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Table A The definition of weight change patterns using the period of age 25 years to ten years before baseline as an example

BMI at age 25 years	BMI at ten years before baseline		
	<25 kg/m^2	25-29.9 kg/m^2	$\geq$30 kg/m^2
<25 kg/m^2	Stable normal	Maximum overweight	Non-obese to obese
25-29.9 kg/m^2	Maximum overweight	Maximum overweight	Non-obese to obese
$\geq$30 kg/m^2	Obese to non-obese	Obese to non-obese	Stable obese

Table B Correlation coefficients for BMI at three time points and absolute weight changes during three intervals

	BMI			Absolute weight change		
	At age 25 years	At ten years before baseline	At baseline	From age 25 years to ten year before baseline	From age 25 years to baseline	From ten years before baseline to baseline
BMI at age 25 years	1.00	-	-	-	-	-
BMI at ten years before baseline	0.63	1.00	-	-	-	-
BMI at baseline	0.46	0.69	1.00		-	-
Weight change from age 25 years to ten year before baseline	-0.15	0.67	0.44	1.00	-	-
Weight change from age 25 years to baseline	-0.24	0.28	0.75	0.59	1.00	-
Weight change from ten years before baseline to baseline	-0.15	-0.30	0.48	-0.23	0.65	1.00

Table C Baseline characteristics of study participants in the NHANES 1988-2014 according to weight change patterns from age 25 years to ten years before baseline*

Characteristics[†]	Total	Weight change patterns from age 25 years to ten years before baseline					P value[‡]
		Stable normal	Maximum overweight	Obese to non-obese	Non-obese to obese	Stable obese	
No. of participants, n (%)	33 300	12 154 (42.3)	12 760 (36.1)	399 (1.2)	6083 (15.3)	1904 (5.2)	
Age, years	57.1 (56.7 to 57.4)	55.0 (54.5 to 55.5)	58.7 (58.3 to 59.2)	58.0 (56.6 to 59.3)	59.8 (59.3 to 60.2)	54.2 (53.6 to 54.9)	<0.001
Women	16 819 (52.7)	7323 (64.9)	5280 (40.7)	156 (37.0)	3145 (51.1)	915 (45.4)	<0.001
BMI, kg/m^2							
At age 25 years.	23.4 (23.4 to 23.5)	20.9 (20.8 to 20.9)	23.9 (23.8 to 24.0)	33.2 (32.6 to 33.8)	25.1 (25.0 to 25.2)	34.6 (34.3 to 34.8)	<0.001
At 10 years before baseline	26.6 (26.5 to 26.7)	22.2 (22.1 to 22.2)	27.0 (27.0 to 27.1)	26.8 (26.3 to 27.2)	33.8 (33.6 to 34.0)	38.2 (37.7 to 38.6)	<0.001
At survey	28.2 (28.1 to 28.4)	24.4 (24.3 to 24.5)	28.8 (28.7 to 28.9)	29.3 (28.4 to 30.2)	34.0 (33.8 to 34.2)	38.1 (37.6 to 38.5)	<0.001
Absolute weight change, kg	8.8 (8.6 to 9.0)	3.7 (3.6 to 3.8)	8.9 (8.6 to 9.1)	-18.4 (-20.6 to -16.1)	24.2 (23.5 to 24.9)	10.2 (8.9 to 11.4)	
Race							<0.001
Non-Hispanic White	16 989 (78.1)	6465 (79.0)	6544 (78.4)	207 (78.6)	2910 (76.0)	863 (75.5)	
Non-Hispanic Black	7180 (9.6)	2453 (8.4)	2568 (9.4)	81 (9.4)	1494 (12.1)	584 (14.8)	
Mexican American	5608 (4.3)	1658 (3.2)	2360 (4.9)	79 (4.4)	1185 (5.6)	326 (5.2)	
Others	3523 (7.9)	1578 (9.4)	1288 (7.3)	32 (7.7)	494 (6.3)	131 (4.6)	
Education level							<0.001
Less than high school	10 958 (22.4)	3536 (19.6)	4329 (23.3)	174 (28.6)	2259 (27.0)	660 (23.0)	
High school or equivalent	8352 (28.4)	3108 (27.8)	3149 (28.3)	93 (29.1)	1529 (29.5)	473 (30.1)	
College or above	13 916 (49.3)	5482 (52.5)	5255 (48.4)	131 (42.2)	2284 (43.5)	764 (46.9)	
Family income-poverty ratio level							<0.001
0-1.0	5295 (10.0)	1898 (9.8)	1907 (9.3)	80 (11.4)	1033 (11.1)	377 (13.1)	
1.1-3.0	13 085 (36.3)	4464 (33.8)	5039 (36.0)	164 (46.3)	2585 (40.9)	833 (43.6)	
>3.0	12 193 (53.6)	4767 (56.4)	4755 (54.7)	130 (42.3)	1978 (48.0)	563 (43.3)	
Marital status							<0.001
Married	20 999 (69.2)	7631 (69.1)	8309 (71.1)	242 (67.5)	3722 (66.4)	1095 (65.9)	
Separated	9809 (25.1)	3545 (25.1)	3600 (23.8)	124 (25.5)	1984 (28.8)	556 (22.6)	
Never married	2177 (5.7)	866 (5.9)	716 (5.1)	30 (7.0)	329 (4.7)	236 (11.6)	
Alcohol drinking							<0.001
Non-drinker	12 160 (38.3)	4352 (37.6)	4450 (36.5)	147 (46.1)	2475 (43.0)	736 (40.9)	
Low-to-moderate drinker	16 409 (52.3)	5843 (51.9)	6471 (53.5)	197 (47.9)	2945 (50.6)	953 (53.2)	
Heavy drinker	2583 (9.4)	1111 (10.5)	1029 (10.0)	30 (6.0)	310 (6.4)	103 (5.9)	
Smoking status							<0.001
Never smoker	15 809 (45.9)	5664 (45.3)	6011 (45.4)	144 (35.3)	3020 (48.2)	970 (49.2)	

							P value
Former smoker	10 801 (33.2)	3503 (30.5)	4436 (35.7)	165 (40.5)	2139 (34.6)	558 (31.7)	
Current smoker	6676 (21.0)	2979 (24.2)	2309 (18.9)	90 (24.2)	923 (17.2)	375 (19.1)	
Leisure-time physical activity level							<0.001
0 times/week	15 975 (37.7)	5352 (33.9)	5943 (36.6)	216 (40.7)	3359 (46.4)	1105 (49.9)	
1-2 times/week	6454 (25.5)	2501 (27.1)	2524 (25.3)	63 (20.9)	1058 (22.7)	308 (22.2)	
≥3 times/week	10853 (36.8)	4297 (39.0)	4281 (38.0)	120 (38.4)	1666 (30.9)	489 (27.8)	
Healthy eating index scores							<0.001
Quartile 1	7915 (24.7)	2792 (23.7)	2942 (23.9)	113 (31.9)	1495 (26.9)	573 (29.3)	
Quartile 2	7902 (24.7)	2863 (24.8)	2996 (24.2)	91 (24.2)	1472 (25.7)	480 (25.4)	
Quartile 3	7906 (24.5)	2795 (23.4)	3126 (26.2)	84 (19.7)	1467 (23.7)	434 (24.9)	
Quartile 4	7905 (26.1)	3028 (28.0)	3077 (25.7)	87 (24.1)	1374 (23.8)	339 (20.3)	
Family history of diabetes or heart attack	16 574 (50.0)	5553 (47.0)	6214 (48.6)	218 (60.4)	3437 (57.2)	1152 (60.4)	<0.001
Self-reported health							<0.001
Very good to excellent	12 362 (46.2)	5399 (53.5)	4777 (45.7)	115 (31.7)	1621 (33.4)	450 (31.3)	
Good	11 612 (33.5)	4022 (30.0)	4547 (34.9)	145 (35.9)	2226 (38.2)	672 (37.8)	
Poor to fair	9310 (20.3)	2729 (16.5)	3430 (19.4)	139 (32.4)	2230 (28.4)	782 (30.9)	
Self-reported chronic diseases							
Diabetes	4853 (10.2)	700 (4.0)	1742 (10.0)	91 (12.6)	1702 (22.3)	618 (27.1)	<0.001
Hypertension	12 306 (32.3)	3080 (21.2)	4853 (34.8)	145 (30.7)	3227 (50.0)	1001 (52.8)	<0.001
Cardiovascular diseases	5044 (11.6)	1241 (7.4)	2045 (13.2)	89 (20.4)	1261 (17.5)	408 (16.6)	<0.001
Chronic obstructive pulmonary diseases	2990 (9.5)	1095 (9.4)	990 (8.1)	48 (17.2)	660 (12.3)	197 (10.4)	<0.001
Cancer§	3173 (8.6)	1004 (7.7)	1302 (9.1)	42 (10.1)	665 (10.1)	160 (6.8)	<0.001

*Complex survey designs are considered for all estimates; data are presented as No. (%) for categorical variables and mean (95% confidence interval) for continuous variables. Among the 36 051 participants, a total of 2751 participants were excluded in the analyses due to missing values of BMI at both times.

†A total of 74, 2727, 315, 2148, 14, 18, 1672 and 16 participants had missing information on education, family income poverty ratio, marital status, alcohol drinking, smoking status, leisure-time physical activity level, healthy eating index score and self-reported health respectively.

‡For categorical variables, *P* value was calculated by Rao-Scott chi-square test, which is a design-adjusted version of Pearson chi-square test. For continuous variables, ANOVA adjusting for sampling weights was used to calculate *P* value.

§Skin cancer was not included.

Table D Baseline characteristics of study participants in the NHANES 1988-2014 according to weight change patterns in ten years period before baseline [*]

| Characteristics[†] | Total | Weight change patterns from ten years before baseline to baseline | | | | | P value[‡] |
		Stable normal	Maximum overweight	Obese to non-obese	Non-obese to obese	Stable obese	
No. of participants, n (%)	34 582	7785 (26.9)	12 932 (37.2)	1982 (4.2)	5502 (15.4)	6381 (16.3)	
Age, years	57.2 (56.8 to 57.6)	56.3 (55.7 to 56.9)	58.1 (57.6 to 58.6)	61.6 (60.5 to 62.6)	54.9 (54.4 to 55.4)	57.7 (57.3 to 58.2)	0.92
Women	17 545 (52.8)	4370 (63.4)	5578 (44.3)	867 (42.7)	3273 (58.6)	3457 (52.2)	<0.001
BMI, kg/m^2							
At age 25 years	23.4 (23.3 to 23.5)	20.8 (20.7 to 20.9)	23.0 (22.9 to 23.1)	25.8 (25.4 to 26.1)	23.7 (23.6 to 23.9)	27.9 (27.6 to 28.2)	<0.001
At 10 years before baseline	26.6 (26.5 to 26.7)	21.6 (21.6 to 21.7)	25.5 (25.5 to 25.6)	32.9 (32.6 to 33.2)	26.8 (26.7 to 26.9)	35.5 (35.2 to 35.7)	<0.001
At survey	28.2 (28.1 to 28.3)	22.1 (22.0 to 22.2)	26.8 (26.7 to 26.8)	27.5 (27.3 to 27.6)	33.3 (33.2 to 33.5)	36.9 (36.7 to 37.1)	<0.001
Absolute weight change, kg	4.4 (4.2 to 4.7)	1.3 (1.1 to 1.5)	3.5 (3.2 to 3.7)	-15.1 (-15.9 to -14.4)	18.2 (17.7 to 18.6)	4.0 (3.5 to 4.6)	
Race							<0.001
Non-Hispanic White	17 375 (77.6)	4422 (80.6)	6670 (78.5)	865 (73.2)	2419 (73.5)	2999 (75.8)	
Non-Hispanic Black	7477 (9.8)	1399 (7.0)	2433 (8.7)	484 (13.7)	1457 (13.0)	1704 (12.9)	
Mexican American	5992 (4.5)	862 (2.4)	2394 (4.7)	468 (6.8)	1094 (5.9)	1174 (5.4)	
Others	3738 (8.1)	1102 (10.0)	1435 (8.1)	165 (6.3)	532 (7.7)	504 (5.8)	
Education							<0.001
Less than high school	11 810 (23.2)	2273 (19.1)	4506 (23.3)	946 (35.5)	1849 (24.7)	2236 (24.8)	
High school or equivalent	8532 (28.1)	1922 (26.5)	3152 (28.2)	443 (27.4)	1396 (29.0)	1619 (29.8)	
College or above	14 153 (48.7)	3560 (54.4)	5243 (48.5)	586 (37.1)	2250 (46.3)	2514 (45.4)	
Family income-poverty ratio							<0.001
0-1.0	5687 (10.4)	1198 (9.2)	1976 (9.5)	431 (15.7)	972 (12.2)	1110 (11.1)	
1.1-3.0	13 562 (36.6)	2834 (33.8)	5017 (35.1)	887 (45.0)	2155 (37.9)	2669 (41.0)	
>3.0	12 357 (53.1)	3091 (57.0)	4775 (55.3)	474 (39.3)	1914 (49.9)	2103 (47.9)	
Marital status							<0.001
Married	21 595 (68.6)	4812 (67.7)	8387 (70.9)	1128 (62.7)	3423 (68.7)	3845 (66.2)	
Separated	10 355 (25.4)	2355 (26.0)	3660 (23.7)	725 (31.8)	1622 (25.2)	1993 (26.8)	
Never married	2313 (6.0)	548 (6.2)	760 (5.4)	116 (5.5)	398 (6.1)	491 (7.0)	
Alcohol drinking							<0.001
Non-drinker	12 796 (38.7)	2767 (37.1)	4529 (36.6)	816 (42.9)	2081 (40.9)	2603 (43.1)	
Low-to-moderate drinker	16 831 (52.0)	3634 (51.6)	6502 (53.3)	902 (50.5)	2696 (51.2)	3097 (50.8)	
Heavy drinker	2638 (9.3)	787 (11.3)	1060 (10.1)	119 (6.6)	369 (8.0)	303 (6.1)	
Smoking status							<0.001
Never smoker	16 533 (46.1)	3576 (45.6)	6043 (45.0)	901 (45.5)	2689 (46.2)	3324 (49.8)	

							P value
Former smoker	11 119 (33.0)	2123 (28.3)	4406 (35.1)	634 (30.1)	1807 (35.4)	2149 (34.3)	
Current smoker	6915 (20.9)	2082 (26.1)	2476 (19.9)	446 (24.4)	1004 (18.5)	907 (15.9)	
Leisure-time physical activity level							<0.001
0 times/week	16890 (38.3)	3327 (31.7)	5986 (35.8)	1127 (47.2)	2832 (43.0)	3618 (48.0)	
1-2 times/week	6608 (25.3)	1561 (26.1)	2559 (25.9)	303 (20.1)	1072 (26.0)	1113 (23.1)	
≥3 times/week	11066 (36.4)	2894 (42.1)	4379 (38.3)	552 (32.7)	1593 (31.0)	1648 (28.9)	
Healthy eating index scores							<0.001
Quartile 1	8200 (24.6)	1695 (21.9)	2859 (23.1)	515 (27.5)	1487 (29.2)	1644 (27.4)	
Quartile 2	8193 (24.8)	1711 (23.3)	3023 (24.7)	469 (24.8)	1426 (26.8)	1564 (25.9)	
Quartile 3	8187 (24.4)	1807 (23.4)	3165 (25.8)	452 (23.7)	1247 (24.0)	1516 (24.0)	
Quartile 4	8185 (26.1)	2094 (31.4)	3202 (26.4)	438 (24.1)	1091 (20.0)	1360 (22.7)	
Family history of diabetes or heart attack	17 062 (49.6)	3288 (43.5)	6012 (47.6)	1058 (52.0)	2994 (54.6)	3710 (59.0)	<0.001
Self-reported health							<0.001
Very good to excellent	12 597 (45.7)	3603 (56.5)	5173 (49.0)	514 (35.0)	1699 (36.7)	1608 (31.9)	
Good	12 092 (33.6)	2517 (28.6)	4446 (32.5)	666 (33.4)	2103 (39.0)	2360 (39.2)	
Poor to fair	9876 (20.7)	1663 (14.9)	3309 (18.5)	800 (31.6)	1695 (24.3)	2409 (28.8)	
Self-reported chronic diseases							
Diabetes	5152 (10.4)	413 (3.5)	1487 (7.7)	614 (23.5)	791 (11.2)	1847 (23.8)	<0.001
Hypertension	12 779 (32.3)	1725 (17.3)	4342 (29.8)	961 (44.5)	2297 (40.3)	3454 (52.2)	<0.001
Cardiovascular diseases	5275 (11.8)	855 (7.6)	1883 (11.5)	509 (22.1)	780 (12.2)	1248 (16.1)	<0.001
Chronic obstructive pulmonary diseases	3089 (9.5)	715 (9.6)	969 (7.8)	217 (12.4)	516 (10.2)	672 (11.5)	<0.001
Cancer§	3264 (8.5)	716 (8.3)	1248 (8.4)	225 (10.2)	447 (8.4)	628 (8.9)	0.33

*Complex survey designs are considered for all estimates; data are presented as No. (%) for categorical variables and mean (95% confidence interval) for continuous variables. Among 36051 participants, a total of 1469 participants were excluded in the analyses due to missing values of BMI at ten years before baseline.

†A total of 87, 2976, 319, 2317, 15, 18, 1817 and 17 participants had missing information on education, family income poverty ratio, marital status, alcohol drinking, smoking status, leisure-time physical activity level, healthy eating index score and self-reported health respectively.

‡For categorical variables, *P* value was calculated by Rao-Scott chi-square test, which is a design-adjusted version of Pearson chi-square test. For continuous variables, ANOVA adjusting for sampling weights was used to calculate *P* value.

§Skin cancer was not included.

Table E Hazard ratios (95% confidence intervals) of all cause mortality with BMI status at different time points in the NHANES 1988-2014 [*]

	BMI groups						
	<18.5 kg/m²	18.5-19.9 kg/m²	20.0-22.4 kg/m²	22.5-24.9 kg/m²	25.0-29.9 kg/m²	30-34.9 kg/m²	≥35.0 kg/m²
BMI at age 25 years							
All participants							
Mean (95% CI)	17.5 (17.4 to 17.6)	19.3 (19.3 to 19.3)	21.3 (21.3 to 21.3)	23.7 (23.7 to 23.7)	26.8 (26.8 to 26.9)	31.9 (31.8 to 32.0)	40.1 (39.5 to 40.7)
No. of participants	1897	3417	9384	8962	7780	1682	658
No. of deaths/person-years	454/21 140	877/37 188	2610/99 220	2648/87 997	2305/72 779	514/14 668	173/5410
Model 1	0.96 (0.85 to 1.08)	0.89 (0.81 to 0.99)	0.95 (0.89 to 1.02)	1.00	1.10 (1.02 to 1.19)	1.39 (1.21 to 1.60)	1.78 (1.42 to 2.23)
Model 2	0.96 (0.84 to 1.10)	0.92 (0.82 to 1.02)	0.97 (0.90 to 1.04)	1.00	1.10 (1.02 to 1.19)	1.30 (1.11 to 1.52)	1.58 (1.26 to 1.98)
Participants with prevalent chronic diseases at 25 years old excluded[†]							
No. of participants	1860	3369	9218	8783	7594	1628	612
No. of deaths	441	855	2539	2569	2216	488	156
Model 1	0.96 (0.85 to 1.09)	0.89 (0.80 to 0.99)	0.95 (0.88 to 1.02)	1.00	1.10 (1.01 to 1.19)	1.41 (1.22 to 1.61)	1.78 (1.43 to 2.22)
Never smoker							
No. of participants	969	1663	4996	4264	3542	799	338
No. of deaths	194	353	1040	1023	886	205	81
Model 1	0.86 (0.70 to 1.07)	0.88 (0.74 to 1.05)	0.89 (0.78 to 1.02)	1.00	1.02 (0.89 to 1.16)	1.48 (1.22 to 1.79)	1.97 (1.44 to 2.69)
BMI at ten years before baseline							
All participants							
Mean (95% CI)	17.4 (17.3 to 17.6)	19.4 (19.3 to 19.4)	21.4 (21.4 to 21.4)	23.8 (23.8 to 23.8)	27.2 (27.2 to 27.3)	32.0 (32.0 to 32.1)	40.5 (40.2 to 40.8)
No. of participants	546	1147	4350	7105	13 071	5480	2883
No. of deaths/person-years	124/6034	246/13 083	1138/48 590	1974/75 015	3941/129 061	1657/49 801	847/23 599
Model 1	1.46 (1.20 to 1.79)	1.06 (0.88 to 1.28)	1.07 (0.96 to 1.19)	1.00	1.06 (0.99 to 1.14)	1.24 (1.14 to 1.34)	1.62 (1.43 to 1.83)
Model 2	1.47 (1.18 to 1.83)	1.08 (0.89 to 1.30)	1.09 (0.98 to 1.20)	1.00	1.04 (0.96 to 1.12)	1.15 (1.06 to 1.26)	1.37 (1.20 to 1.57)
Participants with prevalent chronic diseases at ten years prior baseline excluded[†]							
No. of participants	506	1048	3992	6384	11 227	4488	2147
No. of deaths	112	200	962	1630	3114	1221	562
Model 1	1.54 (1.27 to 1.85)	1.09 (0.87 to 1.37)	1.07 (0.96 to 1.19)	1.00	1.06 (0.99 to 1.13)	1.22 (1.11 to 1.35)	1.72 (1.51 to 1.96)
Never smoker							
No. of participants	243	550	2034	3264	6217	2699	1526
No. of deaths	46	76	424	722	1608	706	395
Model 1	1.89 (1.39 to 2.59)	0.89 (0.69 to 1.14)	1.17 (1.00 to 1.38)	1.00	1.10 (0.95 to 1.27)	1.32 (1.14 to 1.54)	1.74 (1.45 to 2.08)

BMI at baseline

All participants							
Mean (95% CI)	17.4 (17.3 to 17.5)	19.3 (19.3 to 19.4)	21.4 (21.3 to 21.4)	23.8 (23.8 to 23.8)	27.3 (27.3 to 27.4)	32.1 (32.0 to 32.1)	40.2 (39.9 to 40.4)
No. of participants	547	909	3324	5594	13 216	7540	4921
No. of deaths/person-years	275/4282	377/8216	1207/32 995	1763/57 749	3923/135 093	1886/74 801	1069/45 843
Model 1	1.64 (1.29 to 2.08)	1.27 (1.05 to 1.52)	1.10 (0.97 to 1.25)	1.00	0.94 (0.85 to 1.05)	1.03 (0.91 to 1.16)	1.35 (1.22 to 1.49)
Model 2	1.70 (1.33 to 2.17)	1.30 (1.10 to 1.55)	1.13 (0.99 to 1.28)	1.00	0.93 (0.84 to 1.04)	0.98 (0.87 to 1.10)	1.19 (1.07 to 1.31)
Participants with prevalent chronic diseases at baseline excluded[†]							
No. of participants	391	684	2489	4024	9198	4891	2881
No. of deaths	171	236	735	999	2114	946	463
Model 1	1.70 (1.29 to 2.23)	1.28 (1.00 to 1.63)	1.11 (0.95 to 1.31)	1.00	0.93 (0.81 to 1.07)	1.01 (0.87 to 1.19)	1.49 (1.27 to 1.75)
Never smoker							
No. of participants	179	374	1550	2623	6299	3780	2596
No. of deaths	79	128	511	693	1620	786	477
Model 1	1.70 (1.20 to 2.42)	1.04 (0.80 to 1.33)	1.14 (0.95 to 1.36)	1.00	0.95 (0.80 to 1.13)	1.06 (0.90 to 1.24)	1.28 (1.08 to 1.51)

[*] Complex survey designs are considered for all estimates. Among 36051 participants, a total of 2271 and 1469 participants were excluded due to missing values of BMI at age 25 years and at ten years before baseline respectively. Model 1 was adjusted for baseline age, sex, race, education level, marital status, family income- poverty ratio level, drinking and smoking status, leisure-time physical activity level, healthy eating index scores, self-reported health status and family history of diabetes or heart attack. Model 2 was additionally adjusted for baseline history of diabetes, hypertension, cardiovascular diseases, cancer and chronic obstructive pulmonary diseases.
[†] Participants with prevalent cardiovascular diseases, diabetes or cancer were excluded.

Table F Hazard ratios (95% confidence intervals) of CVD mortality, heart disease mortality and stroke mortality with weight change patterns across adulthood in the NHANES 1988-2010[*]

Cause of death[†]	Weight change patterns				
	Stable normal	Maximum overweight	Obese to non-obese	Non-obese to obese	Stable obese
From age 25 years to ten years before baseline					
CVD mortality					
No. of deaths	611	859	33	397	120
Model 1	1.00	1.12 (0.97 to 1.31)	0.98 (0.60 to 1.60)	1.51 (1.26 to 1.81)	2.44 (1.85 to 3.23)
Model 2	1.00	1.15 (1.00 to 1.33)	0.91 (0.56 to 1.47)	1.53 (1.27 to 1.84)	2.51 (1.92 to 3.27)
Model 3	1.00	1.13 (0.97 to 1.30)	0.84 (0.51 to 1.40)	1.40 (1.16 to 1.69)	2.23 (1.70 to 2.93)
Heart disease mortality					
No. of deaths	459	654	24	311	108
Model 1	1.00	1.12 (0.96 to 1.31)	0.84 (0.50 to 1.42)	1.65 (1.34 to 2.03)	2.86 (2.13 to 3.85)
Model 2	1.00	1.15 (0.98 to 1.34)	0.76 (0.45 to 1.28)	1.66 (1.33 to 2.06)	2.92 (2.20 to 3.88)
Model 3	1.00	1.12 (0.96 to 1.32)	0.68 (0.40 to 1.16)	1.52 (1.22 to 1.89)	2.57 (1.92 to 3.43)
Stroke mortality					
No. of deaths	152	205	9	86	12
Model 1	1.00	1.14 (0.85 to 1.53)	1.45 (0.56 to 3.77)	1.06 (0.67 to 1.67)	0.98 (0.42 to 2.30)
Model 2	1.00	1.16 (0.88 to 1.55)	1.48 (0.59 to 3.70)	1.09 (0.70 to 1.70)	1.04 (0.45 to 2.39)
Model 3	1.00	1.15 (0.86 to 1.53)	1.51 (0.59 to 3.85)	1.02 (0.66 to 1.59)	0.98 (0.42 to 2.25)
From age 25 years to baseline					
CVD mortality					
No. of deaths	580	860	69	466	88
Model 1	1.00	0.98 (0.83 to 1.16)	1.40 (0.99 to 2.00)	1.14 (0.96 to 1.36)	2.00 (1.47 to 2.72)
Model 2	1.00	1.00 (0.84 to 1.18)	1.27 (0.88 to 1.84)	1.15 (0.97 to 1.36)	2.08 (1.56 to 2.78)
Model 3	1.00	0.97 (0.82 to 1.16)	1.16 (0.78 to 1.72)	1.06 (0.89 to 1.27)	1.87 (1.39 to 2.52)
Heart disease mortality					
No. of deaths	441	653	57	359	79
Model 1	1.00	0.94 (0.78 to 1.13)	1.42 (0.98 to 2.08)	1.20 (1.00 to 1.44)	2.28 (1.60 to 3.25)
Model 2	1.00	0.95 (0.80 to 1.15)	1.25 (0.84 to 1.85)	1.20 (1.00 to 1.45)	2.37 (1.68 to 3.33)
Model 3	1.00	0.93 (0.77 to 1.13)	1.11 (0.73 to 1.69)	1.11 (0.92 to 1.34)	2.10 (1.48 to 2.97)
Stroke mortality					
No. of deaths	139	207	12	107	9
Model 1	1.00	1.13 (0.82 to 1.56)	1.33 (0.53 to 3.32)	0.93 (0.66 to 1.32)	0.92 (0.39 to 2.15)

Model 2	1.00	1.15 (0.83 to 1.59)	1.33 (0.55 to 3.24)	0.96 (0.68 to 1.34)	0.99 (0.42 to 2.32)
Model 3	1.00	1.14 (0.82 to 1.60)	1.33 (0.53 to 3.32)	0.89 (0.62 to 1.28)	0.93 (0.39 to 2.24)
From ten years before baseline to baseline					
CVD mortality					
No. of deaths	516	865	218	224	346
Model 1	1.00	0.92 (0.79 to 1.07)	1.69 (1.35 to 2.12)	0.99 (0.79 to 1.25)	1.43 (1.17 to 1.74)
Model 2	1.00	0.94 (0.81 to 1.10)	1.65 (1.31 to 2.07)	1.00 (0.80 to 1.26)	1.47 (1.23 to 1.76)
Model 3	1.00	0.91 (0.78 to 1.06)	1.50 (1.19 to 1.89)	0.93 (0.74 to 1.18)	1.33 (1.11 to 1.59)
Heart disease mortality					
No. of deaths	387	668	168	165	287
Model 1	1.00	0.91 (0.77 to 1.09)	1.75 (1.37 to 2.23)	0.99 (0.79 to 1.26)	1.62 (1.31 to 1.99)
Model 2	1.00	0.94 (0.79 to 1.11)	1.69 (1.31 to 2.18)	1.01 (0.80 to 1.27)	1.66 (1.36 to 2.02)
Model 3	1.00	0.91 (0.76 to 1.07)	1.52 (1.16 to 1.98)	0.93 (0.74 to 1.18)	1.49 (1.23 to 1.81)
Stroke mortality					
No. of deaths	129	197	50	59	59
Model 1	1.00	0.93 (0.71 to 1.23)	1.50 (0.81 to 2.81)	0.98 (0.65 to 1.47)	0.78 (0.50 to 1.24)
Model 2	1.00	0.95 (0.73 to 1.24)	1.53 (0.85 to 2.75)	0.99 (0.66 to 1.49)	0.82 (0.53 to 1.27)
Model 3	1.00	0.93 (0.70 to 1.24)	1.50 (0.82 to 2.74)	0.93 (0.60 to 1.44)	0.78 (0.49 to 1.24)

[*]Complex survey designs are considered for all estimates. Model 1 was adjusted for baseline age, sex, race/ethnicity. Model 2 was additionally adjusted for education level, family income-poverty ratio level, marital status, drinking and smoking status and family history of diabetes or heart attack. Model 3 was further adjusted for baseline leisure-time physical activity level, healthy eating index scores and self-reported general health.

[†]Deaths were followed up to 31st December 2011.

Table G Hazard ratios (95% confidence intervals) of mortality with weight change patterns across adulthood in the NHANES 1988-2014 with further adjustment of baseline disease status[*]

Cause of death[†]	Weight change patterns				
	Stable normal	Maximum overweight	Obese to non-obese	Non-obese to obese	Stable obese
From age 25 years to ten years before baseline					
All cause					
No. of deaths/Person-years	3075/132 955	3821/126 939	159/3688	1827/54 259	516/16 133
Hazard ratio (95% confidence interval)	1.00	1.02 (0.94 to 1.10)	1.18 (0.82 to 1.67)	1.11 (1.01 to 1.22)	1.47 (1.27 to 1.70)
Heart diseases					
No. of deaths	569	862	33	409	139
Hazard ratio (95% confidence interval)	1.00	1.13 (0.97 to 1.31)	0.84 (0.49 to 1.44)	1.29 (1.04 to 1.60)	1.97 (1.49 to 2.62)
Cancer					
No. of deaths	787	868	27	378	90
Hazard ratio (95% confidence interval)	1.00	1.00 (0.86 to 1.16)	0.95 (0.51 to 1.75)	1.18 (0.94 to 1.48)	1.09 (0.85 to 1.40)
Other causes					
No. of deaths	1719	2091	99	1040	287
Hazard ratio (95% confidence interval)	1.00	1.03 (0.94 to 1.12)	1.46 (0.95 to 2.25)	1.13 (1.00 to 1.28)	1.74 (1.41 to 2.16)
From age 25 years to baseline					
All cause					
No. of deaths/Person-years	2677/87 892	3915/131 968	264/4923	2302/98 464	423/15 156
Hazard ratio (95% confidence interval)	1.00	0.91 (0.82 to 0.99)	1.07 (0.80 to 1.42)	0.95 (0.86 to 1.04)	1.38 (1.19 to 1.61)
Heart diseases					
No. of deaths	534	846	66	498	110
Hazard ratio (95% confidence interval)	1.00	0.93 (0.77 to 1.11)	0.91 (0.58 to 1.43)	1.00 (0.84 to 1.19)	1.72 (1.27 to 2.33)
Cancer					
No. of deaths	604	919	47	545	73
Hazard ratio (95% confidence interval)	1.00	0.96 (0.82 to 1.13)	0.88 (0.57 to 1.37)	1.06 (0.92 to 1.21)	1.09 (0.80 to 1.48)
Other causes					
No. of deaths	1539	2150	151	1259	240
Hazard ratio (95% confidence interval)	1.00	0.89 (0.80 to 0.99)	1.28 (0.91 to 1.79)	0.96 (0.84 to 1.09)	1.64 (1.32 to 2.03)
From ten years before baseline to baseline					
All cause					
No. of deaths/Person-years	2362/81 771	3924/131 762	852/16 428	1137/58 251	1652/56 972
Hazard ratio (95% confidence interval)	1.00	0.91 (0.82 to 1.00)	1.17 (1.04 to 1.31)	0.95 (0.82 to 1.09)	1.07 (0.97 to 1.18)

Heart diseases

No. of deaths	462	851	207	243	382
Hazard ratio (95% confidence interval)	1.00	0.89 (0.74 to 1.06)	1.29 (0.98 to 1.70)	0.93 (0.77 to 1.13)	1.21 (0.98 to 1.49)

Cancer

No. of deaths	567	892	138	273	354
Hazard ratio (95% confidence interval)	1.00	0.95 (0.78 to 1.14)	1.06 (0.81 to 1.37)	0.96 (0.75 to 1.21)	1.16 (0.97 to 1.39)

Other causes

No. of deaths	1333	2181	507	621	916
Hazard ratio (95% confidence interval)	1.00	0.92 (0.83 to 1.03)	1.30 (1.10 to 1.53)	1.02 (0.85 to 1.22)	1.12 (0.98 to 1.28)

[*] Complex survey designs are considered for all estimates. A total of 2751, 2271, 1469 participants were excluded in analyses from age 25 years to ten years before baseline, age 25 years to baseline, ten years before baseline to baseline respectively due to missing values of BMI at both times.

[†] For all cause mortality, risk estimates were adjusted for baseline age, sex, race/ethnicity, education level, family income-poverty ratio level, marital status, drinking and smoking status, leisure-time physical activity level, healthy eating index scores, self-reported health status and family history of diabetes or heart attack and baseline history of diabetes, hypertension, cardiovascular diseases, cancer and chronic obstructive pulmonary diseases. For heart disease mortality, risk estimates were adjusted for baseline age, sex, race/ethnicity, education level, family income-poverty ratio level, marital status, drinking and smoking status, leisure-time physical activity level, healthy eating index scores, self-reported health status, family history of diabetes or heart attack and baseline history of diabetes, hypertension, cancer and chronic obstructive pulmonary diseases. For cancer mortality, risk estimates were adjusted for baseline age, sex, race/ethnicity, education level, family income-poverty ratio level, marital status, drinking and smoking status, leisure-time physical activity level, healthy eating index scores, self-reported health status, family history of diabetes or heart attack and baseline history of diabetes, hypertension, cardiovascular diseases and chronic obstructive pulmonary diseases. For other causes mortality, risk estimates were adjusted for baseline age, sex, race/ethnicity, education level, family income-poverty ratio level, marital status, drinking and smoking status, leisure-time physical activity level, healthy eating index scores, self-reported health status, family history of diabetes or heart attack and baseline history of cardiovascular diseases and cancer.

Table H Sensitivity analyses of the associations between weight change patterns across adulthood and risks of all cause mortality in the NHANES 1988-2014 [*]

	Weight change patterns				
	Stable Normal	**Maximum overweight**	**Obese to non-obese**	**Non-obese to obese**	**Stable obese**
From age 25 years to ten years before baseline					
All participants					
No. of deaths	3075	3821	159	1827	516
Hazard ratio (95% confidence interval)	1.00	1.05 (0.98 to 1.12)	1.22 (0.87 to 1.69)	1.22 (1.11 to 1.33)	1.72 (1.52 to 1.95)
Sensitivity analysis 1[†]					
No. of deaths	2477	3092	133	1503	426
Hazard ratio (95% confidence interval)	1.00	1.01 (0.94 to 1.09)	1.17 (0.82 to 1.68)	1.21 (1.09 to 1.35)	1.69 (1.47 to 1.94)
Sensitivity analysis 2[‡]					
No. of deaths	2734	3713	158	1778	516
Hazard ratio (95% confidence interval)	1.00	1.06 (0.99 to 1.14)	1.24 (0.89 to 1.72)	1.23 (1.11 to 1.36)	1.74 (1.54 to 1.96)
Sensitivity analysis 3[§]					
No. of deaths	2585	3097	127	1454	398
Hazard ratio (95% confidence interval)	1.00	1.02 (0.95 to 1.11)	1.25 (0.87 to 1.80)	1.22 (1.10 to 1.35)	1.81 (1.59 to 2.07)
Sensitivity analysis 4[∣]					
No. of deaths	2571	3028	115	1308	359
Hazard ratio (95% confidence interval)	1.00	1.04 (0.97 to 1.11)	1.34 (1.00 to 1.81)	1.21 (1.09 to 1.34)	1.83 (1.60 to 2.10)
From age 25 years to baseline					
All participants					
No. of deaths	2677	3915	264	2302	423
Hazard ratio (95% confidence interval)	1.00	0.92 (0.84 to 1.00)	1.13 (0.86 to 1.49)	1.01 (0.92 to 1.11)	1.61 (1.41 to 1.84)
Sensitivity analysis 1[†]					
No. of deaths	2135	3179	211	1881	358
Hazard ratio (95% confidence interval)	1.00	0.93 (0.84 to 1.04)	1.10 (0.81 to 1.50)	1.04 (0.94 to 1.15)	1.66 (1.43 to 1.92)
Sensitivity analysis 2[‡]					
No. of deaths	2253	3750	262	2228	423
Hazard ratio (95% confidence interval)	1.00	0.94 (0.86 to 1.03)	1.16 (0.88 to 1.53)	1.03 (0.93 to 1.14)	1.64 (1.44 to 1.87)
Sensitivity analysis 3[§]					
No. of deaths	2172	3187	188	1923	343
Hazard ratio (95% confidence interval)	1.00	0.91 (0.82 to 1.00)	1.14 (0.83 to 1.57)	1.04 (0.94 to 1.15)	1.73 (1.51 to 1.99)
Sensitivity analysis 4[∣]					
No. of deaths	1610	2143	115	1145	160
Hazard ratio (95% confidence interval)	1.00	0.89 (0.79 to 0.99)	1.38 (0.99 to 1.92)	1.02 (0.90 to 1.16)	1.76 (1.45 to 2.13)

From ten years before baseline to baseline

All participants

No. of deaths	2362	3924	852	1137	1652
Hazard ratio (95% confidence interval)	1.00	0.93 (0.84 to 1.02)	1.30 (1.16 to 1.45)	1.01 (0.88 to 1.15)	1.20 (1.09 to 1.32)

Sensitivity analysis 1[†]

No. of deaths	1869	3137	692	934	1350
Hazard ratio (95% confidence interval)	1.00	0.93 (0.84 to 1.02)	1.30 (1.15 to 1.46)	1.02 (0.88 to 1.18)	1.22 (1.10 to 1.36)

Sensitivity analysis 2[‡]

No. of deaths	2071	3887	848	1132	1652
Hazard ratio (95% confidence interval)	1.00	0.96 (0.87 to 1.06)	1.35 (1.20 to 1.53)	1.05 (0.92 to 1.20)	1.25 (1.13 to 1.38)

Sensitivity analysis 3[§]

No. of deaths	1940	3172	634	982	1335
Hazard ratio (95% confidence interval)	1.00	0.91 (0.81 to 1.02)	1.30 (1.13 to 1.48)	1.04 (0.89 to 1.22)	1.22 (1.10 to 1.36)

Sensitivity analysis 4[|]

No. of deaths	1506	2166	335	639	691
Hazard ratio (95% confidence interval)	1.00	0.87 (0.77 to 0.97)	1.26 (1.02 to 1.55)	1.00 (0.83 to 1.21)	1.17 (1.03 to 1.32)

[*]Complex survey designs are considered for all estimates. Risk estimates were adjusted for baseline age, sex, race/ethnicity, education level, family income-poverty ratio level, marital status, drinking and smoking status, family history of diabetes or heart attack, leisure-time physical activity level, healthy eating index scores and self-reported general health.

[†]Participants with any missing values for covariates were excluded. A total of 8460, 8111 and 7620 participants were further excluded in analyses from age 25 years to ten years before baseline, age 25 years to baseline, ten years before baseline to baseline respectively due to missing information on covariates.

[‡]Underweight participants were excluded. A total of 2020, 2289 and 946 participants were further excluded in analyses from age 25 years to ten years before baseline, age 25 years to baseline, ten years before baseline to baseline respectively due to being underweight at either time point during the weight change intervals.

[§]Participants with less than three years of follow-up were excluded. A total of 5027, 5100 and 5265 participants were further excluded in analyses from age 25 years to ten years before baseline, age 25 years to baseline, ten years before baseline to baseline respectively due to less than three years of follow up.

[|]Participants with prevalent cardiovascular diseases, diabetes or cancer were excluded. A total of 4584 participants were further excluded in analyses from age 25 years to ten years before baseline due to having prevalent cardiovascular diseases, diabetes or cancer diagnosed at ten years before baseline. A total of 10 663 participants were excluded in analyses from age 25 years to baseline due to having prevalent cardiovascular diseases, diabetes or cancer diagnosed at baseline. A total of 10 994 participants were excluded in analyses from ten years before baseline to baseline due to having prevalent cardiovascular diseases, diabetes or cancer at baseline.

Table I Hazard ratios (95% confidence intervals) of all cause mortality with weight change patterns stratified by age at death among participants younger than 65 years old at baseline in the NHANES 1988-2014[*]

	Weight change patterns				
	Stable Normal	**Maximum overweight**	**Obese to non-obese**	**Non-obese to obese**	**Stable obese**
From age 25 years to ten years before baseline					
Stratified by death age group					
Dead before 65y					
No. of deaths	516	448	22	231	138
Multivariable-adjusted HR (95% CI)	1.00	1.12 (0.94 to 1.33)	1.73 (0.93 to 3.21)	1.32 (1.07 to 1.63)	1.69 (1.38 to 2.08)
Dead before 70y					
No. of deaths	713	665	32	349	176
Multivariable-adjusted HR (95% CI)	1.00	1.08 (0.92 to 1.25)	1.65 (0.90 to 3.02)	1.12 (0.93 to 1.34)	1.70 (1.39 to 2.09)
Dead before 75y					
No. of deaths	868	852	38	451	207
Multivariable-adjusted HR (95% CI)	1.00	1.15 (1.02 to 1.30)	1.63 (0.95 to 2.81)	1.18 (1.01 to 1.38)	1.95 (1.60 to 2.36)
Dead before 80y					
No. of deaths	989	1000	39	520	227
Multivariable-adjusted HR (95% CI)	1.00	1.16 (1.03 to 1.31)	0.94 (0.33 to 2.73)	1.28 (1.10 to 1.50)	1.85 (1.53 to 2.24)
From age 25 years to baseline					
Stratified by death age group					
Dead before 65y					
No. of deaths	334	469	44	416	120
Multivariable-adjusted HR (95% CI)	1.00	0.88 (0.69 to 1.12)	1.29 (0.84 to 1.98)	1.05 (0.84 to 1.32)	1.57 (1.21 to 2.01)
Dead before 70y					
No. of deaths	480	685	55	592	157
Multivariable-adjusted HR (95% CI)	1.00	0.87 (0.73 to 1.04)	1.35 (0.89 to 2.06)	0.99 (0.84 to 1.18)	1.59 (1.29 to 1.95)
Dead before 75y					
No. of deaths	601	871	64	737	186
Multivariable-adjusted HR (95% CI)	1.00	0.95 (0.80 to 1.12)	1.44 (0.93 to 2.23)	1.05 (0.89 to 1.23)	1.80 (1.47 to 2.21)
Dead before 80y					
No. of deaths	693	1003	68	860	203
Multivariable-adjusted HR (95% CI)	1.00	0.95 (0.83 to 1.09)	0.82 (0.35 to 1.91)	1.09 (0.95 to 1.26)	1.75 (1.41 to 2.17)
From ten years before baseline to baseline					
Stratified by death age group					
Dead before 65y					

|					
No. of deaths	307	455	98	254	280
Multivariable-adjusted HR (95% CI)	1.00	0.87 (0.68 to 1.11)	1.54 (1.07 to 2.20)	1.06 (0.80 to 1.42)	1.24 (0.98 to 1.58)
Dead before 70y					
No. of deaths	436	673	140	350	403
Multivariable-adjusted HR (95% CI)	1.00	0.89 (0.74 to 1.06)	1.29 (0.94 to 1.76)	1.06 (0.86 to 1.29)	1.13 (0.95 to 1.34)
Dead before 75y					
No. of deaths	539	849	180	426	502
Multivariable-adjusted HR (95% CI)	1.00	0.98 (0.82 to 1.18)	1.32 (1.00 to 1.74)	1.10 (0.89 to 1.36)	1.25 (1.08 to 1.45)
Dead before 80y					
No. of deaths	626	973	203	499	570
Multivariable-adjusted HR (95% CI)	1.00	0.96 (0.80 to 1.15)	1.39 (1.05 to 1.85)	1.12 (0.92 to 1.35)	1.31 (1.12 to 1.55)

[*]Complex survey designs are considered for all estimates. Risk estimates were adjusted for baseline age, sex, race/ethnicity, education level, family income-poverty ratio level, marital status, drinking and smoking status, family history of diabetes or heart attack, leisure-time physical activity level, healthy eating index scores and self-reported general health.
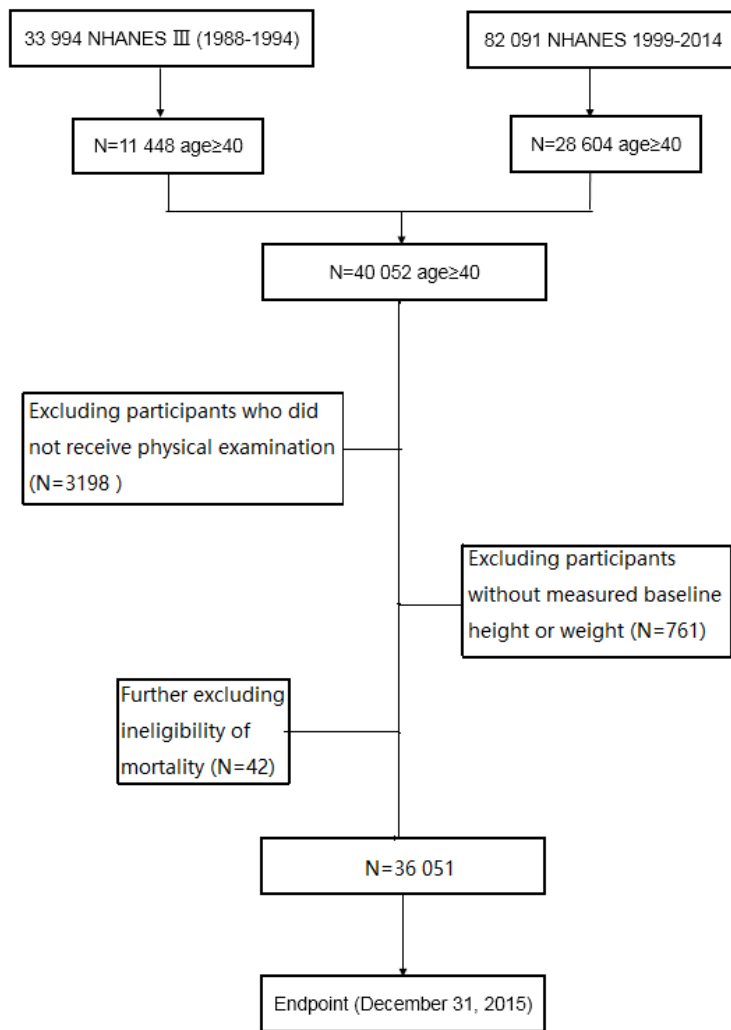
Figure A Flow chart of inclusion and exclusion of study participants

Association between fine weight change patterns and all-cause mortality
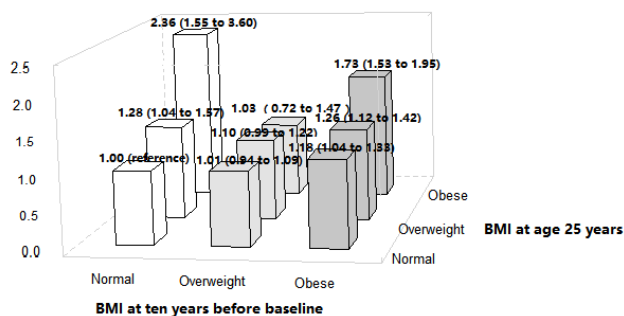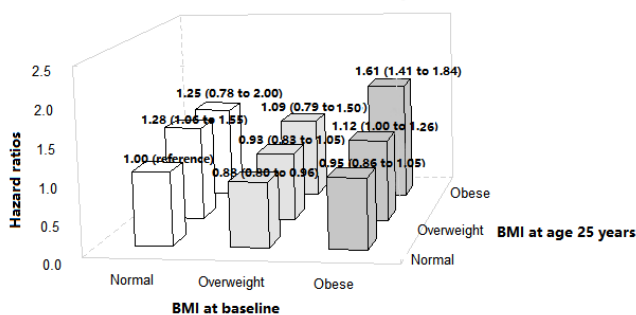

No. of deaths/participants

	BMI at ten years before baseline		
BMI at age 25 years	Normal (<25.0 kg/ m²)	Overweight (25.0- 29.9 kg/ m²)	Obese (≥30.0 kg/m²)
Normal (<25.0 kg/ m²)	3075/12 514	2421/8236	961/2937
Overweight (25.0-30.0 kg/ m²)	219/517	1181/4007	866/3146
Obese (≥30.0 kg/m²)	22/71	137/328	516/1904

Association between fine weight change patterns and all-cause mortality

No. of deaths/particiapants

	BMI at baseline		
BMI at age 25 years	Normal (<25.0 kg/ m²)	Overweight (25.0- 29.9 kg/ m²)	Obese (≥30.0 kg/m²)
Normal (<25.0 kg/ m²)	2677/8529	2532/9209	1380/5922
Overweight (25.0-30.0 kg/ m²)	512/1001	871/2745	922/4034
Obese (≥30.0 kg/ m²)	81/154	183/436	423/1750

Association between fine weight change patterns and all-cause mortality
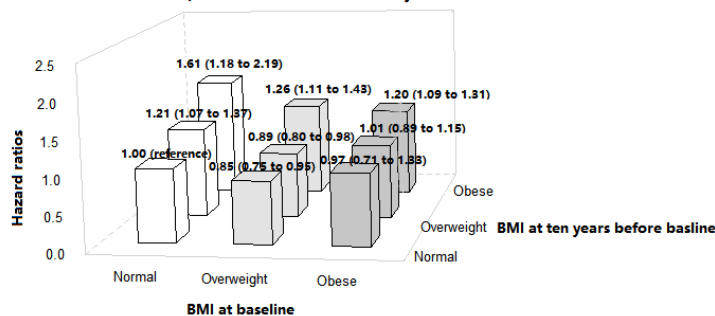
No. of deaths/participants

	BMI at baseline		
BMI at ten years before baseline	Normal (<25.0 kg/ m²)	Overweight (25.0- 29.9 kg/ m²)	Obese (≥30.0 kg/m²)
Normal (<25.0 kg/ m²)	2362/7785	905/4224	215/1139
Overweight (25.0-30.0 kg/ m²)	913/1934	2106/6774	922/4363
Obese (≥30.0 kg/m²)	151/268	701/1714	1652/6381

Figure B Association between fine weight change patterns across adulthood and all cause mortality in the NHANES 1988-2014. All risk estimates were calculated using multivariable Cox regression adjusted for baseline age, sex, race/ethnicity, education level, family income-poverty ratio level, marital status, drinking and smoking status, leisure-time physical activity level, healthy eating index scores, self-reported health status and family history of diabetes or heart attack.
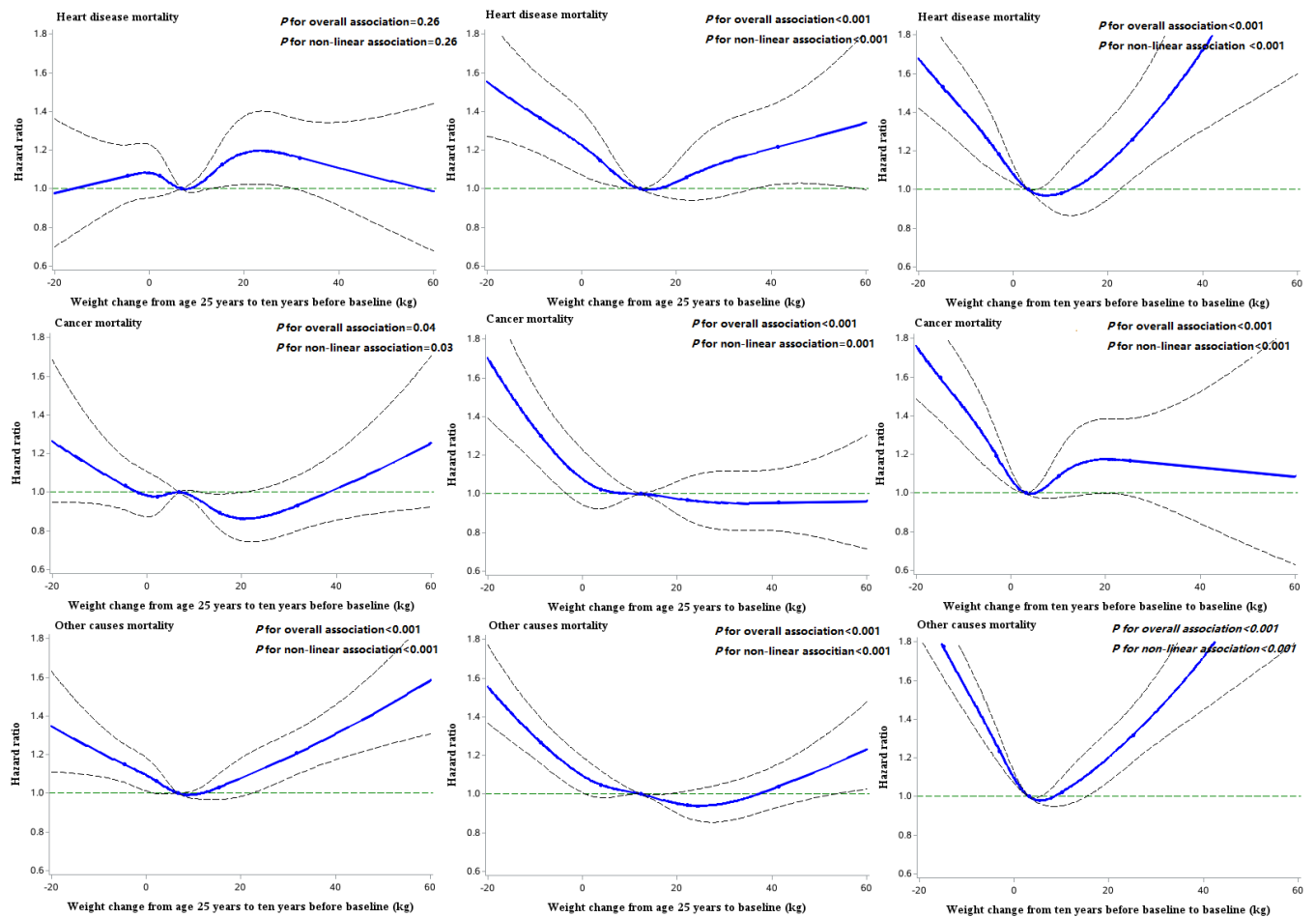
Figure C Dose response association between weight change across adulthood and risk of cause specific mortality in the NHANES 1988-2014. Associations were examined by multivariable Cox regression based on restricted cubic splines. Dash line represents estimates of hazard ratios and dotted line represents 95% confidence intervals. Risk estimates were adjusted for baseline age, sex, race/ethnicity, education level, family income-poverty ratio level, marital status, drinking and smoking status, leisure-time physical activity level, healthy eating index scores, self-reported health status and family history of diabetes or heart attack. For weight change from age 25 years to ten years before baseline or to baseline, weight at age 25 and baseline height were also adjusted. For weight change from ten years before baseline to baseline, weight at 10 years ago and baseline height were adjusted.