Skeletal muscle mass to visceral fat area ratio as a predictor of nonalcoholic fatty liver disease in lean and overweight men and women with effect modification by sex

Running title: SV ratio and fatty liver

Yoosun Cho, MD, PhD[1]; Yoosoo Chang, MD, PhD[2,3,4*]; Seungho Ryu, MD, PhD[2,3,4*]; Hyun-Suk Jung, MD[1]; Chan-won Kim, MD, PhD[1]; Hyungseok Oh, MD[1]; Mi Kyung Kim, PhD [5]; Won Sohn[6];Hocheol Shin, MD, PhD[2,7]; Sarah H. Wild, MB, BChir, PhD [8]; and Christopher D Byrne, MB, BCh, PhD[9,10]

Supplementary Tables

Supplementary Table 1. Estimated mean values (95% CI) and adjusted proportion (95% CI) of baseline characteristics according to skeletal muscle mass to visceral fat area ratio quintiles among men (N=59,699)

Supplementary Table 2. Estimated mean values (95% CI) and adjusted proportion (95% CI) of baseline characteristics by skeletal muscle mass to visceral fat area ratio quintiles among women (N=91,318)

Supplementary Table 3. Baseline characteristics according to missing data for study variables among eligible participants without NAFLD or other liver diseases at baseline (N=164,815)

Supplementary Table 4. Age-and sex-adjusted anthropometry and body composition characteristics according to the missing data (N=164,815)

Supplementary Table 5. Hazard ratios (95% CI) of non-alcoholic fatty liver disease, and NAFLD with intermediate-to-high probability of advanced fibrosis according to skeletal muscle mass to visceral fat area ratio quintiles after further adjustment for waist circumference as continuous variable instead of body mass index

Supplementary Table 6. Comparison of the discriminatory power of the visceral fat area, skeletal mass appendix, skeletal muscle mass, and visceral fat area ratios for detecting non-alcoholic fatty liver disease (base model adjusted for age and either BMI or waist circumference)

Supplementary Table 7. Overall accuracy for non-alcoholic fatty liver disease by adiposity indices

Supplementary Table 8. Age-standardized incidence density of hepatic steatosis (HS) and HS plus intermediate/high probability of advanced fibrosis by sex

Supplementary Table 9. Hazard ratiosa (95% CI) of non-alcoholic fatty liver disease, and NAFLD with intermediate-to-high probability of advanced fibrosis according to skeletal muscle mass to visceral fat area ratio quintiles after further adjustment for HOMA-IR and hs-CRP

Supplementary Table 10. Development of hepatic steatosis (HS) and a high probability of advanced fibrosis by skeletal muscle mass to visceral fat area ratio quintiles

Supplementary Table 11. Hazard ratiosa (95% confidence intervals) of non-alcoholic fatty liver disease according to skeletal muscle mass to visceral fat area quintiles by abdominal obesity

Supplementary Table 12. Hazard ratios (95% confidence intervals) of nonalcoholic fatty liver disease according to skeletal muscle mass to visceral fat area quintiles by BMI categories

Supplementary Table 13. Hazard ratiosa (95% confidence intervals) of non-alcoholic fatty liver disease with intermediate-to-high probability of advanced fibrosis based on Fiborsis-4 score according to skeletal muscle mass to visceral fat area quintiles by overall obesity

Supplementary Table 14. Hazard ratiosa (95% confidence intervals) of non-alcoholic fatty liver disease with intermediate-to-high probability of advanced fibrosis based on Fiborsis-4 score according to skeletal muscle mass to visceral fat area quintiles by abdominal obesity

Supplementary Table 15. Hazard ratiosa (95% confidence intervals) of non-alcoholic fatty liver disease with intermediate-to-high probability of advanced fibrosis based on non-alcoholic fatty liver disease fibrosis score (NFS) according to skeletal muscle mass to visceral fat area quintiles by overall obesity

Supplementary Table 16. Hazard ratiosa (95% confidence intervals) of non-alcoholic fatty liver disease with intermediate-to-high probability of advanced fibrosis based on non-alcoholic fatty liver disease fibrosis score (NFS) according to skeletal muscle mass to visceral fat area quintiles by abdominal obesity

Supplementary Table 17. Hazard ratiosa (95% confidence intervals) of non-alcoholic fatty liver disease according to skeletal muscle mass to visceral fat area quintiles by menopausal status

Supplementary Table 1. Estimated[a] mean values (95% CI) and adjusted[a] proportion (95% CI) of baseline characteristics according to skeletal muscle mass to visceral fat area ratio quintiles among men (N=59,699)

Characteristics	SV ratio quintiles (kg/cm^2)					*p*–trend
	Q1(0. 09-0.26)	Q2(0.26-0.31)	Q3(0.31-0.36)	Q4(0.36-0.45)	Q5(0.45-8.04)	
Number of participants	11,940	11,943	11,937	11,942	11,937	
Age (years)	40.9 (40.8-41.0)	37.8 (37.7-37.9)	36.7 (36.6-36.8)	36.2 (36.1-36.3)	35.6 (35.5-35.7)	<0.001
Seoul center(%)	68.8 (67.9-69.7)	61.0 (60.2-61.9)	53.8 (52.9-54.7)	45.8 (44.9-46.7)	35.8 (34.9-36.6)	<0.001
Alcohol intake (%) [b]	48.2 (47.3-49.1)	47.1 (46.2-48.0)	44.0 (43.1-44.9)	42.7 (41.8-43.5)	39.9 (39.1-40.8)	<0.001
Current smoker (%)	26.4 (25.6-27.2)	27.3 (26.5-28.1)	26.8 (26.0-27.6)	26.6 (25.8-27.4)	28.4 (27.6-29.3)	0.016
HEPA (%)	14.0 (13.4-14.6)	14.8 (14.1-15.4)	15.6 (14.9-16.2)	17.5 (16.8-18.2)	20.4 (19.7-21.2)	<0.001
Education level (%) [c]	92.9 (92.5-93.4)	92.8 (92.3-93.2)	92.0 (91.5-92.5)	90.3 (89.8-90.9)	88.3 (87.7-88.9)	<0.001
History of diabetes (%)	0.9 (0.8-1.0)	1.0 (0.8-1.2)	0.9 (0.7-1.1)	0.8 (0.7-1.0)	1.2 (1.0-1.4)	0.142
History of hypertension (%)	7.8 (7.3-8.2)	6.3 (5.8-6.7)	5.8 (5.3-6.2)	5.6 (5.2-6.0)	4.8 (4.4-5.2)	<0.001
History of CVD (%)	0.9 (0.7-1.1)	0.7 (0.6-0.9)	0.8 (0.7-1.0)	0.8 (0.7-1.0)	0.8 (0.6-0.9)	0.662
Anti-lipid medication use (%)	2.1 (1.9-2.3)	1.7 (1.5-2.0)	1.4 (1.2-1.6)	1.2 (0.9-1.4)	1.0 (0.8-1.2)	<0.001
Obesity (%) [d]	50.3 (49.4-51.2)	29.8 (29.0-30.6)	18.7 (18.0-19.4)	9.8 (9.3-10.3)	2.6 (2.4-2.9)	<0.001
Abdominal obesity (%)[e]	34.3 (33.4-35.2)	17.3 (16.6-18.0)	10.2 (9.7-10.7)	4.1 (3.8-4.5)	0.7 (0.6-0.9)	<0.001
Body mass index (kg/m^2)	25.1 (25.1-25.1)	24.0 (24.0-24.1)	23.3 (23.3-23.4)	22.6 (22.6-22.7)	21.3 (21.3-21.4)	<0.001
Waist circumference (cm)	87.1 (87.0-87.2)	84.5 (84.4-84.6)	82.8 (82.7-82.9)	80.9 (80.8-81.0)	77.1 (77.0-77.2)	<0.001
Glucose (mg/dl)	93.9 (93.7-94.1)	93.8 (93.6-94.0)	93.4 (93.3-93.6)	93.3 (93.1-93.5)	92.6 (92.4-92.8)	<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)	0.008
SBP(mmHg)	113.4 (113.2-113.6)	112.0 (111.8-112.2)	111.3 (111.1-111.5)	110.4 (110.2-110.6)	108.9 (108.7-109.1)	<0.001
DBP(mmHg)	72.8 (72.7-73.0)	71.9 (71.7-72.0)	71.4 (71.3-71.6)	70.7 (70.6-70.9)	69.7 (69.5-69.8)	<0.001
Total cholesterol (mg/dl)	200.1 (199.5-200.7)	196.3 (195.7-196.8)	193.5 (192.9-194.0)	189.8 (189.2-190.3)	183.7 (183.1-184.3)	<0.001
LDL-C(mg/dl)	131.1 (130.5-131.6)	127.9 (127.4-128.4)	125.8 (125.3-126.3)	122.3 (121.8-122.8)	115.7 (115.2-116.2)	
HDL-C (mg/dl)	54.5 (54.2-54.7)	55.3 (55.1-55.5)	56.1 (55.9-56.3)	57.8 (57.6-58.1)	61.2 (61.0-61.4)	<0.001
Triglycerides (mg/dl)	119.1 (118.0-120.1)	113.5 (112.4-114.5)	108.3 (107.3-109.4)	102.9 (101.8-103.9)	90.6 (89.6-91.7)	<0.001
GTP(U/L)	36.3 (35.8-36.8)	31.8 (31.4-32.3)	29.5 (29.0-29.9)	26.9 (26.4-27.3)	23.2 (22.8-23.7)	<0.001
ALT (U/L)	25.0 (24.8-25.2)	23.4 (23.2-23.6)	22.0 (21.8-22.2)	20.6 (20.4-20.8)	18.6 (18.4-18.8)	<0.001
AST (U/L)	21.6 (21.5-21.7)	21.0 (20.9-21.2)	20.6 (20.5-20.7)	20.2 (20.1-20.3)	20.0 (19.9-20.1)	<0.001
hs-CRP (mg/L)	1.21 (1.09-1.34)	1.04 (0.92-1.16)	1.03 (0.91-1.15)	0.91 (0.79-1.03)	1.01 (0.89-1.13)	<0.001
HOMA-IR	1.52 (1.51-1.54)	1.38 (1.37-1.40)	1.30 (1.29-1.32)	1.21 (1.20-1.22)	1.05 (1.04-1.07)	<0.001
Total energy intake (kcal/d) [f]	1517 (1503-1530)	1526 (1513-1539)	1527 (1514-1539)	1533 (1520-1545)	1536 (1523-1549)	0.167

ASM (kg)	23.1 (23.1-23.2)	23.8 (23.8-23.9)	24.0 (24.0-24.1)	24.1 (24.1-24.2)	24.0 (24.0-24.1)	<0.001
Visceral fat area (cm^2)	100.6 (100.4-100.8)	83.2 (83.0-83.4)	72.0 (71.8-72.2)	60.5 (60.3-60.7)	42.1 (41.9-42.2)	<0.001
Fat mass (kg)	19.9 (19.9-20.0)	16.9 (16.8-17.0)	15.1 (15.1-15.2)	13.2 (13.2-13.3)	10.0 (9.9-10.0)	<0.001

[a]Adjusted for age

[b] ≥10 g/day; [c] ≥ College graduate; [d] BMI ≥ 25kg/m^2; [e] waist circumference ≥90 cm; [f] among 40,152 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.

Abbreviations: ALT, alanine aminotransferase; ASM, appendicular skeletal muscle mass; AST, aspartate transaminase; CI, confidence intervals; CVD, cardiovascular disease; HbA1c, haemoglobin A1c; HDL-C, high-density lipoprotein-cholesterol; HEPA, health-enhancing physically active; hs-CRP, high sensitivity C-reactive protein; HOMA-IR, homeostasis model assessment of insulin resistance; SV ratio, skeletal muscle mass to visceral fat area ratio.

Supplementary Table 2. 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 among women (N=91,318)

Characteristics	SV ratio quintiles (kg/cm^2)					*p*– trend
	Q1 (0.06-0.18)	Q2 (0.18-0.22)	Q3 (0.22-0.25)	Q4 (0.25-0.30)	Q5 (0.30-6.34)	
Number of participants	18,265	18,266	18,261	18,263	18,263	
Age (years)	39.7 (39.6-39.8)	37.8 (37.7-37.9)	36.7 (36.6-36.8)	35.7 (35.6-35.8)	34.0 (33.9-34.1)	<0.001
Seoul center (%)	47.1 (46.3-47.8)	49.0 (48.3-49.7)	52.5 (51.8-53.2)	55.4 (54.7-56.1)	63.3 (62.6-64.0)	<0.001
Alcohol intake (%) [b]	11.9 (11.4-12.4)	10.1 (9.6-10.5)	9.8 (9.4-10.2)	10.1 (9.7-10.5)	9.7 (9.3-10.1)	<0.001
Current smoker (%)	1.3 (1.1-1.5)	1.3 (1.1-1.5)	1.2 (1.0-1.4)	1.4 (1.3-1.6)	1.7 (1.5-1.9)	0.001
HEPA (%)	9.7 (9.3-10.1)	10.0 (9.6-10.4)	10.5 (10.1-11.0)	12.1 (11.6-12.5)	13.7 (13.2-14.3)	<0.001
Education level (%) [c]	75.7 (75.1-76.4)	82.1 (81.6-82.7)	85.0 (84.5-85.5)	86.0 (85.5-86.5)	86.4 (85.9-86.9)	<0.001
History of diabetes (%)	0.4 (0.3-0.5)	0.3 (0.2-0.4)	0.3 (0.2-0.4)	0.2 (0.1-0.3)	0.2 (0.2-0.3)	0.004
History of hypertension (%)	2.0 (1.9-2.2)	1.4 (1.2-1.6)	1.2 (1.1-1.4)	1.2 (1.0-1.4)	1.0 (0.8-1.1)	<0.001
History of CVD (%)	0.5 (0.4-0.5)	0.5 (0.4-0.6)	0.5 (0.4-0.6)	0.5 (0.4-0.6)	0.4 (0.3-0.5)	0.321
Anti-lipid medication use (%)	0.9 (0.8-1.0)	0.6 (0.5-0.7)	0.5 (0.4-0.6)	0.4 (0.3-0.5)	0.3 (0.2-0.4)	<0.001
Obesity (%) [d]	27.5 (26.9-28.2)	6.4 (6.0-6.8)	1.9 (1.7-2.1)	0.4 (0.4-0.5)	0.0 (0.0-0.1)	<0.001
Abdominal obesity (%)[e]	23.7 (23.1-24.4)	7.6 (7.2-8.0)	2.3 (2.1-2.5)	0.7 (0.6-0.8)	0.2 (0.1-0.2)	<0.001
Body mass index (kg/m^2)	23.7 (23.6-23.7)	21.9 (21.9-21.9)	20.9 (20.9-20.9)	20.1 (20.1-20.1)	19.0 (19.0-19.1)	<0.001
Waist circumference (cm)	79.9 (79.8-80.0)	76.0 (75.9-76.0)	73.5 (73.4-73.6)	71.4 (71.3-71.5)	68.4 (68.3-68.5)	<0.001
Glucose (mg/dl)	91.1 (91.0-91.2)	90.1 (90.0-90.2)	89.7 (89.6-89.8)	89.2 (89.1-89.4)	88.6 (88.5-88.7)	<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)	0.002
Total cholesterol (mg/dl)	192.4 (192.0-192.9)	186.2 (185.8-186.6)	182.7 (182.2-183.1)	180.7 (180.3-181.1)	178.4 (178.0-178.9)	<0.001
SBP(mmHg)	103 (102.9-103.2)	100.5 (100.4-100.7)	99.6 (99.4-99.7)	99.1 (99.0-99.3)	98.5 (98.3-98.6)	<0.001
DBP(mmHg)	65.5 (65.4-65.6)	64.2 (64.1-64.4)	63.8 (63.7-63.9)	63.7 (63.6-63.9)	63.6 (63.4-63.7)	<0.001
LDL-C(mg/dl)	118.6 (118.2-119.0)	111.5 (111.1-111.8)	107.4 (107.0-107.7)	104.2 (103.8-104.6)	99.8 (99.4-100.2)	<0.001
HDL-C (mg/dl)	64.7 (64.4-64.9)	66.5 (66.3-66.7)	68.1 (67.9-68.4)	70.3 (70.0-70.5)	72.5 (72.3-72.8)	<0.001
Triglycerides (mg/dl)	87.5 (87.0-88.0)	79.8 (79.3-80.3)	75.1 (74.6-75.6)	70.2 (69.7-70.7)	65.3 (64.8-65.8)	<0.001
GTP(U/L)	17.1 (16.9-17.2)	14.9 (14.7-15.0)	14.2 (14.0-14.3)	13.9 (13.7-14.1)	14.1 (13.9-14.2)	<0.001
ALT (U/L)	15.1 (15.0-15.2)	13.9 (13.8-14.0)	13.4 (13.3-13.5)	13.4 (13.2-13.5)	13.4 (13.3-13.6)	<0.001
AST (U/L)	17.8 (17.7-17.8)	17.3 (17.2-17.4)	17.2 (17.2-17.3)	17.4 (17.3-17.5)	17.8 (17.7-17.9)	<0.001
hs-CRP (mg/L)	1.28 (1.17-1.38)	0.83 (0.73-0.93)	0.73 (0.63-0.83)	0.78 (0.68-0.88)	0.62 (0.51-0.72)	<0.001
HOMA-IR	1.59 (1.58-1.60)	1.34 (1.33-1.35)	1.22 (1.21-1.23)	1.10 (1.09-1.11)	0.96 (0.95-0.97)	<0.001
Total energy intake (kcal/d) [f]	1285 (1274-1295)	1290 (1279-1300)	1275 (1264-1285)	1275 (1265-1285)	1309 (1298-1319)	0.001
ASM (kg)	15.4 (15.3-15.4)	15.5 (15.5-15.6)	15.7 (15.6-15.7)	15.8 (15.8-15.9)	16.2 (16.2-16.2)	<0.001

Visceral fat area (cm^2)	93.9 (93.7-94.0)	73.5 (73.4-73.7)	63.7 (63.5-63.9)	55.0 (54.8-55.1)	42.0 (41.8-42.2)	<0.001
Fat mass (kg)	21.7 (21.6-21.7)	17.8 (17.8-17.9)	15.7 (15.6-15.7)	13.7 (13.7-13.8)	11.2 (11.1-11.2)	<0.001

[a]Adjusted for age

[b] ≥10 g/day; [c] ≥ College graduate; [d] BMI ≥ 25kg/m^2; [e] waist circumference ≥85 cm; [f] among 63,738 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 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, haemoglobin A1c; HDL-C, high-density lipoprotein-cholesterol; HEPA, health-enhancing physically active; hs-CRP, high sensitivity C-reactive protein; HOMA-IR, homeostasis model assessment of insulin resistance; SV ratio, skeletal muscle mass to visceral fat area ratio.

Supplementary Table 3. Baseline characteristics according to missing data for study variables among eligible participants without NAFLD or other liver diseases at baseline (N=164,815)

Characteristics	Participants with No missing data (included in the final analysis)	Missing data (not included)
Number	151,017	13,798
Age (years) [a]	37.0 (6.6)	40.7 (8.6)
Male (%)	39.5	26.4
Alcohol intake (%)[c]	23.8	22.4
Current smoker (%)	11.7	8.7
High education level (%)[d]	86.3	80.2
HEPA (%)[e]	13.2	14.8
History of diabetes (%)	0.6	1.1
History of hypertension (%)	3.3	4.6
History of CVD (%)	0.6	1.1
Anti-lipid medication use (%)	1.0	2.1
Systolic BP (mmHg) [a]	104.5 (11.2)	104.2 (11.9)
Diastolic BP (mmHg) [a]	67.0 (8.7)	66.7 (9.0)
Glucose (mg/dL) [a]	91.2 (9.0)	92.1 (9.6)
Total cholesterol (mg/dL) [a]	187.5 (31.4)	190.5 (33.2)
LDL-C (mg/dL) [a]	114.7 (29.4)	118.6 (30.9)
HDL-C (mg/dL) [a]	63.9 (15.5)	83.5 (35.0)
Triglycerides (mg/dL) [b]	76 (57–104)	75 (57–104)
ALT (U/L) [b]	14 (11–20)	14 (11–19)
AST (U/L) [b]	18 (15–21)	17 (14–21)
GGT (U/L) [b]	15 (11–23)	14 (11–21)
hsCRP (mg/L) [b]	0.3 (0.2–0.6)	0.4 (0.2–0.8)
HOMA-IR [b]	1.12 (0.78–1.58)	1.16 (0.80–1.65)
Total calorie intake (kcal/day) [b, f]	1321 (972-1696)	1258 (892-1656)

Data are expressed as [a] mean (standard deviation), [b] median (interquartile range), or percentage.
[c] ≥10 g/day
[d] ≥ college graduate; [e] defined as physical activity that meets either of two criteria: (i) vigorous-intensity activity on three or more days per week accumulating ≥1,500 metabolic equivalents (MET) min/week; or (ii) seven days of any combination of walking, moderate-intensity, or vigorous-intensity activities achieving at least 3,000 MET-min/week
[f] Among 111,535 participants with plausible estimated energy intake levels (within three standard deviations of the log-transformed mean energy intake)
Abbreviations: ALT, alanine aminotransferase; ASM, appendicular skeletal muscle mass; AST, aspartate transaminase; CI, confidence interval; CVD, cardiovascular disease; HbA1c, glycated hemoglobin; 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

Supplementary Table 4. Age-and sex-adjusted anthropometry and body composition characteristics according to the missing data (N=164,815)

Characteristics	Participants with No missing data (included in the final analysis)	Missing data (not included)
Number	151,017	13,798
Body mass index (kg/m^2)	22.0 (21.9–22.0)	22.1 (22.0–22.1)
Waist circumference (cm)	77.2 (77.2–77.2)	77.2 (77.1–77.3)
ASM (kg)	18.8 (18.8–18.8)	18.9 (18.9–18.9)
Visceral fat area (cm^2)	68.2 (68.1–68.3)	69.5 (69.1–69.8)
Fat mass (kg)	15.6 (15.6–15.7)	15.8 (15.8–15.9)
SV ratio	0.31 (0.30–0.31)	0.31 (0.31–0.31)

Adjusted for age and sex;
Abbreviations: ASM, appendicular skeletal muscle mass; CI, confidence intervals; SV ratio, skeletal muscle mass to visceral fat area ratio.

Supplementary Table 5. Hazard ratios[a] (95% CI) of non-alcoholic fatty liver disease, and NAFLD with intermediate-to-high probability of advanced fibrosis according to skeletal muscle mass to visceral fat area ratio quintiles after further adjustment for waist circumference as continuous variable instead of body mass index

SV ratio (kg/cm^2) quintiles	**NAFLD**	**NAFLD+ intermediate-to-high Fib4**	**NAFLD+ intermediate-to-high NFS**
Men			
Q1 (0.09-0.26)	1.91 (1.79-2.04)	1.62 (1.23-2.15)	1.34 (1.06-1.69)
Q2 (0.26-0.31)	1.81 (1.71-1.92)	1.46 (1.11-1.91)	1.46 (1.17-1.83)
Q3 (0.31-0.36)	1.62 (1.53-1.72)	1.47 (1.12-1.92)	1.20 (0.95-1.50)
Q4 (0.36-0.45)	1.41 (1.33-1.50)	1.39 (1.06-1.82)	1.15 (0.91-1.45)
Q5 (0.45-8.04)	1.00 (reference)	1.00 (reference)	1.00 (reference)
p–trend	<0.001	0.005	0.004
Per 0.1 decrease in SV ratio	1.2 (1.18-1.22)	1.17 (1.08-1.26)	1.11 (1.04-1.18)
Women			
Q1 (0.06-0.18)	3.80 (3.38-4.28)	3.43 (1.61-7.31)	3.23 (1.71-6.12)
Q2 (0.18-0.22)	3.27 (2.92-3.67)	2.68 (1.27-5.67)	2.63 (1.40-4.96)
Q3 (0.22-0.25)	2.46 (2.18-2.76)	2.07 (0.95-4.50)	2.07 (1.08-3.98)
Q4 (0.25-0.30)	1.71 (1.51-1.94)	2.26 (1.03-4.97)	1.35 (0.66-2.75)
Q5 (0.30-6.34)	1.00 (reference)	1.00 (reference)	1.00 (reference)
p–trend	<0.001	<0.001	<0.001
Per 0.1 decrease in SV ratio	1.85 (1.77-1.94)	1.54 (1.19-2.01)	1.64 (1.31-2.04)

[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 (not for HS plus intermediate-to-high **NFS**), history of hypertension and waist circumference.

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: FIB-4, Fibrosis-4 score; NFS, non-alcoholic fatty liver disease fibrosis score; CI, confidence interval; HR, hazard ratio; SV ratio, skeletal muscle mass to visceral fat area ratio.

Supplementary Table 6. Comparison of the discriminatory power of the visceral fat area, skeletal mass appendix, skeletal muscle mass, and visceral fat area ratios for detecting non-alcoholic fatty liver disease (base model adjusted for age and either BMI or waist circumference)

	AUROC (95% CI)		NRI[c]		IDI	
	Harrel's C (95% CI)	*P* value	Index	*P* value	Index	*P* value
Men						
Base model (age and BMI)[a]	0.643 (0.638–0.647)	Reference		Reference		Reference
+ Visceral fat area	0.649 (0.645–0.653)	< 0.001	0.00989	< 0.001	0.00459	< 0.001
+ Appendicular skeletal muscle mass	0.646 (0.642–0.650)	< 0.001	0.00586	0.009	0.00200	< 0.001
+ SV ratio	0.650 (0.646–0.654)	< 0.001	0.03994	< 0.001	0.00636	< 0.001
Base model (age and waist circumference)[b]	0.649 (0.644–0.653)	Reference		Reference		Reference
+ Visceral fat area	0.654 (0.655–0.658)	< 0.001	0.00816	0.001	0.00300	< 0.001
+ Appendicular skeletal muscle mass	0.653 (0.649–0.657)	< 0.001	0.01095	< 0.001	0.00391	< 0.001
+ SV ratio	0.656 (0.652–0.660)	< 0.001	0.04078	< 0.001	0.00537	< 0.001
Women						
Base model (age and BMI)[a]	0.779 (0.774–0.783)	Reference		Reference		Reference
+ Visceral fat area	0.781 (0.777–0.786)	< 0.001	–0.00077	0.658	0.00002	0.824
+ Appendicular skeletal muscle mass	0.780 (0.775–0.785)	< 0.001	–0.00047	0.782	0.00013	0.085
+ SV ratio	0.782 (0.778–0.787)	< 0.001	0.00757	0.013	0.00041	0.073
Base model (age and waist circumference)[b]	0.769 (0.765–0.774)	Reference		Reference		Reference
+ Visceral fat area	0.779 (0.774–0.783)	< 0.001	0.01756	< 0.001	0.00323	< 0.001
+ Appendicular skeletal muscle mass	0.770 (0.765–0.775)	< 0.001	0.00564	0.004	0.00006	0.555
+ 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.

Risk cut-offs of 10% and 30% were used.

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

Supplementary Table 7. Overall accuracy for non-alcoholic fatty liver disease by adiposity indices

	AUROCs (95% CI)[a]	
	Men	Women
BMI	0.640 (0.636–0.644)	0.769 (0.765–0.774)
Waist circumference	0.647 (0.643–0.651)	0.759 (0.754–0.764)
SV ratio	0.619 (0.614–0.623)	0.729 (0.724–0.734)

[a] Values are presented as AUROCs with 95% CIs for NAFLD.

Abbreviations: ASM, appendicular skeletal muscle mass; AUROC, area under the receiver operating characteristic curve; BMI, body mass index; CI, confidence interval; SV ratio, skeletal muscle mass and visceral fat area ratio; BMI, body mass index.

Supplementary Table 8. Age-standardized incidence density of hepatic steatosis (HS) and HS plus intermediate/high probability of advanced fibrosis by sex

	Age-standardized incidence density (/ 10^3 PY)		
	For HS	For HS plus intermediate-to-high FIB-4	For HS plus intermediate-to-high NFS
Men	90.5 (89.1–91.8)	4.0 (3.8–4.3)	6.1 (5.8–6.4)
Women	27.1 (26.6–27.7)	0.9 (0.8–1.0)	1.4 (1.3–1.5)

Supplementary Table 9. Hazard ratios[a] (95% CI) of non-alcoholic fatty liver disease, and NAFLD with intermediate-to-high probability of advanced fibrosis according to skeletal muscle mass to visceral fat area ratio quintiles after further adjustment for HOMA-IR and hs-CRP

SV ratio (kg/cm^2) quintiles	**NAFLD**	**NAFLD+ intermediate-to-high Fib4**	**NAFLD+ intermediate-to-high NFS**
Men			
Q1 (0.09-0.26)	1.03 (0.81-1.32)	1.47 (1.10-1.96)	3.84 (3.08-4.78)
Q2 (0.26-0.31)	1.29 (1.02-1.62)	1.40 (1.07-1.85)	3.23 (2.59-4.02)
Q3 (0.31-0.36)	1.10 (0.87-1.39)	1.43 (1.09-1.88)	2.21 (1.76-2.77)
Q4 (0.36-0.45)	1.12 (0.89-1.42)	1.39 (1.06-1.82)	1.74 (1.38-2.21)
Q5 (0.45-8.04)	1.00 (reference)	1.00 (reference)	1.00 (reference)
p–trend	0.861	0.061	<0.001
Per 0.1 decrease in SV ratio	1.04 (0.98-1.1)	1.13 (1.05-1.22)	1.53 (1.44-1.63)
Women			
Q1 (0.06-0.18)	2.48 (1.26-4.88)	3.33 (1.47-7.51)	12.42 (6.53-23.63)
Q2 (0.18-0.22)	2.44 (1.26-4.73)	2.92 (1.31-6.48)	6.37 (3.31-12.23)
Q3 (0.22-0.25)	2.13 (1.08-4.21)	2.41 (1.06-5.46)	3.95 (2.01-7.79)
Q4 (0.25-0.30)	1.38 (0.66-2.91)	2.45 (1.06-5.66)	1.96 (0.93-4.11)
Q5 (0.30-6.34)	1.00 (reference)	1.00 (reference)	1.00 (reference)
p–trend	0.002	0.005	<0.001
Per 0.1 decrease in SV ratio	1.29 (1.03-1.62)	1.44 (1.09-1.90)	3.87 (3.11-4.82)

[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 (not for HS plus intermediate-to-high **NFS**), history of hypertension, HOMA-IR and hs-CRP.

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: FIB-4, Fibrosis-4 score; NFS, non-alcoholic fatty liver disease fibrosis score; CI, confidence interval; HR, hazard ratio; SV ratio, skeletal muscle mass to visceral fat area ratio.

Supplementary Table 10. Development of hepatic steatosis (HS) and a high probability of advanced fibrosis by skeletal muscle mass to visceral fat area ratio quintiles

SV ratio (kg/cm^2) quintiles	HS plus high FIB-4				HS plus 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)	47,466	28	0.6	3.37 (1.47–7.75)	47,476	31	0.7	12.61 (3.76–42.31)
Q2 (0.26–0.30)	47,684	23	0.5	2.93 (1.29–6.66)	47,687	21	0.4	8.00 (2.36–27.10)
Q3 (0.31–0.35)	47,421	21	0.4	2.70 (1.18-6.14)	47,428	18	0.4	6.53 (1.91–22.27)
Q4 (0.36–0.44)	46,958	18	0.4	2.27 (0.98–5.22)	46,962	18	0.4	6.22 (1.83–21.15)
Q5 (≥ 0.45)	46,489	8	0.2	3.37 (1.47–7.75)	46,497	3	0.1	1.00 (reference)
p–trend				0.005				<0.001
Per 0.1 decrease in SV ratio				1.36 (1.10–1.67)				1.89 (1.45–2.47)
Women								
Q1 (< 0.19)	68,204	8	0.1	3.31 (0.37–29.29)	68,204	7	0.1	4.63 (0.54–40.07)
Q2 (0.19–0.22)	72,203	4	0.1	2.45 (0.27–22.28)	72,205	3	0.0	2.13 (0.22–20.72)
Q3 (0.23–0.26)	70,883	–	–	–	70,883	–	–	–
Q4 (0.27–0.31)	70,215	1	0.0	0.85 (0.05–13.70)	70,220	–	–	–
Q5 (≥ 0.32)	70,371	1	0.0	1.00 (reference)	70,371	1	0.0	1.00 (reference)
p–trend				0.073				<0.001
Per 0.1 decrease in SV ratio				1.76 (0.65–4.73)				2.99 (0.87–10.28)

[a] Estimated from Cox proportional hazard models with adjustment for age, center, year of screening examination, 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 was Q1, 0.23; Q2, 0.29; Q3, 0.33; Q4, 0.40 and Q5 = 0.63.

The mean SV ratios in each quintile among women were 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.

Supplementary Table 11. Hazard ratios[a] (95% confidence intervals) of non-alcoholic fatty liver disease according to skeletal muscle mass to visceral fat area quintiles by abdominal obesity

SV ratio (kg/cm^2) quintiles	No abdominal obesity				Abdominal Obesity				*P value*[b]
	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)	24,913	2,983	119.7	3.13 (2.94-3.33)	9,514	1,953	205.3	1.66 (1.2-2.3)	<0.001
Q2 (0.26-0.30)	31,185	3,301	105.9	2.71 (2.55-2.87)	5,569	974	174.9	1.38 (0.99-1.91)	
Q3 (0.31-0.35)	34,872	3,077	88.2	2.21 (2.09-2.35)	3,486	551	158.1	1.23 (0.88-1.72)	
Q4 (0.36-0.44)	38,427	2,748	71.5	1.75 (1.65-1.86)	1,492	213	142.7	1.11 (0.78-1.57)	
Q5 (≥ 0.45)	42,101	1,762	41.9	1.00 (reference)	288	37	128.3	1.00 (reference)	
p–trend				<0.001				<0.001	
Per 0.1 decrease in SV ratio				0.77 (0.76-0.78)				0.87 (0.84-0.90)	0.099
Women									
Q1 (< 0.19)	46,466	2,375	51.1	8.83 (7.87-9.9)	12,299	1,542	125.4	2.46 (1.02-5.92)	<0.001
Q2 (0.19-0.22)	61,833	2,001	32.4	6.03 (5.38-6.76)	4,606	401	87.1	1.79 (0.74-4.33)	
Q3 (0.23-0.26)	66,033	1,330	20.1	3.84 (3.41-4.32)	1,449	101	69.7	1.41 (0.57-3.46)	
Q4 (0.27-0.31)	67,795	789	11.6	2.26 (1.99-2.56)	459	29	63.1	1.3 (0.5-3.36)	
Q5 (≥ 0.32)	69,403	351	5.1	1.00 (reference)	106	5	47.0	1.00 (reference)	
p–trend				<0.001				<0.001	
Per 0.1 decrease in SV ratio				0.34 (0.33-0.36)				0.53 (0.47-0.60)	<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, 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.

Supplementary Table 12. Hazard ratios (95% confidence intervals) of nonalcoholic fatty liver disease according to skeletal muscle mass to visceral fat area quintiles by BMI categories

SV ratio (kg/cm^2) quintiles	Lean (BMI <23 kg/m^2)		Overweight (BMI 23-24.9 kg/m^2)		Obesity (BMI ≥25 kg/m^2)		*P value*[b]
	Incidence density (/ 10^3 PY)	Multivariable-adjusted HR[a] (95% CI)	Incidence density (/ 10^3 PY)	Multivariable-adjusted HR[a] (95% CI)	Incidence density (/ 10^3 PY)	Multivariable-adjusted HR[a] (95% CI)	
Men							
Q1 (< 0.26)	84.5	2.52 (2.29–2.78)	128.6	2.00 (1.80–2.23)	190.3	1.68 (1.39–2.03)	<0.001
Q2 (0.26–0.30)	80.3	2.40 (2.20–2.61)	118.1	1.82 (1.64–2.02)	161.0	1.40 (1.16–1.70)	
Q3 (0.31–0.35)	67.1	1.98 (1.83–2.15)	103.8	1.57 (1.42–1.75)	149.4	1.30 (1.07–1.57)	
Q4 (0.36–0.44)	60.0	1.74 (1.61–1.88)	87.1	1.30 (1.17–1.45)	120.7	1.04 (0.85–1.28)	
Q5 (≥ 0.45)	35.4	1.00 (reference)	67.1	1.00 (reference)	115.4	1.00 (reference)	
p–trend		<0.001		<0.001		<0.001	
Per 0.1 decrease in SV ratio		1.27 (1.25–1.30)		1.26 (1.22–1.30)		1.30 (1.24–1.35)	0.550
Women							
Q1 (< 0.19)	34.6	6.03 (5.31–6.84)	68.4	1.76 (1.13–2.74)	132.4	1.80 (0.45–7.19)	<0.001
Q2 (0.19–0.22)	24.5	4.68 (4.14–5.28)	63.2	1.74 (1.12–2.71)	101.6	1.44 (0.36–5.79)	
Q3 (0.23–0.26)	17.3	3.40 (3.01–3.85)	46.7	1.30 (0.83–2.05)	96.2	1.34 (0.33–5.43)	
Q4 (0.27–0.31)	10.3	2.07 (1.81–2.36)	47.2	1.33 (0.83–2.14)	115.8	1.64 (0.39–6.86)	
Q5 (≥ 0.32)	4.8	1.00 (reference)	34.6	1.00 (reference)	66.5	1.00 (reference)	
p–trend		<0.001		<0.001		<0.001	
Per 0.1 decrease in SV ratio		2.39 (2.26–2.52)		1.35 (1.22–1.49)		1.46 (1.29–1.65)	<0.001

[a] Estimated from Cox proportional hazard models. The multivariable model was adjusted for age, center, year of screening examination, 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.

[b] *P for interaction by BMI categories*

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

The mean SV ratios in each quintile among women were 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.

Supplementary Table 13. Hazard ratios[a] (95% confidence intervals) of non-alcoholic fatty liver disease with intermediate-to-high probability of advanced fibrosis based on **Fiborsis-4** score according to skeletal muscle mass to visceral fat area quintiles by **overall obesity**

SV ratio (kg/cm^2) quintiles	No obesity				Obesity				*P value*[b]
	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)	25,471	204	8.0	2.57 (1.93-3.43)	21,318	164	7.7	0.68 (0.37-1.27)	<0.001
Q2 (0.26-0.30)	33,718	146	4.3	2.06 (1.54-2.74)	13,576	77	5.7	0.62 (0.33-1.16)	
Q3 (0.31-0.35)	38,316	134	3.5	1.90 (1.43-2.54)	8,779	52	5.9	0.67 (0.35-1.28)	
Q4 (0.36-0.44)	42,093	122	2.9	1.66 (1.24-2.22)	4,635	31	6.7	0.76 (0.38-1.51)	
Q5 (≥ 0.45)	45,068	75	1.7	1.00 (reference)	1,276	11	8.6	1.00 (reference)	
p–trend				<0.001				0.450	
Per 0.1 decrease in SV ratio				1.30 (1.20-1.40)				1.00 (0.89-1.13)	<0.001
Women									
Q1 (< 0.19)	50,334	118	2.3	2.33 (1.50-3.63)	17,545	59	3.4	0.69 (0.09-5.00)	0.631
Q2 (0.19-0.22)	67,568	55	0.8	1.48 (0.93-2.36)	4,515	10	2.2	0.66 (0.08-5.21)	
Q3 (0.23-0.26)	69,488	34	0.5	1.07 (0.65-1.78)	1,335	1	0.7	0.23 (0.01-3.76)	
Q4 (0.27-0.31)	69,838	27	0.4	1.00 (reference)	324	1	3.1	1.00 (reference)	
Q5 (≥ 0.32)	70,328	8	0.1	0.36 (0.17-0.80)	37	-	-	-	
p–trend				<0.001				0.549	
Per 0.1 decrease in SV ratio				2.22 (1.71-2.88)				1.05 (0.53-2.08)	0.034

[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 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.

Supplementary Table 14. Hazard ratios[a] (95% confidence intervals) of non-alcoholic fatty liver disease with intermediate-to-high probability of advanced fibrosis based on **Fiborsis-4** score according to skeletal muscle mass to visceral fat area quintiles by **abdominal obesity**

SV ratio (kg/cm^2) quintiles	No abdominal obesity				Abdominal Obesity				*P value*[b]
	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)	32,306	248	7.7	2.47 (1.88-3.23)	14,480	120	8.3	0.98 (0.31-3.08)	0.388
Q2 (0.26-0.30)	39,215	182	4.6	2.13 (1.63-2.78)	8,080	41	5.1	0.67 (0.21-2.17)	
Q3 (0.31-0.35)	42,172	159	3.8	1.94 (1.48-2.54)	4,917	27	5.5	0.72 (0.22-2.38)	
Q4 (0.36-0.44)	44,652	141	3.2	1.69 (1.29-2.22)	2,066	12	5.8	0.72 (0.20-2.54)	
Q5 (≥ 0.45)	45,953	83	1.8	1.00 (reference)	386	3	7.8	1.00 (reference)	
p−trend				<0.001				0.104	
Per 0.1 decrease in SV ratio				0.77 (0.72-0.83)				0.77 (0.60-0.98)	0.997
Women									
Q1 (< 0.19)	51,704	128	2.5	2.68 (1.72-4.18)	15,893	48	3.0	2.46 (1.02-5.92)	0.018
Q2 (0.19-0.22)	66,370	52	0.8	1.48 (0.92-2.38)	5,567	13	2.3	1.79 (0.74-4.33)	
Q3 (0.23-0.26)	68,937	34	0.5	1.12 (0.67-1.87)	1,681	1	0.6	1.41 (0.57-3.46)	
Q4 (0.27-0.31)	69,504	26	0.4	1.00 (reference)	517	2	3.9	1.00 (reference)	
Q5 (≥ 0.32)	70,148	8	0.1	0.38 (0.17-0.83)	116	-	-	-	
p−trend				<0.001				0.955	
Per 0.1 decrease in SV ratio				0.41 (0.32-0.53)				1.14 (0.61-2.14)	0.002

[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, 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.

Supplementary Table 15. Hazard ratios[a] (95% confidence intervals) of non-alcoholic fatty liver disease with intermediate-to-high probability of advanced fibrosis based on non-alcoholic fatty liver disease fibrosis score (**NFS**) according to skeletal muscle mass to visceral fat area quintiles by **overall obesity**

SV ratio (kg/cm^2) quintiles	No obesity				Obesity				*P value*[b]
	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)	25,428	226	8.9	2.43 (1.88-3.14)	20,868	344	16.5	0.94 (0.59-1.50)	0.006
Q2 (0.26-0.30)	33,598	205	6.1	2.43 (1.90-3.13)	13,353	181	13.6	0.90 (0.56-1.44)	
Q3 (0.31-0.35)	38,294	155	4.0	1.81 (1.40-2.34)	8,677	96	11.1	0.76 (0.46-1.24)	
Q4 (0.36-0.44)	42,048	144	3.4	1.57 (1.21-2.04)	4,580	51	11.1	0.73 (0.43-1.24)	
Q5 (≥ 0.45)	45,027	95	2.1	1.00 (reference)	1,265	19	15.0	1.00 (reference)	
p–trend				<0.001				0.087	
Per 0.1 decrease in SV ratio				1.30 (1.21-1.39)				1.13 (1.00-1.27)	0.308
Women									
Q1 (< 0.19)	50,317	129	2.6	4.08 (2.59-6.43)	17,385	145	8.3	0.67 (0.21-2.12)	0.033
Q2 (0.19-0.22)	67,541	76	1.1	2.65 (1.66-4.23)	4,472	29	6.5	0.67 (0.20-2.22)	
Q3 (0.23-0.26)	69,433	49	0.7	1.91 (1.17-3.14)	1,326	5	3.8	0.40 (0.10-1.69)	
Q4 (0.27-0.31)	69,857	23	0.3	1.00 (reference)	319	3	9.4	1.00 (reference)	
Q5 (≥ 0.32)	70,314	11	0.2	0.56 (0.27-1.16)	37	-	-	-	
p–trend				<0.001				0.665	
Per 0.1 decrease in SV ratio				2.59 (2.06-3.26)				1.16 (0.75-1.82)	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, 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.

Supplementary Table 16. Hazard ratios[a] (95% confidence intervals) of non-alcoholic fatty liver disease with intermediate-to-high probability of advanced fibrosis based on non-alcoholic fatty liver disease fibrosis score (**NFS**) according to skeletal muscle mass to visceral fat area quintiles by **abdominal obesity**

SV ratio (kg/cm^2) quintiles	No abdominal obesity				Abdominal Obesity				*P value*[b]
	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)	32,168	316	9.8	2.69 (2.12-3.41)	14,126	254	18.0	0.96 (0.45-2.04)	0.051
Q2 (0.26-0.30)	39,019	273	7.0	2.66 (2.11-3.35)	7,931	113	14.2	0.81 (0.38-1.73)	
Q3 (0.31-0.35)	42,101	196	4.7	1.94 (1.53-2.46)	4,865	55	11.3	0.63 (0.29-1.38)	
Q4 (0.36-0.44)	44,587	170	3.8	1.61 (1.26-2.05)	2,031	25	12.3	0.63 (0.27-1.46)	
Q5 (≥ 0.45)	45,912	107	2.3	1.00 (reference)	377	7	18.6	1.00 (reference)	
p–trend				<0.001				0.004	
Per 0.1 decrease in SV ratio				0.74 (0.70-0.79)				0.74 (0.63-0.88)	0.956
Women									
Q1 (< 0.19)	51,654	159	3.1	5.65 (3.55-8.99)	15,764	115	7.3	0.69 (0.25-1.89)	0.001
Q2 (0.19-0.22)	66,336	76	1.1	2.98 (1.84-4.84)	5,531	29	5.2	0.66 (0.23-1.87)	
Q3 (0.23-0.26)	68,879	48	0.7	2.08 (1.24-3.47)	1,674	6	3.6	0.45 (0.13-1.60)	
Q4 (0.27-0.31)	69,525	21	0.3	1.00 (reference)	511	4	7.8	1.00 (reference)	
Q5 (≥ 0.32)	70,133	11	0.2	0.61 (0.29-1.27)	116	-	-	-	
p–trend				<0.001				0.563	
Per 0.1 decrease in SV ratio				0.30 (0.24-0.38)				0.84 (0.55-1.30)	<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, 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.

Supplementary Table 17. Hazard ratios[a] (95% confidence intervals) of non-alcoholic fatty liver disease according to skeletal muscle mass to visceral fat area quintiles by menopausal status

SV ratio (kg/cm^2) quintiles	Pre-menopause (N= 87,940)				Post-menopause (N=3,378)				*P value*[b]
	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)	
Q1 (< 0.19)	54,018	3,553	65.8	11.86 (10.6-13.26)	5,004	375	74.9	5.66 (2.80-11.44)	<0.001
Q2 (0.19-0.22)	64,734	2,308	35.7	6.61 (5.90-7.40)	1,840	98	53.3	5.13 (2.49-10.55)	
Q3 (0.23-0.26)	66,145	1,396	21.1	3.99 (3.54-4.49)	1,535	37	24.1	2.79 (1.30-5.98)	
Q4 (0.27-0.31)	67,156	801	11.9	2.30 (2.03-2.61)	1,237	18	14.5	1.75 (0.76-4.02)	
Q5 (≥ 0.32)	68,570	348	5.1	1.00 (reference)	1,041	8	7.7	1.00 (reference)	
p–trend				<0.001				<0.001	
Per 0.1 decrease in SV ratio				3.66 (3.51-3.82)				2.08 (1.76-2.47)	<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, and history of hypertension

[b] *P for interaction*

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.