

Table 1. Estimated ^a mean values (95% CI) and adjusted ^a proportion (95% CI) of baseline characteristics by skeletal muscle mass to visceral fat area ratio quintiles (n=151,017)

Characteristics	SV ratio (kg/cm ²) quintiles					<i>p</i> -trend
	Q1	Q2	Q3	Q4	Q5	
Number of participants	30,205	30,209	30,198	30,205	30,200	
Age (years)	40.2 (40.1-40.2)	37.8 (37.7-37.9)	36.7 (36.6-36.8)	35.9 (35.8-35.9)	34.6 (34.6-34.7)	<0.001
Male (%)	38.3 (37.8-38.9)	39.2 (38.7-39.8)	39.7 (39.1-40.2)	40.0 (39.4-40.5)	40.4 (39.9-41.0)	<0.001
Alcohol intake (%) ^b	26.4 (25.9-26.8)	24.5 (24.1-25.0)	23.2 (22.7-23.6)	22.9 (22.5-23.4)	21.9 (21.4-22.3)	<0.001
Current smoker (%)	11.4 (11.1-11.7)	11.7 (11.4-12.1)	11.4 (11.1-11.8)	11.5 (11.2-11.9)	12.5 (12.1-12.8)	0.001
HEPA (%)	11.4 (11.1-11.8)	12.0 (11.6-12.3)	12.6 (12.2-12.9)	14.2 (13.8-14.6)	16.2 (15.8-16.6)	<0.001
Education level (%) ^c	82.7 (82.3-83.1)	86.4 (86.0-86.8)	87.8 (87.4-88.2)	87.7 (87.4-88.1)	87.1 (86.7-87.5)	<0.001
History of diabetes (%)	0.6 (0.5-0.6)	0.6 (0.5-0.7)	0.5 (0.4-0.6)	0.5 (0.4-0.5)	0.6 (0.5-0.7)	0.764
History of hypertension (%)	4.4 (4.2-4.6)	3.3 (3.1-3.5)	3.0 (2.8-3.2)	2.9 (2.7-3.1)	2.5 (2.3-2.7)	<0.001
History of CVD (%)	0.6 (0.5-0.7)	0.6 (0.5-0.7)	0.6 (0.5-0.7)	0.6 (0.5-0.7)	0.5 (0.4-0.6)	0.342
Anti-lipid medication use (%)	1.4 (1.3-1.5)	1.1 (0.9-1.2)	0.9 (0.7-1.0)	0.7 (0.6-0.8)	0.6 (0.5-0.7)	<0.001
Obesity (%) ^d	36.6 (36.1-37.2)	15.7 (15.3-16.1)	8.6 (8.3-8.9)	4.2 (3.9-4.4)	1.1 (1.0-1.2)	<0.001
Abdominal obesity (%) ^e	28.0 (27.5-28.5)	11.5 (11.1-11.8)	5.5 (5.2-5.7)	2.1 (1.9-2.2)	0.4 (0.3-0.4)	<0.001
Body mass index (kg/m ²)	24.2 (24.2-24.3)	22.7 (22.7-22.8)	21.9 (21.8-21.9)	21.1 (21.1-21.1)	19.9 (19.9-19.9)	<0.001
Waist circumference (cm)	82.8 (82.7-82.8)	79.3 (79.3-79.4)	77.2 (77.1-77.3)	75.2 (75.1-75.3)	71.8 (71.8-71.9)	<0.001
Glucose (mg/dl)	92.2 (92.1-92.3)	91.5 (91.5-91.6)	91.2 (91.1-91.3)	90.8 (90.7-90.9)	90.2 (90.1-90.3)	<0.001
HbA1c (%)	5.5 (5.5-5.5)	5.5 (5.5-5.5)	5.5 (5.5-5.5)	5.5 (5.5-5.5)	5.5 (5.5-5.5)	0.682
SBP (mmHg)	107.1 (107-107.2)	105.1 (105-105.2)	104.2 (104.1-104.3)	103.6 (103.5-103.7)	102.5 (102.4-102.6)	<0.001
DBP (mmHg)	68.4 (68.3-68.5)	67.3 (67.2-67.3)	66.8 (66.7-66.9)	66.5 (66.4-66.6)	66.0 (65.9-66.1)	<0.001
Total cholesterol (mg/dl)	195.5 (195.1-195.8)	190.2 (189.9-190.6)	187.0 (186.6-187.3)	184.3 (183.9-184.6)	180.5 (180.1-180.8)	<0.001
LDL-C (mg/dl)	123.5 (123.2-123.8)	118.0 (117.7-118.3)	114.7 (114.4-115.0)	111.3 (111-111.6)	106.0 (105.7-106.3)	<0.001
HDL-C (mg/dl)	60.6 (60.5-60.8)	62.1 (61.9-62.2)	63.4 (63.2-63.6)	65.3 (65.2-65.5)	68.0 (67.9-68.2)	<0.001
Triglycerides (mg/dl)	100.1 (99.5-100.6)	93.0 (92.5-93.6)	88.2 (87.7-88.7)	83.1 (82.6-83.6)	75.4 (74.9-75.9)	<0.001
ALT (U/L)	19.0 (18.9-19.1)	17.7 (17.6-17.8)	16.9 (16.0-17)	16.2 (16.1-16.3)	15.4 (15.3-15.5)	<0.001
AST (U/L)	19.3 (19.2-19.3)	18.8 (18.7-18.9)	18.6 (18.5-18.6)	18.5 (18.5-18.6)	18.6 (18.6-18.7)	<0.001
GTP (U/L)	24.7 (24.5-24.9)	21.6 (21.4-21.8)	20.2 (20.0-20.4)	19.0 (18.8-19.2)	17.7 (17.5-17.9)	<0.001
hs-CRP (mg/L)	1.25 (1.17-1.33)	0.91 (0.84-0.99)	0.85 (0.78-0.93)	0.83 (0.75-0.91)	0.78 (0.70-0.85)	<0.001
HOMA-IR	1.56 (1.56-1.57)	1.36 (1.35-1.37)	1.25 (1.24-1.26)	1.14 (1.14-1.15)	1.00 (0.99-1.00)	<0.001

Total energy intake (kcal/d) ^f	1,374 (1,366-1,382)	1,382 (1,374-1,390)	1,373 (1,365-1,381)	1,375 (1,367-1,383)	1,395 (1,387-1,403)	0.002
ASM (kg)	18.4 (18.4-18.5)	18.8 (18.8-18.8)	19.0 (19.0-19.0)	19.1 (19.1-19.2)	19.3 (19.2-19.3)	<0.001
Visceral fat area (cm ²)	96.5 (96.4-96.7)	77.4 (77.3-77.5)	67.0 (66.9-67.1)	57.1 (57.0-57.3)	41.9 (41.8-42.1)	<0.001
Fat mass (kg)	21.0 (20.9-21.0)	17.5 (17.4-17.5)	15.4 (15.4-15.5)	13.5 (13.5-13.6)	10.7 (10.7-10.7)	<0.001

^aAdjusted for age and sex; ^b≥10 g/day; ^c≥ College graduate; ^dBMI ≥ 25kg/m²; ^e waist circumference ≥90 cm for men ≥85 cm for women; ^f among 103,890 participants with plausible estimated energy intake levels (within three standard deviations from the log-transformed mean energy intake)

The mean SV ratio in each quintile among men: Q1, 0.23; Q2, 0.29; Q3, 0.33; Q4, 0.40 and Q5, 0.63.

The mean SV ratio in each quintile among women: Q1, 0.17; Q2, 0.21; Q3, 0.25; Q4, 0.29 and Q5, 0.40.

Abbreviations: ALT, alanine aminotransferase; ASM, appendicular skeletal muscle mass; AST, aspartate transaminase; CI, confidence intervals; CVD, cardiovascular disease; HbA1c, HDL-C, high-density lipoprotein-cholesterol; HEPA, health-enhancing physically active; HOMA-IR, homeostasis model assessment of insulin resistance; hs-CRP, high sensitivity C-reactive protein; SV ratio, skeletal muscle mass to visceral fat area ratio.

Table 2. Development of non-alcoholic fatty liver disease by skeletal muscle mass to visceral fat area ratio quintiles

SV ratio (kg/cm ²) quintiles	Person- years (PY)	Incident cases	Incidence density (/ 10 ³ PY)	Age adjusted HR (95% CI)	Multivariable-adjusted HR ^a (95% CI)		HR (95% CI) ^b in a model with time-dependent variables
					Model 1	Model 2	
Men							
Q1 (< 0.26)	34,429	4,937	143.4	3.42(3.24-3.61)	3.77 (3.56-3.99)	1.92 (1.8-2.05)	2.46 (2.30-2.63)
Q2 (0.26-0.30)	36,754	4,275	116.3	2.75(2.60-2.90)	2.97 (2.81-3.15)	1.84 (1.74-1.96)	2.29 (2.15-2.44)
Q3 (0.31-0.35)	38,362	3,628	94.6	2.23(2.10-2.36)	2.36 (2.23-2.50)	1.66 (1.56-1.76)	2.00 (1.88-2.13)
Q4 (0.36-0.44)	39,930	2,961	74.2	1.74(1.65-1.85)	1.81 (1.70-1.92)	1.44 (1.35-1.53)	1.64 (1.54-1.75)
Q5 (≥ 0.45)	42,393	1,800	42.5	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
<i>p</i> -trend				<0.001	<0.001	<0.001	<0.001
<i>Per 0.1 decrease in SV ratio</i>				1.41(1.39-1.43)	1.45 (1.43-1.48)	1.21 (1.19-1.23)	1.28 (1.26-1.31)
Women							
Q1 (< 0.19)	59,022	3,928	66.6	11.27 (10.10-12.58)	11.69 (10.46-13.06)	3.37 (2.99-3.8)	3.65 (3.18-4.19)
Q2 (0.19-0.22)	66,574	2,406	36.1	6.44 (5.76-7.21)	6.73 (6.01-7.53)	3.19 (2.84-3.57)	3.76 (3.28-4.31)
Q3 (0.23-0.26)	67,680	1,433	21.2	3.87 (3.45-4.35)	4.02 (3.58-4.51)	2.46 (2.19-2.77)	2.50 (2.17-2.87)
Q4 (0.27-0.31)	68,393	819	12.0	2.24 (1.98-2.54)	2.31 (2.04-2.61)	1.74 (1.54-1.98)	1.74 (1.50-2.02)
Q5 (≥ 0.32)	69,611	356	5.1	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
<i>p</i> -trend				<0.001	<0.001	<0.001	<0.001
<i>Per 0.1 decrease in SV ratio</i>				3.46 (3.32-3.60)	3.55 (3.40-3.70)	1.68 (1.60-1.76)	1.53 (1.47-1.60)

^a Estimated from Cox proportional hazard models. Multivariable model 1 was adjusted for age, centre, year of screening exam, alcohol consumption, smoking, physical activity, total energy intake, education level, medication for hyperlipidaemia, history of diabetes, and history of hypertension; model 2: model 1 plus adjustment for body mass index.

^b Estimated from Cox proportional hazard models with quintiles of SV ratio, smoking, alcohol consumption, physical activity, total energy intake, BMI, medication for hyperlipidaemia, history of diabetes, and history of hypertension as time-dependent categorical variables and baseline age, center, year of screening exam, education level as time-fixed variables.

The mean SV ratio in each quintile among men: Q1, 0.23; Q2, 0.29; Q3, 0.33; Q4, 0.40 and Q5, 0.63

The mean SV ratio in each quintile among women: Q1, 0.17; Q2, 0.21; Q3, 0.25; Q4, 0.29 and Q5, 0.40

Abbreviations: CI, confidence interval; HR, hazard ratio; PY, person-years; SV ratio, skeletal muscle mass to visceral fat area ratio.

Table 3. Comparison of the discriminatory power of the skeletal muscle mass to visceral fat area ratios in the detection of non-alcoholic fatty liver disease

	AUROC (95% CI)		NRI ^c		IDI	
	Harrel's C (95% CI)	<i>P</i> value	Index	<i>P</i> value	Index	<i>P</i> value
Addition of SV ratio to BMI						
Men						
Base model (age and BMI) ^a	0.643 (0.638–0.647)	reference		reference		reference
+ SV ratio	0.650 (0.646–0.654)	< 0.001	0.03994	< 0.001	0.00636	< 0.001
Women						
Base model (age and BMI) ^a	0.779 (0.774–0.783)	reference		reference		reference
+ SV ratio	0.782 (0.778–0.787)	< 0.001	0.00757	0.013	0.00041	0.073
Addition of SV ratio to waist circumference						
Men						
Base model (age and waist circumference) ^b	0.649 (0.644–0.653)	reference		reference		reference
+ SV ratio	0.656 (0.652–0.660)	< 0.001	0.04078	< 0.001	0.00537	< 0.001
Women						
Base model (age and waist circumference) ^b	0.769 (0.765–0.774)	reference		reference		reference
+ SV ratio	0.778 (0.774–0.783)	< 0.001	0.02538	< 0.001	0.00371	< 0.001

^a Base model adjusted for age and BMI.^b Base model adjusted for age and waist circumference.^c Risk cut-offs of 10% and 30% were used.

Abbreviations: AUROC, area under the receiver operating characteristic curve; BMI, body mass index; CI, confidence interval; IDI, integrated discrimination improvement; NRI, net reclassification improvement; SV ratio, skeletal muscle mass and visceral fat area ratio.

Table 4. Development of hepatic steatosis (HS) plus intermediate / high probability of advanced fibrosis by skeletal muscle mass to visceral fat area ratio quintiles

SV ratio (kg/cm ²) quintiles	HS plus intermediate-to-high FIB-4				HS plus intermediate-to-high NFS			
	Person-years (PY)	Incident cases	Incidence density (/ 10 ³ PY)	Multivariable-adjusted HR ^a (95% CI)	Person-years (PY)	Incident cases	Incidence density (/ 10 ³ PY)	Multivariable-adjusted HR ^a (95% CI)
Men								
Q1 (< 0.26)	46,789	368	7.9	2.83 (2.19-3.64)	46,297	570	12.3	3.98 (3.21-4.93)
Q2 (0.26-0.30)	47,295	223	4.7	2.20 (1.70-2.84)	46,950	386	8.2	3.23 (2.60-4.00)
Q3 (0.31-0.35)	47,094	186	3.9	2.01 (1.56-2.61)	46,972	251	5.3	2.20 (1.76-2.75)
Q4 (0.36-0.44)	46,728	153	3.3	1.71 (1.31-2.23)	46,628	195	4.2	1.70 (1.35-2.14)
Q5 (≥ 0.45)	46,344	86	1.9	1.00 (reference)	46,292	114	2.5	1.00 (reference)
<i>p</i> -trend				<0.001				<0.001
<i>Per 0.1 decrease in SV ratio</i>				1.36 (1.27-1.45)				1.55 (1.46-1.65)
Women								
Q1 (< 0.19)	67,879	177	2.6	7.96 (3.85-16.44)	67,702	274	4.0	12.69 (6.88-23.41)
Q2 (0.19-0.22)	72,083	65	0.9	4.60 (2.20-9.61)	72,014	105	1.5	6.27 (3.36-11.69)
Q3 (0.23-0.26)	70,823	35	0.5	3.01 (1.39-6.49)	70,759	54	0.8	3.74 (1.95-7.16)
Q4 (0.27-0.31)	70,163	28	0.4	2.84 (1.29-6.23)	70,176	26	0.4	2.01 (0.99-4.07)
Q5 (≥ 0.32)	70,365	8	0.1	1.00 (reference)	70,350	11	0.2	1.00 (reference)
<i>p</i> -trend				<0.001				<0.001
<i>Per 0.1 decrease in SV ratio</i>				2.57 (2.01-3.28)				3.95 (3.21-4.87)

^a Estimated from Cox proportional hazard models with adjustment for age, center, year of screening exam, alcohol consumption, smoking, physical activity, total energy intake, education level, medication for hyperlipidemia, history of diabetes (only for HS plus intermediate-to-high FIB-4) and history of hypertension.

The mean SV ratio in each quintile among men: Q1, 0.23; Q2, 0.29; Q3, 0.33; Q4, 0.40 and Q5, 0.63

The mean SV ratio in each quintile among women: Q1, 0.17; Q2, 0.21; Q3, 0.25; Q4, 0.29 and Q5, 0.40

Abbreviations: CI, confidence interval; HR, hazard ratio; SV ratio, skeletal muscle mass to visceral fat area ratio.

Table 5. Hazard ratios^a (95% confidence intervals) of non-alcoholic fatty liver disease according to skeletal muscle mass to visceral fat area quintiles by overall obesity

	No obesity				Obesity				<i>P value</i> ^b
SV ratio (kg/cm ²) quintiles	Person-years (PY)	Incident cases	Incidence density (/ 10 ³ PY)	Multivariable-adjusted HR ^a (95% CI)	Person-years (PY)	Incident cases	Incidence density (/ 10 ³ PY)	Multivariable-adjusted HR ^a (95% CI)	
Men									
Q1 (< 0.26)	20,065	2,203	109.8	2.92 (2.73-3.13)	14,363	2,734	190.3	1.72 (1.42-2.07)	<0.001
Q2 (0.26-0.30)	27,067	2,716	100.3	2.63 (2.47-2.80)	9,686	1,559	161.0	1.42 (1.17-1.72)	
Q3 (0.31-0.35)	31,908	2,664	83.5	2.15 (2.02-2.28)	6,455	964	149.4	1.31 (1.08-1.59)	
Q4 (0.36-0.44)	36,326	2,526	69.5	1.75 (1.64-1.86)	3,604	435	120.7	1.05 (0.85-1.28)	
Q5 (≥ 0.45)	41,404	1,686	40.7	1.00 (reference)	988	114	115.4	1.00 (reference)	
<i>p</i> -trend				<0.001				<0.001	
<i>Per 0.1 decrease in SV ratio</i>				1.34 (1.32-1.36)				1.31 (1.26-1.37)	0.308
Women									
Q1 (< 0.19)	45,524	2,141	47.0	7.97 (7.10-8.94)	13,498	1,787	132.4	1.87 (0.47-7.48)	<0.001
Q2 (0.19-0.22)	62,913	2,034	32.3	5.93 (5.29-6.65)	3,661	372	101.6	1.49 (0.37-5.99)	
Q3 (0.23-0.26)	66,588	1,328	19.9	3.75 (3.33-4.22)	1,092	105	96.2	1.39 (0.34-5.62)	
Q4 (0.27-0.31)	68,134	789	11.6	2.22 (1.96-2.52)	259	30	115.8	1.69 (0.40-7.09)	
Q5 (≥ 0.32)	69,580	354	5.1	1.00 (reference)	30	2	66.5	1.00 (reference)	
<i>p</i> -trend				<0.001				<0.001	
<i>Per 0.1 decrease in SV ratio</i>				2.77 (2.65-2.90)				1.50 (1.32-1.69)	<0.001

^a Estimated from Cox proportional hazard models. Multivariable model was adjusted for age, centre, year of screening exam, alcohol consumption, smoking, physical activity, total energy intake, education level, medication for hyperlipidaemia, history of diabetes (only for HS plus intermediate-to-high FIB-4), and history of hypertension

^b *P* for interaction

The mean SV ratio in each quintile among men: Q1, 0.23; Q2, 0.29; Q3, 0.33; Q4, 0.40 and Q5, 0.63

The mean SV ratio in each quintile among women: Q1, 0.17; Q2, 0.21; Q3, 0.25; Q4, 0.29 and Q5, 0.40

Abbreviations: CI, confidence interval; HR, hazard ratio; SV ratio, skeletal muscle mass to visceral fat area ratio.