

Supplementary Methods

Body mass index (BMI) was assessed at baseline and at follow-up visits at 12, 24, and 36 months. Height and weight were measured by trained staff using standardized protocols, and BMI was calculated as body weight (kg) divided by height squared (m^2). To comprehensively capture longitudinal changes in BMI, we derived four indicators:

BMI trajectory

Longitudinal BMI data across four time points were modeled using latent class growth analysis in Mplus (version 8.1). We compared models with two to five latent classes, and model selection was guided by the Bayesian Information Criterion (BIC), Akaike Information Criterion (AIC), entropy values, and clinical interpretability. Each participant was classified into the trajectory group with the highest posterior probability (≥ 0.70). Please see the table below for model fit indices by number of classes. Although the 4 and 5 class solutions showed slightly better fit indices (AIC/BIC), the improvement beyond the 3-class model was not statistically supported by the Lo-Mendell-Rubin test (TECH11). In addition, the 5-class solution yielded lower entropy, suggesting less clear classification. Given the limited sample size, selecting a three-class model represents a reasonable balance between statistical fit and interpretability. It also ensures sufficient cases per class to allow stable and clinically meaningful interpretation.

Table. Model fit indices by number of classes.

Number of Classes	AIC	BIC	Entropy	TECH11 p-value
2	12505.61	12550.56	0.713	<0.001
3	11689.12	11749.06	0.779	0.032
4	11181.50	11256.42	0.798	0.144
5	10818.09	10908.00	0.792	0.121

BMI variability

The purpose of this method is to capture fluctuations in BMI. BMI variability refers to the degree of fluctuation in an individual's BMI measured at different time points, rather than a single BMI value. It is commonly used to assess the stability of long-term weight changes. Studies have shown that high BMI variability is associated with an increased risk of cardiovascular disease, metabolic syndrome, and diabetes[1]. At each pair of consecutive time points (with BMI measured once every 12 months), the difference between the two

measurements is calculated, and its absolute value is taken. Over the observation period (3 years, comprising 3 intervals), all successive variabilities are summed and then divided by the number of intervals. (As shown in the figure below) After computing the average successive variability of BMI for all participants, the values were ranked according to their distribution and categorized into tertiles, with Tertile 1 representing the lowest variability and Tertile 3 the highest.

$$\text{Average Successive Variability} = \frac{|weight_1 - weight_0| + |weight_2 - weight_1| + |weight_3 - weight_2|}{3}$$

Figure. Equation for BMI variability

BMI change

The total change in BMI was defined as the difference between BMI measured at 36 months and at baseline. Based on this difference, participants were categorized into three groups: those with values between -1 and $+1$ (stable weight group), those with values greater than $+1$ (weight gain group), and those with values less than -1 (weight loss group). The group with stable weight was defined as the reference group for weight change.

Cumulative overweight-years

To capture the cumulative burden of overweight exposure, we estimated overweight-years using the trapezoidal method. According to Taiwan's Health Promotion Administration, adult BMI cut-off values are classified as underweight (<18.5 kg/m²), normal weight (18.5 – 23.9 kg/m²), overweight (24.0 – 26.9 kg/m²), and obese (≥ 27.0 kg/m²). For each adjacent pair of BMI measurements, we calculated the mean excess above a BMI of 24 kg/m², multiplied by the time interval in years. Values below the cutoff were set to zero. The products were then summed across all intervals to yield the cumulative overweight-years for each participant. The values were ranked based on their distribution and divided into tertiles, with Tertile 1 representing the lowest cumulative overweight-years and Tertile 3 representing the highest.

Table. Summary of the four obesity dynamics

Indicator	What it captures	Operational definition
BMI trajectory	BMI pattern over 3 years	Latent class growth analysis
BMI variability	Degree of BMI fluctuation between consecutive visits	Mean of absolute BMI differences between consecutive measurements
BMI change	Net BMI change across 3 years	$\Delta\text{BMI} = \text{BMI}_{36} - \text{BMI}_0$
Cumulative overweight-years	Cumulative burden of exposure above overweight threshold	Trapezoidal method using excess BMI above 24 kg/m ²

Reference:

[1] Massey RJ, Siddiqui MK, Pearson ER, Dawed AY. Weight variability and cardiovascular outcomes: a systematic review and meta-analysis. *Cardiovasc Diabetol*. 2023;22:5.

Supplementary Table SI. Compares baseline characteristics between participants who completed the study and those who were lost to follow-up

Characteristic	Completed (n=478)	Lost to follow-up (n=613)	P-value
Age, years	70.49 ± 5.55	70.16 ± 5.08	0.30
BMI, kg/m ²	24.06 ± 3.16	24.18 ± 3.38	0.53
Waist circumference, cm	79.70 ± 8.98	80.33 ± 9.45	0.26
Grip strength, kg	30.41 ± 8.67	28.95 ± 8.64	0.006
Gait speed, m/s	1.34 ± 0.24	1.37 ± 0.26	0.07
SMI	6.75 ± 1.05	6.74 ± 1.05	0.96
Body fat, %	29.81 ± 7.06	29.87 ± 7.61	0.91
Physical activity, MET-minutes/week	9954.29 ± 3399.56	10387.61 ± 3275.42	0.03
Sex			0.87
Male	203 (42.5%)	264 (43%)	
Female	275 (57.5%)	349 (57%)	
Stroke	5 (1%)	10 (1.6%)	0.22
CAD	26 (5.4%)	35 (5.7%)	0.29
Arthritis	67 (14%)	79 (12.9%)	0.86
Osteoarthritis	64 (13.4%)	65 (10.6%)	0.02
Depression	15 (3.1%)	38 (6.2%)	0.06

Abbreviations: BMI, body mass index; SMI, skeletal muscle mass index; CAD, coronary artery disease.

Continuous variables are presented as mean ± standard deviation, and categorical variables are presented as number (percentage).

Values with $p < 0.05$ are shown in bold.

Supplementary Table SII. Comparison of Baseline and 3-Year BMI Across BMI Trajectory, Change, Variability, and Cumulative Overweight-Years Categories.

	Baseline BMI	BMI at 3-Year Follow-up
BMI trajectory		
Stable-normal weight (n=157)	20.76 ± 1.47	20.64 ± 1.39
Persistent overweight (n=231)	24.57 ± 1.46	24.52 ± 1.25
Persistent obesity (n=90)	28.49 ± 2.10	28.59 ± 1.87
BMI change		
Stable (n=341)	23.75 ± 3.00	23.71 ± 3.01
Decreased (n=66)	25.99 ± 3.42	24.25 ± 3.38
Increased (n=71)	23.57 ± 2.98	25.32 ± 3.24
BMI variability		
Tertile 1 (n=139)	23.26 ± 2.93	23.25 ± 2.92
Tertile 2 (n=141)	24.24 ± 3.35	24.18 ± 3.35
Tertile 3 (n=141)	24.61 ± 3.14	24.57 ± 3.11
Cumulative overweight-years		
Tertile 1 (n=200)	21.45 ± 1.68	21.37 ± 1.67
Tertile 2 (n=80)	24.50 ± 1.01	24.46 ± 0.66
Tertile 3 (n=141)	27.46 ± 2.10	27.48 ± 1.95

Abbreviations: BMI, body mass index.

BMI presented as mean ± standard deviation.

Supplementary Table SIII. Risk of low grip strength (ORs) by obesity dynamics assessment.

	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
BMI trajectory			
Stable-normal weight (n=157)	1.00	1.00	1.00
Persistent overweight (n=231)	1.09 (0.47-2.52)	1.04 (0.45-2.44)	1.04 (0.44-2.44)
Persistent obesity (n=90)	2.24 (0.90-5.59)	2.20 (0.87-5.55)	2.30 (0.90-5.89)
BMI change			
Stable (n=341)	1.00	1.00	1.00
Decreased (n=66)	1.26 (0.49-3.23)	1.28 (0.49-3.37)	1.31 (0.50-3.46)
Increased (n=71)	1.44 (0.59-3.55)	1.38 (0.54-3.48)	1.37 (0.54-3.47)
BMI variability			
Tertile 1 (n=139)	1.00	1.00	1.00
Tertile 2 (n=141)	0.95 (0.36-2.49)	0.91 (0.34-2.44)	0.87 (0.32-2.35)
Tertile 3 (n=141)	0.92 (0.35-2.42)	0.93 (0.35-2.48)	0.90 (0.34-2.42)
Cumulative overweight-years			
Tertile 1 (n=200)	1.00	1.00	1.00
Tertile 2 (n=80)	0.75 (0.23-2.45)	0.76 (0.23-2.51)	0.75 (0.23-2.47)
Tertile 3 (n=141)	1.41 (0.59-3.34)	1.45 (0.60-3.50)	1.54 (0.64-3.71)

Abbreviations: BMI, body mass index; OR, odds ratio; CI, confidence interval.

Model 1 Adjusted age and sex

Model 2 Additional adjustment stroke, coronary artery disease, arthritis, and depression

Model 3 Additional adjustment smoking, alcohol consumption, and physical activity

Values with $p < 0.05$ are shown in bold.

Low muscle strength definition: handgrip strength <28 kg in males and <18 kg in females.

Supplementary Table SIV. Risk of poor physical performance (ORs) by obesity dynamics assessment.

	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
BMI trajectory			
Stable-normal weight (n=157)	1.00	1.00	1.00
Persistent overweight (n=231)	1.34 (0.77-2.32)	1.31 (0.75-2.29)	1.33 (0.76-2.32)
Persistent obesity (n=90)	1.72 (0.89-3.34)	1.81 (0.92-3.53)	1.84 (0.93-3.64)
BMI change			
Stable (n=341)	1.00	1.00	1.00
Decreased (n=66)	1.42 (0.76-2.68)	1.44 (0.76-2.73)	1.44 (0.76-2.76)
Increased (n=71)	0.89 (0.45-1.75)	0.84 (0.42-1.69)	0.85 (0.42-1.70)
BMI variability			
Tertile 1 (n=139)	1.00	1.00	1.00
Tertile 2 (n=141)	1.12 (0.60-2.08)	1.12 (0.60-2.11)	1.11 (0.59-2.10)
Tertile 3 (n=141)	1.01 (0.54-1.88)	1.00 (0.53-1.87)	0.98 (0.52-1.84)
Cumulative overweight-years			
Tertile 1 (n=200)	1.00	1.00	1.00
Tertile 2 (n=80)	0.97 (0.48-1.95)	1.01 (0.50-2.05)	1.02 (0.50-2.07)
Tertile 3 (n=141)	1.47 (0.84-2.58)	1.55 (0.87-2.76)	1.54 (0.86-2.75)

Abbreviations: BMI, body mass index; OR, odds ratio; CI, confidence interval.

Model 1 Adjusted age and sex

Model 2 Additional adjustment stroke, coronary artery disease, arthritis, and depression

Model 3 Additional adjustment smoking, alcohol consumption, and physical activity

Values with $p < 0.05$ are shown in bold.

Poor physical performance: defined as a 6-meter walking speed <1.0 m/s.

Supplementary Table SV. Summary of odds ratios (ORs) for sarcopenia risk by obesity dynamics assessment, excluding individuals with cancer (n=39).

	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
BMI trajectory			
Stable-normal weight (n=143)	1.00	1.00	1.00
Persistent overweight (n=211)	0.33 (0.15-0.74)	0.33 (0.14-0.74)	0.33 (0.14-0.74)
Persistent obesity (n=85)	0.24 (0.07-0.84)	0.25 (0.07-0.88)	0.23 (0.06-0.85)
BMI change			
Stable (n=318)	1.00	1.00	1.00
Decreased (n=63)	2.80 (1.18-6.64)	3.01 (1.24-7.26)	3.00 (1.24-7.27)
Increased (n=58)	1.30 (0.45-3.70)	1.32 (0.45-3.86)	1.31 (0.45-3.86)
BMI variability			
T1 (n=128)	1.00	1.00	1.00
T2 (n=130)	0.87 (0.32-2.36)	0.85 (0.31-2.33)	0.84 (0.30-2.31)
T3 (n=131)	1.28 (0.51-3.19)	1.24 (0.50-3.09)	1.23 (0.49-3.09)
Cumulative overweight-years			
T1 (n=185)	1.00	1.00	1.00
T2 (n=75)	0.27 (0.08-0.96)	0.27 (0.08-0.97)	0.28 (0.08-0.99)
T3 (n=129)	0.24 (0.08-0.72)	0.24 (0.08-0.75)	0.23 (0.07-0.73)

Abbreviations: BMI, body mass index; OR, odds ratio; CI, confidence interval.

Model 1 Adjusted age and sex

Model 2 Additional adjustment stroke, coronary artery disease, arthritis, and depression

Model 3 Additional adjustment smoking, alcohol consumption, and physical activity

Values with p < 0.05 are shown in bold.

Supplementary Table SVI. Summary of odds ratios (ORs) for sarcopenia risk by obesity dynamics assessment, excluding individuals with BMI < 18.5 (n=9).

	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
BMI trajectory			
Stable-normal weight (n=148)	1.00	1.00	1.00
Persistent overweight (n=231)	0.32 (0.15-0.70)	0.32 (0.14-0.70)	0.32 (0.15-0.71)
Persistent obesity (n=90)	0.22 (0.06-0.76)	0.22 (0.06-0.78)	0.21 (0.06-0.77)
BMI change			
Stable (n=334)	1.00	1.00	1.00
Decreased (n=71)	2.74 (1.19-6.30)	3.01 (1.28-7.07)	3.02 (1.28-7.11)
Increased (n=64)	1.17 (0.41-3.31)	1.21 (0.42-3.50)	1.21 (0.42-3.50)
BMI variability			
T1 (n=133)	1.00	1.00	1.00
T2 (n=138)	0.61 (0.22-1.67)	0.60 (0.21-1.67)	0.59 (0.21-1.65)
T3 (n=141)	1.24 (0.52-2.93)	1.23 (0.52-2.92)	1.22 (0.51-2.90)
Cumulative overweight-years			
T1 (n=191)	1.00	1.00	1.00
T2 (n=80)	0.33 (0.11-0.99)	0.33 (0.11-1.02)	0.34 (0.11-1.04)
T3 (n=141)	0.21 (0.07-0.63)	0.21 (0.07-0.63)	0.20 (0.07-0.63)

Abbreviations: BMI, body mass index; OR, odds ratio; CI, confidence interval.

Model 1 Adjusted age and sex

Model 2 Additional adjustment stroke, coronary artery disease, arthritis, and depression

Model 3 Additional adjustment smoking, alcohol consumption, and physical activity

Values with p < 0.05 are shown in bold.

Supplementary Table SVII. Linear regression results for BMI variability and cumulative overweight-years stratified by sarcopenia status.

	Model 1 β (95% CI)	p-value	Model 2 β (95% CI)	p-value	Model 3 β (95% CI)	p-value
BMI variability						
Reference	-		-		-	
Sarcopenia group	0.19 (0.04- 0.33)	0.012	0.19 (0.04- 0.33)	0.012	0.18 (0.04- 0.33)	0.013
Cumulative overweight-years						
Reference	-		-		-	
Sarcopenia group	-2.80 (-4.85- -0.76)	0.007	-2.71 (-4.76- -0.67)	0.009	-2.71 (-4.73- -0.69)	0.009

Abbreviations: BMI, body mass index; CI, confidence interval.

Model 1 Adjusted age and sex

Model 2 Additional adjustment stroke, coronary artery disease, arthritis, and depression

Model 3 Additional adjustment smoking, alcohol consumption, and physical activity

Values with $p < 0.05$ are shown in bold.