Supplemental Materials

Joint Trajectories of Body Mass Index and Waist Circumference in Early to Mid-life Adulthood and Incident Hypertension: the China Health and Nutrition Survey

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Trajectory Analysis

Repeated trajectory analyses were performed to identify the latent classes by changing the number of groups from 2 to 3, with the same starting values calculated from the 1-group model. The shapes and optimal number of groups were determined by the following criteria: 1) Bayesian information criterion (BIC) decreased at least 20; 2) high mean posterior class membership probabilities (> 0.65); 3) high mean posterior probabilities (> 0.7). Estimation of latent class models was performed with lcmm (version 1.7.8) package in R (version 4.0.4). To avoid convergence towards local maxima, LCGMM models with 2 or 3 classes were performed for several times with different sets of random starting value based on 1-class model. Finally, according to criteria above, a model of quadratic parameters with two classes was chosen for both BMI and WC as the best fit. The final model of BMI was described as:

$$BMI_{ij} \mid_{c_{i=g}} = (\upsilon_{0g} + u_{0ig}) + (\upsilon_{1g} + u_{1ig})age + (\upsilon_{2g} + u_{2ig})age^2 + \varepsilon_{ij}$$

where $\upsilon = (\upsilon_{0g}, \upsilon_{1g}, \upsilon_{2g})$ is a vector of fixed effect parameters in the group "g", $u = (u_{0ig}, u_{1ig}, u_{2ig})$ is a vector of random effect parameters of the individual "i" in the group "g", ε_{ij} is an unknown error term (the model of WC is similar with BMI).

Table S1. Baseline characteristics of participants included and excluded.

Variable	Excluded	Included	*P*-Value
N	26777	6571	
Age, y	30.8 (23.0)	35.4 (8.6)	<0.001
Male, n (%)	12931 (48.3)	3063 (46.6)	0.017
BMI, kg/m^2	20.9 (4.8)	22.0 (2.7)	<0.001
WC, cm	75.9 (15.6)	75.8 (8.4)	0.365
SBP, mm Hg	116.0 [102.0, 129.0]	110.0 [103.0, 120.0]	<0.001
DBP, mm Hg	75.0 [68.0, 81.0]	74.0 [70.0, 80.0]	<0.001
Smoker, n (%)	4475 (27.2)	2123 (32.5)	<0.001
Drinker, n (%)	5162 (29.4)	2312 (35.5)	<0.001

BMI indicates body mass index; DBP, diastolic blood pressure; SBP, systolic blood pressure; WC, waist circumference.

Table S2. Latent Class Growth Mixture Models (LCGMM) results of model fitting process for BMI.

No. Latent class	Polynomial degree	Log-Lik	BIC	% Participants per class	Mean posterior probabilities	% Posterior probabilities > 70%
1	Linear	-59740	119525	100	na	na
	Quadratic	-59623	119308	100	na	na
	Cubic	-59604	119289	100	na	na
2	Linear	-59299	118678	9.98/90.02	0.79/0.95	66.92/95.38
	Quadratic	**-59122**	**118351**	**84.96/15.04**	**0.93/0.81**	**93.19/72.37**
	Cubic	-59120	118373	15.17/84.83	0.82/0.93	73.22/93.00
3	Linear	-59190	118495	24.97/72.12/2.91	0.74/0.87/0.79	56.98/84.30/67.02
	Quadratic	-58989	118128	73.40/23.09/3.51	0.88/0.73/0.78	85.32/57.61/64.07
	Cubic	-58985	118155	4.34/78.45/17.21	0.74/0.90/0.73	58.25/88.13/54.38

BMI indicate body mass index; NO. Latent class: latent class number of the model; Log-Lik: the maximum Log-Likelihood; BIC: the Bayesian information Criterion; % Participants per class: proportion of participants per class; The best fitting model is highlighted in bold characters. (na: not applicable)

Table S3. Latent Class Growth Mixture Models (LCGMM) results of model fitting process for WC.

No. Latent class	Polynomial degree	Log-Lik	BIC	% Participants per class	Mean posterior probabilities	% Posterior probabilities > 70%
1	Linear	-98380	196839	100	na	na
	Quadratic	-98387	196836	100	na	na
	Cubic	-98397	196839	100	na	na
2	Linear	-98042	196163	83.32/16.68	0.92/0.78	91.98/65.42
	Quadratic	**-97946**	**195998**	**80.53/19.47**	**0.92/0.80**	**91.35/68.67**
	Cubic	-97940	196012	80.18/19.82	0.92/0.80	91.41/69.79
3	Linear	-98008	195918	50.95/36.74/12.81	0.95/0.89/0.77	96.19/86.74/63.06
	Quadratic	-97875	195900	54.95/9.34/35.71	0.80/0.77/0.70	70.99/64.12/50.57
	Cubic	-97866	195112	50.46/36.74/12.80	0.71/0.87/0.68	52.88/84.85/42.74

WC indicate waist circumference; NO. Latent class: latent class number of the model; Log-Lik: the maximum Log-Likelihood; BIC: the Bayesian information Criterion; % Participants per class: proportion of participants per class; The best fitting model is highlighted in bold characters. (na: not applicable)

Table S4. Parameters estimates for the best fitting 2-class quadratic Latent Class Growth Mixture Model for BMI.

		Intercept (se)*	Linear (se)	Quadratic (se)
Fixed effect				
	Group 1	23.519 (0.0487)	0.077 (0.0024)	$-5x10^{-5}$ (0.0002)
	Group 2	27.177 (0.1337)	0.155 (0.0076)	-0.009 (0.0005)
Random effects: variance-covariance matrix				
σ^2_{int} = 3.88				
$\sigma^2_{linear\ slope}$ = 0.0105				
$\sigma^2_{quadratic\ slope}$ < 0.001				
σ^2_{error} = 1.24				

se = standard error; BMI = body mass index.

*: Intercept interpreted as the expected level of BMI in kg/m^2 at 42 years of age (centering to the mean age of the sample)

Table S5. Parameters estimates for the best fitting 2-class quadratic Latent Class Growth Mixture Model for WC.

		Intercept (se)*	Linear (se)	Quadratic (se)
Fixed effect				
	Group 1	76.890 (0.1459)	0.338 (0.0084)	0.004 (0.0006)
	Group 2	89.963 (0.3340)	0.501 (0.0226)	-0.020 (0.0015)
Random effects: variance-covariance matrix				
σ^2_{int} = 24.31				
$\sigma^2_{linear\ slope}$ = 0.0984				
$\sigma^2_{quadratic\ slope}$ < 0.001				
σ^2_{error} = 5.38				

se = standard error; WC = waist circumference.

*: Intercept interpreted as the expected level of WC in cm at 42 years of age (centering to the mean age of the sample)

Table S6. Hazard Ratios and 95% of BMI Trajectory Groups for Incident Hypertension

	Model 1	Model 2	Model 3	Model 4
Trajectory groups				
Low-increasing group	Reference	Reference	Reference	Reference
High-increasing group	1.79 (1.58, 2.03)	1.44 (1.22, 1.69)	1.47 (1.25, 1.73)	1.49 (1.26, 1.75)
Covariates				
Age, y		1.07 (1.06, 1.08)	1.06 (1.05, 1.07)	1.06 (1.05, 1.07)
Female		0.74 (0.67, 0.83)	0.86 (0.77, 0.96)	0.97 (0.83, 1.14)
Baseline BMI		1.09 (1.06, 1.12)	1.07 (1.04, 1.10)	1.07 (1.04, 1.10)
Baseline WC		1.01 (1.00,1.02)	1.01 (1.00, 1.02)	1.01 (1.00, 1.02)
Baseline SBP			1.03 (1.02, 1.04)	1.03 (1.02, 1.04)
Smoker				1.11 (0.96, 1.30)
Drinker				1.11 (0.97, 1.27)

BMI, body mass index; SBP, systolic blood pressure; WC, waist circumference.

Table S7. Hazard Ratios and 95% of WC Trajectory Groups for Incident Hypertension

	Model 1	Model 2	Model 3	Model 4
Trajectory groups				
Low-increasing group	Reference	Reference	Reference	Reference
High-increasing group	1.71 (1.53, 1.93)	1.45 (1.24, 1.69)	1.42 (1.21, 1.66)	1.43 (1.22, 1.68)
Covariates				
Age, y		1.07 (1.06, 1.08)	1.06 (1.05, 1.07)	1.06 (1.05, 1.07)
Female		0.80 (0.72, 0.90)	0.92 (0.82, 1.03)	1.04 (0.89, 1.23)
Baseline BMI		1.10 (1.07, 1.13)	1.08 (1.05, 1.11)	1.08 (1.05, 1.11)
Baseline WC		1.01 (1.00, 1.02)	1.00 (0.99, 1.01)	1.01 (1.00, 1.02)
Baseline SBP			1.03 (1.02, 1.04)	1.03 (1.02, 1.04)
Smoker				1.12 (0.96, 1.30)
Drinker				1.10 (0.96, 1.26)

BMI, body mass index; SBP, systolic blood pressure; WC, waist circumference.

Table S8. Model-estimated levels and linear slopes of BMI in means (SD) by incident hypertension at follow-up

	BMI Level (kg/m^2)			**BMI Slope (kg/m^2/year)**		
Age, (years)	NTN	HTN	*P*-Value	NTN	HTN	*P*-Value
20	21.50 (2.03)	21.40 (1.95)	0.068	0.14 (0.17)	0.20 (0.21)	<0.001
21	21.64 (1.96)	21.59 (1.87)	0.407	0.13 (0.17)	0.19 (0.20)	<0.001
22	21.77 (1.90)	21.78 (1.82)	0.828	0.13 (0.16)	0.19 (0.19)	<0.001
23	21.90 (1.85)	21.97 (1.78)	0.199	0.13 (0.16)	0.19 (0.19)	<0.001
24	22.03 (1.82)	22.16 (1.76)	0.019	0.13 (0.15)	0.18 (0.18)	<0.001
25	22.16 (1.80)	22.34 (1.76)	<0.001	0.12 (0.15)	0.18 (0.17)	<0.001
26	22.28 (1.79)	22.51 (1.77)	<0.001	0.12 (0.14)	0.17 (0.17)	<0.001
27	22.40 (1.79)	22.68 (1.80)	<0.001	0.12 (0.14)	0.17 (0.16)	<0.001
28	22.52 (1.80)	22.85 (1.84)	<0.001	0.12 (0.13)	0.16 (0.15)	<0.001
29	22.64 (1.82)	23.01 (1.88)	<0.001	0.11 (0.13)	0.16 (0.15)	<0.001
30	22.75 (1.84)	23.17 (1.94)	<0.001	0.11 (0.12)	0.16 (0.14)	<0.001
31	22.86 (1.87)	23.32 (1.99)	<0.001	0.11 (0.12)	0.15 (0.13)	<0.001
32	22.97 (1.90)	23.48 (2.05)	<0.001	0.11 (0.11)	0.15 (0.13)	<0.001
33	23.07 (1.93)	23.62 (2.11)	<0.001	0.10 (0.11)	0.14 (0.12)	<0.001
34	23.18 (1.97)	23.76 (2.17)	<0.001	0.10 (0.10)	0.14 (0.11)	<0.001
35	23.28 (2.00)	23.90 (2.23)	<0.001	0.10 (0.10)	0.14 (0.11)	<0.001
36	23.38 (2.04)	24.04 (2.28)	<0.001	0.10 (0.09)	0.13 (0.10)	<0.001
37	23.48 (2.07)	24.16 (2.33)	<0.001	0.09 (0.09)	0.13 (0.10)	<0.001
38	23.57 (2.11)	24.29 (2.38)	<0.001	0.09 (0.09)	0.12 (0.09)	<0.001
39	23.66 (2.14)	24.41 (2.43)	<0.001	0.09 (0.08)	0.12 (0.09)	<0.001
40	23.75 (2.17)	24.53 (2.47)	<0.001	0.09 (0.08)	0.11 (0.08)	<0.001
41	23.84 (2.20)	24.64 (2.51)	<0.001	0.09 (0.07)	0.11 (0.08)	<0.001
42	23.92 (2.22)	24.75 (2.55)	<0.001	0.08 (0.07)	0.11 (0.07)	<0.001
43	24.01 (2.25)	24.85 (2.58)	<0.001	0.08 (0.07)	0.10 (0.07)	<0.001
44	24.08 (2.27)	24.96 (2.60)	<0.001	0.08 (0.07)	0.10 (0.07)	<0.001
45	24.16 (2.28)	25.05 (2.62)	<0.001	0.08 (0.07)	0.09 (0.07)	<0.001
46	24.24 (2.30)	25.14 (2.64)	<0.001	0.07 (0.07)	0.09 (0.07)	<0.001
47	24.31 (2.31)	25.23 (2.65)	<0.001	0.07 (0.07)	0.09 (0.07)	<0.001

48	24.38 (2.32)	25.32 (2.66)	<0.001	0.07 (0.07)	0.08 (0.07)	<0.001
49	24.45 (2.33)	25.40 (2.66)	<0.001	0.07 (0.07)	0.08 (0.07)	<0.001
50	24.51 (2.33)	25.47 (2.66)	<0.001	0.06 (0.07)	0.07 (0.07)	<0.001
51	24.58 (2.33)	25.54 (2.65)	<0.001	0.06 (0.07)	0.07 (0.07)	<0.001
52	24.64 (2.33)	25.61 (2.64)	<0.001	0.06 (0.07)	0.06 (0.08)	0.008
53	24.69 (2.33)	25.67 (2.62)	<0.001	0.06 (0.07)	0.06 (0.08)	0.075
54	24.75 (2.33)	25.73 (2.60)	<0.001	0.05 (0.08)	0.06 (0.09)	0.316
55	24.80 (2.32)	25.79 (2.58)	<0.001	0.05 (0.08)	0.05 (0.09)	0.766
56	24.85 (2.31)	25.84 (2.56)	<0.001	0.05 (0.08)	0.05 (0.10)	0.737
57	24.90 (2.30)	25.88 (2.53)	<0.001	0.05 (0.09)	0.04 (0.10)	0.367
58	24.95 (2.29)	25.93 (2.50)	<0.001	0.04 (0.09)	0.04 (0.11)	0.159
59	25.00 (2.28)	25.96 (2.48)	<0.001	0.04 (0.10)	0.04 (0.11)	0.063
60	25.03 (2.27)	26.00 (2.45)	<0.001	0.04 (0.10)	0.03 (0.12)	0.023

NTN = normotension; HTN = hypertension.

Table S9. Model-estimated levels and linear slopes of WC in means (SD) by incident hypertension at follow-up

	WC Level (cm)			**WC Slope (cm/year)**		
Age, (years)	NTN	HTN	*P*-Value	NTN	HTN	*P*-Value
20	71.75 (4.90)	71.60 (4.52)	0.271	0.36 (0.50)	0.52 (0.57)	<0.001
21	72.12 (4.80)	72.12 (4.45)	0.997	0.36 (0.48)	0.51 (0.55)	<0.001
22	72.48 (4.75)	72.63 (4.44)	0.272	0.36 (0.46)	0.51 (0.53)	<0.001
23	72.84 (4.73)	73.13 (4.48)	0.032	0.36 (0.45)	0.50 (0.51)	<0.001
24	73.21 (4.76)	73.64 (4.58)	0.002	0.36 (0.43)	0.50 (0.49)	<0.001
25	73.57 (4.81)	74.13 (4.71)	<0.001	0.36 (0.42)	0.49 (0.47)	<0.001
26	73.93 (4.89)	74.63 (4.88)	<0.001	0.36 (0.40)	0.49 (0.45)	<0.001
27	74.30 (5.00)	75.11 (5.06)	<0.001	0.36 (0.38)	0.48 (0.43)	<0.001
28	74.66 (5.12)	75.59 (5.26)	<0.001	0.36 (0.37)	0.48 (0.41)	<0.001
29	75.02 (5.25)	76.07 (5.47)	<0.001	0.36 (0.35)	0.47 (0.39)	<0.001
30	75.38 (5.38)	76.54 (5.68)	<0.001	0.36 (0.34)	0.47 (0.37)	<0.001
31	75.75 (5.25)	77.01 (5.90)	<0.001	0.36 (0.32)	0.46 (0.35)	<0.001
32	76.11 (5.67)	77.47 (6.10)	<0.001	0.36 (0.31)	0.46 (0.33)	<0.001
33	76.47 (5.81)	77.93 (6.30)	<0.001	0.36 (0.29)	0.45 (0.31)	<0.001
34	76.83 (5.95)	78.38 (6.50)	<0.001	0.36 (0.28)	0.45 (0.30)	<0.001
35	77.19 (6.08)	78.83 (6.68)	<0.001	0.36 (0.26)	0.44 (0.28)	<0.001
36	77.55 (6.21)	79.27 (6.85)	<0.001	0.36 (0.25)	0.44 (0.26)	<0.001
37	77.91 (6.33)	79.71 (7.01)	<0.001	0.36 (0.24)	0.43 (0.25)	<0.001
38	78.27 (6.44)	80.14 (7.15)	<0.001	0.36 (0.23)	0.43 (0.23)	<0.001
39	78.63 (6.54)	80.56 (7.28)	<0.001	0.36 (0.22)	0.42 (0.22)	<0.001
40	78.99 (6.63)	80.99 (7.39)	<0.001	0.36 (0.21)	0.42 (0.20)	<0.001
41	79.35 (6.71)	81.40 (7.49)	<0.001	0.36 (0.20)	0.41 (0.19)	<0.001
42	79.71 (6.78)	81.82 (7.58)	<0.001	0.36 (0.19)	0.41 (0.18)	<0.001
43	80.07 (6.83)	82.22 (7.64)	<0.001	0.36 (0.19)	0.40 (0.17)	<0.001
44	80.43 (6.88)	82.62 (7.70)	<0.001	0.36 (0.18)	0.40 (0.17)	<0.001
45	80.79 (6.92)	83.02 (7.73)	<0.001	0.36 (0.18)	0.39 (0.17)	<0.001
46	81.15 (6.94)	83.41 (7.75)	<0.001	0.36 (0.18)	0.39 (0.17)	<0.001
47	81.51 (6.95)	83.80 (7.75)	<0.001	0.36 (0.18)	0.38 (0.17)	<0.001

48	81.87 (6.96)	84.18 (7.74)	<0.001	0.36 (0.19)	0.38 (0.17)	<0.001
49	82.23 (6.95)	84.56 (7.72)	<0.001	0.36 (0.19)	0.37 (0.18)	0.006
50	82.59 (6.93)	84.93 (7.67)	<0.001	0.36 (0.20)	0.37 (0.19)	0.074
51	82.94 (6.90)	85.30 (7.72)	<0.001	0.36 (0.21)	0.36 (0.20)	0.355
52	83.30 (6.86)	85.66 (7.55)	<0.001	0.36 (0.22)	0.36 (0.22)	0.883
53	83.66 (6.81)	86.02 (7.46)	<0.001	0.36 (0.23)	0.35 (0.23)	0.586
54	84.02 (6.76)	86.37 (7.37)	<0.001	0.36 (0.24)	0.35 (0.25)	0.248
55	84.37 (6.70)	86.72 (7.26)	<0.001	0.36 (0.25)	0.34 (0.26)	0.091
56	84.73 (6.63)	87.06 (7.14)	<0.001	0.36 (0.26)	0.34 (0.28)	0.030
57	85.09 (6.56)	87.40 (7.02)	<0.001	0.36 (0.28)	0.33 (0.30)	0.010
58	85.45 (6.48)	87.73 (6.89)	<0.001	0.36 (0.29)	0.33 (0.32)	0.003
59	85.80 (6.41)	88.06 (6.75)	<0.001	0.36 (0.31)	0.32 (0.33)	0.001
60	86.16 (6.34)	88.38 (6.61)	<0.001	0.36 (0.32)	0.32 (0.35)	<0.001

NTN = normotension; HTN = hypertension.