

Supplementary Information

Supplementary Table 1. Definition of five predefined vitality patterns over 20 years.

Predefined vitality patterns over 20 years

Vitality pattern ^a	Vitality Status (Rounds t1-t5)				
	t1	t2	t3	t4	t5
Persistent good	Good	Good	Good	Good	Good
Persistent poor	Poor	Poor/Good/Missing	Poor	Poor	Poor
	Poor	Poor	Poor/Good/Missing	Poor	Poor
	Poor	Poor	Poor	Poor/Good/Missing	Poor
Improving	Poor	Poor/Good/Missing	Good	Good	Good
	Poor	Poor	Poor/Good/Missing	Good	Good
	Poor	Poor	Poor	Poor/Good/Missing	Good
Worsening	Good	Poor/Good/Missing	Poor	Poor	Poor
	Good	Good	Poor/Good/Missing	Poor	Poor
	Good	Good	Good	Poor/Good/Missing	Poor
Varying	Changing (at least 2 changes from Poor/Good or vice versa, and not in other subgroups)				

a. Vitality status is defined as good when SF-36 vitality subdomain score > 50 and as poor when SF-36 vitality subdomain score ≤ 50.

Supplementary Methods 1. R script for determining the model with the optimal number of classes.

Fit an LCMM with 1 latent class and use a natural spline with 3 degrees of freedom for time, this model will be used for the starting values of the models with more than 1 class

```
lcmm_continuous_1class <- lcmm(
  fixed = vitality ~ ns(time, df = 3), # Use a natural spline with 3 degrees of freedom for 'time'
  random = ~ time,                    # Random intercept and slope per individual
  subject = "ID",                     # ID variable for individuals
  ng = 1,                             # Number of latent classes (1 in this case)
  link = "linear",                     # Link between the continuous outcome and latent classes
  data = dataset                       # The dataset
)
```

Define the number of latent classes to test (2 to 10)

```
classes <- 2:10
```

Fit an LCMM for different numbers of latent classes (2 to 10)

```
lcmm_continuous_class_list <- lapply(classes, function(i) {
  lcmm(
    fixed = vitality ~ ns(time, df = 3), # Use a natural spline with 3 degrees of freedom for 'time'
    random = ~ time,                    # Random intercept and slope per individual
    mixture = ~ ns(time, df = 3),       # The effect that distinguishes latent classes (here, the whole trajectory)
    subject = "ID",                     # ID variable for individuals
    ng = i,                             # Number of latent classes (varies from 2 to 10)
    B = lcmm_continuous_1class,         # Starting values from the model with 1 latent class
    link = "linear",                     # Link between the continuous outcome and latent classes
    data = dataset                       # The dataset
  )
})
```

Supplementary Table 2. Bayesian Information Criteria (BIC) of fitting 1-10 classes for a model with a natural spline (df = 3), random intercept and slope.

Number of classes	BIC
1	118,014.2
2	117,848.1
3	117,645.8
4	117,507.8
5	117,369.9
6	117,264.9
7	117,304.9
8	117,345.0
9	117,530.1
10	117,282.6

Supplementary Table 3. Random effect parameters of the optimal model with 6 classes.

<i>Random effects</i>	
Intercept variance (Var(ID))	1.07081
Slope variance (Var(time))	0.02221
Covariance of intercept and slope (Cov(ID, time))	-0.07131

Supplementary Table 4. Associations of baseline (t1) sociodemographic, lifestyle and health characteristics with 20-year predefined vitality patterns relative to the persistent good vitality pattern assessed with a multivariate multinomial logistic regression model.

Baseline (t1) Predefined patterns	Persistent Poor Vitality		Worsening Vitality		Improving Vitality		Varying	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Sex								
<i>Female</i>	0.91	(0.41-2.0)	1.98	(1.07-3.66)	1.08	(0.62-1.87)	1.53	(1.06-2.21)
Age								
<i>t1: 41-55 years</i>	0.51	(0.29-0.90)	0.68	(0.43-1.08)	0.75	(0.51-1.13)	0.78	(0.60-1.01)
<i>t1: 56-70 years</i>	0.20	(0.07-0.55)	1.64	(0.88-3.06)	0.38	(0.19-0.78)	0.58	(0.38-0.90)
Education								
<i>Intermediate education</i>	0.69	(0.37-1.27)	0.81	(0.51-1.30)	1.01	(0.66-1.55)	0.90	(0.68-1.18)
<i>High education</i>	0.88	(0.44-1.77)	1.13	(0.70-1.82)	1.45	(0.93-2.26)	1.09	(0.82-1.46)
Household status								
<i>Not living with a partner</i>	1.45	(0.73-2.88)	1.40	(0.79-2.47)	1.96	(1.20-3.18)	1.50	(1.05-2.15)
Work status								
<i>Unemployed</i>	1.57	(0.88-2.80)	1.08	(0.68-1.72)	1.32	(0.85-2.05)	1.07	(0.80-1.42)
Smoking								
<i>Smoker</i>	0.97	(0.55-1.71)	1.59	(1.03-2.47)	1.20	(0.80-1.80)	1.51	(1.16-1.97)
Alcohol consumption								
<i>More than 1 glass alcohol per day</i>	0.71	(0.39-1.30)	1.24	(0.82-1.88)	0.85	(0.57-1.25)	0.86	(0.67-1.11)
Sleep								
<i>Short sleeper (6h or less)</i>	2.03	(0.61-6.81)	1.66	(0.52-5.33)	2.33	(0.84-6.43)	1.75	(0.77-3.96)
<i>Long sleeper (9h or more)</i>	0.42	(0.24-0.73)	0.67	(0.46-0.99)	0.66	(0.46-0.95)	0.91	(0.72-1.14)
Physical activity								
<i>Nonadherence to guidelines</i>	1.74	(1.06-2.85)	0.90	(0.62-1.32)	1.38	(0.98-1.95)	1.02	(0.81-1.27)
BMI								
<i>Overweight</i>	0.80	(0.46-1.40)	0.97	(0.63-1.49)	1.24	(0.85-1.80)	1.20	(0.94-1.54)
<i>Obesity</i>	0.66	(0.27-1.61)	2.18	(1.24-3.81)	0.79	(0.39-1.61)	1.13	(0.75-1.71)
Chronic disease								
<i>Chronic disease</i>	3.07	(1.81-5.21)	1.50	(0.95-2.37)	1.33	(0.86-2.04)	1.30	(0.97-1.75)
Pain								
<i>Pain (score <62)</i>	3.05	(1.76-5.29)	1.49	(0.95-2.33)	2.07	(1.40-3.07)	1.51	(1.15-1.98)
Physical functioning								
<i>Physical limitation (score <83)</i>	3.12	(1.76-5.54)	1.34	(0.81-2.22)	1.92	(1.23-3.00)	1.68	(1.24-2.29)
Mental health								
<i>Poor mental health (score ≤60)</i>	51.99	(29.32-92.19)	2.15	(1.07-4.32)	20.84	(13.60-31.92)	6.12	(4.21-8.88)
Lung function								
<i>FEV₁ (L)</i>	1.13	(0.46-2.79)	0.94	(0.48-1.87)	0.96	(0.52-1.78)	0.73	(0.49-1.09)
<i>FVC (L)</i>	0.74	(0.35-1.56)	1.08	(0.63-1.86)	1.08	(0.66-1.78)	1.11	(0.81-1.54)

A multivariate multinomial model was fitted for variables at baseline (t1), including all variables. Reference groups were set to: male; t1: 26-40 years & t5:45-60 years; employed; low educational level; moderate sleep; normal/low BMI; living with a partner; employed; non-smoker; conforming to physical activity guidelines; no chronic disease; pain scale ≥ 62; physical scale ≥ 83; mental health scale > 60; alcohol consumption of ≤1 alcoholic beverage a day. Persistent good vitality was used as a reference for the other long-term vitality patterns. Statistical significance is displayed in bold.

Supplementary Table 5. Associations of follow-up (t5) sociodemographic, lifestyle and health characteristics with 20-year predefined vitality patterns relative to the persistent good vitality pattern assessed with a multivariate multinomial logistic regression model.

Follow-up (t5) Predefined patterns	Persistent Poor Vitality		Worsening Vitality		Improving Vitality		Varying	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Sex								
<i>Female</i>	1.00	(0.49-2.04)	1.16	(0.60-2.25)	1.56	(0.95-2.58)	1.48	(1.04-2.11)
Age								
<i>t1: 41-55 years</i>	0.37	(0.20-0.70)	0.50	(0.27-0.96)	0.78	(0.49-1.26)	0.78	(0.56-1.09)
<i>t1: 56-70 years</i>	0.08	(0.03-0.25)	0.76	(0.32-1.82)	0.40	(0.18-0.88)	0.49	(0.29-0.84)
Education								
<i>Intermediate education</i>	0.57	(0.31-1.04)	1.23	(0.72-2.12)	0.98	(0.64-1.50)	0.92	(0.69-1.23)
<i>High education</i>	0.86	(0.47-1.57)	1.28	(0.72-2.27)	1.38	(0.92-2.08)	0.90	(0.67-1.22)
Household status								
<i>Not living with a partner</i>	1.21	(0.69-2.11)	1.04	(0.62-1.77)	1.50	(1.01-2.21)	1.17	(0.87-1.56)
Work status								
<i>Unemployed</i>	1.55	(0.83-2.90)	0.93	(0.50-1.73)	1.51	(0.96-2.36)	1.02	(0.74-1.40)
Smoking								
<i>Smoker</i>	1.05	(0.50-2.22)	1.35	(0.65-2.82)	1.49	(0.86-2.56)	1.58	(1.07-2.33)
Alcohol consumption								
<i>More than 1 glass alcohol per day</i>	0.88	(0.50-1.55)	0.88	(0.51-1.50)	1.07	(0.75-1.54)	0.82	(0.63-1.07)
Sleep								
<i>Short sleeper (6h or less)</i>	1.83	(0.72-4.64)	2.15	(0.91-5.10)	0.86	(0.32-2.31)	0.88	(0.46-1.70)
<i>Long sleeper (9h or more)</i>	0.63	(0.37-1.07)	0.67	(0.41-1.09)	0.79	(0.56-1.11)	0.70	(0.54-0.89)
Physical activity								
<i>Nonadherence to guidelines</i>	1.57	(0.97-2.54)	1.58	(1.01-2.47)	1.72	(1.23-2.40)	1.33	(1.05-1.69)
BMI								
<i>Overweight</i>	0.83	(0.47-1.48)	0.52	(0.30-0.90)	1.02	(0.70-1.47)	1.07	(0.82-1.39)
<i>Obesity</i>	1.19	(0.61-2.32)	1.06	(0.59-1.92)	1.11	(0.66-1.84)	1.15	(0.81-1.64)
Chronic disease								
<i>Chronic disease</i>	2.80	(1.68-4.65)	1.65	(1.02-2.67)	1.28	(0.89-1.84)	1.65	(1.28-2.12)
Pain								
<i>Pain (score <62)</i>	2.70	(1.57-4.64)	3.08	(1.85-5.12)	1.63	(1.12-2.38)	2.06	(1.58-2.68)
Physical functioning								
<i>Physical limitation (score <83)</i>	4.20	(2.35-7.49)	3.86	(2.23-6.67)	1.25	(0.81-1.92)	1.39	(1.04-1.87)
Mental health								
<i>Poor mental health (score ≤60)</i>	51.34	(27.96-94.28)	24.52	(13.42-44.81)	3.40	(1.68-6.87)	9.50	(5.91-15.28)
Lung function								
<i>FEV₁ (L)</i>	1.01	(0.44-2.33)	1.75	(0.75-4.09)	1.13	(0.64-2.00)	0.84	(0.57-1.26)
<i>FVC (L)</i>	0.96	(0.48-1.91)	0.54	(0.27-1.09)	1.07	(0.67-1.69)	1.09	(0.79-1.51)

A multivariate multinomial model was fitted for variables at follow-up (t5), including all variables. Reference groups were set to: male; t1: 26-40 years & t5:45-60 years; employed; low educational level; moderate sleep; normal/low BMI; living with a partner; employed; non-smoker; conforming to physical activity guidelines; no chronic disease; pain scale ≥ 62 ; physical scale ≥ 83 ; mental health scale > 60 ; alcohol consumption of ≤ 1 alcoholic beverage a day. Persistent good vitality was used as a reference for the other long-term vitality patterns.

Supplementary Table 6. Associations of follow-up (t5) sociodemographic, lifestyle and health characteristics with 20-year data-driven patterns relative to the persistent good vitality pattern assessed with a multivariate multinomial logistic regression model.

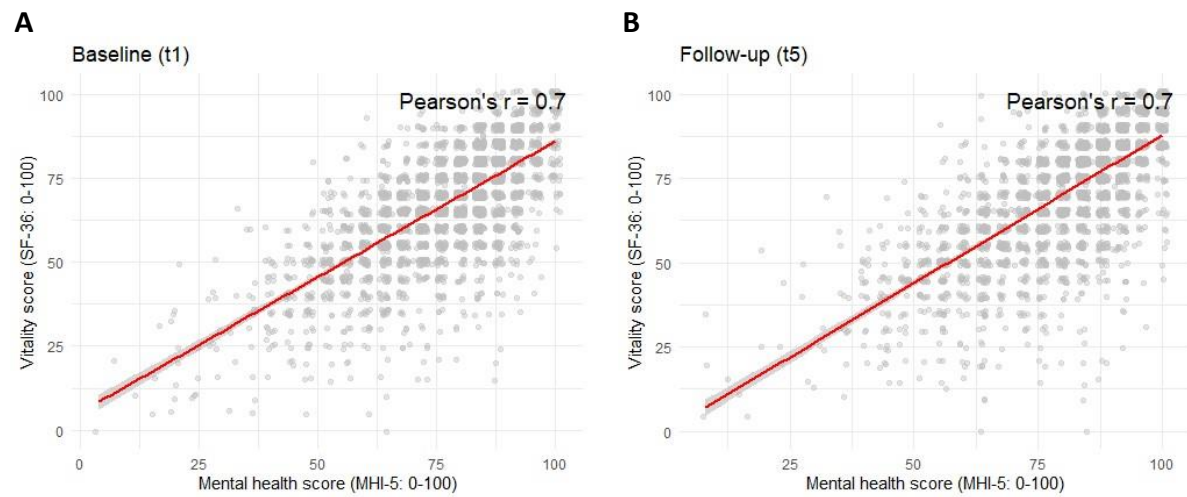
Baseline (t1) Data-driven patterns	Persistent Poor Vitality		Worsening Vitality		Improving Vitality		Varying	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Sex								
<i>Female</i>	1.20	(0.72-2.02)	1.59	(0.78-3.24)	1.48	(0.65-3.39)	1.04	(0.58-1.85)
Age								
<i>t1: 41-55 years</i>	0.63	(0.44-0.91)	0.42	(0.24-0.72)	0.71	(0.40-1.27)	0.56	(0.37-0.84)
<i>t1: 56-70 years</i>	0.42	(0.22-0.78)	1.28	(0.64-2.56)	0.30	(0.08-1.16)	0.51	(0.26-1.02)
Education								
<i>Intermediate education</i>	0.79	(0.53-1.18)	0.87	(0.51-1.47)	1.41	(0.76-2.60)	0.66	(0.43-1.03)
<i>High education</i>	1.37	(0.90-2.08)	1.09	(0.61-1.93)	1.34	(0.66-2.72)	0.81	(0.50-1.29)
Household status								
<i>Not living with a partner</i>	1.58	(1.02-2.45)	1.28	(0.69-2.36)	2.20	(1.15-4.22)	1.20	(0.69-2.10)
Work status								
<i>Unemployed</i>	1.19	(0.81-1.74)	1.09	(0.64-1.86)	0.52	(0.25-1.07)	0.68	(0.42-1.09)
Smoking								
<i>Smoker</i>	1.31	(0.91-1.89)	1.41	(0.86-2.31)	1.27	(0.71-2.27)	1.20	(0.79-1.80)
Alcohol consumption								
<i>More than 1 glass alcohol per day</i>	0.78	(0.53-1.14)	1.67	(1.03-2.70)	0.81	(0.45-1.46)	1.01	(0.67-1.51)
Sleep								
<i>Short sleeper (6h or less)</i>	1.57	(0.66-3.72)	2.73	(1.02-7.27)	3.83	(1.22-12.05)	1.23	(0.36-4.23)
<i>Long sleeper (9h or more)</i>	0.66	(0.47-0.92)	0.65	(0.41-1.03)	1.02	(0.60-1.74)	0.92	(0.64-1.32)
Physical activity								
<i>Nonadherence to guidelines</i>	1.11	(0.80-1.53)	0.86	(0.55-1.34)	1.25	(0.74-2.11)	0.94	(0.65-1.34)
BMI								
<i>Overweight</i>	1.12	(0.78-1.61)	0.76	(0.46-1.27)	1.87	(1.07-3.25)	1.15	(0.77-1.70)
<i>Obesity</i>	1.49	(0.87-2.54)	1.45	(0.72-2.92)	0.71	(0.20-2.48)	1.43	(0.78-2.63)
Chronic disease								
<i>Chronic disease</i>	2.02	(1.41-2.88)	1.48	(0.88-2.48)	1.36	(0.74-2.50)	1.38	(0.89-2.16)
Pain								
<i>Pain (score <62)</i>	2.53	(1.78-3.60)	1.55	(0.94-2.58)	2.42	(1.36-4.31)	1.61	(1.06-2.44)
Physical functioning								
<i>Physical limitation (score <83)</i>	2.16	(1.48-3.14)	1.35	(0.77-2.36)	1.93	(1.03-3.60)	1.12	(0.69-1.83)
Mental health								
<i>Poor mental health (score ≤60)</i>	8.17	(5.82-11.47)	2.79	(1.63-4.76)	9.33	(5.43-16.05)	1.57	(0.94-2.63)
Lung function								
<i>FEV₁ (L)</i>	1.01	(0.57-1.81)	1.16	(0.51-2.63)	2.19	(0.84-5.74)	0.86	(0.45-1.64)
<i>FVC (L)</i>	0.94	(0.58-1.52)	0.81	(0.41-1.57)	0.65	(0.29-1.44)	0.84	(0.50-1.43)

A multivariate multinomial model was fitted for variables at baseline (t1), including all variables. Reference groups were set to: male; t1: 26-40 years & t5:45-60 years; employed; low educational level; moderate sleep; normal/low BMI; living with a partner; employed; non-smoker; conforming to physical activity guidelines; no chronic disease; pain scale ≥ 62; physical scale ≥ 83; mental health scale > 60; alcohol consumption of ≤1 alcoholic beverage a day. Persistent good vitality was used as a reference for the other long-term vitality patterns.

Supplementary Table 7. Associations of follow-up (t5) sociodemographic, lifestyle and health characteristics with 20-year data-driven patterns relative to the persistent good vitality pattern assessed with a multivariate multinomial logistic regression model.

Follow-up (t5) Data-driven patterns	Persistent Poor Vitality		Worsening Vitality		Improving Vitality		Varying	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Sex								
<i>Female</i>	0.88	(0.55-1.40)	0.59	(0.28-1.21)	2.25	(0.99-5.15)	0.85	(0.49-1.48)
Age								
<i>t1: 41-55 years</i>	0.53	(0.35-0.82)	0.34	(0.17-0.69)	0.71	(0.35-1.46)	0.53	(0.32-0.87)
<i>t1: 56-70 years</i>	0.20	(0.10-0.41)	0.63	(0.26-1.56)	0.29	(0.07-1.18)	0.25	(0.10-0.59)
Education								
<i>Intermediate education</i>	0.72	(0.49-1.06)	1.02	(0.56-1.84)	1.83	(0.94-3.57)	0.80	(0.51-1.24)
<i>High education</i>	0.97	(0.65-1.45)	1.36	(0.73-2.53)	1.47	(0.72-3.01)	0.75	(0.47-1.22)
Household status								
<i>Not living with a partner</i>	1.45	(1.01-2.10)	1.27	(0.74-2.18)	1.67	(0.93-3.01)	1.40	(0.91-2.15)
Work status								
<i>Unemployed</i>	1.43	(0.94-2.18)	1.83	(0.91-3.69)	2.25	(1.13-4.49)	1.07	(0.65-1.75)
Smoking								
<i>Smoker</i>	1.17	(0.72-1.91)	1.17	(0.55-2.49)	1.13	(0.48-2.63)	0.95	(0.53-1.72)
Alcohol consumption								
<i>More than 1 glass alcohol per day</i>	0.79	(0.54-1.15)	0.62	(0.33-1.16)	1.41	(0.81-2.45)	0.80	(0.52-1.24)
Sleep								
<i>Short sleeper (6h or less)</i>	1.54	(0.79-3.01)	1.38	(0.56-3.42)	0.50	(0.07-3.80)	0.87	(0.33-2.34)
<i>Long sleeper (9h or more)</i>	0.78	(0.55-1.10)	0.59	(0.33-1.05)	1.09	(0.64-1.87)	0.87	(0.59-1.29)
Physical activity								
<i>Nonadherence to guidelines</i>	1.69	(1.23-2.32)	2.18	(1.32-3.58)	1.33	(0.78-2.27)	1.20	(0.82-1.75)
BMI								
<i>Overweight</i>	1.03	(0.71-1.50)	0.85	(0.48-1.52)	1.12	(0.63-1.99)	0.90	(0.58-1.38)
<i>Obesity</i>	1.15	(0.74-1.81)	0.94	(0.48-1.85)	0.67	(0.27-1.66)	1.11	(0.66-1.89)
Chronic disease								
<i>Chronic disease</i>	1.64	(1.17-2.30)	1.22	(0.72-2.08)	0.93	(0.51-1.70)	1.57	(1.05-2.34)
Pain								
<i>Pain (score <62)</i>	2.03	(1.42-2.89)	3.36	(1.91-5.93)	1.01	(0.54-1.90)	1.91	(1.27-2.89)
Physical functioning								
<i>Physical limitation (score <83)</i>	2.63	(1.80-3.84)	1.45	(0.80-2.62)	1.68	(0.86-3.30)	1.17	(0.74-1.85)
Mental health								
<i>Poor mental health (score ≤60)</i>	9.28	(6.31-13.63)	18.50	(10.85-31.53)	2.80	(1.25-6.25)	5.44	(3.35-8.82)
Lung function								
<i>FEV₁ (L)</i>	1.23	(0.70-2.16)	2.61	(0.98-6.94)	2.71	(0.99-7.45)	0.78	(0.41-1.47)
<i>FVC (L)</i>	0.80	(0.50-1.27)	0.32	(0.14-0.70)	0.69	(0.31-1.54)	0.97	(0.57-1.64)

A multivariate multinomial model was fitted for variables at follow-up (t5), including all variables. Reference groups were set to: male; t1: 26-40 years & t5:45-60 years; employed; low educational level; moderate sleep; normal/low BMI; living with a partner; employed; non-smoker; conforming to physical activity guidelines; no chronic disease; pain scale ≥ 62 ; physical scale ≥ 83 ; mental health scale > 60 ; alcohol consumption of ≤ 1 alcoholic beverage a day. Persistent good vitality was used as a reference for the other long-term vitality patterns.



Supplementary Fig. 1. Plots of Pearson's correlation coefficient between the continuous SF-36 vitality score and the MHI-5 mental health score within the included study population ($n=3,013$). (A) Correlation at baseline. (B) Correlation at follow-up.