life my lead* report (Australian Government Department of Health, 2017):

> *The cultural determinants of health encompass the cultural factors that promote resilience, foster a sense of identity and support good mental and physical health and wellbeing for individuals, families and communities. While the concept of cultural determinants of health is less understood than the social determinants of health, strong evidence is emerging on the various ways that culture can support better health outcomes. (p. 7)*

Aboriginal and Torres Strait Islander males have cultural roles, histories, and experiences, that are linked to their current health status. Aboriginal and Torres Strait Islander health policies, government health plans and health services all support the notion of a holistic approach to healthcare for Aboriginal and Torres Strait Islander people (and males in particular), that encompasses social and cultural determinants of health, and extends beyond the individual to the community. The *National Aboriginal and Torres Strait Islander Male Health Framework* adopted the 1989 Aboriginal Health Strategy definition of Aboriginal health (National Aboriginal Health Strategy Working Party, 1989) to underpin its second guiding principle of a 'holistic approach to male health' (Australian Government Department of Health and Ageing, 2010a):

> *Aboriginal health means not just the physical wellbeing of an individual but refers to the social, emotional and cultural wellbeing of the whole Community in which each individual is able to achieve their full potential as a human being thereby bringing about the total wellbeing of their Community. It is a whole of life view and includes the cyclical concept of life-death-life. (p. 2)*

A holistic approach that includes the diversity of spiritualities, political beliefs, economic status, sexualities and lifestyles that are part of Aboriginal and Torres Strait Islander communities is seen as vital for improving the health of Aboriginal and Torres Strait Islander males (Australian Government Department of Health and Ageing, 2010a; Prehn & Ezzy, 2020). It follows then, although not stated overtly, that a holistic approach should include male sexual health, and all the factors (cultural, social, physical, psychological) that have an impact on sexual health and wellbeing.

The way forward

In a recent commentary, Kootsy Canuto eloquently described the necessary change in focus if there is to be a move towards better health and wellbeing for Aboriginal and Torres Strait Islander males (K. Canuto, Harfield, Wittert, & Brown, 2019):

> *We need to stop describing problems and blaming individuals, and start acknowledging Aboriginal and Torres Strait Islander men as the dynamic, essential elements of families, communities and societies they have always been. The inherent personal and cultural strengths and attributes of Aboriginal and Torres Strait Islander men must be unshackled, and positive energy directed towards the development of new ways forward by men and their communities, who are empowered and supported to do so. (p. 308)*

Respectful practices that non-Indigenous and Aboriginal and Torres Strait Islander healthcare providers can use to engage with male patients and each other are needed. Based on the experience of a range of healthcare providers, a framework addressing the approach, skills and personal attributes of healthcare providers, including practical strategies, that any healthcare provider cane use to develop respectful practice (Wilson et al., 2020). The Australian Health Minister's Advisory Council's *National Aboriginal and Torres Strait Islander Health Standing Committee's National Cultural Respect Framework 2016-2026 for Aboriginal and Torres Strait Islander health* provides a framework at a much broader level for developing respectful health services, from policy and legislation, to how organisations are run, through to the planning and delivery of services (Australian Health Ministers' Advisory Council's National Aboriginal and Torres Strait Islander Health Standing Committee, 2016).

Other approaches to addressing male health disparities could include:

- adoption of a 'decolonised', holistic approach to Aboriginal male health to move away from the individualised western biomedical view of health and address the social and cultural determinants of male health (Prehn & Ezzy, 2020)
- development and promotion of interventions that empower men, such as men's camps, men's health clinics, men's sheds, based on the success of already existing programs (M. Adams, 2014; K. Canuto et al., 2019; Prehn & Ezzy, 2020; Wenitong, 2002)
- ensuring cultural safety through workforce training, changing the clinical environment and engaging Aboriginal and Torres Strait Islander male health workers (Davy et al., 2016; Gee et al., 2014; Tremblay et al., 2020; Wilson et al., 2020), with potential for positive effects on patient outcomes; such training could be adapted for male-specific services in chronic disease and sexual health
- catering to the diversity of Aboriginal and Torres Strait Islander communities, not a one-size-fits-all approach (Australian Government Department of Health and Ageing, 2010a; Davy et al., 2016; Prehn & Ezzy, 2020). For example, the differing needs of men in remote, rural and urban areas
- health services developed with the community and embedded in the community (Davy et al., 2016; Gee et al., 2014)
- a gendered approach to male healthcare (M. Adams, 2014; Arney & Westby, 2012; K. Canuto et al., 2018; K. Canuto et al., 2018; Prehn & Ezzy, 2020; Thomson et al., 2010)
- use approaches that are successful in improving engagement with primary health services, for example, the Inala Indigenous Health Service (N. Hayman, 2010; N. E. Hayman, Askew, & Spurling, 2014)
- programs for male health delivered through ACCHOs (Gee et al., 2014).

There is now a need to adopt approaches identified in multiple studies, to improve the health of Aboriginal and Torres Strait Islanders males, particularly with respect to sexual health and chronic disease. A recent commentary has put out the call to primary healthcare services to 'collaborate, listen and understand' as the time for action is now (K. Canuto et al., 2019). Some frameworks referred to above may be helpful if adapted specifically to health services for male patients, although they have not yet been evaluated (Davy C. et al., 2017; Wilson et al., 2020).

Prevention, awareness initiatives, programs and services

There are currently no prevention programs, awareness initiatives or services that focus specifically on Aboriginal and Torres Strait Islander male sexual health (except for those related to sexually transmitted infections). However, there are programs and services for male health in general that could be vehicles for male sexual health initiatives. In addition, cultural competency training for healthcare providers could potentially encompass cultural factors that are particularly relevant to male sexual health.

Male-specific programs and male spaces

In 2017-18, there were 134 primary healthcare organisations providing 'men's group' programs or activities for Aboriginal and Torres Strait Islander males across Australia (Australian Institute of Health and Welfare & National Indigenous Australians Agency, 2020). Some examples of male-specific programs that could be relevant to engaging males about their sexual health are listed in Table 8.

Table 8. Aboriginal and Torres Strait Islander male health programs in Australia, 2021

Program	Location	Description	Contact
Budja Budja Men's Group	Halls Gap region, Victoria	Builds healthy and supportive relationships through regular activities that focus on cultural reconnection and heritage, including 'Yarn-Up' sessions, mentorship and health promotion such as healthy eating and diabetes management.	https://budjabudjacoop.org.au/cooperative-services/mens-group/
Bush TV: Camping on Country	National	The camps provide a space for community leaders and Law men to discuss current health issues in their community and support for developing and improving health programs.	https://bushtv.com.au/back-on-country-program/
Danila Dilba Men's Clinic	Darwin, Northern Territory	Operated by male health workers who engage with males about a variety of health and wellbeing issues.	https://ddhs.org.au/clinics/mens-clinic-new-location
Gurriny Yealamucka Health Services Men's Program	Yarrabah, Queensland	Two male workers operate social and wellbeing activities in a male-only space.	https://www.gyhsac.org.au/social-emotional-wellbeing-services
Ingkintja: Wurra apa artwuka pmara	Alice Springs, Northern Territory	Provides care for health and wellbeing including a safe place to discuss issues of cultural sensitivity such *Men's Business* and ceremony.	https://www.caac.org.au/client-services/ingkintja-male-health-service
Kirrip Men's Group	Melbourne, Victoria	Provides traditional cultural learning, strengthening and connection for Aboriginal and Torres Strait Islander males aged 17 years and over.	https://kirripaboriginalcorporation.org/mens-group/
Men's Sheds Australia	National	Runs programs that aim to decrease social isolation, create friendships, enhance self-esteem and offer health promotion activities.	https://mensshed.org
Mibbinbah Spirit Healing	National	Male-only camp providing safe spaces for males to 'yarn'.	https://www.mibbinbah.org/

Rekindling the Spirit	Lismore, New South Wales	Aims to empower Aboriginal males through a process of spiritual, emotional, sexual and physical healing.	https://www.rekindlingthespirit.org.au/
StrongBala Men's Health Program	Katherine, Northern Territory	Culturally appropriate clinical services and support for males to make meaningful contributions to their family, community and culture.	https://www.wurli.org.au/clinical-services/strongbala-mens-health/
Strong Young Men and Boys Program (Red Dust Role Models)	Northern Territory	Supports the development of strong male Aboriginal youth through a combination of strategies including yarning circles, explicit instruction, peer led participatory approaches and hands-on interactive activities, offered in local language/s and English. Sexuality and health topics are explored.	https://reddust.org.au/work/programs/
Walan-Budhang-Gibir Men's Group	Griffith, New South Wales	Provides opportunities to gather socially and to culturally connect with other Aboriginal and Torres Strait Islander males, as well as health education, support and advocacy.	https://www.griffithams.org.au/mensgroup

Source: Australian Indigenous Health*InfoNet* database of programs (2021) (Budja Budja Aboriginal Co-operative, 2021; BushTV, 2021; Central Australian Aboriginal Congress, 2021; Danila Dilba Health Service, 2021; Griffith Aboriginal Medical Service, 2021; Gurriny Yealamucka Health Service Aboriginal Corporation, 2021; Jo Thompson Consulting, 2019; Kirrip, 2021; Rekindling the Spirit, 2021; Wurli Wurlinjang Health Service, 2021)

These programs all have similar underlying philosophies: empowerment, social support, strengthening culture, 'yarning' and providing a culturally safe space (Arney & Westby, 2012).

Cultural competency training

Cultural competency is '…a key strategy for reducing inequalities in healthcare access and improving the quality and effectiveness of care for Indigenous people…' (p. 2) (Bainbridge, McCalman, Clifford, & Tsey, 2015). Cultural competency is more than cultural awareness and should encompass behaviours, attitudes, and policies for effective cross-cultural work at the level of systems, agencies and healthcare providers (Bainbridge et al., 2015).

Cultural competency training to support male health is vital for non-Indigenous healthcare providers and services, especially for those practising in the areas of male sexual health, which has specific cultural sensitivities (Healthy Male, 2018c). There are no specific training programs for those whose practice involves Aboriginal and Torres Strait Islander male sexual health. However, cultural competency training for other areas of health may be adaptable to the needs of male patients with sexual health conditions and chronic disease. There is presently a lack of robust evidence for the effectiveness of cultural competency interventions, particularly with respect to patient outcomes (Bainbridge et al., 2015; Clifford, McCalman, Bainbridge, & Tsey, 2015), apart from some work in diabetes management (Tremblay et al., 2020). The development of any competency training for Aboriginal and Torres Strait Islander male sexual health will need evaluation embedded into the program.

Future directions

This review illustrates a lack of knowledge about the links between male sexual health and general health, particularly in the development of chronic disease. It also highlights a lack of, and barriers to accessing, sexual health services for Aboriginal and Torres Strait Islander males. Addressing the three levels of 'silence' identified by Adams in the only male sexual health study conducted to date (M. Adams, 2014; M. J. Adams et al., 2013) (research level, healthcare provider level and community level) provide a framework for thinking about future directions to improve this situation.

Research

The lack of data on sexual health in Aboriginal and Torres Strait Islander males, identified in a 2002 review (Wenitong, 2002) remains a barrier to improving male health and wellbeing. The single study to date has provided rich data about the extent of specific sexual health conditions in several communities in the NT and Qld, as well as insights into the reasons for silence about sexual health and barriers and enablers for engaging with services (M. Adams, 2014; M. J. Adams et al., 2013). Far more work is needed to understand the extent of sexual health problems of Aboriginal and Torres Strait Islander males across the country and the links with chronic disease, as well as the best approaches for bringing sexual health into general healthcare through culturally appropriate and gender-specific services.

As an Aboriginal and Torres Strait Islander man, Adams (M. Adams, 2014) wrote about the importance for males in communities to have genuine ownership of the research project he conducted, his role in facilitating the dissemination of information about the study, and ensuring cultural protocols were in place. This study provides a model for how research on a sensitive topic as sexual health can be conducted (M. Adams, 2014). All researchers need to consider their protocols to ensure there are no inherent barriers to the inclusion of Aboriginal and Torres Strait Islander males in any type of research study.

The types of research that could be useful in the male sexual health context include:

- prevalence and incidence studies
- investigation of links between sexual health and chronic disease in Aboriginal and Torres Strait Islander communities
- identification of barriers and enablers to seeking or obtaining sexual healthcare, both from the perspective of healthcare providers and of Aboriginal and Torres Strait Islander males
- intervention studies to trial and evaluate approaches to improving access to services and engagement with males about sexual health, including cultural competency interventions
- examination of strategies to encourage the inclusion of sexual health into general health checks and chronic disease assessment and management in Aboriginal and Torres Strait Islander males.

Healthcare providers

One measure of progress can be seen in the commitment of health services to provide culturally safe health care. In 2017–18, 95% of Indigenous-specific primary health care providers had in place a formal commitment to providing culturally safe health care, and approximately half (49%) of their health care workers identified as Aboriginal and/or Torres Strait Islander (Australian Institute of Health and Welfare, 2020a). To incorporate sexual health into general health consultations with Aboriginal and Torres Strait Islander clients, requires taking further steps to ensure healthcare providers have the knowledge and training to feel comfortable and competent to start the discussion. However, there are few education or awareness programs for healthcare providers specifically related to male health in general, or sexual health in particular, apart from the Healthy Male resource: *A lot of Aboriginal men sort of keep it to themselves: Communicating specific Men's Business* (Andrology Australia, 2013) (found at: https://www.healthymale.org.au/health-professionals/professional-education/aboriginal-and-

torres-strait-islander-health). Among primary healthcare providers, knowledge of sexual health conditions is often low and there is a general lack of awareness of links with cardiovascular disease and T2DM. General practitioners, ATSIHWPs and nurses could all benefit from specific awareness or training programs, but the best way to deliver these will likely depend on the needs of the healthcare provider and service, and the local community where the health service is located.

One model of male health training for ATSIHWPs has been evaluated and the findings could inform broader dissemination of such training (Tsey et al., 2014). A male health module (developed by Healthy Male) was piloted in three workshops; one with potential trainers of health workers; one with male health workers; and one with both male and female health workers. The participants overwhelmingly felt the course was relevant to their work and filled a gap in workforce training. The holistic approach underpinning the module was consistent with Aboriginal and Torres Strait Islanders' way of thinking. Importantly, participants felt the training enhanced their personal development and sense of empowerment (Tsey et al., 2014). However, there was concern that health workers face barriers to participating in such training, including having too many training programs for a limited number of health workers, not being able to take time off work to attend, and the difficulty of catering to the range of health workers across the country (Tsey et al., 2014).

Aboriginal and Torres Strait Islander males and communities

In response to the identified barriers to health service use and discussions among males in communities about sexual health, there is a great need for health promotion and awareness programs to de-stigmatise sexual health and encourage males to seek help when they have a problem. Understanding the links between sexual health and CVD and T2DM, including the common risk factors, may provide an additional motivator for males to seek help (M. Adams, 2014; Wenitong et al., 2014).

The importance of involving health professionals and Aboriginal and Torres Strait Islander people in the development of health promotion and education programs is highlighted in the *National Aboriginal and Torres Strait Islander Health Plan 2013-2023* (Australian Government Department of Health and Ageing, 2013). There is a pressing need for health promotion programs relating to male sexual health and chronic disease. While there are programs aimed at raising awareness about sexually transmitted infections among Aboriginal and Torres Strait Islander people (for example, Condoman (2Spirits Program, 2018)), there are none for sexual health conditions associated with CVD and T2DM.

A review of health promotion programs aimed at modifying chronic disease risk factors showed a lack of evaluation. Moreover, most programs focused on changing individual behaviours rather than the broader context of health, such as supportive environments and health services, in apparent disregard for the holistic approach to health that is necessary to achieve the desired outcomes (K. J. Canuto et al., 2021). Any programs that are developed to increase awareness and knowledge of male sexual health and chronic disease need to incorporate the wider context of Aboriginal and Torres Strait Islander male health and be based on an empowerment model that involves the local community as well as healthcare providers and services, and must include evaluation. The review found that programs delivered through ACCHOs had the advantage of fostering community involvement and empowerment (K. J. Canuto et al., 2021).

Possible strategies for incorporating male sexual health into chronic disease care, prevention and health promotion

Raising the awareness of males and healthcare providers about male sexual health conditions and the links with chronic disease is a basic requirement before there can be any change in help-seeking or health service provision. As a starting point, The *National Aboriginal and Torres Strait Islander Male Health Framework - Revised Guiding Principles* (Australian Government Department of Health and Ageing, 2010a) provides a solid basis on which to address the health of Aboriginal and Torres Strait Islander males: it emphasises a gender-specific, holistic approach, that provides opportunities for reconstructing male empowerment and self-determination.

Including sexual health assessments in general health checks could be a simple and effective strategy. Moreover, sexual health could be incorporated into annual preventive health assessments for Aboriginal and Torres Strait Islander people (MBS item 715) (National Aboriginal Community Controlled Health Organisation & Royal Australian College of General Practitioners, 2018). Once the links between sexual health conditions and chronic disease are better understood, and the potential for improving both sexual health and general health through risk factor prevention and management is realised, healthcare providers may see the benefit of a more holistic approach to their male patients (Healthy Male, 2018c; Wenitong et al., 2014).

Developing and designing interventions and services for male sexual health within current frameworks would support the holistic health and wellbeing of Aboriginal and Torres Strait Islander males. Most Aboriginal and Torres Strait Islander primary healthcare services manage male patients with CVD and T2DM and other chronic health conditions (Australian Institute of Health and Welfare, 2012). The *Aboriginal and Torres Strait Islander Health Performance Framework 2020 summary report* found that in 2018-19, 248,800 Aboriginal and Torres Strait Islander people accessed an Indigenous-specific health check and 82% of Aboriginal and Torres Strait Islander males reported having consulted a GP or specialist doctor in the previous 12 months, with 44% reporting they had discussed lifestyle issues with the health professional (Australian Institute of Health and Welfare, 2020a). In very remote areas, 75% of those who attended a health service went to an Aboriginal Medical Service (AMS) or community clinic in 2017-18 (Australian Institute of Health and Welfare, 2020a). These findings show positive utilisation of Indigenous-specific health services and support the incorporation of male sexual health into chronic disease management in primary healthcare services (such as AMSs) in consultation with ACCHOs.

Upskilling healthcare providers so they can confidently and competently facilitate sensitive clinical encounters with male patients and manage male sexual health conditions is another key strategy to improve the current 'silence' on this front. Training programs that specifically target health workers can have wider effects due to the role of health workers as agents of change in Aboriginal and Torres Strait Islander primary care. Such training may also makes it more attractive for Aboriginal and Torres Strait Islander males to enter a health workforce traditionally dominated by women (Tsey et al., 2014). As identified in the pilot study of a male health module for ATSIHWPs, barriers to participating in training programs also need to be addressed before there will be widespread uptake (Tsey et al., 2014).

Policies and funding

Policy responses at all levels of government are required to improve the health of Aboriginal and Torres Strait Islander male health (Prehn & Ezzy, 2020). At present, there is a lack of specific policy actions to address the well-documented poor health outcomes for Aboriginal and Torres Islander males. Apart from the *National Aboriginal and Torres Strait Islander Male Health Framework - Revised Guiding Principles* (Australian Government Department of Health and Ageing, 2010a), other federal policies (the *National Aboriginal and Torres Strait Islander Health Plan 2013-2023* (Australian Government Department of Health and Ageing, 2013) and the *National Men's Health Strategy 2020–2030* (Australian Government Department of Health, 2020)), do not include specific strategies to improve Aboriginal and Torres Strait Islander male health, or the necessary funding commitments. At a local health district level, the Northern Sydney Local Health District *Aboriginal and Torres Strait Islander Men's Health Plan 2015-2020* (Northern Sydney Local Health District, 2015) is a possible template for other local health districts to develop specific strategies to improve Aboriginal and Torres Strait Islander male health (Prehn & Ezzy, 2020).

Complicated funding pathways, short-term funding, and sudden loss of funding are barriers to implementing and sustaining health interventions in Aboriginal and Torres Strait Islander health in general (Gibson et al., 2015) and male health in particular (K. Canuto et al., 2019; Prehn & Ezzy, 2020), although some strategies for improving engagement of males with healthcare services can be low-cost (K. Canuto et al., 2019; Gibson et al., 2015; Prehn & Ezzy, 2020). The *NACCHO 10-point plan* identified the development of a funding strategy as a key step to success to achieving their 2030 vision (National Aboriginal Community Controlled Health Organisation, 2013). The design phase of any interventions

to address male sexual health and chronic disease would therefore need to identify specific and sustainable funding streams to give the intervention the best chance of success.

Concluding comments

The links between male sexual health and chronic conditions are well established, however, there is poor knowledge and awareness of male sexual health and the links with general health among both health professionals and Aboriginal and Torres Strait Islander males. In addition, there is a lack of research and data about sexual problems among Aboriginal and Torres Strait Islander males and how they are managed. There is clearly a need to improve knowledge about male sexual health in Aboriginal and Torres Strait Islander communities to guide health promotion programs and health services. The growing evidence base about the links between male sexual health and general health, including shared risk factors can provide opportunities to address not only sexual health concerns of males but also potentially improve their general health.

Strategies such as the inclusion of sexual health in general health assessments, utilising existing services and programs to create awareness of sexual health and address sexual problems among males, and the development and supported implementation of culturally appropriate training for healthcare providers working with Aboriginal and Torres Strait Islander males are some key strategies recommended in this review to improve health service provision in this area and address some of the barriers to access faced by Aboriginal and Torres Strait Islander males.

This review outlines the mounting evidence that ED can be a sign of future CVD or T2DM. This is an important message that has the potential to motivate males of all ages to seek help if they experience ED, and for health professionals to become skilled in discussing sexual health with their male patients. The latter requires further consideration of cultural factors for Aboriginal and Torres Strait Islander males and the social and historical context in which their health and wellbeing exists.

Glossary

Androgen

A male sex hormone such as testosterone responsible for the development of male characteristics

Androgen deficiency

A clinical diagnosis made when a male has low levels of serum testosterone detected on two separate occasions. (*See also Low testosterone*)

Atherosclerosis

A process that results in the build-up of plaques or deposits in arteries that may lead to obstruction of blood flow

Cardiovascular disease

The term for all of the diseases and conditions that affect the heart and blood vessels

Diabetes

A metabolic disorder where blood glucose levels are imbalanced

Endocrine system

The system of glands (including the pituitary, thyroid, adrenals, testes) which secrete their products (hormones) into the blood stream

Endocrinologist

A doctor who specialises in problems in the endocrine system (hormones and hormonal function)

Erectile dysfunction

An ongoing problem getting and maintaining an erection that is firm enough for sexual intercourse

Hormone

A substance that circulates through the body in the blood stream and promotes growth, reproduction and general well-being

Hypogonadism

An inability of the testes to produce high enough levels of testosterone (androgen deficiency) and/or sperm (spermatogenesis)

Klinefelter syndrome

A chromosome problem that causes low testosterone levels, breast development, small testes and infertility in men

Low testosterone

A condition where a male cannot produce enough testosterone for his body to function normally. Clinically defined by a lower-than-normal serum testosterone level. (See also Androgen Deficiency)

Luteinizing hormone (LH)

A hormone produced by the pituitary gland which stimulates the production of testosterone in the testes

Micropenis

Abnormal smallness of the penis. Micropenis occurs when the penis fails to grow for the last two-thirds of the embryo’s development

Morbidity

An illness or abnormal condition

Nitrate

Type of drug which contains nitric acid

PBS (Pharmaceutical Benefits Scheme)

Australian Government program for the subsidy of prescribed essential drugs, to provide them cheaper to the consumer

PDE5 (phosphodiesterase) inhibitors

Family of drugs used for treating erectile dysfunction by promoting the body's natural response to sexual stimulation

Penile

Relating to the penis

Penis

Male organ for urination and sexual intercourse.

Peyronie's disease

Build-up of plaques around the core of the penis, which can lead to change in shape and painful erections

Prostate

A gland within the male reproductive system that is located just below the bladder

Risk factor

An aspect of lifestyle or behaviour, a health condition, an environmental exposure or an inborn or inherited characteristic, known to be linked with health-related conditions considered important to prevent

Serum

The clear liquid that can be separated from clotted blood

Sex-hormone binding globulin

A protein produced by the liver that binds sex hormones (testosterone and oestradiol) in the blood

Sperm

Mature male sex cell

Testicle/testis (plural: testes)

The male reproductive organ that produces sperm and the male sex hormones

Testicular function

The ability of the testicles to produce sperm and testosterone

Testosterone

Male sex hormone

Vascular

Conditions involving blood vessels

Most of the terms listed in this glossary have been sourced from a glossary published on the Healthy Male website which can be accessed here: https://www.healthymale.org.au/resources-tools/glossary

Appendix 1 – Limitations

Aboriginal and Torres Strait Islander status

Identification of individuals as Aboriginal and Torres Strait Islanders is a problem across all administrative datasets, resulting in an under-estimate of their number in any given dataset involving both non-Indigenous and Aboriginal and Torres Strait Islander people. There has been some improvement in the identification of Aboriginal and Torres Strait Islander people in recent years and strategies are in place to improve recording of Indigenous status (Northern Sydney Local Health District, 2019; RACGP National Faculty of Aboriginal and Torres Strait Islander Health, 2011).

Sexual health conditions

Apart from ED and low testosterone, other male sexual health conditions may be linked to CVD and/or T2DM but they have not been included in this review. For example, there is some evidence that lower urinary tract symptoms (LUTS) are associated with chronic conditions, particularly CVD, but the evidence on the nature of the associations is not yet clear (Blanker et al., 2016; Bouwman et al., 2015).

Androgens and steroid abuse

In the review of testosterone and CVD, androgenic steroid abuse (e.g., by body builders) is not included. While long-term androgenic steroid abuse may be associated with cardiovascular damage, in addition to other effects on the male reproductive system, the extent of the use or abuse of drugs or supplements for body-building or cosmetic purposes in Aboriginal and Torres Strait Islander males is not known.

Hospitalisation data

Statistics on hospitalisation provide some indication of the burden of disease in the population. They are, however, a poor reflection of the extent and patterns of treatable illness in the community because they only represent illness serious enough for hospitalisation, and are influenced to some extent by the geographic accessibility of hospitals and variations in admission policies and practices. As is the case with other major health-related data collections (such as births and deaths), the identification of Indigenous status in hospital data collections is incomplete.

Another limitation of the available hospital statistics as indicators of the health of the population, is that they relate to episodes of hospitalisation rather than to individual patients. Also, it is difficult to analyse patterns of care for patients hospitalised multiple times (for example for kidney dialysis) from the current national hospitalisation data.

Hospitalisation rates will be affected by advancements in the health system, improvements in self- identification by Aboriginal and Torres Strait Islander people, and reforms that tackle the social determinants of health.

Appendix 2 – Detailed review of studies of erectile dysfunction and low testosterone and links with cardiovascular disease and type 2 diabetes

Australian studies estimating the prevalence of erectile dysfunction

Several studies have estimated the prevalence of ED in Australian men, albeit using a range of measures and population samples that precludes making direct comparisons (M. J. Adams et al., 2013; Banks et al., 2013; K. K. Chew et al., 2008; Holden et al., 2005; S. Martin et al., 2012; Schlichthorst et al., 2016; Weber et al., 2013; Wen et al., 2017).

Only one study has reported ED among Aboriginal and Torres Strait Islander males specifically (M. J. Adams et al., 2013). In this 2004/2005 study of males aged 18 to 74 years in communities across the Northern Territory (NT) and Queensland (Qld) (n=293), 16% reported mild or mild-moderate ED and 14% had moderate-severe ED, with increased prevalence across age groups (M. J. Adams et al., 2013). Notably, moderate to severe ED was reported by around 10% of younger Aboriginal and Torres Strait Islander males (in both the 18 to 24 and 25 to 34 years age-groups).

A study of a random sample of men in WA aged 20 to 99 years (n=1,580; recruited 2001 to 2002) found the prevalence of 'any ED (from mild to severe)', adjusted for the age distribution of the WA population, was 25% and the prevalence of severe ED was 8.5% (K. K. Chew et al., 2008). There was a strong association with age: the prevalence of 'any ED' in men aged 20-29 was 16% and increased incrementally to 68% in men aged 80 years or older (severe ED ranged from 3% to 57%, respectively) (K. K. Chew et al., 2008).

The MATeS study of a representative population sample of 5,990 Australian men aged 40 years or over (recruited 2003) found one in five men reported moderate or severe ED, with prevalence ranging from 3% in men aged 40-49 years up to 68% in men aged 70 years or older (Holden et al., 2005).

In the NSW '45 and Up' study' of men aged 45 years and over with no prior diagnosis of prostate cancer (n=101,674; recruited 2006 to 2010), 19% had moderate ED and 17% had severe ED (Weber et al., 2013). There was a steep increase across age groups: prevalence of severe ED ranged from 2.2% for men aged 45-54 years to 75% in men 85 years old and older (Banks et al., 2013).

In a random sample of 1,195 community-dwelling men aged 35-80 years from SA (the FAMAS cohort, recruited 2002 to 2005), 18% reported moderate to severe ED, again with a sharp increase across age groups (S. Martin et al., 2012).

In the Ten to Men longitudinal study of Australian men aged 18 to 55 years (n=12,636; recruited 2013 to 2014), 14% indicated they 'had trouble getting or keeping an erection' for at least three months in the previous 12 months (Schlichthorst et al., 2016).

The Second Australian Study of Health and Relationships found 12% of the sample of sexually active men aged 16 to 69 years (n=9,611; recruited 2012 to 2013) had difficulty in keeping an erection during a period of one month or longer in the previous 12 months (Wen et al., 2017).

Links between erectile dysfunction and cardiovascular disease

Cross-sectional studies

Many cross-sectional studies show that ED is more common in men with CVD and they share common risk factors, such as obesity, high blood glucose, hypertension (high blood pressure) and hyperlipidaemia (high cholesterol levels), or a combination of these (metabolic syndrome) (Gandaglia et al., 2014; Kaya, Sikka, & Gur, 2015). Although the temporal relationship between ED and CVD cannot be ascertained from cross-sectional data, identified associations combined with the possible common pathophysiological pathways, led to the hypothesis that ED is not only a consequence of chronic conditions but can pre-exist chronic disease, particularly CVD.

In addition to the many early studies demonstrating ED and CVD associations (Gandaglia et al., 2014), a more recent very large study from the United States of America (USA) (over 500,000 men with a diagnosis of ED and over 9 million men without a diagnosis of ED) using insurance claims data showed associations of ED with diabetes, depression and CVD, independent of possible confounding demographic factors (Goldstein et al., 2018). Moreover, the relationships between ED and the other chronic conditions were evident in men as young as 30-39 years of age (Goldstein et al., 2018).

Although most international studies have been done in populations of European ethnicity (including Australia, as described below) one study from the from the Pacific nation of the Solomon Islands, of men who were sexually active in the four weeks prior to assessment, showed that over half reported at least one type of sexual difficulty (including 19% who experienced erectile difficulties 'sometimes' and 4.3% 'most times') (Lui, Dunne, Baker, & Isom, 2017). Sexual difficulties were associated with having a chronic health condition (diabetes, high blood pressure and/or heart disease), after adjusting for age. Notably, this was a relatively young population, with almost half aged 20-29 years (Lui et al., 2017).

Australian studies

The 2004/2005 study in Aboriginal and Torres Strait Islander males showed a strong association between moderate to severe ED and self-reported diabetes, heart disease and high blood pressure (M. J. Adams et al., 2013).

An assessment of the associations between biomedical and lifestyle factors and reproductive health disorders in the MATeS study of men aged 40 years and older showed (self-reported) diabetes and CVD, but not hypertension, were associated with ED (Holden, McLachlan, et al., 2010). Depression, sedentary lifestyle and being underweight or obese were also associated with ED in age-adjusted models (Holden, McLachlan, et al., 2010). In the FAMAS cohort of men aged 35-80 years in SA, increasing age, abdominal fat mass, obstructive sleep apnoea risk, and the absence of a regular partner were associated with both mild and moderate-severe ED (S. Martin et al., 2012). Furthermore, insufficient physical activity, low risk[19] alcohol consumption, and hypertension were associated with mild ED, and voiding lower urinary tract symptoms, diabetes, and lower plasma testosterone were independently associated with moderate-severe ED (S. Martin et al., 2012).

A study of NSW men from the '45 and Up' cohort showed that in those aged 45 and over with no prior diagnosis of prostate cancer, the prevalence of moderate/complete ED was higher among those with low socioeconomic status, high body mass index, sedentary lifestyle, were current smokers and those with diabetes, heart disease, and depression/anxiety, compared with men without these risk factors (Weber et al., 2013). Moderate alcohol consumption was associated with a significantly reduced prevalence of ED in men aged 45-54 years, but not in older men (Weber et al., 2013).

A study using data from the Ten to Men longitudinal study of Australian men found associations between 'trouble getting or keeping an erection' and cigarette smoking, alcohol consumption, some drug use, obesity (older men only), self-rated health lower than 'excellent', daily pain self-medication (older men only), having a disability (older men only), and having a diagnosis of one or more physical or mental health conditions in men aged 18 to 55 years (Schlichthorst et al., 2016).

Longitudinal studies

Many longitudinal (most prospective, some retrospective) studies support the hypothesis that ED predicts the onset of CVD some years later (Zhao et al., 2019). One of the first prospective studies, published in 2005, showed that men aged 55 years or over with prevalent (present at baseline) or incident ED (n=8,063) had a 45% greater risk (HR=1. 45)

19 According to Australian National Health and Medical Research Council (2001) Australian alcohol guidelines: health risks and benefits, low risk alcohol consumption was defined as: up to six standard drinks on any one day, no more than three days per week.

of experiencing a cardiovascular event than men without ED during the seven-year study (Thompson et al., 2005). By one year following a report of ED, 2% of men had experienced a cardiovascular event and by five years this rose to 11% (Thompson et al., 2005). The authors concluded that ED had an effect on subsequent cardiovascular events equal to or greater than a family history of myocardial infarction (heart attack), cigarette smoking, or hyperlipidaemia (high levels of lipids such as cholesterol in the blood) (Thompson et al., 2005). A possible limitation is that the study population was a selected group of adult males in the USA participating in the placebo arm of a prostate cancer prevention trial (Thompson et al., 2005).

Another widely quoted longitudinal study, published in 2009, used data from a USA population sample of men aged 40 years or over (n=1,402) followed for 10 years (Inman et al., 2009). After adjustment for common CVD risk factors in those with no known CAD at baseline, there was about an 80% increased risk of developing CAD over 10 years for men with ED compared to those without (Inman et al., 2009). An important finding from this study was that the association between ED and CAD was much stronger at younger ages: men aged 40-49 years with ED had about double the risk compared to those without ED (adjusted HR=2.1) and the risk conferred by ED decreased across age-groups. In men aged 70 years or over, ED had very little effect on the incidence of CAD (Inman et al., 2009).

Another USA study of a population sample of men aged 40-70 years without CVD or diabetes (n=1,057) found that ED predicted the development of CVD over 12 years follow-up: in models adjusted for established risk factors, men with ED had a 40% higher risk of developing CVD (including a wide range of CVD end-points), compared to men without ED (Araujo et al., 2010). Many USA studies include predominantly white men. However, an analysis of the 'Multi-Ethnic Study of Atherosclerosis' (n=1,757 men with a mean age of 69 years and no CVD followed for 3.8 years) showed ED was a predictor of CVD events, including CHD and stroke, after adjusting for traditional CVD risk factors, depression and use of beta-blockers (hypertension medication) (Uddin et al., 2018). The odds for a CVD event in men with ED at baseline was about twice that for men without ED. This study also showed that men who developed CVD during the study had a higher chance of also developing ED (Uddin et al., 2018).

Australian studies

A retrospective WA study (ED diagnosed between Jan 1995 and Dec 2004) linked data on men aged 20 years or older with ED and no reported atherosclerotic CVD (n=1,660) to administrative hospital data and death records (up to 2005) to determine hospitalisations and/or death from CVD over a 10-year period (K. Chew et al., 2010). The incidence of atherosclerotic CVD events (those due to narrowing or hardening of the arteries) in the study population was more than two times higher than men in the general WA male population (K. Chew et al., 2010). Interestingly, 12% of men in the study had their first-ever event within five years of developing ED (K. Chew et al., 2010).

Tobacco smoking, presence of comorbidities (other health problems) and socioeconomic disadvantage were associated with a stronger link between ED and later development of CVD. An age effect was also identified: incidence rates of CVD for men with ED were significantly higher than the incidence rates in the general population in all age groups younger than 70 years; however, the difference in CVD incidence between the men with ED and the general population was greater in younger men (K. Chew et al., 2010). This age effect supported the findings from the USA study (Inman et al., 2009).

A study of NSW men from the '45 and Up' cohort (n=95,038) linked questionnaire data to hospitalisation and death data, with a mean follow-up time of 2.2 years for hospital admission and 2.8 years for deaths (Banks et al., 2013). For men with no CVD at baseline, severe ED (compared to no ED) conferred increased risks of IHD (relative risk (RR^{20})=1.6), heart failure (RR=8.0), peripheral vascular disease (RR=1.9), all CVD combined (RR=1.4)

20 RR = relative risk. This gives an estimate of the increased risk of developing CVD in men with ED compared to those without ED. For example, RR=1.6 means that men with severe ED had 1.6 times the chance of developing CVD than men with no ED.

and deaths from all causes (RR=1.9), but not primary hypertension or intracerebral haemorrhage (stroke caused by bleeding in the brain), after adjustment for the main CVD risk factors (Banks et al., 2013). Similar risks were identified for men with CVD at baseline. A novel finding from this study was a dose-response relationship between the severity of ED and the risk of CVD, that is, the risk of CVD was greater for those with more severe ED (Banks et al., 2013).

Links between low testosterone and cardiovascular disease

The fact that older men are more at risk of CVD and also more likely to have lower testosterone levels and be overweight, poses the question of whether lower testosterone is just a consequence of ill-health or whether low testosterone may be a marker or predictor of subsequent CVD, independent of other CVD risk factors. Reviews of current evidence suggest that this question has not yet been answered adequately and research is ongoing. Most studies so far have not had a sufficient sample size to make definitive conclusions about specific CVD outcomes, particularly CVD-related deaths, while adjusting for other possible explanatory factors (Yeap et al., 2021; Yeap, Page, & Grossmann, 2018; Yeap & Wu, 2019). Three reviews have assessed studies of associations between low circulating testosterone levels and CVD or deaths due to CVD or any cause, summarised below (Meyer & Wittert, 2018; Yeap et al., 2019; Yeap et al., 2018).

Testosterone and cardiovascular disease

Yeap (Yeap et al., 2018; Yeap & Wu, 2019) reviewed studies published between 2005 and 2016 (n=16 studies) that examined associations between testosterone and various CVD outcomes. Studies varied with respect to sample size, follow-up time, age range, type of CVD measured and assays used to measure testosterone. Most studies adjusted their analyses for age, body mass index and other conventional CVD risk factors (Yeap et al., 2018; Yeap & Wu, 2019).

There was a mix of studies reporting positive associations, inconclusive results and negative results. The larger cohort studies using mass spectrometry to assay hormones (gold standard) tended to support an increased risk of CVD with lower testosterone (Yeap et al., 2018; Yeap & Wu, 2019).

The main findings from Yeap's reviews (Yeap et al., 2018; Yeap & Wu, 2019) are:

- Studies examining sex hormones and composite measures of CVD events generally support an association between testosterone levels and risk of CVD events in middle-aged and older men, but possibly more so in older men. The association may be linear or U-shaped (where both low and high levels of testosterone predict CVD).
- Studies examining fatal and non-fatal myocardial infarction (heart attack) did not show a convincing association with circulating testosterone levels.
- Lower circulating testosterone levels are associated with having a stroke but whether it is a causative factor is not yet clear.

Testosterone and deaths due to CVD or any cause

Fourteen of the studies included in the reviews described in the previous section reported associations between testosterone levels and deaths due to CVD in mostly middle-aged or older men, although two studies included men aged 20 years and over (Yeap et al., 2018; Yeap & Wu, 2019). Despite conflicting findings, overall the studies reviewed support a modest association between low testosterone and death due to CVD, but again, a causal link is not yet established (Yeap et al., 2018; Yeap & Wu, 2019).

A separate review of studies assessing associations between testosterone and dying from any cause concluded that men with lower testosterone levels have a higher risk of dying overall (from any cause), noting that CVD was the predominant cause of death in most studies (Meyer & Wittert, 2018). However, given that men with low testosterone are more likely to be obese and have metabolic disease it is difficult to determine whether the low testosterone is a reflection of a man's health status or whether it contributes causally to these conditions (Meyer & Wittert, 2018).

In contrast, a recent study of nearly 150,000 men aged 40 to 69 years followed for 11 years showed an association between low testosterone and deaths from any cause and cancer specifically, but not deaths due to CVD (Yeap et al., 2021). An association between low serum testosterone levels and CVD deaths was found in unadjusted analyses, but not once all other risk factors were taken into account. The large size of this study allowed for statistical adjustment for many CVD risk factors and sex hormones other than testosterone, which could explain why the association with CVD deaths has been found in other studies but not in this cohort (Yeap et al., 2021).

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