**Supplementary material**

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| **Table S1.** The distribution of ideal CVH metrics. |
| CVH (No.) | N | % |
| 0 | 3 | 0.1 |
| 1 | 96 | 2.9 |
| 2 | 606 | 18.4 |
| 3 | 1091 | 33.2 |
| 4 | 910 | 27.7 |
| 5 | 485 | 14.7 |
| 6 | 100 | 3.0 |
| Notes: CVH, cardiovascular health metrics. |

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| **Table S2.** Average posterior Probabilities and percentages of group assignment, Bayesian information criterion (BIC) statistics of model fit. |
|  | Group1 | Group2 | Group3 | Group4 | Group5 | BIC | 2ΔBIC |
| 2 groups | 0.94 (16.2) | 0.98 (83.8) |  |  |  | -40714.46 | NA |
| 3 groups | 0.89 (3.6) | 0.88 (16.3) | 0.97 (80.1) |  |  | -40450.54 | 527.84 |
| 4 groups | 0.92 (6.6) | 0.83 (11.1) | 0.87 (4.9) | 0.97 (77.4) |  | -39993.29 | 914.50 |
| 5 groups | 0.92 (4.2) | 0.83 (11.4) | 0.93 (3.0) | 0.87 (5.3) | 0.97 (76.1) | -39684.44 | 617.70 |
| Notes: BIC, Bayesian information criterion; NA, not available; 2ΔBIC, twice the difference between the BIC values. |

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| **Table S3.** Sensitivity analysis for risks of abnormal cognitive aging by changing the order of time-varying covariate under interventions. |
| Intervention | Unstable |  | Slow decline |  | Rapid decline |
|  | Risk (95% CI)a | RR (95% CI)b |  | Risk (95% CI)a | RR (95% CI)b |  | Risk (95% CI)a | RR (95% CI)b |
| **Natural coursec** | 5.54 (4.42-6.67) | 1.00 |  | 10.66 (8.96-12.36) | 1.00 |  | 7.37 (6.02-8.72) | 1.00 |
| **Single interventions** |  |  |  |  |  |  |  |  |
| Hypertension | 6.05 (4.19-7.91) | 1.09 (0.88-1.35) |  | 10.01 (7.71-12.30) | 0.94 (0.81-1.09) |  | 6.02 (4.37-7.67) | **0.82 (0.67-0.99)** |
| Diabetes | 5.36 (4.21-6.51) | 0.97 (0.78-1.21) |  | 10.86 (9.25-12.48) | 1.02 (0.88-1.18) |  | 6.62 (5.39-7.86) | 0.90 (0.74-1.09) |
| Exercise | 3.54 (0.22-4.90) | **0.64 (0.50-0.82)** |  | 8.27 (5.75-10.79) | **0.78 (0.66-0.91)** |  | 5.52 (3.76-7.28) | **0.75 (0.61-0.92)** |
| BMI | 3.46 (2.08-4.84) | **0.62 (0.49-0.80)** |  | 9.70 (7.56-11.84) | 0.91 (0.78-1.06) |  | 5.80 (4.28-7.33) | **0.79 (0.65-0.96)** |
| Diet | 2.92 (1.27-4.56) | **0.53 (0.41-0.68)** |  | 6.22 (4.16-8.28) | **0.58 (0.49-0.69)** |  | 4.24 (2.67-5.81) | **0.58 (0.46-0.71)** |
| Smoke | 6.34 (4.89-7.80) | 1.14 (0.93-1.41) |  | 12.33 (10.41-14.26) | **1.16 (1.00-1.33)** |  | 8.69 (7.11-10.27) | 1.18 (0.99-1.41) |
| **Joint interventions** |  |  |  |  |  |  |  |  |
| BMI + Exercise | 2.70 (1.35-4.05) | **0.49 (0.38-0.63)** |  | 7.24 (4.55-9.94) | **0.68 (0.58-0.80)** |  | 4.38 (2.59-6.17) | **0.59 (0.48-0.74)** |
| Diet + BMI | 2.66 (1.28-4.05) | **0.48 (0.37-0.62)** |  | 6.29 (4.24-8.33) | **0.59 (0.50-0.70)** |  | 3.45 (1.80-5.10) | **0.47 (0.37-0.59)** |
| Diet + Exercise | 1.90 (0.58-3.22) | **0.34 (0.26-0.46)** |  | 4.82 (2.85-6.78) | **0.45 (0.38-0.55)** |  | 3.24 (1.67-4.81) | **0.44 (0.35-0.56)** |
| Diet + BMI + Exercise | 1.60 (0.50-2.71) | **0.29 (0.21-0.39)** |  | 4.33 (2.28-6.40) | **0.41 (0.34-0.49)** |  | 3.06 (1.64-4.49) | **0.42 (0.33-0.53)** |
| **Note:** RR, risk ratio; BMI, body mass index.The order of time-varying covariate in this analysis was diabetes, exercise, BMI, smoke, diet, hypertension, social engagement, social support, psychological resilience.a The observed risks of “Unstable”, “Slow decline”, “Rapid decline” trajectory groups are 5.58%, 11.51%, 7.76%.b Estimated using the parametric g-formula with fixed covariates: age, sex, education status, marriage status, living arrangement; and time-varying covariates: hypertension, diabetes, exercise, BMI, diet, smoke, psychological resilience, social support, and social engagement.c As simulated under no intervention. |

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| **Table S4.** Sensitivity analysis for risks of abnormal cognitive aging by changing the order of time-varying covariate under interventions. |
| Intervention | Unstable |  | Slow decline |  | Rapid decline |
|  | Risk (95% CI)a | RR (95% CI)b |  | Risk (95% CI)a | RR (95% CI)b |  | Risk (95% CI)a | RR (95% CI)b |
| **Natural coursec** | 5.54 (4.39-6.69) | 1.00 |  | 10.38 (8.74-12.03) | 1.00 |  | 7.62 (6.28-8.96) | 1.00 |
| **Single interventions** |  |  |  |  |  |  |  |  |
| Hypertension | 6.81 (5.01-8.63) | 1.23 (1.00-1.51) |  | 10.39 (8.05-12.73) | 1.00 (0.86-1.17) |  | 6.23 (4.58-7.88) | **0.82 (0.67-0.99)** |
| Diabetes | 5.47 (4.23-6.70) | 0.99 (0.79-1.23) |  | 10.66 (8.94-12.38) | 1.03 (0.88-1.20) |  | 7.09 (5.87-8.31) | 0.93 (0.77-1.12) |
| Exercise | 3.39 (1.99-4.79) | **0.61 (0.48-0.79)** |  | 8.40 (5.89-10.92) | **0.81 (0.69-0.95)** |  | 5.24 (3.48-6.99) | **0.69 (0.56-0.84)** |
| BMI | 3.65 (2.27-5.02) | **0.66 (0.52-0.84)** |  | 9.81 (7.70-11.91) | 0.95 (0.81-1.11) |  | 5.66 (4.16-7.16) | **0.74 (0.61-0.91)** |
| Diet | 3.03 (1.43-4.62) | **0.55 (0.42-0.71)** |  | 6.80 (4.75-8.85) | **0.66 (0.55-0.78)** |  | 4.34 (2.74-5.95) | **0.57 (0.46-0.70)** |
| Smoke | 5.03 (3.63-6.43) | 0.91 (0.73-1.14) |  | 12.06 (10.20-13.92) | **1.16 (1.00-1.35)** |  | 8.55 (6.96-10.14) | 1.12 (0.94-1.34) |
| **Joint interventions** |  |  |  |  |  |  |  |  |
| BMI + Exercise | 2.81 (1.45-4.16) | **0.51 (0.39-0.66)** |  | 7.55 (4.84-10.26) | **0.73 (0.61-0.86)** |  | 4.27 (2.46-6.09) | **0.56 (0.45-0.69)** |
| Diet + BMI | 2.84 (1.44-4.25) | **0.51 (0.39-0.67)** |  | 6.25 (4.20-8.31) | **0.60 (0.50-0.72)** |  | 3.49 (1.83-5.15) | **0.46 (0.37-0.57)** |
| Diet + Exercise | 2.04 (0.73-3.35) | **0.37 (0.28-0.49)** |  | 4.65 (2.62-6.68) | **0.45 (0.37-0.54)** |  | 3.21 (1.64-4.77) | **0.42 (0.33-0.53)** |
| Diet + BMI + Exercise | 1.60 (0.51-2.70) | **0.29 (0.21-0.39)** |  | 4.61 (2.60-6.62) | **0.44 (0.37-0.54)** |  | 2.99 (1.53-4.45) | **0.39 (0.31-0.50)** |
| **Note:** RR, risk ratio; BMI, body mass index.The order of time-varying covariate in this analysis was diet, exercise, BMI, hypertension, smoke, diabetes, social engagement, psychological resilience, social support.a The observed risks for “Unstable”, “Slow decline”, “Rapid decline” trajectory groups are 5.58%, 11.51%, 7.76%.b Estimated using the parametric g-formula with fixed covariates: age, sex, education status, marriage status, living arrangement; and time-varying covariates: hypertension, diabetes, exercise, BMI, diet, smoke, psychological resilience, social support, and social engagement.c As simulated under no intervention. |

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| **Table S5.** Sensitivity analysis for risks of abnormal cognitive aging by changing the order of time-varying covariate under interventions. |
| Intervention | Unstable |  | Slow decline |  | Rapid decline |
|  | Risk (95% CI)a | RR (95% CI)b |  | Risk (95% CI)a | RR (95% CI)b |  | Risk (95% CI)a | RR (95% CI)b |
| **Natural coursec** | 5.36 (4.23-6.48) | 1.00 |  | 10.63 (8.95-12.30) | 1.00 |  | 7.73 (6.39-9.07) | 1.00 |
| **Single interventions** |  |  |  |  |  |  |  |  |
| Hypertension | 6.53 (4.73-8.32) | 1.22 (0.99-1.50) |  | 10.39 (8.01-12.76) | 0.98 (0.84-1.14) |  | 6.34 (4.71-7.97) | **0.82 (0.68-0.99)** |
| Diabetes | 5.61 (4.38-6.85) | 1.05 (0.84-1.30) |  | 10.83 (9.13-12.53) | 1.02 (0.88-1.18) |  | 7.16 (5.91-8.40) | 0.93 (0.77-1.11) |
| Exercise | 3.46 (2.05-4.87) | **0.65 (0.50-0.83)** |  | 8.40 (5.85-10.95) | **0.79 (0.67-0.93)** |  | 5.16 (3.41-6.92) | **0.67 (0.55-0.82)** |
| BMI | 3.57 (2.21-4.94) | **0.67 (0.52-0.85)** |  | 9.91 (7.76-12.05) | 0.93 (0.80-1.08) |  | 5.80 (4.32-7.29) | **0.75 (0.62-0.91)** |
| Diet | 3.17 (1.57-4.78) | **0.59 (0.46-0.76)** |  | 6.18 (4.16-8.21) | **0.58 (0.49-0.69)** |  | 4.06 (2.45-5.67) | **0.53 (0.42-0.65)** |
| Smoke | 5.14 (3.75-6.53) | 0.96 (0.77-1.20) |  | 12.09 (10.26-13.93) | 1.14 (0.99-1.31) |  | 8.44 (6.85-10.03) | 1.09 (0.92-1.30) |
| **Joint interventions** |  |  |  |  |  |  |  |  |
| BMI + Exercise | 2.77 (1.41-4.13) | **0.52 (0.40-0.67)** |  | 7.62 (4.91-10.32) | **0.72 (0.61-0.84)** |  | 4.27 (2.47-6.08) | **0.55 (0.45-0.68)** |
| Diet + BMI | 2.73 (1.33-4.14) | **0.51 (0.39-0.67)** |  | 6.66 (4.60-8.72) | **0.63 (0.53-0.74)** |  | 3.77 (2.13-5.42) | **0.49 (0.39-0.61)** |
| Diet + Exercise | 2.15 (0.83-3.47) | **0.40 (0.30-0.53)** |  | 4.82 (2.80-6.84) | **0.45 (0.38-0.55)** |  | 3.21 (1.64-4.77) | **0.42 (0.33-0.52)** |
| Diet + BMI + Exercise | 1.71 (0.62-2.80) | **0.32 (0.23-0.43)** |  | 4.37 (2.33-6.41) | **0.41 (0.34-0.50)** |  | 2.88 (1.43-4.34) | **0.37 (0.29-0.47)** |
| **Note:** RR, risk ratio; BMI, body mass index.The order of time-varying covariate in this analysis was diet, exercise, BMI, hypertension, smoke, diabetes, social engagement, social support, psychological resilience.a The observed risks for “Unstable”, “Slow decline”, “Rapid decline” trajectory groups are 5.58%, 11.51%, 7.76%.b Estimated using the parametric g-formula with fixed covariates: age, sex, education status, marriage status, living arrangement; and time-varying covariates: hypertension, diabetes, exercise, BMI, diet, smoke, psychological resilience, social support, and social engagement.c As simulated under no intervention. |

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| **Table S6.** Sensitivity analysis for risks of abnormal cognitive aging by changing the order of time-varying covariate under interventions. |
| Intervention | Unstable |  | Slow decline |  | Rapid decline |
|  | Risk (95% CI)a | RR (95% CI)b |  | Risk (95% CI)a | RR (95% CI)b |  | Risk (95% CI)a | RR (95% CI)b |
| **Natural coursec** | 5.61 (4.49-6.74) | 1.00 |  | 10.86 (9.17-12.56) | 1.00 |  | 7.69 (6.36-9.02) | 1.00 |
| **Single interventions** |  |  |  |  |  |  |  |  |
| Hypertension | 6.56 (4.77-8.35) | 1.17 (0.95-1.44) |  | 9.91 (7.60-12.21) | 0.91 (0.78-1.06) |  | 5.91 (4.28-7.54) | **0.77 (0.63-0.93)** |
| Diabetes | 5.54 (4.40-6.69) | 0.99 (0.79-1.23) |  | 11.10 (9.47-12.74) | 1.02 (0.88-1.18) |  | 6.80 (5.54-8.06) | 0.88 (0.73-1.07) |
| Exercise | 3.06 (1.59-4.53) | **0.55 (0.42-0.70)** |  | 8.03 (5.48-10.58) | **0.74 (0.63-0.87)** |  | 5.80 (4.02-7.59) | **0.75 (0.62-0.92)** |
| BMI | 4.23 (2.83-5.63) | **0.75 (0.60-0.95)** |  | 9.77 (7.71-11.84) | 0.90 (0.77-1.05) |  | 5.73 (4.25-7.22) | **0.75 (0.61-0.91)** |
| Diet | 3.03 (1.39-4.66) | **0.54 (0.42-0.70)** |  | 6.05 (3.99-8.10) | **0.56 (0.47-0.66)** |  | 4.27 (2.74-5.81) | **0.56 (0.45-0.69)** |
| Smoke | 6.09 (4.58-7.59) | 1.09 (0.88-1.34) |  | 12.09 (10.08-14.10) | 1.11 (0.97-1.28) |  | 8.62 (7.07-10.17) | 1.12 (0.94-1.34) |
| **Joint interventions** |  |  |  |  |  |  |  |  |
| BMI + Exercise | 2.84 (1.50-4.19) | **0.51 (0.39-0.66)** |  | 7.00 (4.32-9.69) | **0.64 (0.55-0.76)** |  | 4.49 (2.74-6.24) | **0.58 (0.47-0.72)** |
| Diet + BMI | 2.59 (1.19-3.99) | **0.46 (0.35-0.60)** |  | 6.52 (4.45-8.61) | **0.60 (0.51-0.71)** |  | 3.49 (1.88-5.10) | **0.45 (0.36-0.57)** |
| Diet + Exercise | 1.93 (0.60-3.26) | **0.34 (0.26-0.46)** |  | 4.99 (2.99-6.99) | **0.46 (0.38-0.55)** |  | 3.06 (1.50-4.63) | **0.40 (0.31-0.50)** |
| Diet + BMI + Exercise | 1.68 (0.58-2.77) | **0.30 (0.22-0.41)** |  | 4.51 (2.46-6.56) | **0.42 (0.34-0.50)** |  | 2.81 (1.39-4.23) | **0.37 (0.29-0.46)** |
| **Note:** CVH, cardiovascular health metrics; BMI, body mass index.The order of time-varying covariate in this analysis was hypertension, diabetes, exercise, BMI, diet, smoke, social engagement, social support, psychological resilience.a The observed risks for “Unstable”, “Slow decline”, “Rapid decline” trajectory groups are 5.58%, 11.51%, 7.76%.b Estimated using the parametric g-formula with fixed covariates: age, sex, education status, marriage status, living arrangement; and time-varying covariates: hypertension, diabetes, exercise, BMI, diet, smoke, psychological resilience, social support, and social engagement.c As simulated under no intervention. |

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| **Table S7.** Sensitivity analysis for risks of abnormal cognitive aging by changing the order of time-varying covariate under interventions. |
| Intervention | Unstable |  | Slow decline |  | Rapid decline |
|  | Risk (95% CI)a | RR (95% CI)b |  | Risk (95% CI)a | RR (95% CI)b |  | Risk (95% CI)a | RR (95% CI)b |
| **Natural coursec** | 5.80 (4.64-6.95) | 1.00 |  | 10.45 (8.80-12.11) | 1.00 |  | 7.41 (6.09-8.72) | 1.00 |
| **Single interventions** |  |  |  |  |  |  |  |  |
| Hypertension | 6.49 (4.68-8.30) | 1.12 (0.91-1.38) |  | 10.35 (8.07-12.64) | 0.99 (0.85-1.15) |  | 6.23 (4.58-7.88) | 0.84 (0.69-1.02) |
| Diabetes | 5.18 (4.04-6.31) | 0.89 (0.72-1.11) |  | 11.14 (9.47-12.80) | 1.07 (0.92-1.24) |  | 7.02 (5.77-8.26) | 0.95 (0.79-1.11) |
| Exercise | 3.10 (1.65-4.54) | **0.53 (0.41-0.69)** |  | 7.99 (5.48-10.51) | **0.76 (0.65-0.90)** |  | 5.27 (3.53-7.01) | **0.71 (0.58-0.87)** |
| BMI | 4.30 (2.92-5.69) | **0.74 (0.59-0.93)** |  | 9.87 (7.81-11.94) | 0.94 (0.81-1.10) |  | 5.34 (3.83-6.86) | **0.72 (0.59-0.88)** |
| Diet | 3.03 (1.39-4.66) | **0.52 (0.40-0.67)** |  | 6.66 (4.61-8.71) | **0.64 (0.54-0.76)** |  | 4.34 (2.72-5.97) | **0.59 (0.47-0.73)** |
| Smoke | 5.87 (4.37-7.37) | 1.01 (0.82-1.25) |  | 11.89 (9.92-13.86) | 1.14 (0.98-1.31) |  | 8.51 (6.94-10.09) | 1.15 (0.96-1.37) |
| **Joint interventions** |  |  |  |  |  |  |  |  |
| BMI + Exercise | 2.81 (1.45-4.16) | **0.48 (0.37-0.63)** |  | 7.21 (4.47-9.94) | **0.69 (0.58-0.81)** |  | 4.49 (2.74-6.24) | **0.61 (0.49-0.75)** |
| Diet + BMI | 2.59 (1.20-3.97) | **0.45 (0.34-0.58)** |  | 6.22 (4.13-8.30) | **0.60 (0.50-0.71)** |  | 3.60 (1.99-5.21) | **0.49 (0.39-0.61)** |
| Diet + Exercise | 2.01 (0.67-3.34) | **0.35 (0.26-0.46)** |  | 4.92 (2.90-6.94) | **0.47 (0.39-0.57)** |  | 3.21 (1.64-4.77) | **0.43 (0.34-0.55)** |
| Diet + BMI + Exercise | 1.68 (0.59-2.76) | **0.29 (0.21-0.39)** |  | 4.82 (2.79-6.94) | **0.46 (0.38-0.56)** |  | 2.71 (1.27-4.15) | **0.37 (0.29-0.47)** |
| **Note:** CVH, cardiovascular health metrics; BMI, body mass index.The order of time-varying covariate in this analysis was hypertension, diabetes, exercise, BMI, diet, smoke, social engagement, psychological resilience, social support.a The observed risks for “Unstable”, “Slow decline”, “Rapid decline” trajectory groups are 5.58%, 11.51%, 7.76%.b Estimated using the parametric g-formula with fixed covariates: age, sex, education status, marriage status, living arrangement; and time-varying covariates: hypertension, diabetes, exercise, BMI, diet, smoke, psychological resilience, social support, and social engagement.c As simulated under no intervention. |