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Supplementary webappendix

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Separate and combined associations of body-mass index and abdominal adiposity with cardiovascular disease: collaborative analysis of 58 prospective studies

The Emerging Risk Factors Collaboration

Supplementary material

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eTable 1 Descriptive summaries, grouped by study, of individuals with complete information on adiposity measures, age and sex

Study design/ Study[a]	Total no with weight, height, waist & hip measured	Age (yrs) mean (sd)	Male (%)	BMI (kg/m^2) mean (sd)	Waist (cm) mean (sd)	Waist-to-hip ratio mean (sd)	Follow-up (yrs) median (5th & 95th percentiles)	Coronary heart disease (CHD) events	All CHD deaths	Non-fatal MI events	Ischaemic stroke events	Hemorrhagic stroke events	Unclassified stroke events	All cerebrovascular events	All cerebrovascular deaths	Cardiovascular disease events
Cohort studies																
ARIC[1]	14383	54 (6)	6213 (43)	28 (5)	97 (14)	0.92 (0.08)	14.0 (4.9 to 15.7)	865	198	667	455	56	16	564	24	1429
ATENA[11,c]	4741	50 (7)	0 (0)	27 (4)	85 (10)	0.82 (0.07)	6.7 (5.2 to 8.1)	18	1	17	1	2	0	4	0	22
ATTICA[2]	1503	51 (11)	769 (51)	27 (4)	93 (14)	0.88 (0.11)	5.0 (5.0 to 5.0)	0	0	0	0	0	0	0	0	0
AUSDIAB[3]	9204	53 (13)	4079 (44)	27 (5)	91 (14)	0.87 (0.09)	5.0 (4.8 to 8.5)	65	41	24	13	7	18	46	28	111
BRHS[4]	3466	68 (5)	3466 (100)	27 (4)	97 (10)	0.95 (0.06)	5.0 (1.9 to 5.0)	160	92	68	3	1	104	112	26	272
BRUN[5]	817	58 (11)	398 (49)	25 (4)	87 (11)	0.89 (0.07)	15.3 (3.9 to 15.5)	54	31	23	24	15	0	40	18	94
BWHHS[6]	2779	68 (5)	0 (0)	27 (5)	85 (12)	0.81 (0.07)	7.3 (3.2 to 8.4)	89	13	76	0	1	89	90	1	179
CAPS[7]	1062	62 (4)	1062 (100)	27 (4)	93 (10)	0.93 (0.06)	3.1 (1.8 to 3.3)	29	16	13	0	0	2	2	2	31
CHARL[8]	428	71 (7)	179 (42)	27 (5)	95 (13)	0.94 (0.08)	11.8 (1.3 to 12.9)	56	28	28	2	4	31	39	14	95
CHS1[9,b]	3881	72 (5)	1489 (38)	26 (5)	93 (13)	0.92 (0.09)	12.1 (1.9 to 12.9)	593	213	380	368	62	37	467	2	1060
CHS2[9,b]	480	72 (5)	181 (38)	29 (5)	99 (15)	0.94 (0.07)	9.1 (1.7 to 9.5)	56	23	33	40	5	4	49	0	105
COPEN[10]	8166	58 (15)	3502 (43)	26 (4)	87 (13)	0.87 (0.10)	13.2 (2.7 to 14.9)	509	41	468	368	73	121	591	44	1100
DRECE[12]	497	57 (11)	222 (45)	28 (4)	95 (13)	0.92 (0.11)	1.5 (1.5 to 1.5)	0	0	0	0	0	0	0	0	0
EMOFRI[11,c]	360	55 (6)	176 (49)	26 (4)	91 (11)	0.90 (0.07)	6.8 (6.5 to 7.2)	2	0	2	2	1	0	3	1	5
EPESENCA[13]	1001	77 (5)	333 (33)	27 (5)	93 (13)	0.88 (0.08)	4.0 (1.4 to 4.6)	45	17	28	30	5	15	50	4	95
FINRISK92[14]	5276	46 (10)	2446 (46)	26 (4)	88 (13)	0.86 (0.10)	11.8 (7.1 to 11.9)	150	31	119	84	36	0	124	7	274
FINRISK97[14]	6382	52 (11)	3167 (50)	27 (4)	90 (13)	0.87 (0.09)	6.8 (6.0 to 6.9)	109	34	75	75	19	0	95	5	204
FRAMOFF[15]	2685	60 (9)	1183 (44)	28 (5)	99 (14)	0.94 (0.08)	5.2 (3.1 to 7.0)	51	4	47	24	1	0	25	0	76
GOH[16]	634	70 (7)	305 (48)	28 (5)	99 (11)	1.03 (0.12)	3.9 (0.3 to 6.9)	0	0	0	0	0	0	0	0	0
GOTO13[17]	756	54 (0)	756 (100)	25 (3)	87 (9)	0.93 (0.05)	23.5 (5.0 to 30.5)	211	2	209	0	1	115	116	1	327
GOTO33[18]	729	51 (0)	729 (100)	26 (3)	95 (9)	0.93 (0.06)	12.8 (5.8 to 13.1)	27	13	14	0	0	8	8	0	35
GOTO43[18]	762	50 (0)	762 (100)	26 (3)	95 (9)	0.99 (0.06)	10.0 (7.9 to 10.7)	28	1	27	9	1	1	12	1	40
GOTOW[19]	1401	47 (7)	0 (0)	24 (4)	74 (9)	0.74 (0.05)	32.2 (8.7 to 32.7)	147	54	93	0	0	174	174	34	321
HBS[20]	1268	60 (4)	1268 (100)	26 (3)	97 (9)	0.97 (0.06)	20.5 (6.0 to 20.5)	85	85	0	0	0	26	26	26	111
HISAYAMA[21]	2515	59 (11)	1068 (42)	23 (3)	81 (9)	0.91 (0.07)	14.0 (3.2 to 14.0)	77	10	67	146	47	0	216	7	293
HOORN[22]	2226	61 (7)	979 (44)	27 (4)	91 (11)	0.89 (0.09)	8.8 (3.7 to 9.9)	73	13	60	3	4	46	53	11	126
IKNS[23]	1942	59 (10)	830 (43)	24 (3)	83 (9)	0.90 (0.07)	7.1 (4.1 to 14.6)	11	5	6	23	8	8	43	4	54
LASA[24]	1806	69 (8)	827 (46)	27 (4)	97 (11)	0.94 (0.08)	9.9 (1.8 to 10.4)	33	0	33	0	0	19	19	0	52
MATISS83[11,c]	1317	61 (9)	614 (47)	29 (4)	94 (10)	0.91 (0.09)	8.7 (3.7 to 9.7)	20	3	17	13	6	17	36	1	56
MATISS87[11,c]	1077	58 (9)	510 (47)	29 (4)	94 (11)	0.91 (0.09)	8.5 (5.0 to 9.5)	12	5	7	4	2	19	26	0	38
MATISS93[11,c]	1206	49 (9)	579 (48)	28 (5)	91 (11)	0.91 (0.08)	8.3 (7.0 to 9.3)	14	3	11	1	2	3	7	0	21
MESA[25]	6768	62 (10)	3190 (47)	28 (5)	98 (14)	0.93 (0.08)	4.8 (2.5 to 5.2)	83	14	69	68	13	2	84	1	167

eTable 1 cont'd Descriptive summaries, grouped by study, of individuals with complete information on adiposity measures, age and sex

Study design/ Study[a]	Total no with weight, height, waist & hip measured	Age (yrs) mean (sd)	Male (%)	BMI (kg/m^2) mean (sd)	Waist (cm) mean (sd)	Waist-to-hip ratio mean (sd)	Follow-up (yrs) median (5th & 95th percentiles)	Coronary heart disease (CHD) events	All CHD deaths	Non-fatal MI events	Ischaemic stroke events	Hemorrhagic stroke events	Unclassified stroke events	All cerebrovascular events	All cerebrovascular deaths	Cardiovascular disease events
MOGERAUG2[26]	3934	53 (12)	1935 (49)	27 (4)	90 (12)	0.87 (0.08)	7.9 (2.3 to 8.4)	102	41	61	1	1	3	7	7	109
MOGERAUG3[26]	3368	55 (10)	1663 (49)	28 (4)	92 (12)	0.88 (0.09)	3.0 (1.8 to 3.6)	18	7	11	2	1	2	5	5	23
MONFRI89[11,c]	1330	49 (8)	658 (49)	26 (4)	88 (12)	0.87 (0.09)	13.6 (6.6 to 13.7)	28	6	22	10	5	5	20	3	48
MONFRI94[11,c]	1291	49 (8)	627 (49)	26 (4)	90 (12)	0.88 (0.09)	8.5 (7.2 to 8.8)	11	0	11	5	7	2	16	1	27
MORGEN[27]	17707	46 (9)	8046 (45)	26 (4)	88 (12)	0.86 (0.09)	10.8 (8.5 to 13.1)	77	77	0	3	10	4	24	24	101
MOSWEGOT[28]	4132	47 (11)	1966 (48)	25 (4)	85 (12)	0.86 (0.09)	12.9 (7.6 to 18.6)	141	39	102	65	17	15	116	8	257
MRCOLD[29]	9933	80 (4)	3747 (38)	26 (4)	90 (12)	0.88 (0.08)	8.7 (1.2 to 11.7)	1118	1118	0	52	59	504	821	821	1939
NHANESIII[30]	10450	53 (16)	4859 (46)	27 (6)	95 (14)	0.93 (0.09)	8.8 (4.2 to 11.7)	320	320	0	0	0	113	113	113	433
NSHS[31]	1608	54 (15)	765 (48)	27 (6)	90 (15)	0.87 (0.10)	9.7 (3.7 to 10.0)	24	24	0	1	1	48	51	4	75
OSAKA[32]	717	49 (7)	602 (84)	23 (3)	84 (8)	0.90 (0.05)	7.7 (3.9 to 16.8)	4	2	2	3	1	2	6	0	10
PREVEND[33]	7368	50 (12)	3583 (49)	26 (4)	89 (13)	0.88 (0.09)	8.2 (6.7 to 8.9)	145	22	123	0	17	7	31	7	176
PRIME[34]	9563	55 (3)	9563 (100)	27 (3)	95 (10)	0.96 (0.06)	5.2 (5.0 to 7.3)	145	17	128	33	6	3	42	0	187
RANCHO[35]	1784	68 (11)	739 (41)	25 (4)	85 (12)	0.84 (0.09)	14.2 (2.0 to 18.1)	222	3	219	0	1	175	185	10	407
ROTT[36]	4607	68 (8)	1752 (38)	26 (4)	90 (11)	0.90 (0.09)	11.9 (3.2 to 14.1)	235	33	202	37	21	58	132	132	367
SHHEC[37]	3489	49 (11)	1625 (47)	26 (5)	86 (13)	0.85 (0.10)	10.0 (4.8 to 10.0)	119	44	75	26	9	24	70	5	189
SHS[38]	4135	56 (8)	1615 (39)	31 (6)	105 (15)	0.95 (0.06)	12.4 (2.1 to 14.3)	449	147	302	8	10	190	214	44	663
TARFS[39]	2559	49 (12)	1270 (50)	28 (5)	93 (12)	0.89 (0.09)	9.0 (2.0 to 10.0)	102	68	34	1	0	27	28	22	130
TOYAMA[40]	4523	46 (7)	2907 (64)	23 (3)	78 (9)	0.85 (0.07)	12.7 (7.8 to 12.8)	34	1	33	24	17	0	51	0	85
TROMSØ[41]	1573	60 (10)	811 (52)	26 (4)	91 (11)	0.87 (0.08)	11.1 (2.6 to 11.3)	146	18	128	78	15	3	102	1	248
ULSAM[42]	962	71 (1)	962 (100)	26 (3)	94 (9)	0.94 (0.05)	12.2 (2.3 to 14.9)	137	43	94	83	15	7	111	4	248
WHITEII[43]	7862	49 (6)	5414 (69)	25 (4)	85 (11)	0.87 (0.09)	7.6 (3.8 to 8.2)	167	22	145	1	0	3	6	6	173
WHS[44]	24138	60 (7)	0 (0)	27 (5)	89 (14)	0.83 (0.08)	4.7 (3.0 to 5.6)	115	4	111	117	11	0	135	2	250
SUBTOTAL (54 studies)	218551	58 (9)	96391 (44)	27 (4.56)	91 (12.6)	0.90 (0.08)	7.9 (2.9 to 14.7)	7531	3047	4484	2306	596	2070	5407	1481	12938
Nested case-control studies																
EPICNOR[45]	1417	66 (8)	960 (68)	27 (4)	93 (11)	0.90 (0.08)	7.1 (2.2 to 9.3)	479	224	255	-	-	-	-	-	-
HPFS[46]	394	66 (8)	394 (100)	26 (4)	99 (10)	0.96 (0.06)	4.0 (0.8 to 4.0)	129	21	108	-	-	-	-	-	-
NHS[47]	372	58 (6)	0 (0)	25 (4)	81 (11)	0.79 (0.07)	12.0 (5.2 to 12.0)	151	16	135	-	-	-	-	-	-
WHIHABPS[48]	1200	68 (6)	0 (0)	27 (6)	86 (13)	0.82 (0.09)	6.8 (1.2 to 9.3)	-	-	-	600	-	-	-	-	-
SUBTOTAL (4 studies)	3383	64 (7)	1354 (40)	26 (4.46)	90 (11.8)	0.87 (0.08)	6.9 (1.5 to 12.0)	759	261	498	600	-	-	-	-	-
TOTAL (58 studies)	**221934**	**58 (9)**	**97745 (44)**	**27 (4.56)**	**91 (12.6)**	**0.90 (0.083)**	**7.9 (2.9 to 14.7)**	**8290**	**3308**	**4982**	**2906**	**596**	**2070**	**5407**	**1481**	**12938**

[a]eAppendix lists study acronyms and study references. [b]CHS included an original cohort (here termed CHS1) and a supplemental African-American cohort (here termed CHS2), which were analysed separately. [c]Progetto CUORE was analysed as 7 different studies (ie, ATENA, EMOFRI, MATISS83, MATISS87, MATISS93, MONFRI89 and MONFRI94).

eTable 2 Description of methods used to assess adiposity measures in the contributing studies

Study abbreviation[a]	Country	Year(s) of baseline survey	Measurement of height & weight	Measurement of waist & hip	Assessment of height & weight	Assessment of waist circumference	Assessment of hip circumference
ARIC	USA	1987-1989	Assessed	Assessed	participant wearing a scrub suit and no shoes	umbilical level	around the maximum buttocks
ATENA[c]	Italy	1993-1996	Assessed	Assessed	light clothing and no shoes	midway between lower rib margin and the iliac crest	maximum circumference over the buttocks
ATTICA	Greece	2001	Assessed	Assessed	light undergarments and no shoes	midway between lower rib margin and the iliac crest	around the maximum buttocks
AUSDIAB	Australia	1999-2000	Assessed	Assessed	light clothing and no shoes	midway between lower rib margin and the iliac crest	maximum circumference over the buttocks
BRHS	UK	1998-2000	Assessed	Assessed	light undergarments and no shoes	midway between lower rib margin and the iliac crest	largest circumference below the waist
BRUN	Italy	1990	Assessed	Assessed	measured after an overnight fast, subjects wearing only undergarments.	umbilical level	at greater trochanters
BWHHS	UK	1999-2001	Assessed	Assessed	light clothing and no shoes	midway between lower rib margin and the iliac crest	largest circumference below the waist
CAPS	UK	1990-1993	Assessed	Assessed	NA	narrowest point between the costal line and the iliac crest	at greater trochanters
CHARL	USA	1987-1989	Assessed	Assessed	light clothing and no shoes	umbilical level	at greater trochanters
CHS1[b]	USA	1989-1990	Assessed	Assessed	NA	umbilical level	maximum hip circumference
CHS2[b]	USA	1992-1993	Assessed	Assessed	NA	umbilical level	maximum hip circumference
COPEN	Denmark	1992-1994	Assessed	Assessed	light clothing or underwear and no shoes	midway between lower rib margin and the iliac crest	maximum circumference over the buttocks
DRECE	Spain	2006	Assessed	Assessed	NA	NA	NA
EMOFRI[c]	Italy	1995-1996	Assessed	Assessed	light clothing and no shoes	midway between lower rib margin and the iliac crest	maximum circumference over the buttocks
EPESENCA	USA	1992-1993	Self-reported	Assessed	NA	umbilical level	NA
EPICNOR	UK	1993-1997	Assessed	Assessed	no shoes	smallest circumference between the ribs and iliac crest	maximum circumference between the iliac crest and the crotch
FINRISK92	Finland	1992	Assessed	Assessed	light clothing and no shoes	midway between lower rib margin and the iliac crest	maximum circumference over the buttocks
FINRISK97	Finland	1997	Assessed	Assessed	light clothing and no shoes	midway between lower rib margin and the iliac crest	maximum circumference over the buttocks
FRAMOFF	USA	1998-2000	Assessed	Assessed	light clothing and no shoes	umbilical level	NA
GOH	Israel	1999-2005	Assessed	Assessed	light clothing and no shoes	one finger width above superior iliac crest	At groin level
GOTO13	Sweden	1967	Assessed	Assessed	wearing underpants	umbilical level	at the level of the anterior iliac crest
GOTO33	Sweden	1983-1984	Assessed	Assessed	after an overnight fast, indoor clothing, and 0.8 kg deducted from the recorded weight	umbilical level	at the level of the anterior iliac crest
GOTO43	Sweden	1993-1994	Assessed	Assessed	after an overnight fast, indoor clothing, and 0.8 kg deducted from the recorded weight	umbilical level	at the level of the anterior iliac crest
GOTOW	Sweden	1968-1969	Assessed	Assessed	no shoes	midway between lower rib margin and the iliac crest	widest point between hip and buttock
HBS	Finland	1986	Assessed	Assessed	without shoes and shirt	umbilical level	at the level of the anterior iliac crest

eTable 2 cont'd Description of methods used to assess adiposity measures in the contributing studies

Study abbreviation[a]	Country	Year(s) of baseline survey	Measurement of height & weight	Measurement of waist & hip	Assessment of height & weight	Assessment of waist circumference	Assessment of hip circumference
HISAYAMA	Japan	1988	Assessed	Assessed	light clothing and no shoes	umbilical level	Around the buttocks, 4cm below the anterior superior iliac spine
HOORN	Netherlands	1990-1991	Assessed	Assessed	light clothing and no shoes	midway between lower rib margin and the iliac crest	widest level over the greater trochanters
HPFS	USA	1996	Self-reported	Self-reported	NA	umbilical level	largest circumference between the waist and thighs
IKNS	Japan	1990-1993	Assessed	Assessed	light clothing and no shoes	umbilical level	maximum circumference over the buttocks
LASA	Netherlands	1992-1993	Assessed	Assessed	light clothing	midway between lower rib margin and the iliac crest	widest level over the greater trochanters
MATISS83[c]	Italy	1993-1996	Assessed	Assessed	light clothing and no shoes	midway between lower rib margin and the iliac crest	maximum circumference over the buttocks
MATISS87[c]	Italy	1993-1996	Assessed	Assessed	light clothing and no shoes	midway between lower rib margin and the iliac crest	maximum circumference over the buttocks
MATISS93[c]	Italy	1993-1995	Assessed	Assessed	light clothing and no shoes	midway between lower rib margin and the iliac crest	maximum circumference over the buttocks
MESA	USA	2001	Assessed	Assessed	light clothing and no shoes	umbilical level	NA
MOGERAUG2	Germany	1989-1990	Assessed	Assessed	light clothing and no shoes	midway between lower rib margin and the iliac crest	maximum circumference over the buttocks
MOGERAUG3	Germany	1994-1995	Assessed	Assessed	light clothing and no shoes	midway between lower rib margin and the iliac crest	maximum circumference over the buttocks
MONFRI89[c]	Italy	1989	Assessed	Assessed	light clothing and no shoes	midway between lower rib margin and the iliac crest	maximum circumference over the buttocks
MONFRI94[c]	Italy	1994	Assessed	Assessed	light clothing and no shoes	midway between lower rib margin and the iliac crest	maximum circumference over the buttocks
MORGEN	Netherlands	1993-1997	Assessed	Assessed	indoor clothing and no shoes	midway between lower rib margin and the iliac crest	at the level of the greater trochanters
MOSWEGOT	Sweden	1985-1995	Assessed	Assessed	light clothing and no shoes after at least 4 h of fasting	midway between lower rib margin and the iliac crest	maximum circumference over the buttocks
MRCOLD	UK	1995-1998	Assessed	Assessed	light undergarments and no shoes	midway between lower rib margin and the iliac crest (Duplicate measurements)	maximum circumference over the buttocks and below the iliac crest (Duplicate measurements)
NHANESIII	USA	1988-1993	Assessed	Assessed	paper shirt and pants and foam slippers	at level with the iliac crest at the end of a normal expiration	maximum circumference over the buttocks
NHS	USA	1986	Self-reported	Self-reported	NA	umbilical level	largest circumference around hips (including buttocks)
NSHS	Canada	1995	Assessed	Assessed	light clothing and no shoes	at the point of noticeable waist narrowing	at the level of the symphysis pubis and the greatest gluteal protuberance
OSAKA	Japan	1992-1997	Assessed	Assessed	light clothing and no shoes	umbilical level	maximum circumference over the buttocks
PREVEND	Netherlands	1997-1998	Assessed	Assessed	light clothing and no shoes	midway between lower rib margin and the iliac crest	maximum circumference over the buttocks
PRIME	France/N. Ireland	1991-1993	Assessed	Assessed	light clothing and no shoes	midway between lower rib margin and the iliac crest	above the buttocks

eTable 2 cont'd Description of methods used to assess adiposity measures in the contributing studies

Study abbreviation[a]	Country	Year(s) of baseline survey	Measurement of height & weight	Measurement of waist & hip	Assessment of height & weight	Assessment of waist circumference	Assessment of hip circumference
RANCHO	USA	1984-1986	Assessed	Assessed	indoor clothing and no shoes	at the bending point (the natural indentation when bending sideways)	largest girth below the waist
ROTT	Netherlands	1990-1993	Assessed	Assessed	no shoes and heavy outer garments	midway between lower rib margin and the iliac crest	maximum circumference over the buttocks
SHHEC	UK	1989-1995	Assessed	Assessed	NA	NA	NA
SHS	USA	1989-1991	Assessed	Assessed	light clothing and no shoes	umbilical level	at the maximum protrusion of gluteal muscles
TARFS	Turkey	1998	Assessed	Assessed	light clothing and no shoes	midway between lower rib margin and the iliac crest	at the level of the greater trochanters
TOYAMA	Japan	1996	Assessed	Assessed	light clothing and no shoes	midway between lower rib margin and the iliac crest	maximum circumference over the buttocks
TROMSØ	Norway	1994-1995	Assessed	Assessed	light clothing and no shoes	umbilical level	at the widest point at the hips
ULSAM	Sweden	1991-1994	Assessed	Assessed	NA	midway between lower rib margin and the iliac crest	measured over the widest part
WHIHABPS	USA	1994	Assessed	Assessed	light clothing and no shoes	at the natural waist or narrowest part of the torso	maximum circumference over the buttocks
WHITEII	UK	1991-1993	Assessed	Assessed	NA	midway between lower rib margin and the iliac crest	at the level of the greater trochanters
WHS	USA	1999-2001	Self-reported	Self-reported	NA	umbilical level	maximum circumference between the umbilicus and the thigh

[a]eAppendix lists study acronyms and study references.
[b]CHS included an original cohort (here termed CHS1) and a supplemental African-American cohort (here termed CHS2), which were analysed separately.
[c]Progetto CUORE was analysed as 7 different studies (ie, ATENA, EMOFRI, MATISS83, MATISS87, MATISS93, MONFRI89 and MONFRI94).
Abbreviations: Assessed, anthropometric marker was assessed by a trained person; Self-reported, anthropometric marker was measured by the subject itself; NA, information not available.

eTable 3 Summary of data available and associations with adiposity measures

A

	Summary of available data on BMI, waist & hip circumference			Difference (95% CI) in row variables per 1-SD higher level of adiposity measures[¶]		
	No of studies	No of participants	Mean (SD) or %	BMI (kg/m^2)	Waist circumference (cm)	Waist-to-hip ratio
Adiposity measures						
BMI (kg/m^2)	58	221934	27 (4.56)	-	4.06 (3.95 to 4.17)	2.21 (2.05 to 2.38)
Waist circumference (cm)	58	221934	91 (12.6)	10.05 (9.85 to 10.26)	-	9.50 (9.08 to 9.91)
Waist-to-hip ratio	58	221934	0.90 (0.083)	0.03 (0.03 to 0.03)	0.05 (0.05 to 0.06)	-
BP and glucose						
Systolic BP (mmHg)	53	191170	135 (20)	4.40 (4.00 to 4.81)	4.41 (4.02 to 4.80)	3.37 (3.08 to 3.67)
Diastolic BP (mmHg)	53	191112	80 (11)	2.95 (2.60 to 3.31)	2.93 (2.59 to 3.27)	2.09 (1.83 to 2.35)
Fasting glucose (mmol/l)	34	85330	5.6 (1.8)	0.29 (0.26 to 0.32)	0.33 (0.28 to 0.37)	0.29 (0.22 to 0.36)
Lipid markers						
Total cholesterol (mmol/l)	53	179735	5.8 (1.1)	0.09 (0.06 to 0.11)	0.09 (0.07 to 0.12)	0.12 (0.10 to 0.14)
Non-HDL-cholesterol (mmol/l)	50	174024	4.40 (1.12)	0.19 (0.16 to 0.22)	0.21 (0.18 to 0.24)	0.22 (0.19 to 0.25)
HDL-cholesterol (mmol/l)	50	174095	1.40 (0.40)	-0.11 (-0.11 to -0.10)	-0.12 (-0.12 to -0.11)	-0.10 (-0.11 to -0.09)
Log$_e$ triglyceride (mmol/l)	47	146974	0.31 (0.53)	0.16 (0.14 to 0.18)	0.18 (0.17 to 0.20)	0.18 (0.16 to 0.19)
Apo AI (g/l)	17	63156	1.53 (0.30)	-0.05 (-0.06 to -0.04)	-0.05 (-0.06 to -0.04)	-0.04 (-0.06 to -0.03)
Apo B (g/l)	16	62347	1.13 (0.30)	0.05 (0.03 to 0.06)	0.05 (0.04 to 0.07)	0.05 (0.03 to 0.07)
Log$_e$ Lp(a) (mg/dl)	15	55520	2.45 (1.17)	0.01 (-0.02 to 0.04)	-0.01 (-0.04 to 0.01)	-0.04 (-0.07 to -0.01)
Inflammatory markers						
Fibrinogen (µmol/l)	28	97608	8.7 (2.1)	0.33 (0.27 to 0.39)	0.35 (0.28 to 0.41)	0.30 (0.24 to 0.37)
Log$_e$ CRP (mg/l)	30	67483	0.66 (1.08)	0.33 (0.29 to 0.37)	0.36 (0.32 to 0.40)	0.31 (0.26 to 0.35)
Albumin (g/l)	19	64230	43 (3)	-0.11 (-0.25 to 0.03)	-0.10 (-0.22 to 0.03)	0.02 (-0.06 to 0.10)
Log$_e$ leukocyte count (x10^9 per l)	18	61522	1.82 (0.28)	0.03 (0.02 to 0.03)	0.03 (0.03 to 0.04)	0.04 (0.03 to 0.05)
Log$_e$ Interleukin 6 (ng/l)	8	24290	0.57 (0.64)	0.15 (0.11 to 0.19)	0.16 (0.12 to 0.21)	0.14 (0.10 to 0.19)

[¶]Change in row variable (adiposity measure or potential mediating risk factor) per 1-SD higher levels of adiposity measure, adjusted for age and sex, pooled across studies using random effects meta-analysis.

eTable 3 cont'd Summary of data available and associations with adiposity measures

B

				Difference (95% CI) in Z-score of adiposity measures per 1-SD higher level of row variable or compared to reference category ‡		
	No of studies	**No of participants**	**Mean (SD) or %**	**BMI (kg/m^2)**	**Waist circumference (cm)**	**Waist-to-hip ratio**
Age at survey (yrs)	58	221934	58 (9)	0.02 (-0.02 to 0.06)	0.11 (0.08 to 0.14)	0.15 (0.12 to 0.17)
Categorical variables						
Sex	58	221934				
Female		124189	56%	0.04 (-0.04 to 0.11)	-0.63 (-0.74 to -0.52)	-1.15 (-1.27 to -1.03)
Male		97745	44%	Ref	Ref	Ref
Ethnicity	44	145882				
Non-white		28956	20%	0.24 (0.13 to 0.35)	0.10 (0.00 to 0.20)	0.10 (0.01 to 0.18)
White		116926	80%	Ref	Ref	Ref
Smoking status	58	219092				
Current		52261	24%	-0.21 (-0.24 to -0.18)	-0.12 (-0.15 to -0.09)	0.05 (0.02 to 0.07)
Not current		166831	76%	Ref	Ref	Ref
Alcohol status	47	195186				
Current		110199	56%	-0.13 (-0.17 to -0.09)	-0.08 (-0.12 to -0.04)	-0.02 (-0.05 to 0.01)
Not current		84987	44%	Ref	Ref	Ref
History of diabetes	56	203849				
Yes		13899	7%	0.43 (0.37 to 0.49)	0.46 (0.40 to 0.52)	0.36 (0.32 to 0.41)
No		189950	93%	Ref	Ref	Ref
Level of education reached	33	125162				
Tertiary		34013	27%	-0.29 (-0.34 to -0.23)	-0.24 (-0.29 to -0.19)	-0.26 (-0.30 to -0.21)
Secondary		64186	51%	-0.17 (-0.21 to -0.13)	-0.14 (-0.18 to -0.11)	-0.13 (-0.16 to -0.10)
Primary		26963	22%	Ref	Ref	Ref

‡Difference in mean Z-score of adiposity measure levels per 1-SD higher levels of the row variable or compared to reference category, adjusted for age and sex, pooled across studies using random effects meta-analysis. To obtain the original scale of each adiposity measure, Z-scores have to be multiplied by the standard deviation of corresponding adiposity measure.

eTable 4 Hazard ratios for coronary heart disease and ischaemic stroke per 1-SD higher baseline BMI, waist circumference and waist-to-hip ratio levels with adjustment for baseline levels of potential mediating risk factors

	HR (95% CI)		
Outcome / adjusted variables[†]	**Body-mass index**	**Waist circumference**	**Waist-to-hip ratio**
Coronary heart disease			
(34 studies, 114083 participants & 4800 cases)			
Adjusted for age, sex and smoking	1.28 (1.21 to 1.36)	1.30 (1.23 to 1.37)	1.30 (1.22 to 1.38)
plus intermediate risk factors	1.10 (1.05 to 1.16)	1.11 (1.06 to 1.17)	1.14 (1.10 to 1.18)
plus $\log_e$ triglyceride	1.10 (1.05 to 1.15)	1.11 (1.06 to 1.16)	1.15 (1.11 to 1.19)
(21 studies, 50492 participants & 2854 cases)			
Adjusted for age, sex and smoking	1.26 (1.17 to 1.35)	1.28 (1.19 to 1.38)	1.28 (1.19 to 1.37)
plus possible intermediate risk factors	1.10 (1.02 to 1.18)	1.11 (1.03 to 1.20)	1.12 (1.07 to 1.17)
plus $\log_e$ C-reactive protein	1.04 (0.97 to 1.12)	1.05 (0.98 to 1.13)	1.08 (1.04 to 1.13)
(21 studies, 82557 participants & 3568 cases)			
Adjusted for age, sex and smoking	1.25 (1.16 to 1.34)	1.26 (1.17 to 1.35)	1.27 (1.18 to 1.37)
plus intermediate risk factors	1.08 (1.01 to 1.14)	1.08 (1.02 to 1.15)	1.13 (1.09 to 1.18)
plus fibrinogen	1.06 (1.00 to 1.12)	1.06 (1.00 to 1.12)	1.13 (1.09 to 1.18)
Ischaemic stroke			
(20 studies, 81017 participants & 2395 cases)			
Adjusted for age, sex and smoking	1.19 (1.11 to 1.28)	1.25 (1.18 to 1.33)	1.25 (1.18 to 1.33)
plus intermediate risk factors	1.06 (0.99 to 1.13)	1.11 (1.05 to 1.17)	1.15 (1.09 to 1.21)
plus loge triglyceride	1.06 (0.99 to 1.13)	1.11 (1.05 to 1.18)	1.15 (1.09 to 1.21)
(12 studies, 30758 participants & 1656 cases)			
Adjusted for age, sex and smoking	1.16 (1.08 to 1.25)	1.21 (1.13 to 1.29)	1.22 (1.13 to 1.31)
plus intermediate risk factors	1.07 (0.98 to 1.16)	1.11 (1.03 to 1.20)	1.15 (1.06 to 1.25)
plus $\log_e$ C-reactive protein	1.02 (0.95 to 1.10)	1.11 (1.03 to 1.20)	1.13 (1.04 to 1.23)
(15 studies, 59328 participants & 1856 cases)			
Adjusted for age, sex and smoking	1.21 (1.12 to 1.31)	1.26 (1.18 to 1.34)	1.28 (1.17 to 1.39)
plus intermediate risk factors	1.08 (1.00 to 1.16)	1.12 (1.05 to 1.18)	1.17 (1.08 to 1.25)
plus fibrinogen	1.06 (0.99 to 1.13)	1.11 (1.05 to 1.17)	1.16 (1.08 to 1.24)

[†]Intermediate risk factors were systolic blood pressure, history of diabetes, and total and HDL cholesterol.

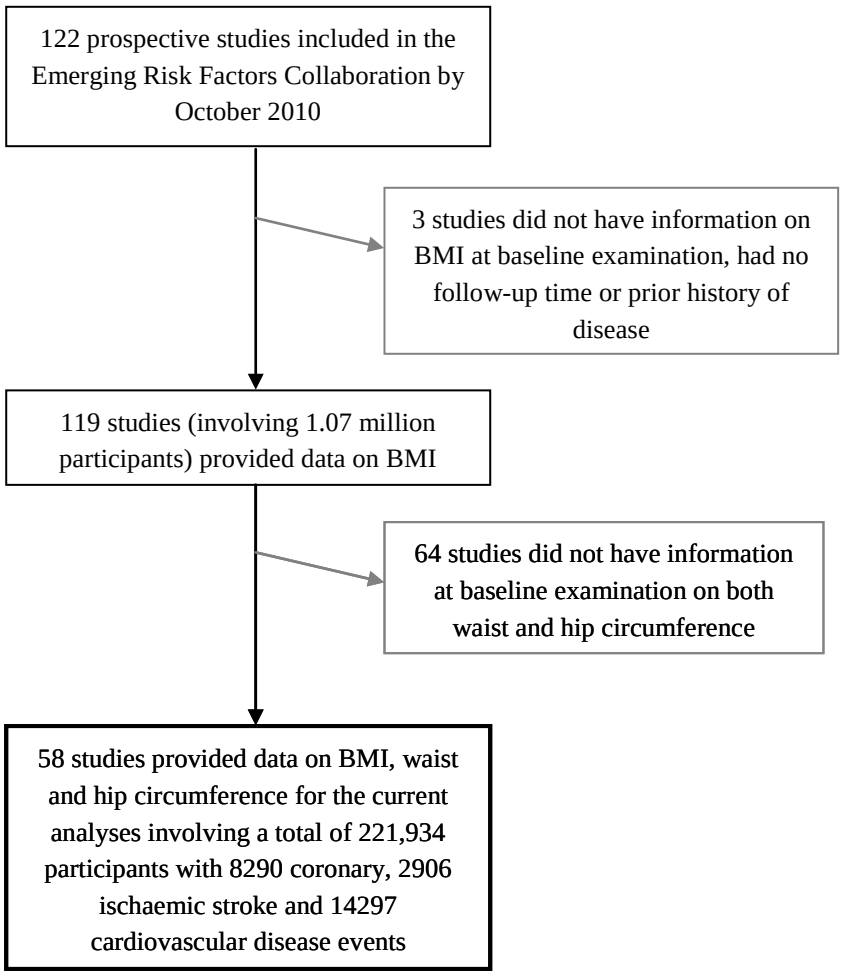
Hazard ratios (HRs) are presented per 4.56 kg/m^2 higher BMI, 12.6 cm higher waist circumference and 0.083 higher waist-to-hip ratio (ie, 1-SD higher baseline values). Analyses are restricted to participants with BMI values of 20 kg/m^2 or higher and complete information on age, sex, smoking status, and intermediate risk factors plus triglyceride, CRP or fibrinogen in turn.

eTable 5 Reclassification of 10-year predicted risk of cardiovascular disease after addition of BMI or waist-to-hip ratio or total and HDL-cholesterol measures to a non-lipid-based model

	Body-mass index	Waist-to-hip ratio	Total cholesterol & HDL-C
Reclassification (20 studies, 4777 cases, 43944 non-cases)			
Participants who developed CVD at 10 years			
Appropriately reclassified	159 (3.33%)	211 (4.42%)	509 (10.66%)
Inappropriately reclassified	137 (2.87%)	189 (3.96%)	381 (7.98%)
No change	4481 (93.80%)	4377 (91.63%)	3887 (81.37%)
Participants who were event free at 10 years			
Appropriately reclassified	1033 (2.35%)	1572 (3.58%)	3095 (7.04)
Inappropriately reclassified	1161 (2.64%)	1544 (3.51%)	3027 (6.89%)
No change	41750 (95.01%)	40828 (92.91%)	37822 (86.07%)
NRI (95% CI)	0.17% (-0.57%, 0.91%)	0.52% (-0.33%, 1.38%)	2.83% (1.56%, 4.11%)
p-value	0.652	0.231	<0.0001
IDI (95% CI)	0.0005 (0.0001, 0.0010)	0.0019 (0.0012, 0.0026)	0.0059 (0.0046, 0.0072)
p-value	0.022	<0.001	<0.0001

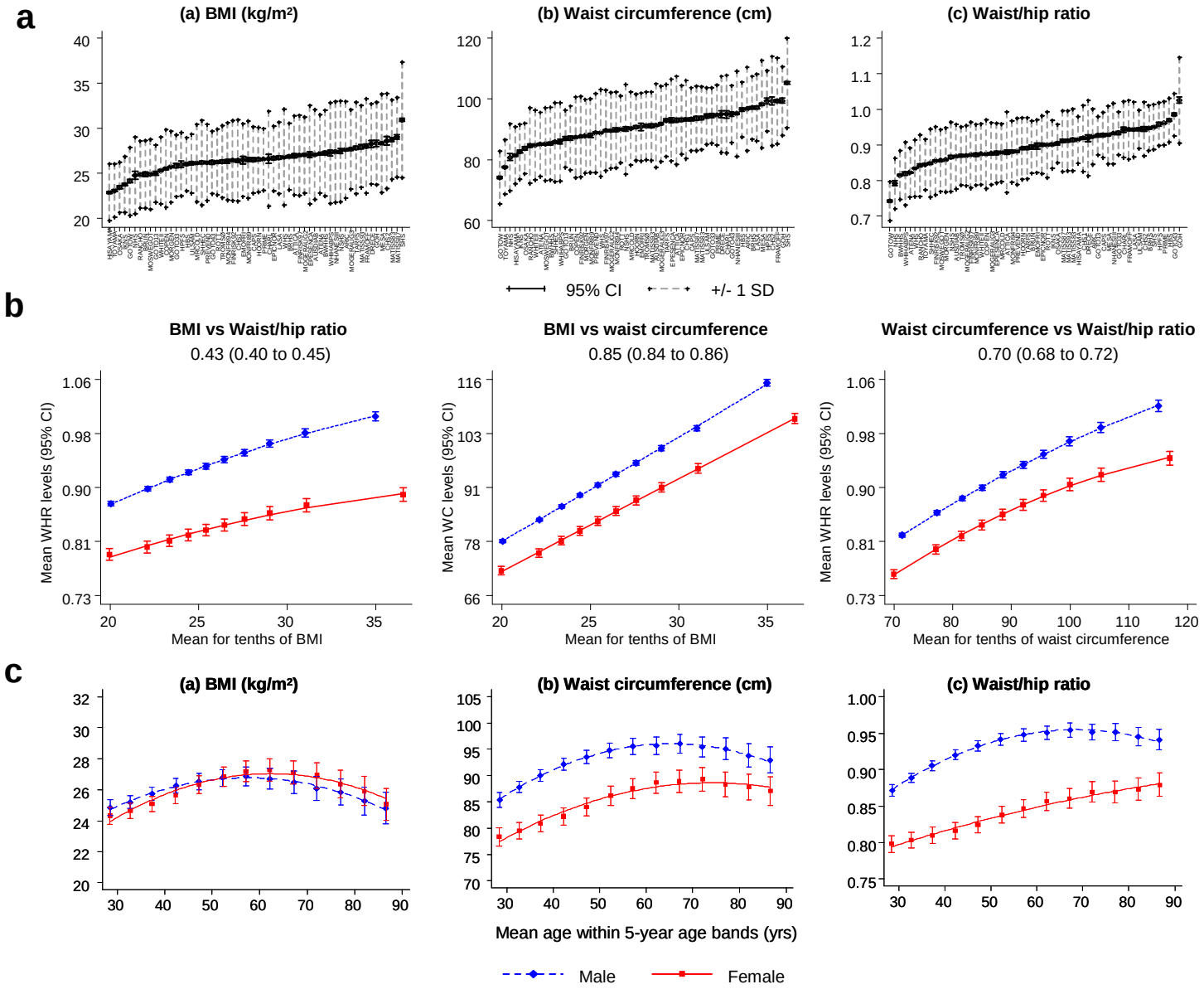
Non-lipid-based variables were age, smoking status, systolic blood pressure and history of diabetes. Model was stratified by sex. Analyses are restricted to cohorts and participants with BMI of 20 kg/m^2 or higher. Cohort studies recording both fatal and non-fatal cardiovascular outcomes and more than 10 years of follow-up contributed to reclassification analyses. NRI, Net Reclassification Improvement; IDI, Integrated Discrimination Improvement.

eFigure 1 Flow diagram showing steps involved in study selection for the current analysis



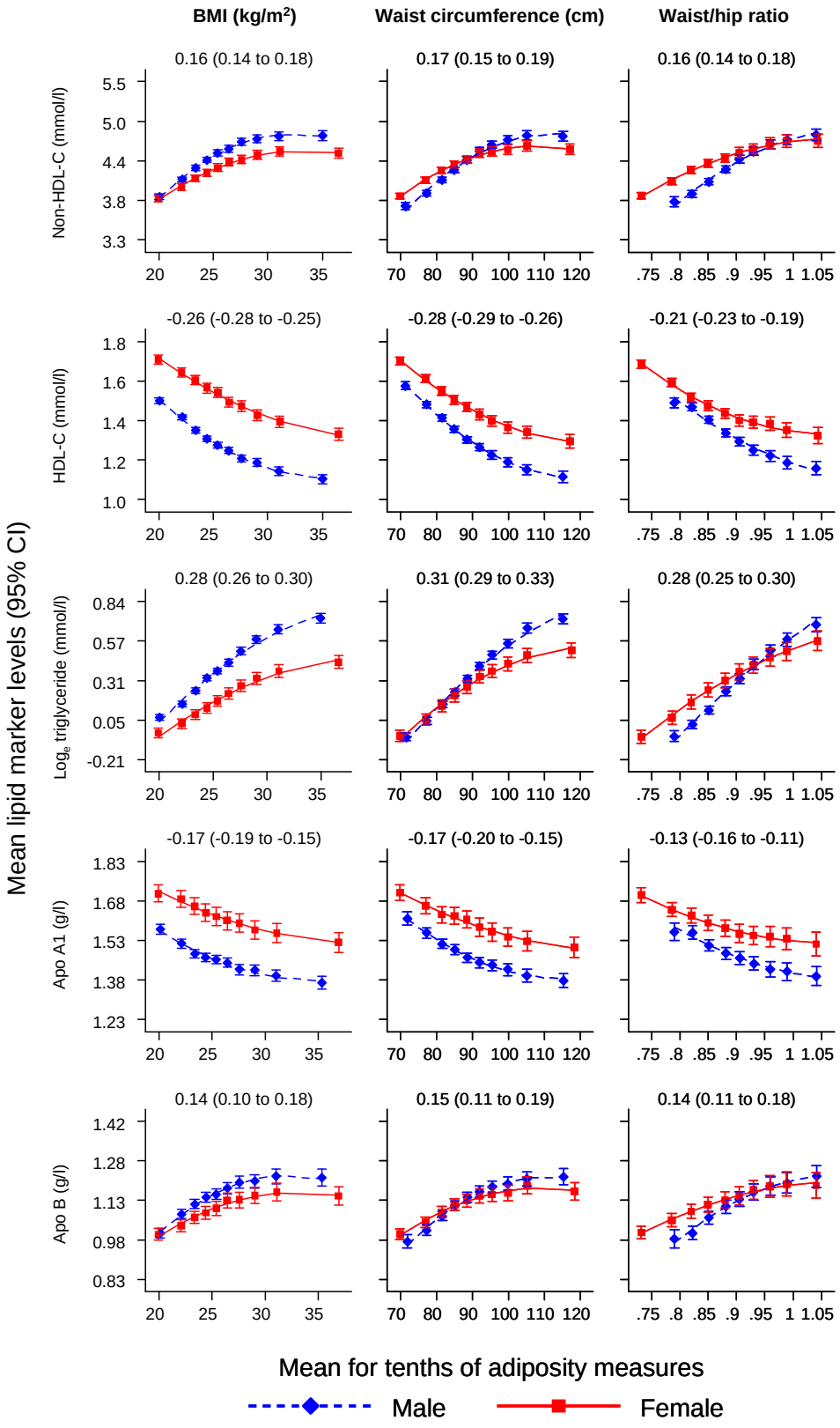
To be eligible for inclusion in the Emerging Risk Factors Collaboration (ERFC), prospective studies (reported variously as observational cohort studies, trials, or analyses of nested case-control or case-cohort subsets) had: (1) data available from baseline measurements of at least one of the relevant markers assessed; (2) at least 1 year of follow-up; (3) participants not selected on the basis of having previous cardiovascular diseases; and (4) information on cause-specific mortality and/or major cardiovascular morbidity collected during follow-up. Studies were included if they were known to have recorded at least 20 000 person years at risk. Most eligible studies were identified in previously published meta-analyses, with additional studies identified through updated computer-assisted literature searches of databases, scanning of reference lists, hand-searching of relevant journals and correspondence with authors of relevant reports. Further details of the ERFC (including search strategies, contributing studies, data provision and management, and other characteristics) have been reported previously (*Eur J Epidemiol. 2007;22:839-869*).

eFigure 2 Mean adiposity measure levels in each study (part a), according to quantiles of adiposity measures (part b) and within 5-year age bands (part c)



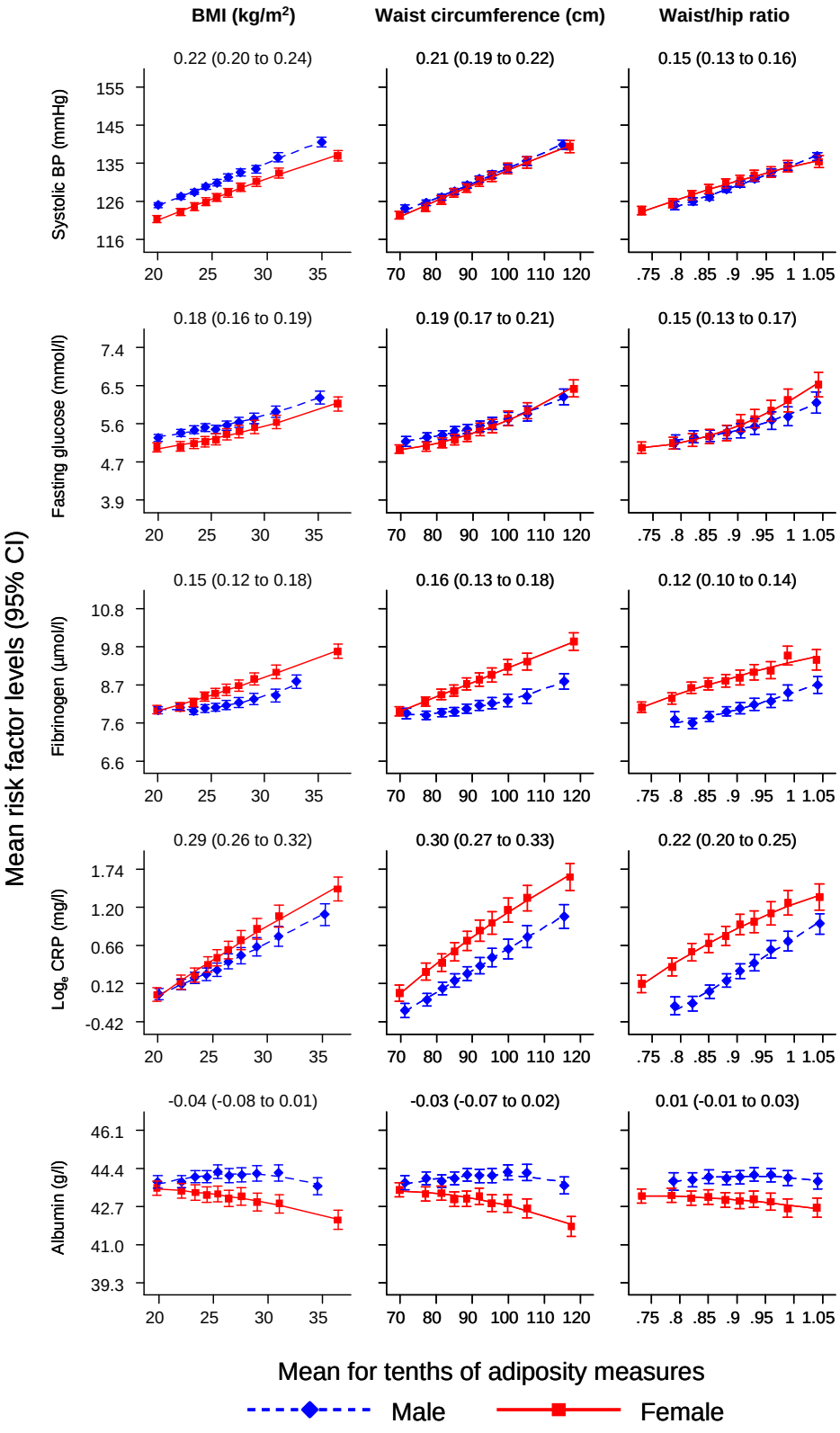
For cross-sectional associations between adiposity measures (part b), see also footnote to eFigures 3-4. The values presented above each figure in part b correspond to the age- and sex- adjusted partial correlation coefficient (95% CI) between adiposity measures in males and females combined. eAppendix lists study acronyms.

eFigure 3 Cross-sectional associations of adiposity measures with lipid markers



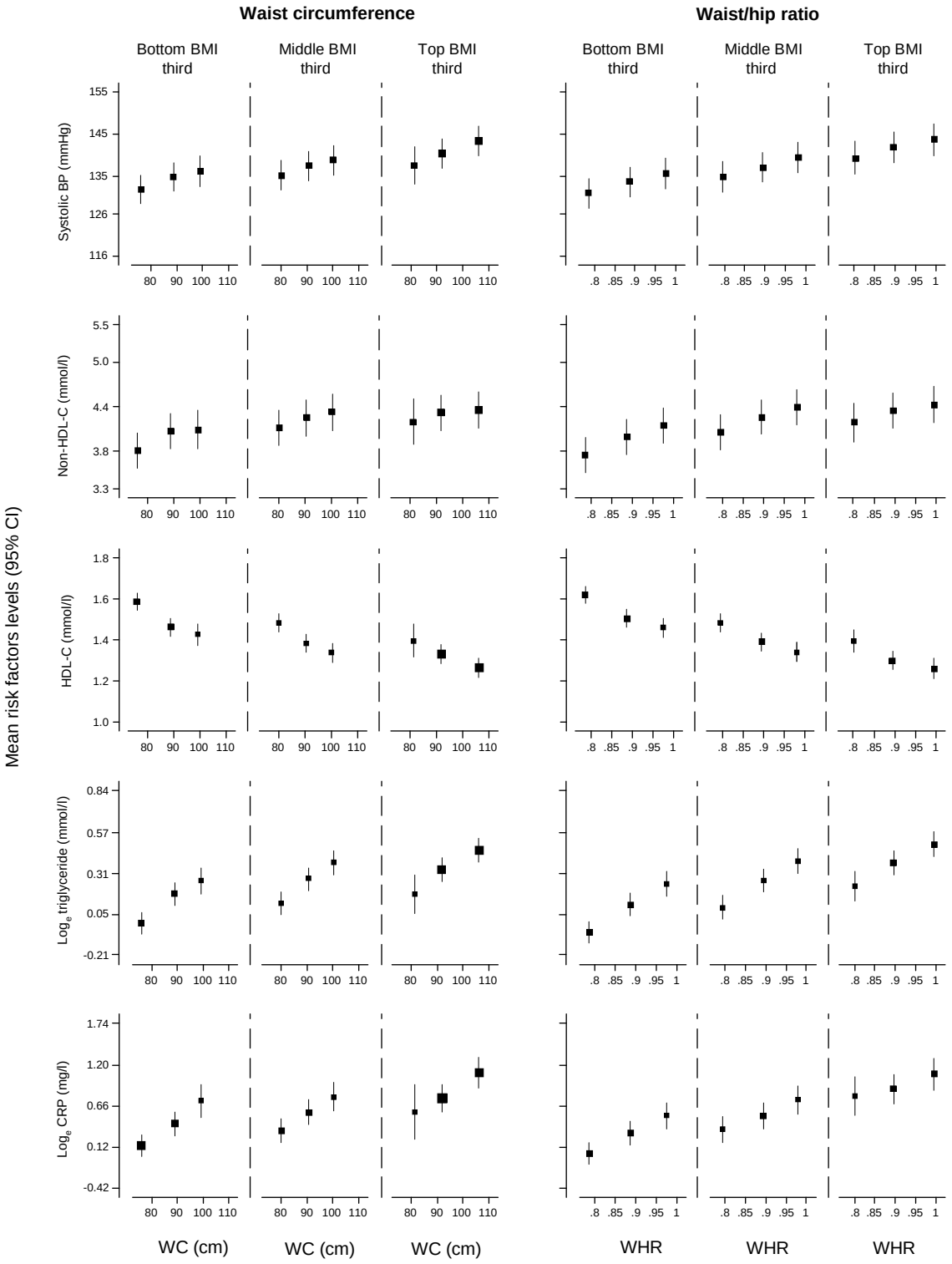
Mean lipid levels were adjusted to age 50 years. The values presented above each figure correspond to the age- and sex-adjusted partial correlation coefficient (95% CI) between lipid markers and adiposity measures in males and females combined. Lowest waist/hip ratio category in males was removed because it included only a few individuals. Error bars represent the 95% CIs.

eFigure 4 Cross-sectional associations of adiposity measures with systolic blood pressure, fasting glucose and some inflammatory markers

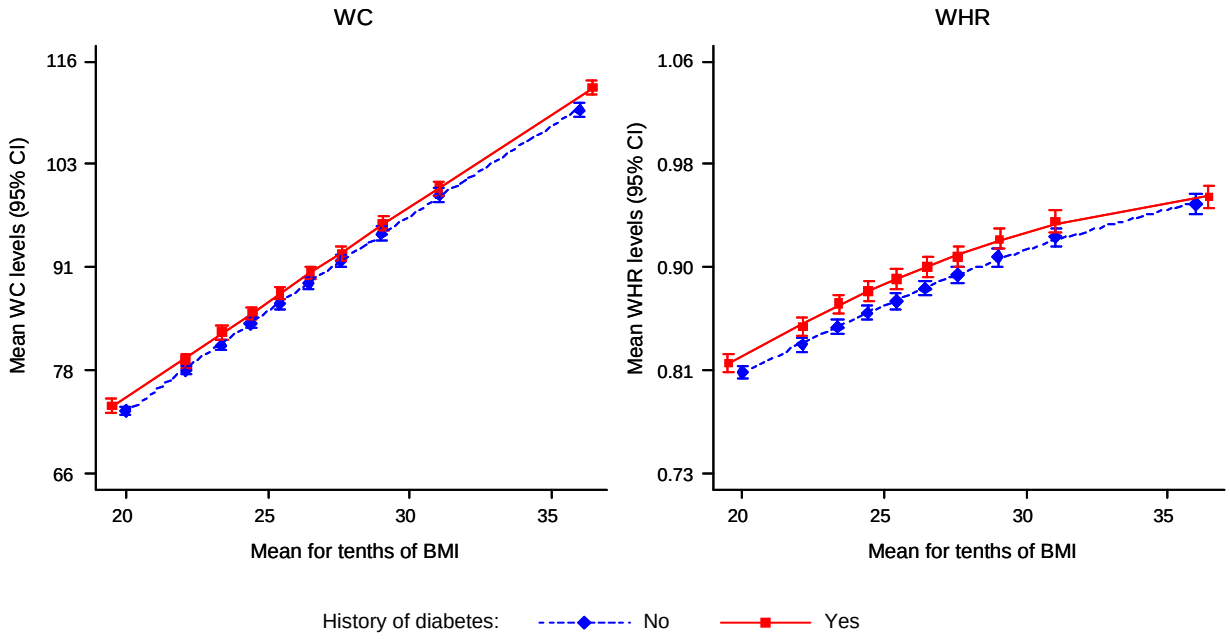


Mean risk factor levels were adjusted to age 50 years. The values presented above each figure correspond to the age- and sex- adjusted partial correlation coefficient (95% CI) between risk markers and adiposity measures in males and females combined. Lowest waist/hip ratio category in males was removed because it included only a few individuals. Error bars represent the 95% CIs.

eFigure 5 Mean risk factors levels across thirds of waist circumference and waist-to-hip ratio by baseline BMI levels

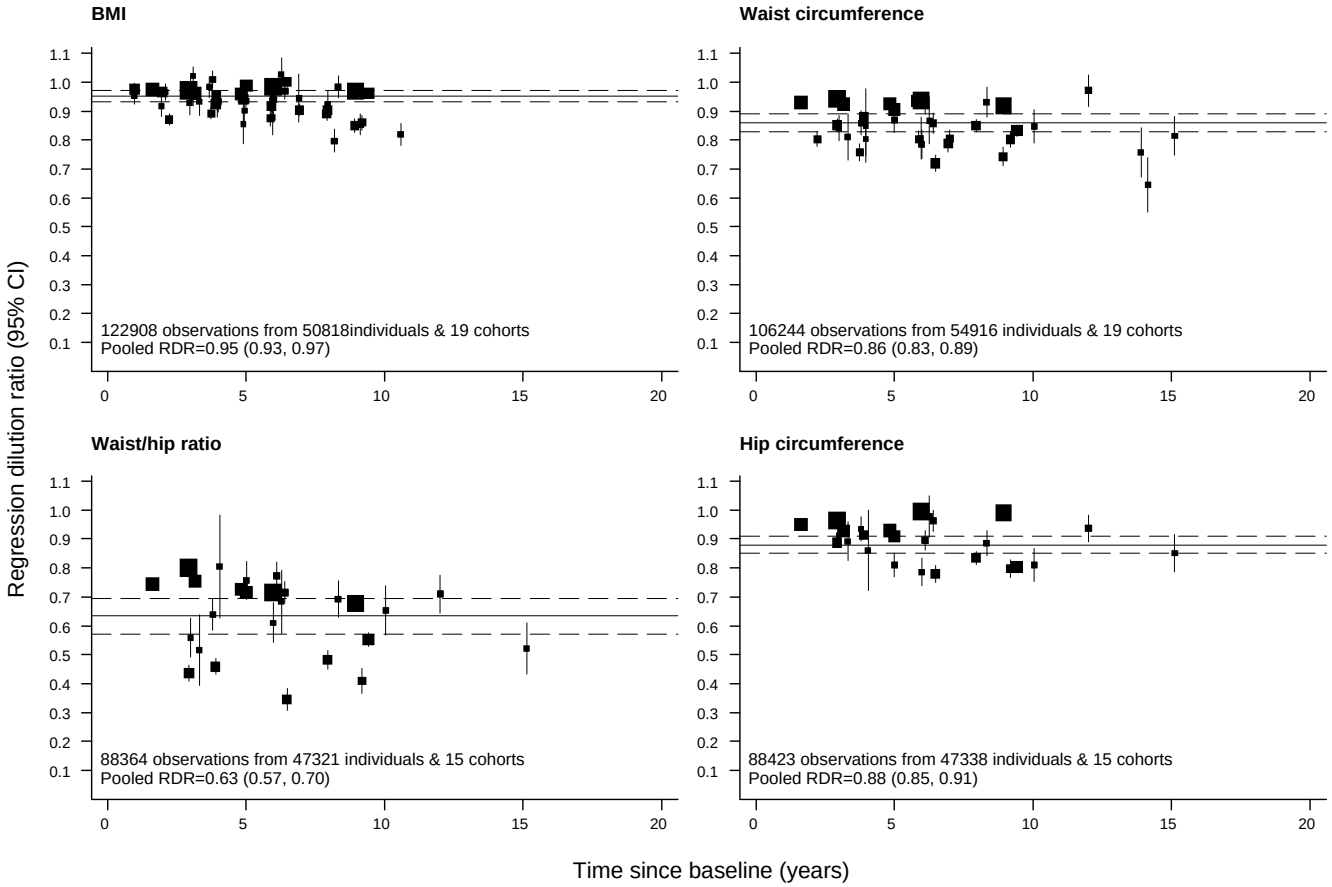


eFigure 6 Mean waist circumference and waist-to-hip ratio levels by diabetes status at baseline, according to deciles of BMI levels



Mean waist circumference and waist-to-hip ratio levels were adjusted to age 50 years. Age, sex and BMI adjusted differences between people with and without history of diabetes were 1.52cm (95% CI: 1.27cm-1.77cm) with waist circumference and 0.018 (95% CI: 0.015-0.021) with waist-to-hip ratio. Error bars represent the 95% CIs.

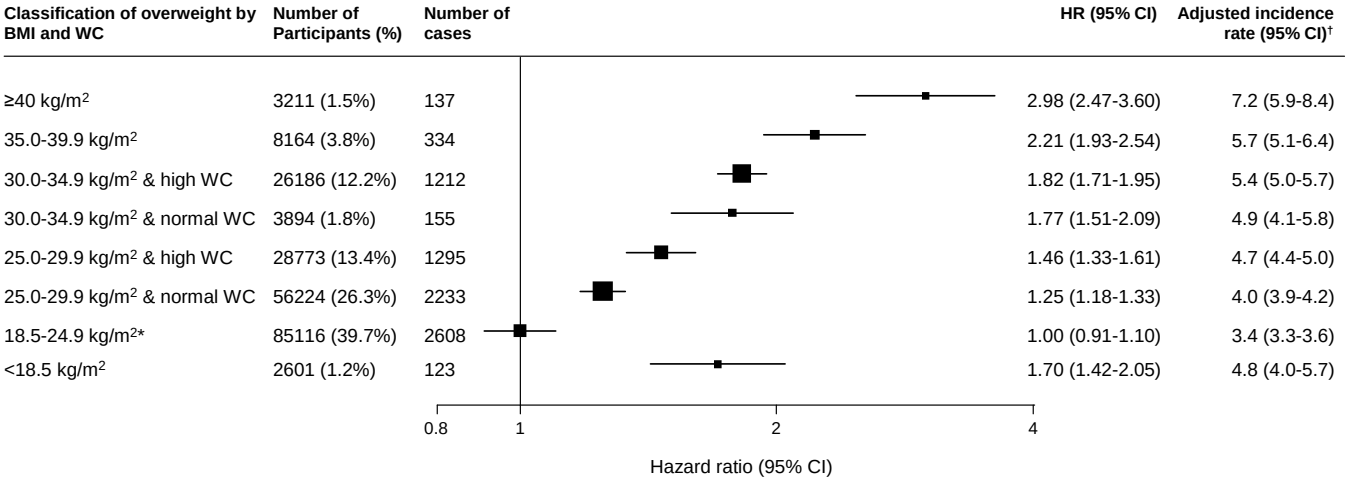
eFigure 7 Regression dilution ratios for adiposity measure levels plotted against time since baseline measurement by study



Analyses were adjusted for age at baseline and sex. Re-surveys after 20 years since baseline were excluded from figure. CI indicates confidence interval. The RDRs for waist/hip ratio are lower in comparison to the separate RDRs for waist and hip, largely due to a relative decrease in the between-person variance for the ratio measure as a result of highly correlated and similarly distributed waist and hip measures (ie, for two similarly distributed measures, the between-person variance of the ratio tends to zero as their correlation approaches one). The reduction in the between-person variability leads to a relatively larger within-person variance and subsequently reduced RDRs.

RDRs were 0.75 (0.72, 0.79) for HDL-C, 0.63 (0.59, 0.67) for non-HDL-C, 0.65 (0.61, 0.68) for $\log_e$ triglyceride, and 0.57 (0.52, 0.61) for systolic blood pressure.

eFigure 8 Hazard ratios for coronary heart disease by clinically defined categories of baseline BMI and waist circumference levels

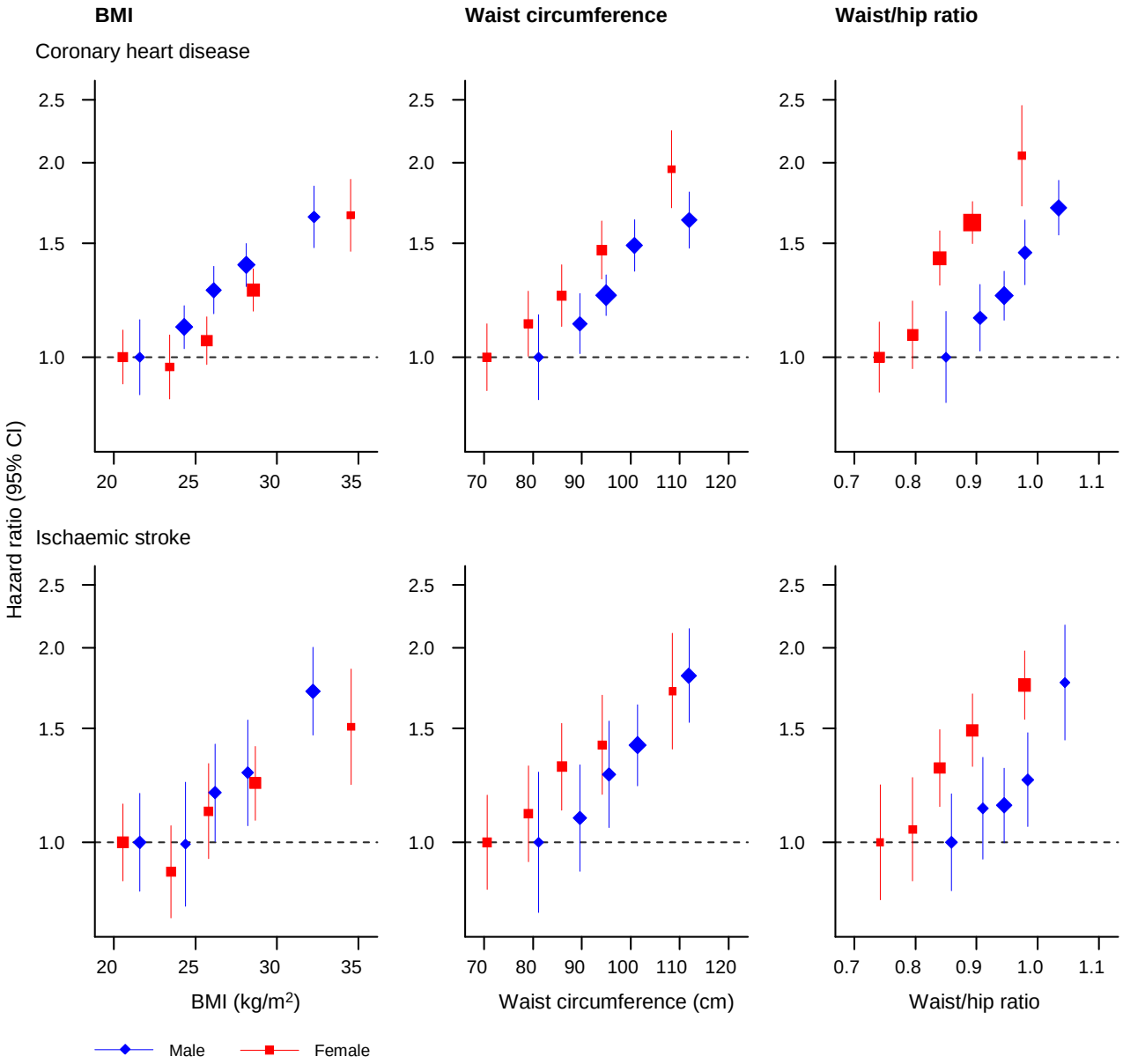


*Reference group

†Sex and smoking adjusted incidence rates of CHD per 1000 person-years. Analyses excluded nested case-control studies and were based on 215,856 participants (involving 7397 cases).

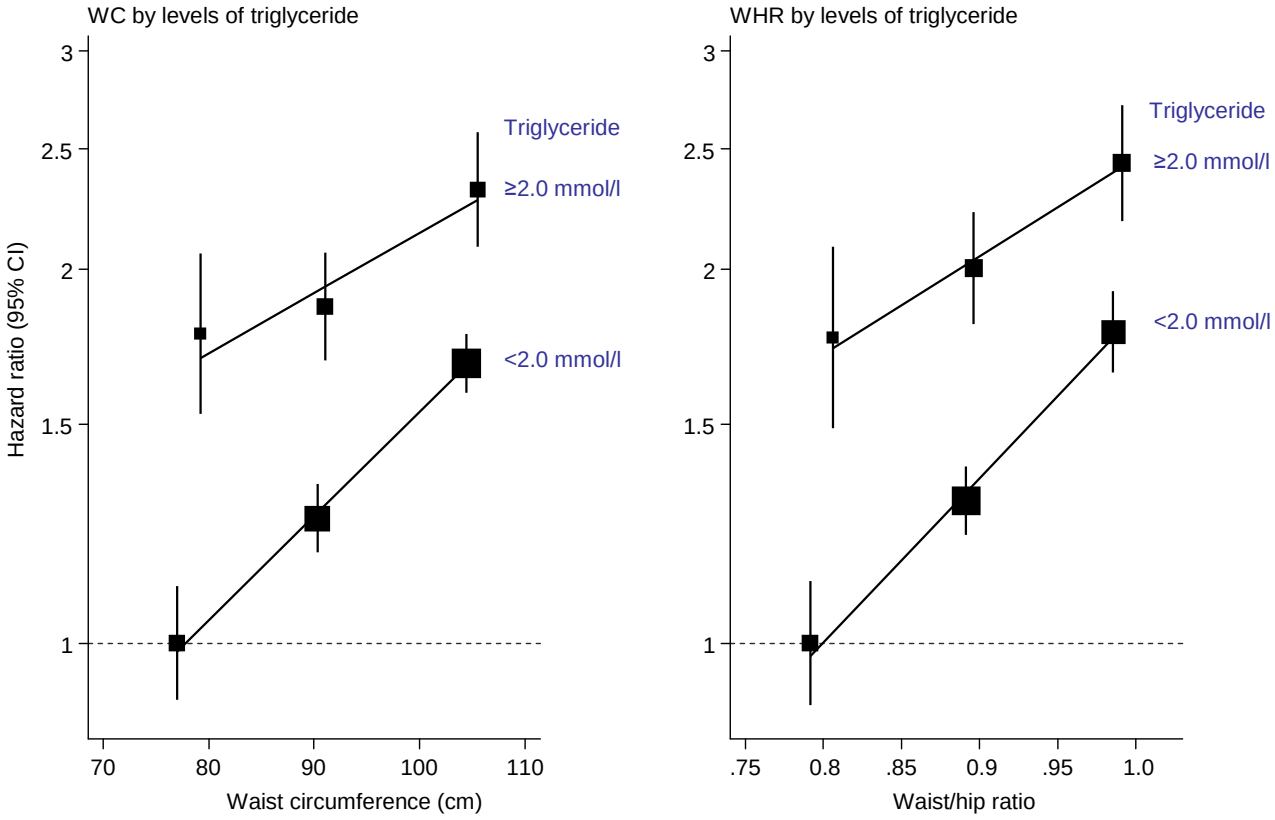
Analysis was based on 214,169 participants (involving 8097 cases) from 52 studies. Hazard ratios (HRs) were adjusted for age and smoking status at baseline, and stratified, where appropriate, by sex. Adjusted study-specific log HRs were combined by multivariate random effects meta-analysis. High waist circumference (WC) was defined as waist circumference >102 cm in men and waist circumference >88 cm in women.

eFigure 9 Hazard ratios for coronary heart disease and ischaemic stroke across quintiles of baseline BMI, waist circumference and waist-to-hip ratio levels, among men and women



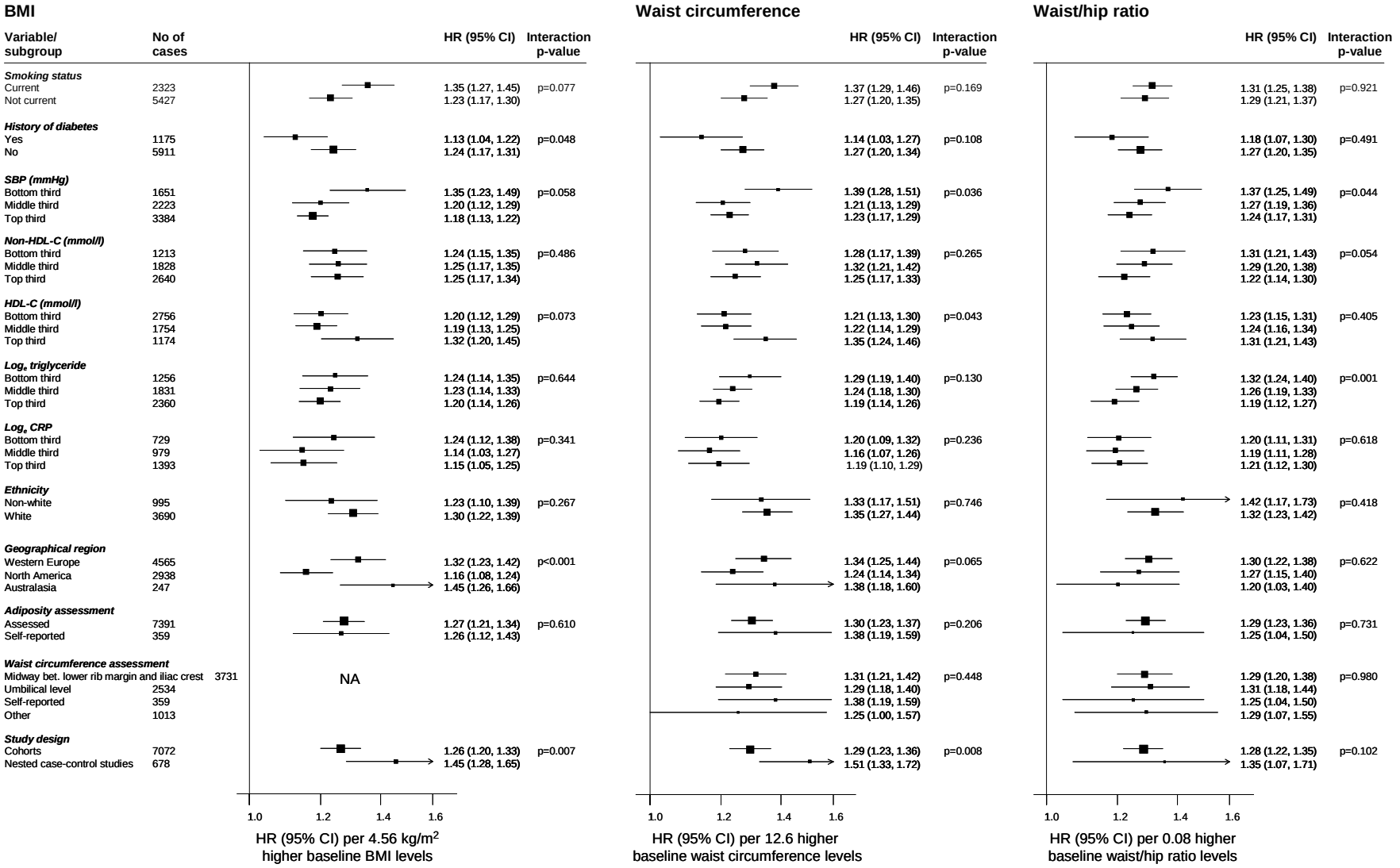
Analyses were restricted to studies with data on both males and females. Analyses for coronary heart disease were based on 67001 men (involving 3818 cases) and 78197 women (involving 2719 cases) from 19 studies. Analyses for ischaemic stroke were based on 32806 men (involving 883 cases) and 42295 women (involving 1034 cases) from 16 studies. Regression analyses were adjusted for age and smoking status. Adjusted study-specific log hazard ratios were combined by multivariate random effects meta-analysis. The y-axes are shown on a log scale.

eFigure 10 Hazard ratios for coronary heart disease across thirds of waist circumference and waist-to-hip ratio by baseline levels of triglyceride



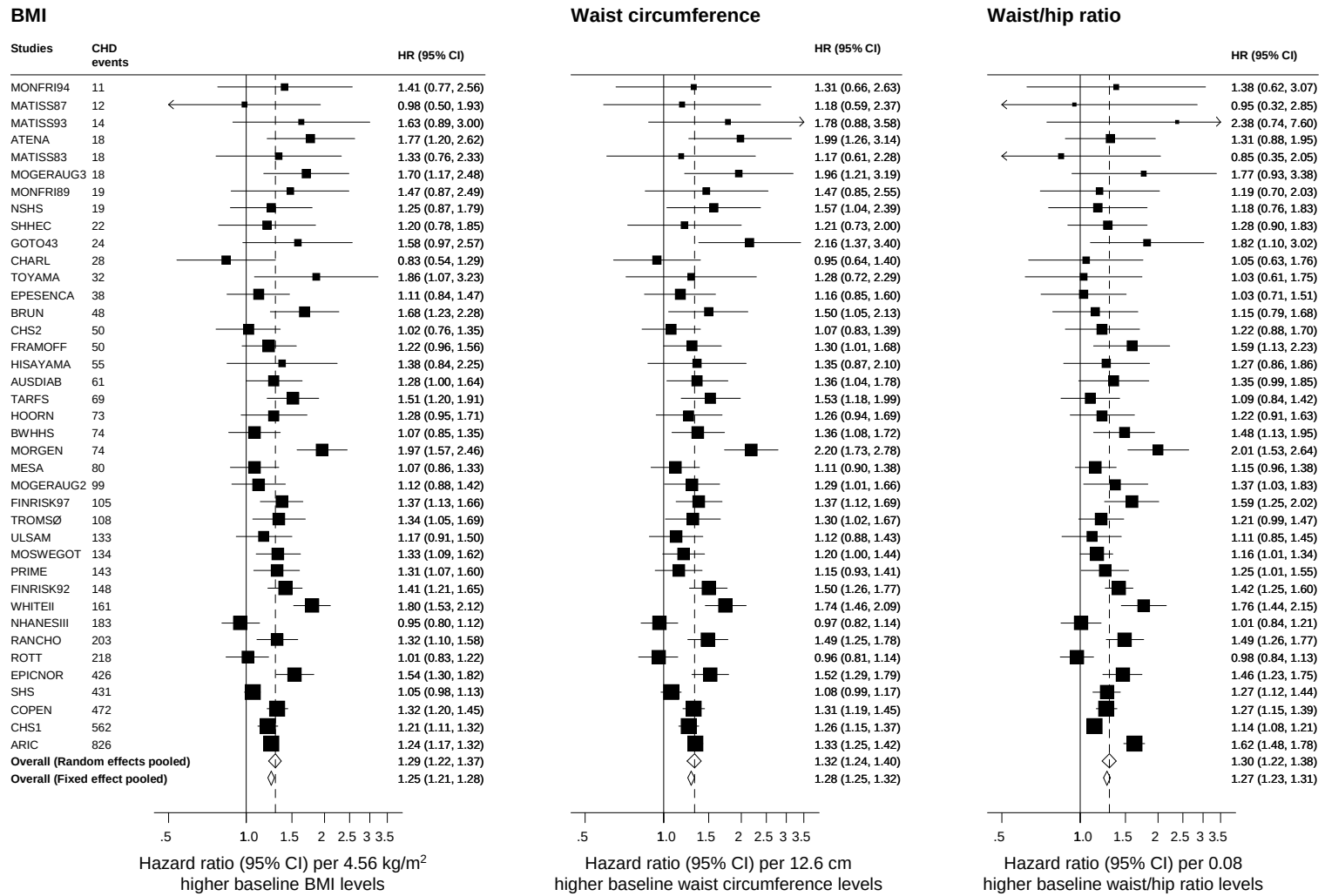
Analysis was based on 141,203 participants (involving 5684 cases) from 41 studies. Regression analyses were adjusted for age at baseline and smoking status, and stratified, where appropriate, by sex. Adjusted study-specific log hazard ratios were combined by multivariate random effects meta-analysis. The y-axes are shown on a log scale. Referent groups are the lowest third of waist circumference or waist-to-hip ratio in the lower level of triglyceride.

eFigure 11 Hazard ratios for coronary heart disease per 1-SD higher baseline BMI, waist circumference and waist-to-hip ratio levels, according to several individual and study level characteristics



Study-specific hazard ratios (HRs) were adjusted for age and smoking, and stratified, where appropriate, by sex. Analyses were restricted to participant with BMI values of 20 kg/m^{2}or higher. CI indicates confidence interval. NA, not applicable

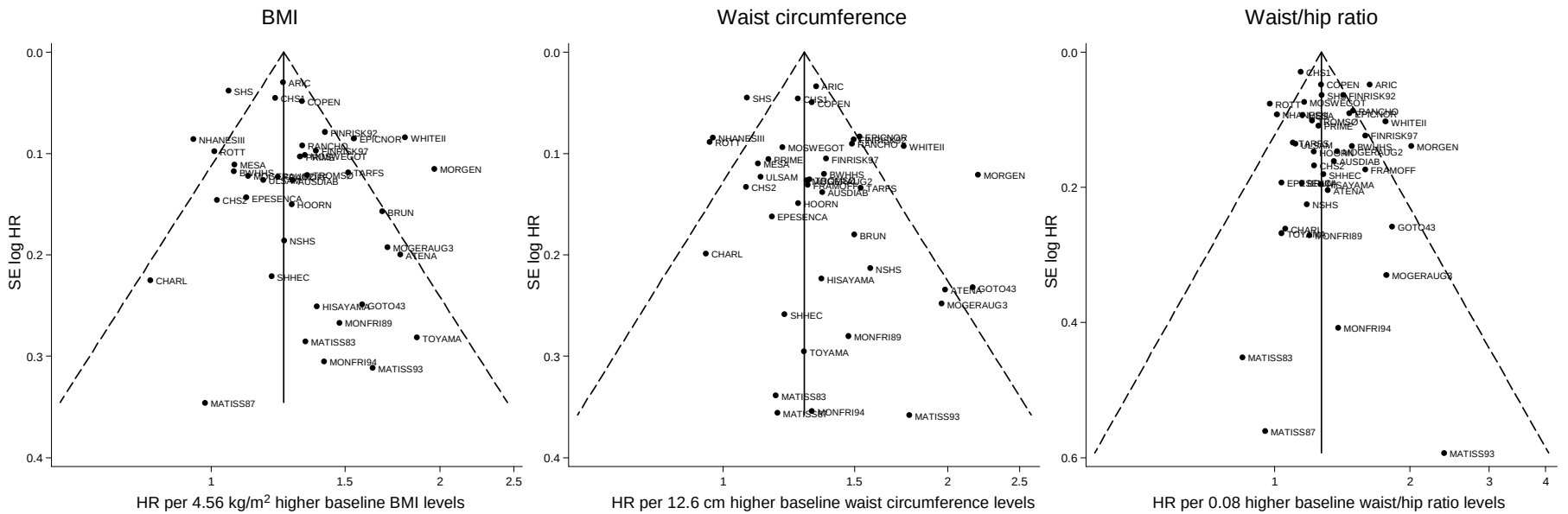
eFigure 12 Study-specific hazard ratios for coronary heart disease per 1-SD higher baseline levels of adiposity measures, adjusted for age, sex, and smoking status in the BMI range ≥20 kg/m^2



Analyses were restricted to participants with BMI values of 20 kg/m^2 or higher and complete information on age, sex, smoking status, history of diabetes, systolic blood pressure and total and HDL cholesterol.

In the BMI analysis, after excluding the 6 most discrepant studies (CHARL, MATISS87, NHANESIII, MORGEN, TOYOMA, WHITEII) the hazard ratio was 1.26 (95% CI 1.20, 1.33) and the I^2 was reduced to 45% (95% CI 17%-64%). In the WC analysis, after excluding the 6 most discrepant studies (CHARL, NHANESIII, ROTT, ATENA, GOTO43, MORGEN) the hazard ratio was 1.31 (95% CI 1.25, 1.38) and the I^2 was reduced to 40% (95% CI 9%-61%).In the waist/hip ratio analysis, after excluding the 6 most discrepant studies (MATISS83, MATISS87, ROTT, GOTO43, MATISS93, MORGEN) the hazard ratio was 1.30 (95% CI 1.22, 1.37) and the I^2 was reduced to 61% (95% CI 43%-73%).

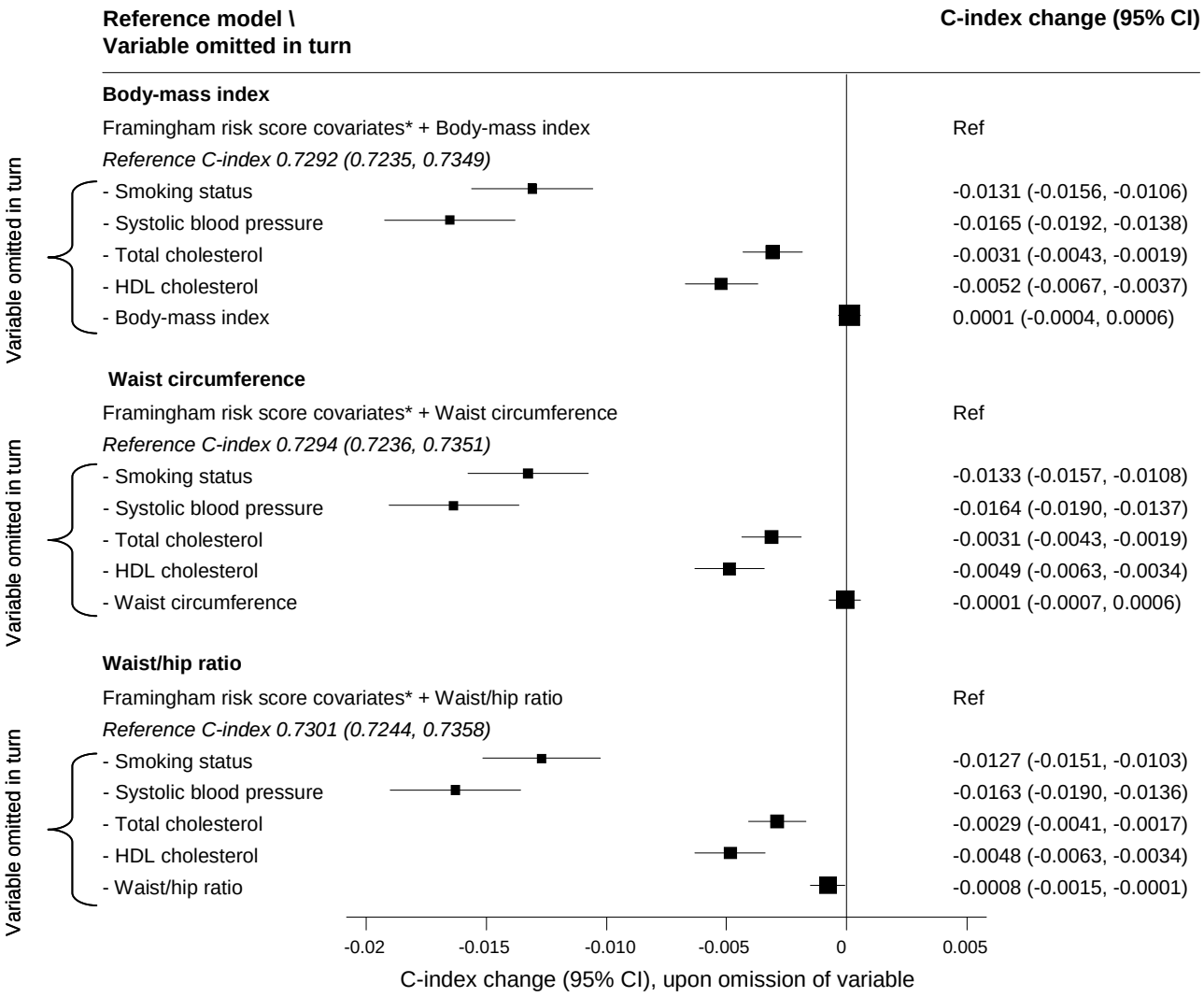
eFigure 13 Funnel plots assessing potential bias due to small studies in the meta-analysis of adiposity measure and coronary heart disease risk



Analyses were restricted to participants with BMI values of 20 kg/m^2 or higher and complete information on age, sex, smoking status, history of diabetes, systolic blood pressure, and total and HDL cholesterol. Dotted lines represent pseudo 95% CI.

There was no evidence of bias from small-study effects for BMI (p=0.123), waist circumference (p=0.211) and waist-to-hip ratio (p=0.414) using Egger's test of small-study effects.

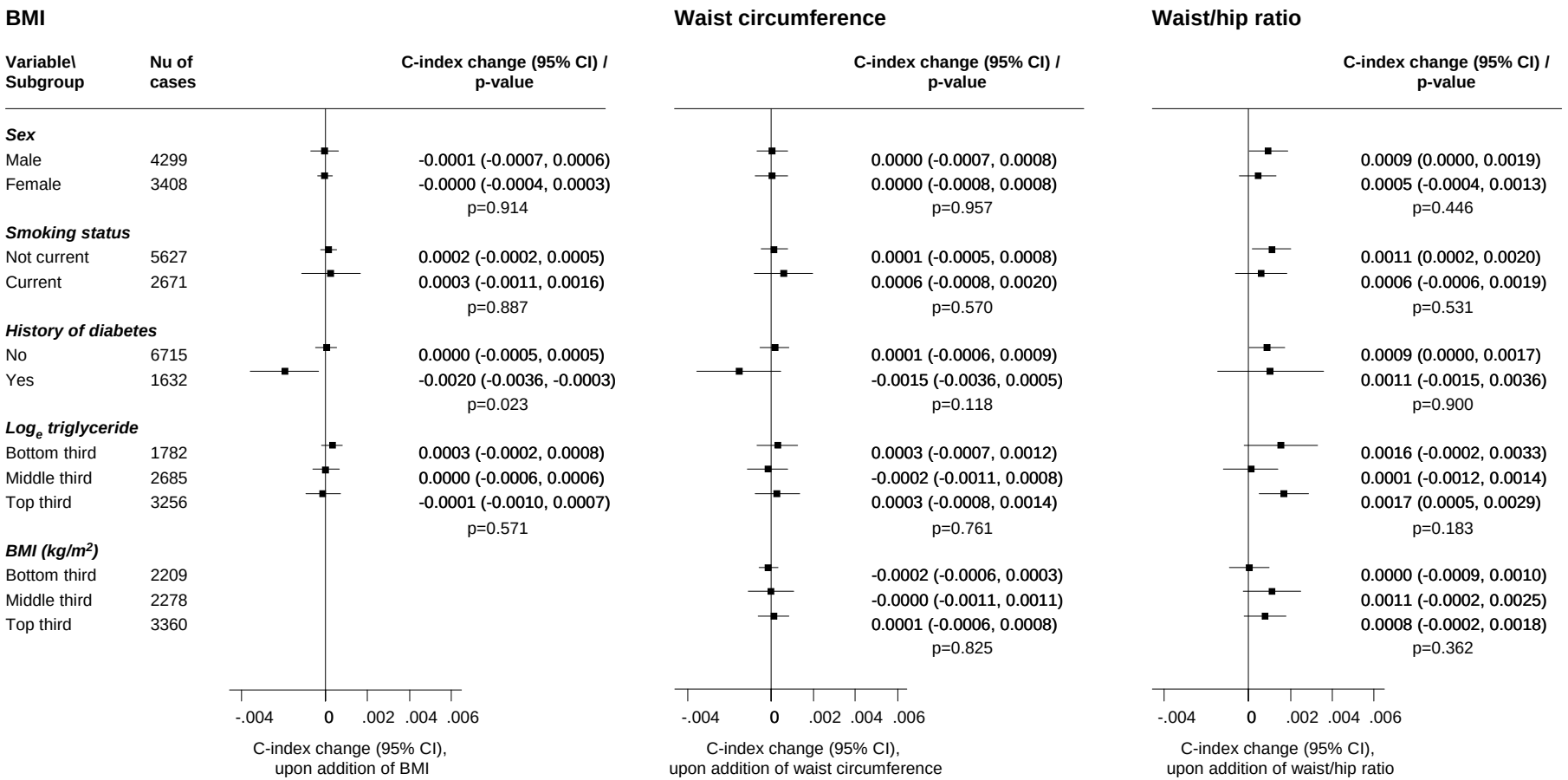
eFigure 14 Changes in C-index for cardiovascular disease risk prediction on omission of individual risk factors from a full model containing the Framingham risk score covariates plus BMI, waist circumference or waist-to-hip ratio in participants without diabetes at baseline



*The Framingham covariates include age, smoking status, systolic blood pressure, history of diabetes, and total and HDL cholesterol. Model was stratified by sex.

Analyses involved 134,287 participants (39 studies) with 6715 cardiovascular events. Analyses are restricted to participants with BMI values of 20 kg/m^2 or higher.

eFigure 15 Changes in C-index for cardiovascular disease risk prediction upon addition of BMI, waist circumference or waist-to-hip ratio on top of Framingham risk score covariates, according to different subgroups



Models contain all Framingham covariates (age, systolic blood pressure, smoking status, history of diabetes and total and HDL-cholesterol) with and without inclusion of BMI, waist circumference or waist-to-hip ratio. Predictive ability added by BMI, waist circumference or waist-to-hip ratio is given, with a p-value testing the null hypothesis of no difference in effect between levels of each subgroup. Error bars indicate 95% confidence limits. In each case only studies with information on both subgroup levels are used. Not all studies used had full information across all subgroups levels, so comparisons across subgroups (eg, men vs smokers) are not reliable due to inclusion of between study differences.

eAppendix List of study acronyms and study references

ARIC, Atherosclerosis Risk in Communities Study
ATTICA, ATTICA Study
AUSDIAB, Australian Diabetes, Obesity and Lifestyle Study
BRHS, British Regional Heart Study
BRUN, Bruneck Study
BWHHS, British Women's Heart and Health Study
CAPS, Caerphilly Prospective Study
CHARL, Charleston Heart Study
CHS, Cardiovascular Health Study
COPEN, Copenhagen City Heart Study
CUORE, Progetto CUORE
DRECE, Diet and Risk of Cardiovascular Disease in Spain
EPESENCA, The Established Populations for the Epidemiologic Study of the Elderly Studies, North Carolina
EPICNOR, EPIC Norfolk Study
FINRISK92, Finrisk Cohort 1992
FINRISK97, Finrisk Cohort 1997
FRAMOFF, Framingham Offspring Cohort
GOH, The Glucose Intolerance, Obesity and Hypertension Study
GOTO13, Göteborg 1913 Study
GOTO33, Göteborg 1933 Study
GOTO43, Göteborg 1943 Study
GOTOW, Population Study of Women in Gothenburg, Sweden
HBS, Helsinki Businessmen Study
HISAYAMA, Hisayama Study
HOORN, Hoorn Study
HPFS, Health Professionals Follow-up Study
IKNS, Ikawa, Kyowa, and Noichi Study
LASA, Longitudinal Aging Study Amsterdam
MESA, Multi-Ethnic Study of Atherosclerosis
MOGERAUG2, MONICA/KORA Augsburg Survey S2
MOGERAUG3, MONICA/KORA Augsburg Survey S3
MORGEN, Monitoring Project on Chronic Disease Risk Factors
MOSWEGOT, MONICA Göteborg Study
MRCOLD, MRC Study of Older People
NHANESIII, Third National Health and Nutrition Examination Survey
NHS, Nurses' Health Study
NSHS, Nova Scotia Health Survey
OSAKA, Osaka Study
PREVEND, Prevention of Renal and Vascular End Stage Disease Study
PRIME, Prospective Epidemiological Study of Myocardial Infarction
RANCHO, Rancho Bernardo Study
ROTT, The Rotterdam Study
SHHEC, Scottish Heart Health Extended Cohort
SHS, Strong Heart Study
TARFS, Turkish Adult Risk Factor Study
TOYAMA, Toyama
TROMSØ, Tromsø Study
ULSAM, Uppsala Longitudinal Study of Adult Men
WHIHABPS, Women's Health Initiative (Hormones and Biomarkers Predicting Stroke in Women)
WHITE2, Whitehall II Study
WHS, Women’s Health Study

Reference list of participating studies (48 references represent the 58 studies that provided data relevant to these analyses)

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