2.2.14 Cancer of the prostate

Cancer of the prostate is the fourth most commonly diagnosed cancer worldwide, and one of the most frequent causes of cancer-related mortality in developed countries.

The relationship between body weight and prostate cancer risk is complex, for several reasons. First, prostate cancer-specific mortality (death attributed to the underlying cancer) is a proxy for incidence in some studies, whereas it is a primary end-point in other studies, along with different types of prostate cancer incidence defined by tumour characteristics. However, prostate cancer-specific mortality may be over-represented in patients who die *with* but not *of* the disease. This is a particular concern if, for example, obese patients with prostate cancer have other comorbid disease and more regular contact with the health-care system; the cancer may be more prominent in their management and may be recorded on the death certificate, even if heart disease is the underlying cause of death. Second, detection bias could also be a concern in studies of prostate cancer incidence; because obese men have lower levels of prostate-specific antigen (PSA), their tumours are more difficult to detect, and they are less likely to undergo a biopsy (Allot et al., 2013). However, potential biological mechanisms have also been proposed to explain a lower risk of early-stage prostate cancer in men who are overweight or obese (see Section 4.3.1d).

In 2001, the Working Group of the *IARC Handbook* on weight control and physical activity (IARC, 2002) concluded that the evidence of an association between avoidance of weight gain and prostate cancer was *inadequate*. Since then, numerous prospective studies with at least 100 cases (Table 2.2.14a) and case–control studies (Table 2.2.14b) have been published, as well as several meta-analyses of observational studies addressing different measures of body fatness (Table 2.2.14c).

(a) Cohort studies

The *IARC Handbook* on weight control and physical activity (IARC, 2002), in the evaluation of prostate cancer risk and measures of body fatness, included 13 prospective cohort studies with at least 100 cases (not shown in Table 2.2.14a). Of those, four found a positive association and nine found no association. Notably, across all prospective studies, the highest category of BMI was overweight (25–29.9 kg/m^2) but not obese (≥ 30 kg/m^2).

Since 2000, associations of body fatness assessed at baseline with total prostate cancer incidence have been examined in numerous individual prospective studies with at least 100 cases and in at least two meta-analyses. In most studies, neither BMI nor weight was associated with risk (Habel et al., 2000; Schuurman et al., 2000; Lee et al., 2001; Jonsson et al., 2003; Rapp et al., 2005; Gong et al., 2006; Lukanova et al., 2006; Tande et al., 2006; Fujino et al., 2007; Giovannucci et al., 2007; Littman et al., 2007; Máchová et al., 2007; Rodriguez et al., 2007; Pischon et al., 2008; Wallström et al., 2009; Andreotti et al., 2010; Stocks et al., 2010; Bassett et al., 2012). However, in some studies statistically significant positive associations (or trends) between BMI at baseline and prostate cancer incidence were found (Engeland et al., 2003; Samanic et al., 2004, 2006; Jee et al., 2008; Barrington et al., 2015), and four prospective studies found lower risk of prostate cancer with increasing BMI (Wright et al., 2007; Bhaskaran et al., 2014; Møller et al., 2015). In a meta-analysis of 27 prospective studies, there was a statistically significant positive association with prostate cancer incidence (RR per 5 kg/m^2 increase in BMI, 1.03; 95% CI, 1.00–1.07) (Renehan et al., 2008).

Associations of body fatness at baseline with stage of the disease were examined in several studies. Regarding the incidence of localized, low-grade, or non-aggressive disease, although five studies found no association (Schuurman et

al., 2000; Giovannucci et al., 2007; Pischon et al., 2008; Wallström et al., 2009; Bassett et al., 2012), at least seven other studies found an inverse association of BMI and/or weight with the incidence of non-aggressive (Littman et al., 2007; Stocks et al., 2010), non-metastatic low- to moderate-grade (Gong et al., 2006; Rodriguez et al., 2007; Møller et al., 2016 for BMI at age 21 years), or localized (Wright et al., 2007; Discacciati et al., 2011; Hernandez et al., 2009 for BMI at age 21 years) prostate cancer. In the Selenium and Vitamin E Cancer Prevention Trial (SELECT), there was evidence of a significant inverse trend between BMI and the incidence of low-grade prostate cancer in non-Hispanic White men, and a statistically significant positive association in African American men (Barrington et al., 2015).

Nine prospective studies found no associations of BMI and/or weight with the incidence of regional or distant prostate cancer (Habel et al., 2000), advanced, high-grade, or moderately to poorly differentiated prostate cancer (Schuurman et al., 2000; Pischon et al., 2008; Discacciati et al., 2011; Møller et al., 2015), aggressive prostate cancer (Littman et al., 2007; Wallström et al., 2009; Stocks et al., 2010), or extraprostatic prostate cancer (Wright et al., 2007). However, five other studies found positive associations or trends of BMI and/or weight with the incidence of high-grade or advanced prostate cancer (Gong et al., 2006; Giovannucci et al., 2007; Rodriguez et al., 2007; Hernandez et al., 2009 for BMI at age 21 years; Bassett et al., 2012; Barrington et al., 2015). A meta-analysis combining data from 24 prospective studies found a statistically significant positive association between BMI and risk of advanced, high-grade, or fatal prostate cancer (RR per 5 kg/m^2 increase in BMI, 1.08; 95% CI, 1.04–1.12) (WCRF/AICR, 2014).

There is considerable evidence of a positive association of BMI with prostate cancer mortality, based on findings from both individual prospective studies (Rodriguez et al., 2001; Calle et al., 2003; Giovannucci et al., 2007; Wright et al., 2007; Stocks et al., 2010 Bassett et al., 2012) and a large pooled analysis of 57 prospective studies from Europe, Japan, and the USA, reporting a relative risk of mortality per 5 kg/m^2 increase in BMI of 1.13 (95% CI, 1.02–1.24) across the BMI range of 15–50 kg/m^2 (Whitlock et al., 2009). However, at least six other individual prospective studies found no association between BMI at baseline and death from prostate cancer (Batty et al., 2005; Fujino et al., 2007; Burton et al., 2010 for BMI at age < 30 years; Discacciati et al., 2011; Meyer et al., 2015; Møller et al., 2015). Similarly, BMI was not associated with prostate cancer mortality in a pooled analysis from the Asia Cohort Consortium (Fowke et al., 2015). [The Working Group noted that in this analysis, the reference group was men with a BMI of 22.5–24.9 kg/m^2, compared with men with a BMI of 25–50 kg/m^2. A possible effect of obesity (BMI > 30 kg/m^2) on prostate cancer mortality might have been missed in this study.]

At least six prospective studies found no associations between BMI or weight at younger ages of adulthood and risk of prostate cancer (total, localized, advanced, or fatal) (Giovannucci et al., 1997; Jonsson et al., 2003; Fujino et al., 2007; Hernandez et al., 2009; Burton et al., 2010; Discacciati et al., 2011; Bassett et al., 2012), whereas in two other studies higher BMI (Schuurman et al., 2000) or weight (Littman et al., 2007) in young adulthood was significantly associated with increased total prostate cancer incidence. In the NIH-AARP cohort, both BMI and weight at age 18 years were not associated with the incidence of total prostate cancer or extraprostatic prostate cancer, whereas inverse associations with localized prostate cancer were reported (P_{trend} = 0.04) (Wright et al., 2007). Similarly, in the Multiethnic Cohort Study and the Health Professionals Follow-up Study, BMI at age 21 years was inversely associated with the incidence of total, localized, and low- and moderate-grade prostate cancer and was not associated with the incidence of high-grade or fatal prostate cancer (Hernandez et al.,

2009; Møller et al., 2016). Similarly, in the study by Littman et al. (2007), the positive association with weight in young adulthood (ages 18, 30, or 45 years) was restricted to the aggressive type. In a meta-analysis of nine prospective studies, Robinson et al. (2008) found a positive association between BMI in early life (i.e. < 29 years) and prostate cancer incidence or mortality (RR per 5 kg/m^2 increase in BMI, 1.08).

In at least four individual prospective studies, change in neither BMI nor weight during adulthood was associated with prostate cancer incidence (Jonsson et al., 2003; Samanic et al., 2006; Rodriguez et al., 2007; Rapp et al., 2008). Similarly, a meta-analysis of four prospective studies also found no associations of adult weight gain [after adjustment for age and baseline BMI or weight in all studies] with total, localized, or advanced prostate cancer incidence (Keum et al., 2015). However, in the Netherlands Cohort Study, there was suggestive evidence of an inverse trend between increase in BMI from age 20 years to baseline (≥ 6 kg/m^2) and total prostate cancer incidence (P_{trend} = 0.07), and this association was statistically significant for poorly differentiated or undifferentiated prostate tumours (Schuurman et al., 2000). In the Vitamins and Lifestyle (VITAL) cohort, both weight loss and weight gain were associated with a lower risk of non-aggressive prostate cancer, but there was no association with aggressive prostate cancer (Littman et al., 2007). In the NIH-AARP cohort, weight gain from age 18 years to baseline was not associated with prostate cancer incidence (total, localized, or extraprostatic), but was associated with prostate cancer mortality (P_{trend} = 0.009) (Wright et al., 2007).

The association between waist circumference and total prostate cancer incidence was examined in at least eight individual prospective studies, and no study found evidence of statistically significant associations with total prostate cancer incidence (Giovannucci et al., 1997; Lee et al., 2001; MacInnis et al., 2003; Gong et al., 2006; Tande et al., 2006; Pischon et al., 2008; Wallström et al., 2009; Møller et al., 2015). On the basis of four prospective studies, the WCRF Continuous Update Project summary (WCRF/AICR, 2014) found no dose–response association between waist circumference and risk of total or non-advanced prostate cancer, but a statistically significant positive association with risk of advanced or fatal prostate cancer (RR per 10 cm increase, 1.12; 95% CI, 1.04–1.21).

(b) Case–control studies

Case–control studies of BMI and other adiposity indices in relation to prostate cancer risk are presented in Table 2.2.14b. In the *IARC Handbook* on weight control and physical activity (IARC, 2002), 15 case–control studies of BMI and prostate cancer were reviewed (not shown here). Since then, at least 35 case–control studies and 5 meta-analyses including case–control study designs, focused on the association between weight, BMI, or waist circumference and prostate cancer, have been conducted in Asia (China, India, Japan, and Pakistan), the Caribbean (Barbados and Jamaica), Europe, the Islamic Republic of Iran, Nigeria, North America, and Oceania (Australia and New Zealand). In all of these studies, BMI was assessed on the basis of self-reported height and body weight, or body weight and height verified at the time of a hospital consultation.

Positive associations between high BMI and total prostate cancer incidence were reported in six of the case–control studies. Bashir et al. (2014), in a hospital-based case–control study in Pakistan with 140 cases and 280 controls, found a significant increase in the risk of prostate cancer for men with BMI > 25 kg/m^2 (OR, 5.78; 95% CI, 2.67–12.6). In a multicentre hospital-based case–control study in Italy, Dal Maso et al. (2004) identified a dose–response relationship between BMI at age 30 years and prostate cancer risk, based on 1257 cases (P_{trend} = 0.004). Ganesh et al. (2011) reported a 2-fold greater risk of prostate cancer

in Indian men with BMI ≥ 25 kg/m² (OR, 2.1; 95% CI, 1.1–4.4). A hospital-based case–control study in France found a positive association between BMI > 29 kg/m² and risk of prostate cancer (OR, 2.47; 95% CI, 1.41–4.34) (Irani et al., 2003). Similarly, a study in Canada reported a significant 27% increase in risk of prostate cancer in men with BMI ≥ 30 kg/m² compared with those with BMI < 25 kg/m² (Pan et al., 2004).

An inverse association between BMI and prostate cancer has also been reported in several studies. Beebe-Dimmer et al. (2009), in a hospital-based case–control study in the USA, found an inverse relationship between high BMI (≥ 30 kg/m²) and prostate cancer risk in Caucasian men, based on 494 cases (OR, 0.51; 95% CI, 0.33–0.80), but not in African American men. Similarly, a study in Canada found a statistically significant inverse relationship between BMI ≥ 30 kg/m² and prostate cancer risk (OR, 0.72; 95% CI, 0.60–0.87), but no associations with waist circumference or waist-to-hip ratio were found (Boehm et al., 2015). A population-based case–control study in the Islamic Republic of Iran (Hosseini et al., 2010), with 137 cases and 137 controls, also found a significant inverse relationship between high BMI (≥ 25 kg/m²) and prostate cancer risk (OR, 0.4; 95% CI, 0.2–0.8). Finally, Agalliu et al. (2015) conducted a small hospital-based case–control study in Nigeria, with 50 cases and 50 controls. Inverse associations were reported for weight (OR per kg increase, 0.97; 95% CI, 0.94–1.00) and waist circumference (OR per cm increase, 0.91; 95% CI, 0.87–0.96).

One additional case–control study found an increased risk of total prostate cancer in men with an increased waist circumference (Beebe-Dimmer et al., 2007).

Three meta-analyses that included case–control studies suggested a small increase in risk of prostate cancer associated with higher BMI (Bergström et al., 2001; MacInnis & English, 2006; Robinson et al., 2008). In one additional meta-analysis, a significant positive association with adult weight was observed for high-risk (RR, 1.13; 95% CI, 1.00–1.28) and fatal (RR, 1.58; 95% CI, 1.01–2.47) prostate cancer subtypes (Chen et al., 2016).

Six case–control studies differentiated prostate cancer by grade, stage, or aggressiveness, and generally reported positive associations of BMI, waist circumference, or waist-to-hip ratio with prostate cancers with higher Gleason scores. Fowke et al. (2012) analysed 809 hospital-based cases and 1057 controls in the USA by Gleason score. On the basis of 135 cases, BMI and waist circumference were marginally associated with increased risk of high-grade prostate cancer (OR per 1 kg/m² increase in BMI, 1.04; 95% CI, 1.00–1.08 and OR per 1 cm increase in waist circumference, 1.01; 95% CI, 0.99–1.03). Jackson et al. (2010) separated patients with high-grade prostate cancer in their hospital-based case–control study (243 cases and 275 controls) in Jamaica. Waist circumference and waist-to-hip ratio were positively associated with high-grade prostate cancer after adjustment for BMI. A dose–response relationship was also observed for waist circumference, and no association was found with BMI. A case–control study in Italy observed significant positive associations of BMI and prostate cancer of Gleason score 7–10 only (P_{trend} < 0.01) (Dal Maso et al., 2004). Liu et al. (2005) conducted a population-based sibling case–control study in the USA with 439 cases and 479 controls and found no association of aggressive prostate cancer (defined as Gleason score ≥ 7 or tumour stage T2C or greater) with increased BMI, whereas an inverse association was observed for lean body mass (P_{trend} = 0.02). Nemesure et al. (2012) conducted a population-based case–control study in Barbados with 963 cases and 941 controls and reported a positive association of waist circumference with all prostate cancers (OR for highest versus lowest quartiles, 1.84; 95% CI, 1.19–2.85), which did not hold when stratifying by disease grade. Robinson et al. (2005) in the USA reported an inverse association between

BMI > 30 kg/m^2 at age 20–29 years and advanced prostate cancer [based on 12 cases].

Several studies assessed BMI and body weight at different ages, and BMI/weight change. In a population-based case–control study in Sweden, Gerdtsson et al. (2015) investigated several anthropometric measures, including BMI and weight, at multiple time points in life. Weight increase in adolescence (age 16–22 years) was associated with increased risk of prostate cancer (OR per 5 kg increase in weight, 1.05; 95% CI, 1.01–1.09), and increase in BMI and weight in middle age (age 44–50 years) was associated with increased mortality from prostate cancer, and with increased metastasis. Weight gain of 10.0–14.9 kg in adulthood was significantly associated with a 3–4-fold greater risk of prostate cancer in a population-based case–control study in Japan (Mori et al., 2011). In the same study, BMI of 23.0–24.9 kg/m^2 at age 20 years was associated with a reduced risk of prostate cancer (OR, 0.47; 95% CI, 0.22–0.98) (Mori et al., 2011) [based on 11 cases only]. In contrast, a total of 16 case–control studies conducted in Australia, Canada, the Czech Republic, Italy, Japan, New Zealand, Spain, Sweden, Switzerland, the United Kingdom, and the USA reported no associations between risk of total prostate cancer and BMI or other adiposity indices at different ages (Putnam et al., 2000; Sharpe & Siemiatycki, 2001; Giles et al., 2003; Friedenreich et al., 2004; Porter & Stanford, 2005; Robinson et al., 2005; Wuermli et al., 2005; Cox et al., 2006; Gallus et al., 2007; Máchová et al., 2007; Nagata et al., 2007; Magura et al., 2008; Dimitropoulou et al., 2011; Pelucchi et al., 2011; Möller et al., 2013; Alvarez-Cubero et al., 2015; Zhang et al., 2015) or BMI change or weight gain from early adulthood (Putnam et al., 2000; Giles et al., 2003; Friedenreich et al., 2004).

(c) Mendelian randomization studies

Three Mendelian randomization studies have been conducted in this context (Table 2.2.14d).

Lewis et al. (2010) showed that each additional A allele of the *FTO* rs9939609 SNP was associated with an increase of 0.56 kg/m^2 (P = 0.007) in BMI across all groups (cases and controls). Estimates obtained from Mendelian randomization analyses provided odds ratios of 0.77 (95% CI, 0.52–1.15; P = 0.20) for prostate cancer and 1.35 (95% CI, 0.90–2.03; P = 0.14) for high-grade versus low-grade cancer with each 1 kg/m^2 increase in BMI.

Davies et al. (2015) extended this work by using a genetic risk score based on 32 SNPs associated with BMI (Speliotes et al., 2010) as an instrument for BMI within a much larger sample size. Each increase of 1 standard deviation in genetically predicted BMI was associated on average with a nonsignificant 2% reduction in risk (95% CI, 0.96–1.00; P = 0.07) in any prostate cancer diagnosis.

In Mendelian randomization analyses that used genetic risk scores based on 77 SNPs for adult BMI (Locke et al., 2015) and 15 SNPs for childhood BMI (Felix et al., 2016), Gao et al. (2016) found no strong evidence for associations of childhood or adult BMI with either total or aggressive prostate cancer risk.

[Although results from Lewis et al. (2010) and Davies et al. (2015) point towards an inverse association between BMI and prostate cancer risk, this association was not significant and was not consistently found in all three studies.]

Table 2.2.14a Cohort studies of measures of body fatness and cancer of the prostate

Reference Cohort Location Follow-up period	Total number of subjects Incidence/ mortality	Organ site or cancer subtype (ICD code)	Exposure categories	Exposed cases	Relative risk (95% CI)	Covariates	Comments
Giovannucci et al. (1997) Health Professionals Follow-up Study USA 1986–1994	47 781 Incidence	Prostate, advanced	BMI at age 21 yr			Age, height	
			< 20	81	1.00		
			20–21.9	117	0.91 (0.69–1.22)		
			22–22.9	59	0.88 (0.62–1.24)		
			23–23.9	56	0.77 (0.54–1.10)		
			24–25.9	60	0.71 (0.50–1.02)		
			≥ 26	26	0.53 (0.33–0.86)		
			[P_{trend}]		[< 0.006]		
		Prostate, all	BMI at age 21 yr				WC also not associated with increased risk
			< 20	229	1.00		
			20–21.9	353	0.98 (0.83–1.16)		
			22–22.9	188	1.00 (0.82–1.22)		
			23–23.9	200	1.03 (0.84–1.26)		
			24–25.9	223	1.00 (0.82–1.22)		
			≥ 26	104	0.87 (0.67–1.12)		
			[P_{trend}]		[0.60]		
Habel et al. (2000) Kaiser Permanente USA 1964–1973 to 1996	70 712 Incidence	Prostate	BMI	2079 total		Age, race, year of birth	Weight also not associated with increased risk No associations were observed in results stratified by race
			< 22.7		1.00		
			22.7–24.3		1.09 (0.93–1.27)		
			24.4–25.9		1.04 (0.89–1.21)		
			26–27.9		1.04 (0.90–1.21)		
			> 27.9		0.99 (0.85–1.15)		
		Prostate, regional/distant	BMI	578 total			
			< 22.7		1.00		
			22.7–24.3		0.84 (0.62–1.13)		
			24.4–25.9		1.05 (0.80–1.39)		
			26–27.9		1.04 (0.79–1.37)		
			> 27.9		0.91 (0.69–1.20)		
Schuurman et al. (2000) Netherlands Cohort Study The Netherlands 1986–1982	58 279 Incidence	Prostate	BMI at baseline			Age, family history of prostate cancer, SES; BMI change results also adjusted for BMI at age 20 yr	
			< 22	63	1.00		
			22–23	164	1.20 (0.84–1.73)		
			24–25	236	1.35 (0.95–1.90)		
			26–27	150	1.26 (0.87–1.83)		
			≥ 28	62	0.89 (0.58–1.37)		
			[P_{trend}]		[0.73]		
			per 2 kg/m^2		1.00 (0.92–1.07)		

Table 2.2.14a (continued)

Reference Cohort Location Follow-up period	Total number of subjects Incidence/ mortality	Organ site or cancer subtype (ICD code)	Exposure categories	Exposed cases	Relative risk (95% CI)	Covariates	Comments
Schuurman et al. (2000) (cont.)	58 279 Incidence		BMI at age 20 yr				
			< 19	57	1.00		
			19–20.9	122	1.06 (0.72–1.56)		
			21–22.9	176	1.09 (0.76–1.58)		
			23–24.9	119	1.39 (0.93–2.06)		
			≥ 25	44	1.33 (0.81–2.19)		
			[P_{trend}]		[0.02]		
			per 2 kg/m^2		1.08 (0.99–1.18)		
			BMI change				
			−9.2 to < 0	47	1.19 (0.74–1.90)		
			0–1.9	120	1.00		
			2–3.9	176	1.32 (0.98–1.79)		
			4–5.9	113	1.04 (0.74–1.47)		
			6–7.9	43	0.83 (0.52–1.31)		
			≥ 8	19	0.67 (0.36–1.23)		
			[P_{trend}]		[0.07]		
			per 2 kg/m^2		0.93 (0.84–1.03)		
		Prostate, localized TNM: T0–2, M0	BMI, per 2 kg/m^2	239 total			
			BMI at baseline		0.96 (0.86–1.06)		
			BMI at age 20 yr		1.18 (1.04–1.35)		
			BMI change		0.87 (0.74–1.02)		
		Prostate, advanced TNM: T3–4, M0; T0–4, M1	BMI, per 2 kg/m^2	226 total			
			BMI at baseline		1.01 (0.90–1.13)		
			BMI at age 20 yr		1.03 (0.91–1.18)		
			BMI change		0.93 (0.80–1.08)		

Table 2.2.14a (continued)

Reference Cohort Location Follow-up period	Total number of subjects Incidence/ mortality	Organ site or cancer subtype (ICD code)	Exposure categories	Exposed cases	Relative risk (95% CI)	Covariates	Comments
Schuurman et al. (2000) (cont.)		Prostate, well-differentiated	BMI, per 2 kg/m^2	194 total			
			BMI at baseline		0.92 (0.82–1.04)		
			BMI at age 20 yr		1.09 (0.94–1.26)		
			BMI change		0.77 (0.65–0.92)		
		Prostate, moderately differentiated	BMI, per 2 kg/m^2	247 total			
			BMI at baseline		1.02 (0.93–1.13)		
			BMI at age 20 yr		1.15 (1.01–1.31)		
			BMI change		0.97 (0.83–1.13)		
		Prostate, poorly differentiated or undifferentiated	BMI, per 2 kg/m^2	174 total			
			BMI at baseline		1.01 (0.89–1.14)		
			BMI at age 20 yr		0.97 (0.83–1.13)		
			BMI change		0.68 (0.58–0.81)		
Lee et al. (2001) Harvard Alumni Health Study USA 1988–1993	8922 Incidence	Prostate	BMI at baseline			Age, smoking, alcohol consumption, paternal history of prostate cancer	WC also not associated with increased risk BMI at age 18 yr (available for 92% of the men) also not associated with increased risk
			< 22.5	87	1.00		
			22.5–24.9	172	1.27 (0.94–1.71)		
			25.0–27.4	134	1.26 (0.92–1.72)		
			27.5	46	1.02 (0.68–1.53)		
			[P_{trend}]		[0.71]		
Rodriguez et al. (2001) Cancer Prevention Study I (CPS I) USA 1959–1972	381 638 Mortality	Prostate ICD-7: 177	BMI			Age, race, height, education level, exercise, smoking status, family history of prostate cancer	
			< 25	782	1.00		
			25–29.99	698	1.02 (0.92–1.14)		
			≥ 30	110	1.27 (1.04–1.56)		
			[P_{trend}]		[0.06]		
Calle et al. (2003) Cancer Prevention Study II (CPS II) USA 1982–1998	404 576 Mortality	Prostate	BMI			Age, education level, smoking, physical activity, alcohol consumption, marital status, race, aspirin use, fat consumption, vegetable consumption	
			18.5–24.9	1681	1.00		
			25–29.9	1971	1.08 (1.01–1.15)		
			30–34.9	311	1.20 (1.06–1.36)		
			≥ 35	41	1.34 (0.98–1.83)		
			[P_{trend}]		[< 0.001]		

Table 2.2.14a (continued)

Reference Cohort Location Follow-up period	Total number of subjects Incidence/ mortality	Organ site or cancer subtype (ICD code)	Exposure categories	Exposed cases	Relative risk (95% CI)	Covariates	Comments
Engeland et al. (2003) Norwegian clinical population Norway 1963–1999 to 2001	951 466 Incidence	Prostate ICD-7: 177	BMI < 18.5 18.5–24.9 25–29.9 ≥ 30 [P_{trend}]	 147 16 720 14 524 1923	 0.92 (0.78–1.08) 1.00 1.07 (1.05–1.09) 1.09 (1.04–1.15) [0.001]	Age at BMI measurement, birth cohort	In stratified analyses by age at BMI measurement, no differences in risk by age strata were observed
Jonsson et al. (2003) Swedish Twin Registry Sweden 1969–2003	8998 Incidence	Prostate ICD-7: 177	BMI at baseline < 18.5 18.5–24.9 25.0–29.9 ≥ 30 BMI at age 25 yr < 18.5 18.5–24.9 ≥ 25 BMI at age 40 yr < 18.5 18.5–24.9 25.0–29.9 ≥ 30 Adult weight change (kg) < 0 0–5 6–10 11–20 ≥ 21	 6 355 248 22 4 436 64 6 368 155 13 96 178 114 95 21	 1.4 (0.6–3.1) 1.0 1.0 (0.8–1.2) 1.0 (0.6–1.5) 0.5 (0.2–1.5) 1.0 1.0 (0.7–1.3) 2.5 (1.1–5.5) 1.0 0.9 (0.7–1.1) 0.9 (0.5–1.6) 0.9 (0.7–1.2) 1.0 1.0 (0.8–1.3) 0.9 (0.7–1.2) 1.1 (0.8–1.8)	Age; BMI at age 25 yr and 40 yr also controlled for BMI at baseline	No associations were observed in stratified analyses by age at diagnosis (≥ 70 yr vs < 70 yr)
Samanic et al. (2004) United States Veterans cohort USA 1969–1996	4 500 700 Incidence	Prostate ICD-9: 185	Obesity Non-obese Obese Non-obese Obese	 Black men: 15 272 815 White men: 45 901 3206	 1.00 1.12 (1.04–1.20) 1.00 1.19 (1.15–1.24)	Age, calendar year	Obesity defined as discharge diagnosis of obesity: ICD-8: 277; ICD-9: 278.0

Table 2.2.14a (continued)

Reference Cohort Location Follow-up period	Total number of subjects Incidence/ mortality	Organ site or cancer subtype (ICD code)	Exposure categories	Exposed cases	Relative risk (95% CI)	Covariates	Comments
Batty et al. (2005) Whitehall Study United Kingdom 1967–2002	18 403 Mortality	Prostate	BMI 18.5–24.9 25.0–29.9 ≥ 30 [P_{trend}]	 243 175 13	 1.00 0.92 (0.75–1.13) 0.91 (0.51–1.63) [0.45]	Age, employment grade, physical activity, smoking, marital status, prevalent disease, past-year weight loss, BP medication, height, skinfold thickness, systolic BP, plasma cholesterol, glucose intolerance, diabetes	
Rapp et al. (2005) Vorarlberg VHM&PP Austria 1985–2001	67 447 Incidence	Prostate ICD-9: 185	BMI 18.5–24.9 25–29.9 30–34.9 ≥ 35 [P_{trend}]	 446 583 99 10	 1.00 1.03 (0.91–1.17) 0.82 (0.66–1.03) 0.73 (0.39–1.37) [0.16]	Age, smoking status, occupation	
Gong et al. (2006) Prostate Cancer Prevention Trial (PCPT) USA N/A–2003	10 258 Incidence	Prostate	BMI < 25 25–26.9 27–29.9 ≥ 30 [P_{trend}]	1936 total	 1.00 0.91 (0.79–1.05) 0.96 (0.83–1.10) 0.96 (0.83–1.10) [0.67]	Age, race, treatment, diabetes, family history of prostate cancer	Analyses of the association of WC with total prostate, and low-grade and high-grade subtypes also reported
		Prostate, low-grade	BMI < 25 25–26.9 27–29.9 ≥ 30 [P_{trend}]	1300 total	 1.00 0.88 (0.74–1.04) 0.88 (0.75–1.04) 0.82 (0.69–0.98) [0.03]		
		Prostate, high-grade	BMI < 25 25–26.9 27–29.9 ≥ 30 [P_{trend}]	521 total	 1.00 0.97 (0.75–1.27) 1.09 (0.85–1.40) 1.29 (1.01–1.67) [0.04]		

Table 2.2.14a (continued)

Reference Cohort Location Follow-up period	Total number of subjects Incidence/ mortality	Organ site or cancer subtype (ICD code)	Exposure categories	Exposed cases	Relative risk (95% CI)	Covariates	Comments
Lukanova et al. (2006) Northern Sweden Health and Disease Cohort (NSHDC) 1985–2003	33 424 Incidence/ mortality	Prostate	BMI 18.5–23.4 23.5–25.3 25.4–27.6 ≥ 27.1 [P_{trend}]	 93 114 129 125	 1.00 1.00 (0.76–1.32) 0.96 (0.74–1.26) 0.89 (0.68–1.16) [0.31]	Age, calendar year, smoking	
Samanic et al. (2006) Swedish Construction Worker Cohort Sweden 1958–1999	362 552 Incidence 107 815 (in BMI change analysis) Incidence	Prostate ICD-7: 177	BMI 18.5–24.9 25–29.9 ≥ 30 [P_{trend}] 6-yr BMI change −4% to 4.9% 5–9.9% 10–14.9% ≥ 15% [P_{trend}]	 3003 3160 528 1281 417 97 22	 1.00 1.06 (1.01–1.12) 1.09 (0.99–1.19) [< 0.05] 1.00 1.09 (0.98–1.22) 0.93 (0.75–1.14) 0.75 (0.49–1.15) [> 0.5]	Attained age, calendar year, smoking	
Tande et al. (2006) Atherosclerosis Risk in Communities (ARIC) Study USA 1987–2000	6332 Incidence	Prostate	BMI < 24.7 24.7–26.9 27.0–29.7 ≥ 29.8	 94 99 91 101	 1.00 1.17 (0.88–1.55) 0.97 (0.72–1.29) 1.14 (0.86–1.50)	Age, race	WC also not associated with increased risk Men with metabolic syndrome were 27% less likely to develop prostate cancer
Fujino et al. (2007) Japan Collaborative Cohort Study for Evaluation of Cancer (JACC) Japan NR	NR Mortality	Prostate	BMI < 18.5 18.5–24 25–29 ≥ 30	 17 107 31 1	 1.39 (0.83–2.34) 1.00 1.56 (1.04–2.34) 0.87 (0.12–6.29)	Age, area of study	[No information reported on follow-up period or total number of participants included in the study] Weight at baseline and at age 20 yr also not associated with increased mortality

Table 2.2.14a (continued)

Reference Cohort Location Follow-up period	Total number of subjects Incidence/ mortality	Organ site or cancer subtype (ICD code)	Exposure categories	Exposed cases	Relative risk (95% CI)	Covariates	Comments
Giovannucci et al. (2007) Health Professionals Follow-up Study USA 1986–2002 Updated follow-up from Giovannucci et al. (1997)	47 750 Incidence	Prostate	BMI < 21 21–22.9 23–24.9 25–27.4 27.5–29.9 ≥ 30 [P_{trend}]	3544 total	 1.00 1.21 1.36 1.24 1.24 1.13 (0.91–1.41) [0.84]	Age, time period, BMI at age 21 yr, height, pack-years of smoking, physical activity, family history of prostate cancer, diabetes, race, energy intake, intake of processed meat, fish, α-linolenic acid, tomato sauce, vitamin E supplements	[CI provided only for the last BMI category] No association was observed with BMI for low-grade or high-grade prostate cancer (based on Gleason score)
		Prostate, advanced TNM: T3b or T4 or N1 or M1	BMI < 21 ≥ 30 [P_{trend}]	523 total	 1.00 1.34 (0.79–2.26) [≤ 0.05]		
	47 750 Mortality	Prostate	BMI 21–22.9 23–24.9 25–27.4 27.5–29.9 ≥ 30	323 total	 1.00 1.44 1.30 1.43 1.80 (1.10–2.93)		
Littman et al. (2007) Vitamins and Lifestyle (VITAL) cohort USA 2000–2004	34 754 Incidence	Prostate	BMI at baseline < 25 25–29.9 ≥ 30 [P_{trend}]	 218 435 155	 1.0 1.1 (0.97–1.4) 0.87 (0.71–1.1) [0.13]	Age, family history of prostate cancer, race, baseline BMI, recent PSA screening	BMI at ages 18 yr, 30 yr, and 45 yr also not associated with increased risk
		Prostate, non-aggressive Gleason score < 7	BMI at baseline < 25 25–29.9 ≥ 30 [P_{trend}]	 129 222 73	 1.0 0.99 (0.79–1.2) 0.69 (0.52–0.93) [0.01]		BMI at ages 18 yr, 30 yr, and 45 yr also not associated with increased risk
		Prostate, aggressive Gleason score 7–10	BMI at baseline < 25 25–29.9 ≥ 30 [P_{trend}]	 85 209 179	 1.0 1.4 (1.1–1.8) 1.1 (0.83–1.6) [0.69]		BMI at ages 18 yr, 30 yr, and 45 yr also not associated with increased risk

Table 2.2.14a (continued)

Reference Cohort Location Follow-up period	Total number of subjects Incidence/ mortality	Organ site or cancer subtype (ICD code)	Exposure categories	Exposed cases	Relative risk (95% CI)	Covariates	Comments
Littman et al. (2007) (cont.)	34 754 Incidence	Prostate	Weight (lb) at age 18 yr			Age, family history of prostate cancer, race, baseline BMI, recent PSA screening	For non-aggressive prostate cancer, weight at age 18 yr and 30 yr was not associated with an increased risk
			< 139	166	1.0		
			139–154	203	1.2 (0.96–1.5)		
			155–170	198	1.1 (0.93–1.4)		
			≥ 171	231	1.2 (1.0–1.5)		
			[P_{trend}]		[0.08]		
			Weight (lb) at age 30 yr				
			< 154	174	1.0		
			154–169	192	1.2 (0.95–1.4)		
			170–184	188	1.1 (0.93–1.4)		
			≥ 185	241	1.3 (1.0–1.6)		
			[P_{trend}]		[0.03]		
			Weight (lb) at age 45 yr				
			< 165	194	1.0		
			165–179	182	1.0 (0.82–1.2)		
			180–199	224	1.1 (0.91–1.3)		
			≥ 200	200	1.1 (0.87–1.3)		
			[P_{trend}]		[0.46]		
			Weight (lb) at baseline				
			< 173	211	1.0		
			174–189	181	1.0 (0.83–1.2)		
			190–214	233	0.99 (0.82–1.2)		
			≥ 215	192	0.92 (0.75–1.1)		
			[P_{trend}]		[0.35]		
		Prostate, non-aggressive Gleason score < 7	Weight (lb) at baseline				Weight gain of ≥ 30 lb since age 18 yr associated with 33% lower risk of incidence
			< 173	130	1.00		
			174–189	90	0.82 (0.62–1.1)		
			190–214	116	0.81 (0.63–1.1)		
			≥ 215	92	0.71 (0.54–0.93)		
			[P_{trend}]		[0.02]		
		Prostate, aggressive Gleason score 7–10	Weight (lb) at age 18 yr			Age, family history of prostate cancer, race, baseline BMI, recent PSA screening	
			< 139	71	1.00		
			139–154	94	1.3 (0.92–1.7)		
			155–170	89	1.2 (0.86–1.6)		
			≥ 171	117	1.4 (1.0–1.9)		
			[P_{trend}]		[0.04]		

Table 2.2.14a (continued)

Reference Cohort Location Follow-up period	Total number of subjects Incidence/ mortality	Organ site or cancer subtype (ICD code)	Exposure categories	Exposed cases	Relative risk (95% CI)	Covariates	Comments
Littman et al. (2007) (cont.)	34 754 Incidence		Weight (lb) at age 30 yr				
			< 154	72	1.0		
			154–169	84	1.2 (0.90–1.7)		
			170–184	93	1.4 (0.99–1.9)		
			≥ 185	119	1.5 (1.1–2.0)		
			[P_{trend}]		[0.01]		
			Weight (lb) at age 45 yr				
			< 165	72	1.0		
			165–179	86	1.3 (0.93–1.8)		
			180–199	111	1.5 (1.1–2.0)		
			≥ 200	102	1.4 (1.1–2.0)		
			[P_{trend}]		[0.032]		
			Weight (lb) at baseline				Weight gain since age 18 yr not associated with risk of incidence
			< 173	78	1.0		
			174–189	87	1.3 (0.96–1.8)		
			190–214	115	1.3 (0.97–1.7)		
			≥ 215	98	1.3 (0.93–1.7)		
			[P_{trend}]		[0.23]		
Máchová et al. (2007) National Cancer Registry Nested case–control study in the population of the Šumperk District Czech Republic 1987–2002	17 334 Incidence	Prostate ICD-10: C61	BMI	338 total		Age, smoking, hypertension, height	
			18.5–24.9		1.00		
			25–29.9		1.05 (0.72–1.39)		
			≥ 30		0.97 (0.66–1.41)		

Table 2.2.14a (continued)

Reference Cohort Location Follow-up period	Total number of subjects Incidence/ mortality	Organ site or cancer subtype (ICD code)	Exposure categories	Exposed cases	Relative risk (95% CI)	Covariates	Comments
Rodriguez et al. (2007) Cancer Prevention Study II (CPS II) Nutrition Cohort USA 1992–2003	69 991 Incidence	Prostate	BMI			Age, race, education level, family history of prostate cancer, energy intake, smoking status, PSA testing, diabetes, physical activity; Weight change also adjusted for BMI in 1982 and height	When stratifying by subtype, weight change also not associated with increased risk for any subtype
			< 25	1935	1.00		
			25–27.4	1742	1.02 (0.96–1.09)		
			27.5–29.9	920	0.98 (0.90–1.06)		
			30–34.9	556	0.94 (0.85–1.04)		
			≥ 35	99	0.91 (0.75–1.12)		
			[P_{trend}]		[0.14]		
			Weight change (lb), 1982–1992				
			≥ 21 loss	113	0.84 (0.69–1.02)		
			11–20 loss	349	0.84 (0.75–0.95)		
			6–19 loss	541	0.98 (0.89–1.08)		
			5 loss to 5 gain	2450	1.00		
			6–10 gain	751	0.98 (0.90–1.06)		
			11–20 gain	687	0.97 (0.89–1.05)		
			≥ 21 gain	322	0.89 (0.79–1.00)		
		Prostate, non-metastatic, low-grade TNM: T1–3, N0, M0 Gleason score ≤ 8	BMI				
			< 25	1544	1.00		
			25–27.4	1409	1.03 (0.96–1.10)		
			27.5–29.9	700	0.92 (0.84–1.01)		
			30–34.9	412	0.86 (0.77–0.97)		
			≥ 35	73	0.84 (0.66–1.06)		
			[P_{trend}]		[0.002]		
		Prostate, non-metastatic high-grade TNM: T1–3, N0, M0 Gleason score > 8	BMI				
			< 25	239	1.00		
			25–27.4	180	0.87 (0.72–1.06)		
			27.5–29.9	140	1.23 (1.00–1.53)		
			≥ 30	103	1.22 (0.96–1.55)		
			[P_{trend}]		[0.03]		
	69 991 Incidence or mortality	Prostate, metastatic or fatal TNM: T4, Nx, Mx or Tx, N1–2, Mx or Tx, Nx, M1	BMI				
			< 25	92	1.00		
			25–27.4	104	1.41 (1.06–1.87)		
			27.5–29.9	46	1.14 (0.79–1.63)		
			≥ 30	46	1.54 (1.06–2.23)		
			[P_{trend}]		[0.05]		

Table 2.2.14a (continued)

Reference Cohort Location Follow-up period	Total number of subjects Incidence/ mortality	Organ site or cancer subtype (ICD code)	Exposure categories	Exposed cases	Relative risk (95% CI)	Covariates	Comments
Wright et al. (2007) NIH-AARP cohort USA 1995–2000	172 961 Incidence	Prostate ICD-9: 185 ICD-10: C61	BMI			Age, race, smoking status, education level, diabetes, family history of prostate cancer For BMI at age 18 yr, also BMI at baseline, height	
			< 25	3076	1.00		
			25–29.9	5054	1.00 (0.95–1.04)		
			30–34.9	1532	0.97 (0.91–1.03)		
			35–39.9	269	0.84 (0.74–0.95)		
			≥ 40	55	0.65 (0.50–0.85)		
			[P_{trend}]		[0.0008]		
			BMI at age 18 yr				
			< 18.5	723	0.95 (0.87–1.04)		
			18.5–20.9	1787	1.00		
			21–22.9	1510	1.01 (0.95–1.09)		
			23–24.9	775	0.90 (0.83–0.98)		
			≥ 25	641	0.93 (0.84–1.02)		
			[P_{trend}]		[0.17]		
			Weight (kg) at age 18 yr, quintiles			Age, race, smoking status, education level, diabetes, family history of prostate cancer, BMI, height	
			< 58.6	1004	1.0		
			58.7–64.5	1338	1.01 (0.93–1.10)		
			64.6–69.9	1043	0.99 (0.91–1.09)		
			70–76.7	1138	0.99 (0.91–1.09)		
			> 76.7	1071	0.92 (0.84–1.02)		
			[P_{trend}]		[0.08]		
			Weight (kg) at baseline, quintiles				Weight at baseline also not associated with increased risk for localized and with metastatic prostate cancer subtypes
			< 74.5	1126	1.0		
			74.6–81.3	1224	1.02 (0.93–1.11)		
			81.4–87.2	1204	1.01 (0.92–1.10)		
			87.3–97.2	1157	1.00 (0.91–1.09)		
			> 97.2	1014	0.91 (0.82–1.00)		
			[P_{trend}]		[0.99]		

Table 2.2.14a (continued)

Reference Cohort Location Follow-up period	Total number of subjects Incidence/ mortality	Organ site or cancer subtype (ICD code)	Exposure categories	Exposed cases	Relative risk (95% CI)	Covariates	Comments
Wright et al. (2007) (cont.)	172 961 Incidence		Weight change (kg), age 18 yr to baseline				Weight change also not associated with increased risk for localized and for extraprostatic prostate cancer subtypes
			< −4	161	1.00 (0.83–1.19)		
			−4 to 3.9	430	1.0		
			4–9.9	936	1.04 (0.93–1.17)		
			10–19.9	1896	1.12 (1.00–1.24)		
			20–29.9	1425	1.12 (1.00–1.26)		
			30–39.9	469	0.99 (0.87–1.14)		
			≥ 40	277	1.03 (0.88–1.20)		
			[P_{trend}]		[0.81]		
		Prostate, localized TNM: T1a to T2b, N0, M0	BMI			Age, race, smoking status, education level, diabetes, family history of prostate cancer For BMI at age 18 yr, also BMI at baseline, height	
			< 25	2652	1.00		
			25–29.9	4328	0.99 (0.94–1.04)		
			30–34.9	1277	0.94 (0.88–1.01)		
			35–39.9	236	0.86 (0.75–0.98)		
			≥ 40	48	0.67 (0.50–0.89)		
			[P_{trend}]		[0.0006]		
			BMI at age 18 yr				
			< 18.5	633	0.95 (0.86–1.04)		
			18.5–20.9	1570	1.0		
			21–22.9	1317	1.01 (0.94–1.09)		
			23–24.9	653	0.87 (0.80–0.96)		
			≥ 25	535	0.89 (0.80–0.99)		
			[P_{trend}]		[0.04]		
			Weight (kg) at age 18 yr, quintiles			Age, race, smoking status, education level, diabetes, family history of prostate cancer, BMI, height	
			< 58.6	881	0.95 (0.86–1.04)		
			58.7–64.5	1185	1.00		
			64.6–69.9	903	1.01 (0.94–1.09)		
			70–76.7	988	0.87 (0.80–0.96)		
			> 76.7	891	0.89 (0.80–0.99)		
			[P_{trend}]		[0.04]		
		Prostate, extraprostatic TNM: T3 or T4, N1, or M1	BMI			Age, race, smoking status, education level, diabetes, family history of prostate cancer For BMI at age 18 yr, also BMI, height	
			< 25	424	1.0		
			25–29.9	726	1.03 (0.91–1.16)		
			30–34.9	255	1.14 (0.97–1.33)		
			≥ 35	40	0.68 (0.49–0.94)		
			[P_{trend}]		[0.64]		

Table 2.2.14a (continued)

Reference Cohort Location Follow-up period	Total number of subjects Incidence/ mortality	Organ site or cancer subtype (ICD code)	Exposure categories	Exposed cases	Relative risk (95% CI)	Covariates	Comments
Wright et al. (2007) (cont.)	172 961 Incidence		BMI at age 18 yr				
			< 18.5	90	0.98 (0.77–1.26)		
			18.5–20.9	217	1.00		
			21–22.9	193	1.04 (0.86–1.27)		
			23–24.9	122	1.11 (0.88–1.39)		
			≥ 25	106	1.15 (0.90–1.47)		
			[P_{trend}]		[0.18]		
			Weight (kg) at age 18 yr, quintiles			Age, race, smoking status, education level, diabetes, family history of prostate cancer, BMI, height	
			< 58.6	123	1.0		
			58.7–64.5	153	0.95 (0.74–1.20)		
			64.6–69.9	140	1.08 (0.84–1.38)		
			70–76.7	150	1.03 (0.80–1.33)		
			> 76.7	180	1.18 (0.91–1.54)		
			[P_{trend}]		[0.13]		
Wright et al. (2007) NIH-AARP cohort USA 1995–2000	Mortality	Prostate ICD-9: 185 ICD-10: C61	BMI			Age, race, smoking status, education level, diabetes, family history of prostate cancer For BMI at age 18 yr, also BMI at baseline, height	Weight at baseline also associated with increased risk Weight (kg) at age 18 yr also not associated with increased mortality
			< 25	44	1.0		
			25–29.9	87	1.25 (0.87–1.80)		
			30–34.9	31	1.46 (0.92–2.33)		
			≥ 35	11	2.12 (1.08–4.15)		
			[P_{trend}]		[0.02]		
			BMI at age 18 yr				
			< 18.5	13	1.67 (0.82–3.42)		
			18.5–20.9	18	1.0		
			21–22.9	25	1.65 (0.90–3.02)		
			23–24.9	16	1.71 (0.86–3.39)		
			≥ 25	11	1.35 (0.62–2.95)		
			[P_{trend}]		[0.73]		
			Weight change (kg), age 18 yr to baseline			Age, race, smoking status, education level, diabetes, family history of prostate cancer, BMI, height	
			< –4	3	1.18 (0.29–4.74)		
			–4 to 3.9	6	1.0		
			4–9.9	12	1.06 (0.40–2.83)		
			10–19.9	23	1.17 (0.47–2.92)		
			20–29.9	24	1.74 (0.69–4.40)		
			30–39.9	10	2.05 (0.72–5.90)		
			40	8	2.98 (0.99–9.04)		
			[P_{trend}]		[0.009]		

Table 2.2.14a (continued)

Reference Cohort Location Follow-up period	Total number of subjects Incidence/ mortality	Organ site or cancer subtype (ICD code)	Exposure categories	Exposed cases	Relative risk (95% CI)	Covariates	Comments
Jee et al. (2008) National Health Insurance Corporation (NHIC) medical evaluation Republic of Korea 1992–2006	770 556 Incidence	Prostate	BMI < 20.0 20.0–22.9 23.0–24.9 25.0–29.9 ≥ 30.0 [P_{trend}]	 265 896 747 638 23	 0.67 (0.56–0.80) 0.87 (0.77–0.98) 1.00 0.95 (0.83–1.08) 1.39 (0.90–2.17) [< 0.0001]	Age, smoking	
Pischon et al. (2008) EPIC cohort 8 European countries, 1992–2000 (8.5 yr follow-up on average)	129 502 Incidence	Prostate ICD-10: C61	BMI, quintiles < 23.6 23.6–25.3 25.4–27 27.1–29.3 ≥ 29.4 [P_{trend}] per 5 kg/m^2	2446 total	 1.00 1.06 (0.93–1.20) 1.08 (0.95–1.23) 0.95 (0.83–1.09) 0.99 (0.86–1.13) [0.37] 0.96 (0.90–1.02)	Study centre, age, smoking status, education level, alcohol consumption, physical activity, height	Also examined hip circumference and waist-to-hip ratio WC also not associated with increased risk
		Prostate, localized TNM: T0–T2 and N0/Nx, M0	BMI, quintiles < 23.6 23.6–25.3 25.4–27 27.1–29.3 ≥ 29.4 [P_{trend}] continuous	991 total	 1.00 1.09 (0.89–1.34) 1.02 (0.83–1.25) 0.88 (0.71–1.10) 0.95 (0.77–1.18) [0.22] 0.92 (0.84–1.01)	Study centre, age, smoking status, education level, alcohol consumption, physical activity, height	WC also not associated with increased risk
		Prostate, advanced TNM: T3–T4 and/or N1–N3 and/or M1	BMI < 23.6 23.6–25.3 25.4–27 27.1–29.3 ≥ 29.4 [P_{trend}] continuous	499 total	 1.00 1.05 (0.78–1.40) 1.25 (0.94–1.66) 1.08 (0.81–1.46) 1.17 (0.86–1.58) [0.34] 1.09 (0.96–1.24)	Study centre, age, smoking status, education level, alcohol consumption, physical activity, height	WC also not associated with increased risk

Table 2.2.14a (continued)

Reference Cohort Location Follow-up period	Total number of subjects Incidence/ mortality	Organ site or cancer subtype (ICD code)	Exposure categories	Exposed cases	Relative risk (95% CI)	Covariates	Comments
Pischon et al. (2008) (cont.)	129 502 Incidence	Prostate, low-grade Gleason score < 7	BMI < 23.6 23.6–25.3 25.4–27 27.1–29.3 ≥ 29.4 [P_{trend}] continuous	841 total	 1.00 0.97 (0.78–1.21) 0.95 (0.77–1.19) 0.83 (0.66–1.04) 0.84 (0.66–1.06) [0.06] 0.88 (0.79–0.98)	Study centre, age, smoking status, education level, alcohol consumption, physical activity, height	WC also not associated with increased risk
		Prostate, high-grade Gleason score ≥ 7	BMI < 23.6 23.6–25.3 25.4–27 27.1–29.3 ≥ 29.4 [P_{trend}] continuous	580 total	 1.00 1.26 (0.96–1.65) 1.34 (1.02–1.76) 1.16 (0.87–1.54) 1.23 (0.92–1.65) [0.37] 1.04 (0.92–1.18)	Study centre, age, smoking status, education level, alcohol consumption, physical activity, height	WC also not associated with increased risk
Rapp et al. (2008) VHM&PP Austria 1985–2002	28 711 Incidence	Prostate ICD-10: C61	BMI change, annual < −0.1 −0.1– < 0.1 0.1– < 0.3 0.3– < 0.5 ≥ 0.5 [P_{trend}]	 164 317 231 72 12	 0.96 (0.79–1.16) 1.00 1.00 (0.85–1.19) 1.01 (0.78–1.31) 0.43 (0.24–0.76) [0.06]	Age, smoking status, blood glucose, occupational group, BMI at baseline	
Hernandez et al. (2009) Multiethnic Cohort USA 1993/1996–2002/2005	83 879 Incidence	Prostate, advanced	BMI at age 21 yr < 18.5 18.5–24.9 ≥ 25.0 [P_{trend}]	 41 475 86	 0.96 (0.69–1.35) 1.00 1.09 (0.85–1.40) [0.46]		No associations were observed with high grade either Inverse associations were observed with localized and with low-grade subtypes

Table 2.2.14a (continued)

Reference Cohort Location Follow-up period	Total number of subjects Incidence/ mortality	Organ site or cancer subtype (ICD code)	Exposure categories	Exposed cases	Relative risk (95% CI)	Covariates	Comments
Wallström et al. (2009) Malmö Diet and Cancer Study Sweden 1991–2005	11 063 Incidence	Prostate ICD-9: 185	BMI < 18.5 18.5–24.9 25–29.9 ≥ 30 [P_{trend}]	 8 287 417 105	 2.29 (1.13–4.63) 1.00 1.02 (0.88–1.19) 1.06 (0.84–1.33) [0.15]	Age, height, cohabitation status, SES, alcohol consumption, smoking, prevalent diabetes, physical activity, country of birth, total intake of eicosapentaenoic acid, docosahexaenoic acid, red meat, calcium	WC also not associated with increased risk
		Prostate, aggressive TNM: T3–T4, or N1 or M1, or Gleason score ≥ 8, or PSA > 50 ng/mL	BMI < 18.5 18.5–24.9 25–29.9 ≥ 30 [P_{trend}]	 4 102 140 35	 3.15 (1.15–8.62) 1.00 0.99 (0.76–1.29) 1.02 (0.69–1.52) [0.16]		WC also not associated with increased risk
		Prostate, non-aggressive Not stage T3–T4, or N1 or M1, or Gleason score ≥ 8, or PSA > 50 ng/mL	BMI < 18.5 18.5–24.9 25–29.9 ≥ 30 [P_{trend}]	 4 183 274 69	 0.84 (0.63–1.11) 1.00 1.16 (0.89–1.50) 1.11 (0.85–1.44) [0.65]		WC also not associated with increased risk
Whitlock et al. (2009) Prospective Studies Collaboration (pooled analysis of 57 cohorts from Europe, Japan, and the USA) Follow-up varied by cohort	894 576 Mortality	Prostate ICD-9: 185	BMI, per 5 kg/m^2 For BMI 15–25 For BMI 25–50 For BMI 15–50	 578 665	 1.00 (0.75–1.32) 1.09 (0.91–1.31) 1.13 (1.02–1.24)	Study, sex, age, smoking	

Table 2.2.14a (continued)

Reference Cohort Location Follow-up period	Total number of subjects Incidence/ mortality	Organ site or cancer subtype (ICD code)	Exposure categories	Exposed cases	Relative risk (95% CI)	Covariates	Comments
Andreotti et al. (2010) Agricultural Health Study USA 1993–2005	39 628 Incidence	Prostate	BMI			Race, smoking status, exercise, family history of prostate cancer	
			< 18.5	0	–		
			18.5–24.9	308	1.00		
			25–29.9	696	1.06 (0.89–1.27)		
			30–34.9	226	0.89 (0.71–1.13)		
			≥ 35	44	0.94 (0.61–1.44)		
			[P_{trend}]		[0.56]		
Burton et al. (2010) Glasgow Alumni Cohort United Kingdom 1948–1968 to 2009	9549 Incidence	Prostate ICD-9: 185 ICD-10: C61	BMI, young adult (age < 30 yr)			Smoking, SES, height	
			< 19	25	1.30 (0.84–1.99)		
			19–22.9	125	1.00		
			23–24.9	33	1.14 (0.78–1.68)		
			≥ 25	14	1.18 (0.68–2.06)		
			per 1 kg/m^2		1.00 (0.93–1.06)		
			[P_{trend}]		[0.89]		
	9549 Mortality	Prostate ICD-9: 185 ICD-10: C61	BMI, young adult (age < 30 yr)				
			< 19	14	1.58 (0.88–2.83)		
			19–22.9	59	1.00		
			23–24.9	21	1.52 (0.92–2.50)		
			≥ 25	8	1.43 (0.68–3.00)		
			per 1 kg/m^2		1.02 (0.93–1.11)		
			[P_{trend}]		[0.74]		
Stocks et al. (2010) Swedish Construction Worker Cohort Sweden 1971–2004	336 159 Mortality	Prostate ICD-7: 177	BMI			Birth cohort, smoking	No association of BMI with incidence of prostate (total), or aggressive prostate cancer subtypes. Significant negative association observed between BMI and incidence for non-aggressive prostate cancer subtype
			< 21.9	230	1.00		
			21.9– < 23.5	383	1.17 (1.00–1.39)		
			23.5– < 25	476	1.09 (0.93–1.27)		
			25– < 27	702	1.26 (1.08–1.46)		
			≥ 27	810	1.28 (1.11–1.49)		
			[P_{trend}]		[0.0004]		

Table 2.2.14a (continued)

Reference Cohort Location Follow-up period	Total number of subjects Incidence/ mortality	Organ site or cancer subtype (ICD code)	Exposure categories	Exposed cases	Relative risk (95% CI)	Covariates	Comments
Discacciati et al. (2011) Sweden 1998–2008	36 959 Incidence	Prostate, localized TNM: T1–2 and NX–0 and MX–0 or PSA < 20 ng/mL or Gleason score < 7	BMI at baseline			BMI at age 30 yr, age, energy intake, physical activity, education level, smoking, family history of prostate cancer, diabetes	
			< 21	62	0.78 (0.54–1.13)		
			21–22.9	245	1.00		
			23–24.9	401	1.00 (0.94–1.06)		
			25–27.4	467	0.95 (0.86–1.05)		
			27.5–29.9	204	0.88 (0.76–1.02)		
			≥ 30	124	0.71 (0.53–0.94)		
			BMI at age 30 yr				
			< 21	287	1.01 (0.91–1.12)		
			21–22.9	539	1.00		
			23–24.9	467	0.99 (0.94–1.05)		
			25–27.4	154	0.99 (0.89–1.10)		
			27.5–29.9	41	0.98 (0.82–1.16)		
			≥ 30	15	0.96 (0.69–1.34)		
			per 5 kg/m^2		0.98 (0.87–1.12)		
		Prostate, advanced TNM: T3–4 and NX–1 and MX–1 or PSA > 100 ng/mL or Gleason score > 7	BMI at baseline			BMI at age 30 yr, age, energy intake, physical activity, education level, smoking, family history of prostate cancer, diabetes	
			< 21	27	0.97 (0.85–1.10)		
			21–22.9	72	1.00		
			23–24.9	163	1.02 (0.95–1.08)		
			25–27.4	150	1.03 (0.90–1.18)		
			27.5–29.9	79	1.05 (0.85–1.31)		
			≥ 30	47	1.11 (0.73–1.68)		
			per 5 kg/m^2		1.04 (0.88–1.22)		
			BMI at age 30 yr				
			< 21	108	1.09 (0.92–1.29)		
			21–22.9	185	1.00		
			23–24.9	164	0.96 (0.88–1.04)		
			25–27.4	69	0.91 (0.77–1.09)		
			27.5–29.9	8	0.87 (0.65–1.15)		
			≥ 30	4	0.76 (0.44–1.30)		
			per 5 kg/m^2		0.90 (0.73–1.11)		

Table 2.2.14a (continued)

Reference Cohort Location Follow-up period	Total number of subjects Incidence/ mortality	Organ site or cancer subtype (ICD code)	Exposure categories	Exposed cases	Relative risk (95% CI)	Covariates	Comments
Discacciati et al. (2011) (cont.)	36 959 Mortality	Prostate	BMI at baseline < 21 21–22.9 23–24.9 25–27.4 27.5–29.9 ≥ 30 per 5 kg/m²	 11 35 62 59 29 23	 0.91 (0.75–1.11) 1.00 1.05 (0.95–1.16) 1.11 (0.89–1.36) 1.16 (0.83–1.63) 1.34 (0.70–2.55) 1.12 (0.87–1.43)	BMI at age 30 yr, age, energy intake, physical activity, education level, smoking, family history of prostate cancer, diabetes	BMI at age 30 yr also not associated with increased risk
Bassett et al. (2012) Melbourne Collaborative Cohort Study (MCCS) Australia 1990–2004 Same cohort as MacInnis et al. (2003)	16 525 Incidence	Prostate ICD-9: 185 ICD-10: C61	BMI at baseline < 18.5 18.5–22.9 23–24.9 ≥ 25 per 5 kg/m² [P_{trend}]	 111 259 757 247	 0.73 (0.59–0.91) 1.00 0.98 (0.85–1.12) 0.96 (0.80–1.15) 1.06 (0.97–1.17) [0.19]	Country of birth, education level	No associations were observed between weight at baseline, BMI or weight (kg) at age 18 yr, or WC, and prostate cancer risk (incidence)
		Prostate, non-aggressive Not Gleason score > 7, stage 4, or death from prostate cancer	BMI at baseline < 18.5 18.5–22.9 23–24.9 ≥ 25 per 5 kg/m² [P_{trend}]	 83 194 527 160	 0.73 (0.56–0.94) 1.00 0.91 (0.77–1.08) 0.83 (0.67–1.03) 0.99 (0.89–1.10) [0.83]	Country of birth, education level	No associations were observed between weight at baseline, BMI or weight (kg) at age 18 yr, or WC, and non-aggressive prostate cancer risk (incidence)
		Prostate, aggressive Gleason score > 7, stage 4, or death from prostate cancer	BMI at baseline < 18.5 18.5–22.9 23–24.9 ≥ 25 per 5 kg/m² [P_{trend}]	 28 65 230 87	 0.74 (0.47–1.15) 1.00 1.17 (0.89–1.54) 1.33 (0.96–1.84) 1.27 (1.08–1.49) [0.004]	Country of birth, education level	No associations were observed between weight at baseline, BMI or weight (kg) at age 18 yr, or WC, and aggressive prostate cancer risk (incidence)
	16 525 Mortality	Prostate ICD-9: 185 ICD-10: C61	BMI at baseline < 18.5 18.5–22.9 23–24.9 ≥ 25 per 5 kg/m² [P_{trend}]	 7 23 71 38	 0.53 (0.23–1.24) 1.00 0.95 (0.59–1.53) 1.52 (0.89–2.58) 1.49 (1.11–2.00) [0.01]	Country of birth, education level	Weight at baseline also associated with increased mortality No association was observed with BMI or weight at age 18 yr and mortality

Table 2.2.14a (continued)

Reference Cohort Location Follow-up period	Total number of subjects Incidence/ mortality	Organ site or cancer subtype (ICD code)	Exposure categories	Exposed cases	Relative risk (95% CI)	Covariates	Comments
Bhaskaran et al. (2014) Clinical Practice Research Datalink United Kingdom 1987–2012	2 379 320 Incidence	Prostate ICD-10: C61	BMI per 5 kg/m^2 [P_{trend}]	24 901 total	0.98 (0.95–1.00) [0.0042]	Age, diabetes, smoking, alcohol consumption, SES, calendar year, sex	No differences were found in non-smokers only
Barrington et al. (2015) Participants in the Selenium and Vitamin E cancer Prevention Trial (SELECT) USA 2001–2008	26 035 Incidence	Prostate	BMI < 25.0 25.0–27.5 27.5–29.9 30–34.9 35–50 [P_{trend}] BMI < 25.0 25.0–27.5 27.5–29.9 30–34.9 35–50 [P_{trend}]	Non-Hispanic White: 289 438 333 299 94 African American: 39 63 57 74 37 	 1.00 1.12 (0.97–1.30) 1.04 (0.89–1.22) 0.96 (0.82–1.13) 0.94 (0.74–1.19) [0.63] 1.28 (0.91–1.80) 1.67 (1.27–2.21) 1.64 (1.23–2.19) 1.68 (1.29–2.18) 1.90 (1.34–2.70) [0.03]	Age, education level, diabetes, smoking, family history of prostate cancer, study arm	For African Americans, BMI < 25.0 in Non-Hispanic Whites was taken as reference
	26 035 Incidence	Prostate, low-grade Gleason score 2–6	BMI < 25.0 25.0–27.5 27.5–29.9 30–34.9 35–50 [P_{trend}] BMI < 25.0 25.0–27.5 27.5–29.9 30–34.9 35–50 [P_{trend}]	Non-Hispanic White: 182 293 202 170 51 African American: 16 37 35 37 23 	 1.00 1.18 (0.98–1.42) 1.00 (0.82–1.22) 0.86 (0.70–1.06) 0.80 (0.58–1.09) [0.02] 0.80 (0.48–1.43) 1.47 (1.03–2.10) 1.52 (1.05–2.20) 1.27 (0.83–1.82) 1.77 (1.14–2.76) [0.05]	Age, education level, diabetes, smoking, family history of prostate cancer, study arm	

Table 2.2.14a (continued)

Reference Cohort Location Follow-up period	Total number of subjects Incidence/ mortality	Organ site or cancer subtype (ICD code)	Exposure categories	Exposed cases	Relative risk (95% CI)	Covariates	Comments
Barrington et al. (2015) (cont.)	26 035 Incidence	Prostate, high-grade Gleason score 7–10	BMI < 25.0 25.0–27.5 27.5–29.9 30–34.9 35–50 [P_{trend}] BMI < 25.0 25.0–27.5 27.5–29.9 30–34.9 35–50 [P_{trend}]	Non-Hispanic White: 84 115 101 104 37 African American: 11 19 17 29 12	 1.00 1.03 (0.78–1.37) 1.11 (0.83–1.49) 1.18 (0.88–1.58) 1.33 (0.90–1.97) [0.01] 1.32 (0.70–2.51) 1.94 (1.17–3.22) 1.87 (1.10–3.16) 2.53 (1.64–3.90) 2.39 (1.29–4.43) [0.02]	Age, education level, diabetes, smoking, family history of prostate cancer, study arm	
Fowke et al. (2015) Pooled analysis in Asia Cohort Consortium (ACC) Different Asian countries (1963–2001) to 2006	522 736 Mortality	Prostate	BMI 12–19.9 20–22.4 22.5–24.9 25–50 [P_{trend}]	 142 188 184 120	 0.98 (0.78–1.23) 0.92 (0.75–1.13) 1.00 1.08 (0.85–1.36) [0.58]	Age, education level, population density, marital status, history of severe cancer, heart disease, or stroke at baseline	Similar results were observed in stratified analyses by region
Meyer et al. (2015) Population-based Swiss cohort study Switzerland 1977–2008	35 703 in cohort, number of men NR Mortality	Prostate ICD-8: 185 ICD-10: C61	BMI < 25 25–29.9 ≥ 30	170 total	 1.00 1.45 (1.03–2.04) 1.54 (0.93–2.55)	Age, survey, alcohol consumption, physical activity, civil status, years of education, nationality, diet	Those who were overweight and who also smoked (ever smoking) had a higher risk

Table 2.2.14a (continued)

Reference Cohort Location Follow-up period	Total number of subjects Incidence/ mortality	Organ site or cancer subtype (ICD code)	Exposure categories	Exposed cases	Relative risk (95% CI)	Covariates	Comments
Møller et al. (2015) Diet, Cancer and Health Study Denmark 1993–2011	26 044 Incidence	Prostate	BMI 15.4–24.9 25–29.9 30–52.7 [P_{trend}]	 649 920 244	 1.00 0.94 (0.85–1.04) 0.86 (0.74–0.99) [0.03]	NR	WC showed no association with total prostate cancer incidence Inverse associations were observed with the upper quartile of body fat percentage (15% decreased risk)
		Prostate Stage 3–4	BMI 15.4–24.9 25–29.9 30–52.7 [P_{trend}]	 208 314 104	 1.00 1.00 (0.84–1.19) 1.14 (0.90–1.44) [0.37]	NR	WC also no associated with advanced prostate cancer incidence Positive associations were observed with the upper quartile of body fat percentage (31% increased risk)
	26 044 Mortality	Prostate	BMI 15.4–24.9 25–29.9 30–52.7 [P_{trend}]	 92 147 51	 1.00 1.10 (0.85–1.43) 1.27 (0.90–1.80) [0.19]	Stage at diagnosis	WC also not associated with increased mortality A positive association was observed with increasing body fat percentage
Møller et al. (2016) Health Professionals Follow-up Study USA 1986–2010	47 491 Incidence and mortality	Prostate	BMI at age 21 yr < 20 20–21.9 22–23.9 24–25.9 ≥ 26 [P_{trend}] per 5 kg/m^2	 825 1546 1852 1132 588	 0.99 (0.90–1.08) 1.00 0.98 (0.91–1.05) 0.92 (0.85–1.00) 0.89 (0.80–0.98) [0.01] 0.94 (0.89–0.98)	Age, calendar time, ethnicity, physical activity, energy intake, smoking, diabetes, family history of prostate cancer, PSA testing	When analysing cumulative BMI average, the significant decrease in risk persisted only in those younger than 65 yr

Table 2.2.14a (continued)

Reference Cohort Location Follow-up period	Total number of subjects Incidence/ mortality	Organ site or cancer subtype (ICD code)	Exposure categories	Exposed cases	Relative risk (95% CI)	Covariates	Comments
Møller et al. (2016) (cont.)	47 491 Incidence and mortality	Prostate, fatal	BMI at age 21 yr				BMI at age 21 yr also not associated with lethal subtypes (incident cases and deaths due to prostate cancer or distant metastases at diagnosis or during follow-up)
			< 20	94	0.83 (0.64–1.07)		
			20–21.9	181	1.00		
			22–23.9	177	0.92 (0.74–1.14)		
			24–25.9	88	0.74 (0.57–0.97)		
			≥ 26	51	0.77 (0.56–1.07)		
			[P_{trend}]		[0.20]		
			per 5 kg/m²		0.88 (0.75–1.02)		
		Prostate, high-grade Gleason score 8–10	BMI at age 21 yr				
			< 20	85	0.82 (0.63–1.07)		
			20–21.9	181	1.00		
			22–23.9	204	0.93 (0.75–1.15)		
			24–25.9	130	0.91 (0.72–1.16)		
			≥ 26	79	1.10 (0.83–1.45)		
			[P_{trend}]		[0.27]		
			per 5 kg/m²		1.03 (0.90–1.19)		
		Prostate, moderate-grade Gleason score 7	BMI at age 21 yr			Age, calendar time, ethnicity, physical activity, energy intake, smoking, diabetes, family history of prostate cancer, PSA testing	
			< 20	233	0.98 (0.83–1.15)		
			20–21.9	446	1.00		
			22–23.9	548	0.98 (0.86–1.11)		
			24–25.9	333	0.90 (0.78–1.04)		
			≥ 26	159	0.77 (0.64–0.93)		
			[P_{trend}]		[0.01]		
			per 5 kg/m²		0.87 (0.80–0.95)		
		Prostate, low-grade Gleason score 2–6	BMI at age 21 yr				
			< 20	333	1.01 (0.88–1.16)		
			20–21.9	620	1.00		
			22–23.9	735	0.94 (0.84–1.05)		
			24–25.9	465	0.90 (0.79–1.02)		
			≥ 26	236	0.88 (0.75–1.03)		
			[P_{trend}]		[0.03]		
			per 5 kg/m²		0.93 (0.87–1.01)		

BMI, body mass index (in kg/m²); BP, blood pressure; CI, confidence interval; EPIC, European Prospective Investigation into Cancer and Nutrition; ICD, International Classification of Diseases; N/A, not applicable; NIH-AARP, National Institutes of Health–AARP Diet and Health Study; NR, not reported; PSA, prostate-specific antigen; SD, standard deviation; SES, socioeconomic status; TNM, tumour–node–metastasis; VHM&PP, Vorarlberg Health Monitoring and Prevention Program; WC, waist circumference; yr, year or years

Table 2.2.14b Case–control studies of measures of body fatness and cancer of the prostate

Reference Study location Period	Total number of cases Source of controls	Exposure categories	Exposed cases	Relative risk (95% CI)	Adjustment for confounding	Comments
Putnam et al. (2000) USA 1986–1989	101 Population	BMI < 24.1 24.1–26.6 > 26.6 BMI change (%) from age 20 yr > 5% loss 5% loss to 5% gain 5.1–10.0% gain 10.1–15.0% gain > 15.0% gain Weight (kg) < 74.8 74.8–83.9 > 83.9	 27 31 38 1 12 15 14 51 22 41 33	 1.0 1.0 (0.6–1.7) 1.3 (0.8- 2.2) 0.2 (0.02–1.5) 1.0 1.3 (0.6–2.7) 1.0 (0.5–1.9) 1.3 (0.8–2.2) 1.0 1.4 (0.8–2.3) 1.2 (0.7–2.1)	Age	
Sharpe & Siemiatycki (2001) Canada 1979–1985	399 Population	BMI < 24.05 24.05–26.66 > 26.66	 127 128 141	 0.87 (0.6–1.22) 1.00 1.14 (0.81–1.61)	Age, ethnicity, respondent status, family income, alcohol consumption	
Giles et al. (2003) Australia 1994–1998	1476 Population	BMI at age 21 yr < 20.5 20.5–22.1 22.2–23.9 > 23.9	 353 372 337 332	 1.00 0.99 (0.79–1.23) 0.96 (0.76–1.20) 1.10 (0.88–1.39)	Age, country of birth, family history of prostate cancer, study centre, calendar year	No associations were observed for weight or WC at age 21 yr
Irani et al. (2003) France 1993–1999	194 Hospital	BMI < 29 > 29	NR	 1.00 2.47 (1.41–4.34)	Age	

Table 2.2.14b (continued)

Reference Study location Period	Total number of cases Source of controls	Exposure categories	Exposed cases	Relative risk (95% CI)	Adjustment for confounding	Comments
Dal Maso et al. (2004) Italy 1991–2002	1294 Hospital	BMI at baseline			Age, study centre, education level, physical activity, family history of prostate cancer	No associations were observed between weight (kg), waist-to-hip ratio, or lean body mass and prostate cancer. When stratified by grade, associations of BMI at diagnosis were only significant with prostate cancer of Gleason score 7–10 (384 cases, $P_{trend} < 0.01$)
		< 24.22	301	1.00		
		24.22–26.18	346	1.18 (0.95–1.47)		
		26.18–28.41	324	1.12 (0.89–1.40)		
		≥ 28.41	319	1.18 (0.94–1.47)		
		[P_{trend}]		[0.23]		
		BMI at age 30 yr				
		< 22.65	406	1.00		
		22.65–24.69	437	1.33 (1.09–1.62)		
		≥ 24.69	414	1.22 (1.01–1.48)		
		[P_{trend}]		[0.004]		
Friedenreich et al. (2004) Canada 1997–2000	988 Population	BMI, quartiles			Age, region, education level, average lifetime total alcohol intake, first-degree family history of prostate cancer, number of times had PSA test done, number of digital rectal exams, total lifetime physical activity	
		Q1	252	1.00		
		Q2	236	0.95 (0.74–1.23)		
		Q3	245	0.98 (0.76–1.26)		
		Q4	254	1.07 (0.83–1.38)		
		[P_{trend}]		[0.57]		
		Weight, quartiles				
		Q1	268	1.00		
		Q2	233	0.93 (0.72–1.21)		
		Q3	262	1.00 (0.78–1.28)		
		Q4	224	0.91 (0.70–1.18)		
		[P_{trend}]		[0.18]		
		Weight gain (kg) since age 20 yr				
		< 4.54	241	1.00		
		4.54–13.6	286	1.14 (0.89–1.47)		
		13.6–20.4	238	1.05 (0.82–1.36)		
		≥ 20.4	215	0.91 (0.70–1.19)		
		[P_{trend}]		[0.26]		

Table 2.2.14b (continued)

Reference Study location Period	Total number of cases Source of controls	Exposure categories	Exposed cases	Relative risk (95% CI)	Adjustment for confounding	Comments
Pan et al. (2004) Canada 1994–1997	1801 Population	BMI < 25 25–30 ≥ 30 [P_{trend}]		 1.00 1.16 (0.94–1.43) 1.27 (1.09–1.47) [0.026]	Age group, province of residence, education level, pack-years of smoking, alcohol consumption, total energy intake, vegetable intake, dietary fibre intake, recreational physical activity	
Liu et al. (2005) USA NR	439 Population (sibling-based)	BMI, quartiles Q1 Q2 Q3 Q4 [P_{trend}] LBM, quartiles Q1 Q2 Q3 Q4 [P_{trend}]	 106 112 110 106 LBM > 66.3: 113 104 114 103	 1.00 1.57 (0.85–2.89) 1.43 (0.78–2.61) 0.91 (0.49–1.70) [0.73] 1.00 0.58 (0.31–1.08) 0.43 (0.22–0.81) 0.41 (0.20–0.84) [0.02]	Age, education, calorie intake	Results are presented for high-aggressiveness prostate cancer (Gleason score ≥ 7, or tumour stage T2C or greater)
Porter & Stanford (2005) USA 1993–1996	753 Population	BMI 18–24.4 24.4–26.5 26.5–29.1 29.1–55 [P_{trend}] Weight (kg) < 77.2 77.2–85.8 85.9–95.3 > 95.3 [P_{trend}]	 195 202 178 178 175 222 193 163	 1.00 1.04 (0.78–1.39) 0.85 (0.64–1.14) 0.91 (0.66–1.21) [0.04] 1.00 0.96 (0.70–1.30) 0.77 (0.56–1.06) 0.74 (0.53–1.03) [0.03]	Age, race, education level, smoking, family history of prostate cancer, prostate cancer screening, dietary fat, energy intake	
Robinson et al. (2005) USA 1997–2000	568 Population	BMI at age 20–29 yr < 25.0 25.0–29.9 ≥ 30.0	 361 191 12	 1.00 1.13 (0.87–1.47) 0.40 (0.20–0.81)	Age, race, family history of prostate cancer, saturated fat intake	This study evaluated the association with advanced prostate cancer

Table 2.2.14b (continued)

Reference Study location Period	Total number of cases Source of controls	Exposure categories	Exposed cases	Relative risk (95% CI)	Adjustment for confounding	Comments
Wuermli et al. (2005) Switzerland 1997–2002	504 Hospital	BMI < 30 > 30	NR	 1.00 0.97 (0.93–1.01)	Age, BMI, diabetes, lipid-lowering drugs	
Cox et al. (2006) New Zealand 1996–1998	550 Population	BMI 5 yr before interview, quintiles Q1 Q2 Q3 Q4 Q5	 50 40 105 122 233	 1.0 0.9 (0.5–1.6) 0.8 (0.6–1.2) 0.9 (0.6–1.3) 0.9 (0.6–1.3)	Age	No associations were observed between BMI or weight at age 20 yr and prostate cancer
Beebe-Dimmer et al. (2007) USA 1996–2002	139 Population (community-based)	WC (cm) ≤ 102 > 102	59	 1.00 1.84 (1.17–2.91)	Age, smoking history	
Gallus et al. (2007) Italy 1991–2002	219 Hospital	BMI < 24.84 24.84–27.76 ≥ 27.77 [P_{trend}]	 69 80 70	 1.0 1.3 (0.8–2.0) 1.2 (0.8–1.9) [0.38]	Age, education level, study centre, occupational physical activity, family history of prostate cancer	
Máchová et al. (2007) Czech Republic 1987–2002	338 Population	BMI 18.5–< 25 25–30 ≥ 30	NR	 1.00 1.05 (0.72–1.39) 0.97 (0.66–1.41)	Age, smoking, hypertension, height	
Nagata et al. (2007) Japan 1996–2003	200 Hospital	BMI 1 yr before diagnosis < 23.0 23.0–24.9 > 25.0 [P_{trend}]	 81 60 59	 1.00 1.28 (0.87–1.87) 1.06 (0.72–1.55) [0.65]	Smoking	BMI at age 40–45 yr not associated with increased risk of prostate cancer
Magura et al. (2008) USA 2004–2006	312 Hospital	BMI < 25 ≥ 25	30 282	 1.00 1.04 (0.58–1.85)	Age, family history of prostate cancer, type 2 diabetes, smoking, use of multivitamins, use of statins	

Table 2.2.14b (continued)

Reference Study location Period	Total number of cases Source of controls	Exposure categories	Exposed cases	Relative risk (95% CI)	Adjustment for confounding	Comments
Beebe-Dimmer et al. (2009) USA 2001–2004	637 Hospital	BMI < 30 ≥ 30	 – 208	 1.00 0.51 (0.33–0.80)	Age, PSA screening history, hypertension, diabetes, low HDL, high triglycerides	Inverse association was observed only in Caucasians (n = 494). No association observed in African Americans (n = 381)
Hosseini et al. (2010) Islamic Republic of Iran 2005–2008	137 Population	BMI ≤ 25 > 25	 105 35	 1.0 0.4 (0.2–0.8)	Age, family history of prostate cancer, history of other cancers, history of prostatitis, alcohol consumption, smoking, physical activity	[Discrepancy in the number of reported cases]
Jackson et al. (2010) Jamaica 2005–2007	243 Hospital	BMI, quartiles Q4 vs Q1 (ref) [P_{trend}] WC, tertiles T3 vs T1 (ref) [P_{trend}] Waist-to-hip ratio < 0.95 ≥ 0.95	NR	 0.90 (0.42–1.91) [0.28] 5.57 (1.43–18.63) [0.008] 1.00 2.94 (1.34–6.38)	BMI: age, education level, medical history, first-degree family history of prostate cancer, smoking, physical activity WC and waist-to-hip ratio: age, height and BMI as continuous; education level, current smoker, physical activity	Results are presented for high-grade cancer (Gleason score ≥ 7) 12% of the cases were obese
Dimitropoulou et al. (2011) United Kingdom 2001–2008	960 Population	BMI < 25.0 25.0–29.9 > 30.0 [P_{trend}] WC, tertiles T1 T2 T3 [P_{trend}]	 264 481 174 385 286 289	 1.00 0.98 (0.82–1.16) 0.83 (0.67–1.03) [0.097] 1.00 1.01 (0.85–1.20) 0.94 (0.80–1.12) [0.517]	Age, family history of prostate cancer	
Ganesh et al. (2011) India 1999–2001	123 Hospital	BMI < 25 ≥ 25	 41 76	 1.0 2.1 (1.1–4.4)	Age, religion, education level, hypertension	

Table 2.2.14b (continued)

Reference Study location Period	Total number of cases Source of controls	Exposure categories	Exposed cases	Relative risk (95% CI)	Adjustment for confounding	Comments
Mori et al. (2011) Japan 2007–2008	117 Population	BMI < 21.0 21.0–22.9 23.0–24.9 ≥ 25.0 [P_{trend}] Weight (kg) < 55 55.0–64.9 65.0–74.9 ≥ 75.0 Weight gain (kg) in adult life < 5 5.0–9.9 10.0–14.9 ≥ 15	 14 29 41 33 7 52 45 13 18 24 43 32	 1.00 1.05 (0.50–2.21) 1.63 (0.77–3.45) 1.39 (0.66–2.96) [0.07] 1.00 1.49 (0.57–3.85) 1.74 (0.65–4.64) 1.64 (0.55–4.91) 1.00 1.22 (0.58–2.55) 3.55 (1.71–7.39) 1.73 (0.83–3.59)	Dietary intake, physical activity, smoking, alcohol consumption	BMI of 23–25 at age 20 yr associated with a 53% reduced risk (based on 11 cases) No associations between body weight at age 20 yr and prostate cancer risk
Pelucchi et al. (2011) Italy 1991–2002	1294 Hospital	BMI < 28 ≥ 28 WC (cm) < 94 ≥ 94 Abdominal obesity (combined WC, BMI) No Yes	 909 381 242 730 470 820	 1.00 0.98 (0.83–1.17) 1.00 1.13 (0.91–1.40) 1.00 1.02 (0.86–1.21)	Age, study centre, education level, smoking, alcohol consumption, physical activity, family history of prostate cancer, non-alcohol energy intake	
Fowke et al. (2012) USA NR	809 Hospital	BMI per 1 kg/m² increase WC per 1 cm increase	 135 135	 1.04 (1.00–1.08) 1.01 (0.99–1.03)	Age, PSA, prostate volume, race, family history of prostate cancer, current treatment for diabetes, benign prostatic hyperplasia, CVD, or hyperlipidaemia	Results are presented for high-grade (Gleason score 8–10) prostate cancer

Table 2.2.14b (continued)

Reference Study location Period	Total number of cases Source of controls	Exposure categories	Exposed cases	Relative risk (95% CI)	Adjustment for confounding	Comments
Nemesure et al. (2012) Barbados 2002–2011	963 Population	WC (cm), quartiles Q1: < 84 Q2: 84–92 Q3: 92–99 Q4: ≥ 99	NR	 1.00 1.36 (1.01–1.85) 1.67 (1.14–2.44) 1.84 (1.19–2.85)	Age, marital status, religion, occupation, smoking, family history of prostate cancer, BMI	Study in African Barbadian population. When stratifying by high-grade (n = 434) vs low-grade (n = 480) prostate cancer, the associations were not significant in either group
Möller et al. (2013) Sweden 2001–2002	1499 Population	BMI < 22.5 22.5– < 25 25– < 27.5 ≥ 27.5 per 5 kg/m^2 [P_{trend}]	 382 655 295 120	 1.00 0.94 (0.76–1.15) 0.90 (0.71–1.15) 0.96 (0.69–1.33) 0.98 (0.83–1.16) [0.54]	Age, region of residence, time span between first and last recalled weight	No associations with BMI when stratifying by low- and intermediate-grade vs high-grade prostate cancer No significant associations with BMI at age 20 yr
Bashir et al. (2014) Pakistan 2012–2013	140 Hospital	BMI ≤ 25 > 25	 66 74	 1.00 5.78 (2.67–12.6)	Age, lifestyle (physical activity), family history of prostate cancer, smoking, diet	
Agalliu et al. (2015) Nigeria 2011–2012	50 Hospital	BMI < 25 25–29.9 ≥ 30 Weight (kg) per kg increase WC (cm) per cm increase	 21 21 8	 1 1.39 (0.59–3.28) 1.35 (0.42–4.36) 0.97 (0.94–1.00) 0.91 (0.87–0.96)	Age	
Alvarez-Cubero et al. (2015) Spain 2011–2014	100 Hospital	BMI ≥ 30 vs < 30	31	1.65 (0.36–7.57)	Age, residential area, family history of prostate cancer	

Table 2.2.14b (continued)

Reference Study location Period	Total number of cases Source of controls	Exposure categories	Exposed cases	Relative risk (95% CI)	Adjustment for confounding	Comments
Boehm et al. (2015) Canada 2005–2012	1933 Population	BMI < 25 25–29.9 ≥ 30 WC (cm) < 102 ≥ 102	 649 922 351 1073 711	 1.00 0.87 (0.74–1.01) 0.72 (0.60–0.87) 1.00 1.03 (0.89–1.19)	Age, ancestry, first-degree family history of prostate cancer, annual physician visits, number of PSA tests within 5 yr before index date	No associations were observed with waist-to-hip ratio
Gerdtsson et al. (2015) Sweden 1974–1996	1355 Population	Weight at age 16–22 yr per 5 kg increase BMI at age 44–50 yr per 5 kg increase Weight at age 44–50 yr per 5 kg increase		Incidence: 1.05 (1.01–1.09) Mortality: 1.08 (1.03–1.13) Mortality: 1.11 (1.03–1.19)		No associations were observed with BMI or weight at age 44–50 yr and prostate cancer risk BMI and weight at age 44–50 yr also associated with metastasis
Zhang et al. (2015) China 2013–2014	101 Hospital	BMI < 24 ≥ 24	 35 66	 1.00 2.51 (0.18–9.52)	WC, BP, triglyceride levels, free blood glucose	

BMI, body mass index (in kg/m^2); BP, blood pressure; CI, confidence interval; CVD, cardiovascular disease; HDL, high-density lipoprotein; LBM, lean body mass; NR, not reported; PSA, prostate-specific antigen; SD, standard deviation; WC, waist circumference; yr, years or years

Table 2.2.14c Meta-analyses of measures of body fatness and cancer of the prostate

Reference	Total number of studies Total number of cases	Organ site or cancer subtype	Exposure categories	Relative risk (95% CI)	Adjustment for confounding	Comments
Bergström et al. (2001)	6 observational studies (4 cohort and 2 case–control) 4592	Prostate	BMI per 1 kg/m^2 increase	1.01 (1.00–1.02)	Different adjustment by study, some non-adjusted	
MacInnis & English (2006)	43 observational studies (22 cohort and 21 case–control) (9 studies for WC) 68 753	Prostate	BMI per 5 kg/m^2 increase	1.05 (1.01–1.08)	Different adjustment by study	No associations were found with WC
Renehan et al. (2008)	27 prospective studies 70 421	Prostate	BMI per 5 kg/m^2 increase	1.03 (1.00–1.07)		Between-study heterogeneity of I^2 = 73% No differences in the results were observed by region (Asia-Pacific, Australia, Europe, North America)
Robinson et al. (2008)	9 cohort studies and 7 case–control studies NR	Prostate	BMI before age 29 yr, per 5 kg/m^2 increase	Cohort: 1.08 (0.97–1.19) Case–control: 1.07 (0.98–1.17)	Age for all; other factors depending on the study	
Guh et al. (2009)	7 cohort studies NR	Prostate	BMI Normal Overweight Obesity	 1.00 1.14 (1.00–1.31) 1.05 (0.85–1.30)	NR	
Esposito et al. (2013)	13 observational studies (cohort and case–control) 4634	Prostate	BMI High vs low	 1.05 (0.97–1.15)	NR	[Cut-off values differ by study]
WCRF/AICR (2014) Continuous Update Project	24 prospective studies for BMI, 4 for WC 11 149	Prostate, advanced	BMI per 5 kg/m^2 increase WC per 10 cm increase	1.08 (1.04–1.12) 1.12 (1.04–1.21)	NR	Advanced prostate cancer includes advanced, high-grade, and fatal prostate cancers

Table 2.2.14c (continued)

Reference	Total number of studies Total number of cases	Organ site or cancer subtype	Exposure categories	Relative risk (95% CI)	Adjustment for confounding	Comments
Keum et al. (2015)	4 prospective studies 6882	Prostate	Weight gain per 5 kg increase	0.98 (0.94–1.02)	Age and baseline BMI or weight in all, and different additional covariates depending on the study	
		Prostate, localized	Weight gain per 5 kg increase	0.96 (0.92–1.00)		
		Prostate, advanced	Weight gain per 5 kg increase	1.04 (0.99–1.09)		
			WC per 10 cm increase	1.03 (0.99–1.07)		
Chen et al. (2016)	9 observational studies (5 cohort, 1 nested case–control, and 3 case–control) 22 338	All Low- and intermediate-grade High-grade Fatal	Adult weight per 5 kg increase	1.01 (0.94–1.08) 0.97 (0.87–1.07) 1.13 (1.00–1.28) 1.58 (1.01–2.47)	Age (in all studies except one) and different covariates depending on the study	

BMI, body mass index (in kg/m^2); CI, confidence interval; NR, not reported; WC, waist circumference; WCRF/AICR, World Cancer Research Fund/American Institute for Cancer Research; yr, years or years

Table 2.2.14d Mendelian randomization studies of measures of body fatness and cancer of the prostate

Reference Study	Characteristics of study population	Sample size	Exposure (unit)	Odds ratio (95% CI) and *P* value (with each unit increase in exposure) of the association between the exposure and outcome(s)	Adjustment for confounding
Lewis et al. (2010) Prostate Testing for Cancer and Treatment Study (ProtecT)	Men aged 50–69 yr from 300 general practices across 9 regions in the United Kingdom	4540 (1550 cases and 2990 controls)	BMI per 1 kg/m² increase per 1 kg/m² increase	All: 0.77 (0.52–1.15) *P* = 0.20 High-grade vs low-grade: 1.35 (0.90–2.03) *P* = 0.15	Age, centre
Davies et al. (2015) Prostate Cancer Association Group to Investigate Cancer-Associated Alterations in the Genome (PRACTICAL) Consortium	19 independent studies of individuals of European descent	41 062 (20 848 cases and 20 214 controls)	Increase of 1 SD in genetically predicted BMI	0.98 (0.96–1.00) *P* = 0.07	8 principal components of population stratification
Gao et al. (2016) Genetic Associations and Mechanisms in Oncology (GAME-ON) Consortium	6 studies of individuals of European ancestry	26 884 (14 160 cases and 12 724 controls)	Increase of 1 SD in genetically predicted BMI (~0.073 kg/m²) Childhood BMI: Adult BMI:	 All: 1.01 (0.83–1.22) *P* = 0.91 Aggressive: 1.10 (0.83–1.45) *P* = 0.49 All: 1.00 (0.96–1.04) *P* = 0.97 Aggressive: 1.02 (0.96–1.08) *P* = 0.44	N/A

BMI, body mass index (in kg/m²); CI, confidence interval; N/A, not applicable; SD, standard deviation; vs, versus; yr, years or years

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