

BODY FATNESS AND WEIGHT GAIN AND THE RISK OF CANCER

WCRF/AICR GRADING		DECREASES RISK		INCREASES RISK	
		Exposure	Cancer site	Exposure	Cancer site
STRONG EVIDENCE	Convincing			Adult body fatness	Oesophagus (adenocarcinoma) 2016 ¹ Pancreas 2012 ¹ Liver 2015 ² Colorectum 2017 ¹ Breast (postmenopause) 2017 ^{1,3} Endometrium 2013 ^{4,5} Kidney 2015 ¹
				Adult weight gain	Breast (postmenopause) 2017 ³
	Probable	Adult body fatness	Breast (premenopause) 2017 ^{1,3}	Adult body fatness	Mouth, pharynx and larynx 2018 ¹ Stomach (cardia) 2016 ² Gallbladder 2015 ^{2,7} Ovary 2014 ^{2,5,8} Prostate (advanced) 2014 ^{1,9}
		Body fatness in young adulthood	Breast (premenopause) 2017 ^{3,6} Breast (postmenopause) 2017 ^{3,6}		
LIMITED EVIDENCE	Limited – suggestive			Adult body fatness	Cervix (BMI ≥ 29 kg/m ²) 2017 ^{2,5}
STRONG EVIDENCE	Substantial effect on risk unlikely	None identified			

- 1 Conclusions for adult body fatness and cancers of the following types were based on evidence marked by body mass index (BMI), waist circumference and waist-hip ratio: mouth, pharynx and larynx; oesophagus (adenocarcinoma); pancreas; colorectum; breast (pre and postmenopause); prostate (advanced); and kidney.
- 2 Conclusions for adult body fatness and cancers of the following types were based on evidence marked by BMI: stomach (cardia), gallbladder, liver, ovary and cervix (BMI ≥ 29 kg/m²).
- 3 Evidence for the link between body fatness, weight gain and breast cancer is presented separately for the risk of pre and postmenopausal breast cancer because of the well-established effect modification by menopausal status.
- 4 The conclusion for adult body fatness and endometrial cancer was based on evidence marked by BMI (including BMI at age 18 to 25 years), weight gain, waist circumference and waist-hip ratio.
- 5 There is no evidence of effect modification by menopausal status for body fatness and the risk of endometrial, ovarian or cervical cancer so the evidence for all women (irrespective of menopausal status) is presented together.
- 6 Evidence for body fatness in young adulthood and breast cancer (pre and postmenopause) comes from women aged about 18 to 30 years and includes evidence marked by BMI.
- 7 Adult body fatness may act indirectly, through gallstones, or directly, either after gallstone formation or in their absence, to cause gallbladder cancer. It is not yet possible to separate these effects.
- 8 The effect of adult body fatness on the risk of ovarian cancer may vary according to tumour type, menopausal hormone therapy use and menopausal status.
- 9 The effect of adult body fatness on the risk of prostate cancer was observed in advanced, high-grade and fatal prostate cancers.

Cancer	Measure	Total no. of studies	No. of studies in meta-analysis	No. of cases	Risk estimate (95% confidence intervals [CI])	Increment	I ² (%)	Conclusion ¹	Date of CUP cancer report ²
Oesophagus (adenocarcinoma)	BMI	9	9	1,725	1.48 (1.35–1.62)	5 kg/m ²	37	Convincing: Increases risk	2016
	Waist circumference	2	2	335	1.34 (1.17–1.52)	10 cm	10		
	Waist-hip ratio	3	3	380	1.38 (1.10–1.73)	0.1 unit	27		
Pancreas	BMI (cancer incidence)	30	23	9,504	1.10 (1.07–1.14)	5 kg/m ²	19	Convincing: Increases risk	2012
	BMI (cancer mortality)	30	7	8,869	1.10 (1.02–1.19)	5 kg/m ²	61		
	Waist circumference	5	5	949	1.11 (1.05–1.18)	10 cm	0		
	Waist-hip ratio	4	4	1,047	1.19 (1.09–1.31)	0.1 unit	11		
Liver	BMI	15	12	14,311	1.30 (1.16–1.46)	5 kg/m ²	78	Convincing: Increases risk	2015
Colorectum	BMI	57	38	71,089	1.05 (1.03–1.07)	5 kg/m ²	74	Convincing: Increases risk	2017
	Waist circumference	13	8	4,301	1.02 (1.01–1.03)	10 cm	0		
	Waist-hip ratio	6	4	2,564	1.02 (1.01–1.04)	0.1 unit	17		
Breast (postmenopausal) ³	BMI	156	56	80,404	1.12 (1.09–1.15)	5 kg/m ²	74	Convincing: Increases risk	2017
	Waist circumference	27	11	14,033	1.11 (1.09–1.13)	10 cm	0		
	Waist-hip ratio	29	18	15,643	1.10 (1.05–1.16)	0.1 unit	60		
Endometrium ⁴	BMI	34	26	18,717	1.50 (1.42–1.59)	5 kg/m ²	86	Convincing: Increases risk	2013
	BMI (age 18 to 25 years)	8	7	3,476	1.42 (1.22–1.66)	5 kg/m ²	79		
	Weight gain	5	5	1,971	1.16 (1.10–1.22)	5 kg	66		
	Waist circumference	4	4	1,641	1.13 (1.08–1.18)	5 cm	71		
	Waist-hip ratio	5	5	2,330	1.21 (1.13–1.29)	0.1 unit	0		
Kidney	BMI	28	23	15,575	1.30 (1.25–1.35)	5 kg/m ²	39	Convincing: Increases risk	2015
	Waist circumference	3	3	751	1.11 (1.05–1.19)	10 cm	0		
	Waist-hip ratio	4	3	751	1.26 (1.18–1.36)	0.1 unit	0		
Mouth, pharynx and larynx ⁵	BMI	20	20	796	1.15 (1.06–1.24)	5 kg/m ²	–	Probable: Increases risk	2018
Stomach (cardia)	BMI	10	7	2,050	1.23 (1.07–1.40)	5 kg/m ²	56	Probable: Increases risk	2016
Gallbladder ⁶	BMI	11	8	6,004	1.25 (1.15–1.37)	5 kg/m ²	52	Probable: Increases risk	2015
Ovary ^{4,7}	BMI	26	25	15,899	1.06 (1.02–1.11)	5 kg/m ²	55	Probable: Increases risk	2014
Prostate (advanced) ⁸	BMI	24	23	11,149	1.08 (1.04–1.12)	5 kg/m ²	19	Probable: Increases risk	2014
	Waist circumference	5	4	1,781	1.12 (1.04–1.21)	10 cm	15		
	Waist-hip ratio	4	4	1,781	1.15 (1.03–1.28)	0.1 unit	0		
Cervix ^{4,9}	BMI	10	9	5,144	1.02 (0.97–1.07)	5 kg/m ²	69	Limited – suggestive: Increases risk	2017
Breast (premenopausal) ³	BMI	128	37	16,371	0.93 (0.90–0.97)	5 kg/m ²	55	Probable: Decreases risk	2017
	Waist circumference	6	6	2,423	0.99 (0.95–1.04)	10 cm	0		
	Waist-hip ratio	11	11	3,465	1.06 (0.98–1.16)	0.1 unit	27		
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Summary of published pooled analyses of body mass index and the risk of oesophageal adenocarcinoma

Publication	Increment	RR (95% CI)	I ² (%)	No. of studies	No. of cases
Me-Can [107]	5 kg/m ²	1.78 (1.45–2.17)	–	7 cohort	114
BEACON Consortium [108]	1 kg/m ²	1.09 (1.06–1.12)	76	2 cohort, 10 case-control	1,897

Summary of published pooled analyses of body mass index and the risk of pancreatic cancer

Publication	Increment/ contrast	RR (95% CI)	I ² (%)	No. of studies	No. of cases
Pooling Project of Prospective Studies on Diet and Cancer [142]	5 kg/m ²	1.14 (1.07–1.21)	–	14 cohort	2,135 diagnoses
National Cancer Institute pooled analysis [144]	5 kg/m ²	1.08 (1.03–1.14)	0	7 cohort	2,454 diagnoses
Asia-Pacific Cohort Studies Collaboration [145]	5 kg/m ²	1.02 (0.83–1.25)	–	39 cohort	301 deaths
Pancreatic Cancer Cohort Consortium (PanScan) [143]	BMI > 35 vs 18.5–24.9 kg/m ²	1.55 (1.16–2.07) ¹	–	12 cohort, 1 case-control	2,095 diagnoses

Summary of published pooled analyses of waist circumference and the risk of pancreatic cancer

Publication	Contrast	RR (95% CI)	I ² (%)	No. of studies (cohort)	No. of cases
Pooling Project of Prospective Studies on Diet and Cancer [142]	Highest vs lowest	1.16 (0.92–1.46)	10	7	743
	Highest vs lowest (additionally adjusted for BMI)	1.04 (0.73–1.47)	26		
Pancreatic Cancer Cohort Consortium (PanScan) [143]	Highest vs lowest	1.23 (0.94–1.62) ptrend = 0.04	–	6	812

Summary of published pooled analyses of waist-hip ratio and the risk of pancreatic cancer

Publication	Contrast	RR (95% CI)	I ² (%)	No. of studies (cohort)	No. of cases
Pooling Project of Prospective Studies on Diet and Cancer [142]	Highest vs lowest	1.35 (1.03–1.78)	0	6	552
	Highest vs lowest (additionally adjusted for BMI)	1.34 (1.00–1.79)	0		
Pancreatic Cancer Cohort Consortium (PanScan) [143]	Highest vs lowest	1.71 (1.27–2.30)	–	6	750

Summary of published pooled analyses of body mass index and the risk of liver cancer

Publication	Increment/contrast	RR (95% CI)	No. of studies (cohort)	No. of cases
Asia-Pacific Cohort Studies Collaboration [165]	≥ 25 vs 18.5–22.9 kg/m ²	1.27 (0.93–1.74)	44	420 deaths
Prospective Studies Collaboration [163]	5 kg/m ²	1.47 (1.26–1.71)	57	422 deaths
Asia-Pacific Cohort Studies Collaboration [145]	30–60 vs 18.5–24.9 kg/m ²	1.10 (0.63–1.91)	39	744 deaths
	5 kg/m ²	1.11 (0.63–1.91)		
European cohorts [164]	Highest vs lowest quintile (median) BMI 31.3 vs 20.7 kg/m ²	1.92 (1.23–2.96)	7	266 diagnoses

Summary of published pooled analyses of body mass index and the risk of postmenopausal breast cancer

Publication	Increment/contrast	RR (95% CI)	No. of studies (cohort)	No. of cases
The Metabolic Syndrome and Cancer Project (Me-Can) [253]	≥ 31.7 vs ≤ 20 kg/m ²		6	
	Incidence	0.87 (0.71–1.07)		1,106 diagnoses
	Mortality	0.92 (0.66–1.27)		219 deaths
Asia-Pacific Cohort Studies Collaboration (APCSC) [145]	Mortality		35	324 deaths
	30–60 vs 18.5–24.9 kg/m ²	1.63 (1.13–2.35)		
	5 kg/m ²	1.19 (1.03–1.38)		
The Australia and New Zealand Diabetes and Cancer Collaboration (ANZDCC) [254]	1 SD	1.06 (1.01–1.12)	10	1,323 diagnoses

Summary of published pooled analyses of waist circumference and the risk of postmenopausal breast cancer

Publication	Increment	RR (95% CI)	No. of studies	No. of cases
The Australia and New Zealand Diabetes and Cancer Collaboration (ANZDCC) [254]	1 SD	1.06 (1.01–1.12)	10 cohort	1,323 diagnoses

Summary of published pooled analyses of waist-hip ratio and the risk of postmenopausal breast cancer

Publication	Increment	RR (95% CI)	No. of studies	No. of cases
The Australia and New Zealand Diabetes and Cancer Collaboration (ANZDCC) [254]	1 SD	1.06 (0.95–1.07)	10 cohort	1,323

Summary of published pooled analyses of body mass index and the risk of kidney cancer

Publication	Increment/contrast	RR (95% CI)	No. of studies (cohort)	No. of cases
Asia-Pacific Cohort Studies Collaboration [145]	BMI \geq 30 vs 18.5–24.9 kg/m ²	1.59 (0.78–3.24)	39	93 deaths
	5 kg/m ²	1.20 (0.86–1.66)		
Metabolic Syndrome and Cancer Project – Me-Can project [317]	BMI 31.7 vs 21.5 kg/m ² (men)	1.51 (1.13–2.03)	7	592 diagnoses
	BMI 31.7 vs 20.0 kg/m ² (women)	2.21 (1.32–3.70)	7	263 diagnoses
Prospective Studies Collaboration [163]	5 kg/m ²	1.23 (1.06–1.43)	57	422 deaths

Summary of published pooled analysis [97] of body mass index and the risk of head and neck cancer

Publication	No. of cases	HR (95% CI) Obese (≥ 30.0) vs. 21 to <23 kg/m ²	HR (95% CI) Underweight (15.0 to 20.9) vs. 21.0 to <23 kg/m ²	HR (95% CI) per 5 kg/m ²	P _{trend}
All	3,760	0.85 (0.76–0.96)	1.28 (1.11–1.46)	0.94 (0.90–0.98)	0.003
People who have never smoked	796	1.40 (1.08–1.81)	1.17 (0.85–1.61)	1.15 (1.06–1.24)	0.0006
People who smoke	1,508	0.58 (0.47–0.72)	1.30 (1.08–1.57)	0.76 (0.71–0.82)	<0.0001
People who used to smoke	1,367	0.96 (0.79–1.18)	1.24 (0.94–1.63)	0.99 (0.93–1.06)	0.79

Summary of published pooled analysis [97] of body mass index and the risk of cancers of the mouth, pharynx and larynx in people who have never smoked

Cancer site	Increment	No. of cases	HR (95% CI)	P _{trend}
Oral cavity	per 5 kg/m ² BMI in people who have never smoked	298	1.10 (0.97–1.25)	0.14
Oral cavity and pharyngeal (not otherwise specified) combined		93	1.36 (1.11–1.66)	0.003
Oropharyngeal		241	0.98 (0.84–1.14)	0.77
Hypopharyngeal		22	0.96 (0.55–1.67)	0.88
Laryngeal		142	1.42 (1.19–1.70)	0.0001

Summary of other pooled analyses of body mass index and the risk of mouth, pharynx, larynx cancer

Publication		Increment/contrast	RR (95% CI)	P _{trend}	No. of cases	No. of cases	
Asia-Pacific Cohort Studies Collaboration [145]	Oropharyngeal and laryngeal combined, mortality	5 kg/m ²	0.66 (0.46–0.95) ¹	–	39 cohort	159 deaths	
	Upper aerodigestive tract, mortality	5 kg/m ²	0.78 (0.62–0.98) ¹	–		388 deaths	
International Head and Neck Cancer Epidemiology (INHANCE) Consortium [332]	Oral cavity	BMI ≥ 35 kg/m ² vs BMI 18.5–24.9 kg/m ²			15 case-control		
		Men	0.65 (0.40–1.10) ²	<0.01		1,516	
		Women	0.92 (0.50–1.60) ²	<0.01		935 diagnoses	
	Oropharyngeal	BMI ≥ 35 kg/m ² vs BMI 18.5–24.9 kg/m ²					
		Men	0.48 (0.30–0.70) ²	<0.01		1,733	
		Women	0.35 (0.20–0.70) ²	<0.01		564 diagnoses	
	Hypopharyngeal	BMI 30.0–34.9 kg/m ² vs BMI < 18.5 kg/m ²					
		Men	0.24 (0.10–0.50) ²	0.10		412	
		Women	0.24 (0.10–0.80) ²	<0.01		96 diagnoses	
	Laryngeal	BMI ≥ 35 kg/m ² vs BMI 18.5–24.9 kg/m ²					
		Men	0.77 (0.40–1.40) ²	<0.01		1,503	
		Women	0.27 (0.10–0.80) ²	<0.01		237 diagnoses	

Summary of published pooled analysis [97] of waist circumference and the risk of head and neck cancer

Publication	No. of cases	HR (95% CI) Highest vs lowest	RR (95% CI) per 5 cm) ¹	P _{trend}
All	1,931	1.08 (0.93–1.25)	1.04 (1.03–1.05)	< 0.0001
People who have never smoked	441	1.51 (1.09–2.08)	1.07 (1.01–1.14)	0.022
People who smoke	706	0.80 (0.62–1.04)	1.04 (1.02–1.05)	< 0.0001
People who used to smoke	745	1.21 (0.94–1.55)	1.06 (1.01–1.11)	0.01

Summary of published pooled analysis [97] of waist-hip ratio and the risk of head and neck cancer

Publication	No. of cases	HR (95% CI) Highest vs lowest	RR (95% CI) per 0.1 unit) ¹	P _{trend}
All	1,677	1.30 (1.12–1.50)	1.07 (1.05–1.09)	< 0.0001
People who have never smoked	382	1.23 (0.89–1.69)	1.06 (0.93–1.11)	0.2013
People who smoke	577	1.38 (1.09–1.75)	1.08 (1.04–1.12)	0.0017
People who used to smoke	685	1.25 (0.98–1.59)	1.10 (1.01–1.21)	0.0351