Title of the manuscript: A comparison of self-rated health, frailty index, and multimorbidity as predictors of four-year all-cause mortality: a multi-cohort study in 30+ adult populations

Appendix

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Supplementary Methods

Data sets

SALT is part of the Swedish Twin Registry, where all Swedish twins born in 1958 or earlier were invited to participate. The health data were collected by telephone interviews between 1998 and 2002 from 43 799 individuals (1), and of these, 43 072 had relevant data available for our analysis. Both the H2000 Survey and FH17 are nationally representative population-based studies conducted by the Finnish Institute for Health and Welfare. H2000 was conducted between 2000 and 2001, with a two-stage stratified cluster sample of 8 028 participants aged 30 and over. Of the original H2000 sample, 84% took part in health examination (2). FH17 was conducted in 2017 using a similar sampling method as the H2000, and out of the original sample of 10 305 participants, 58% took part in the health examination (3). HBCS is a birth cohort study of people born in Helsinki between 1934 and 1944. Of a random sample of the original cohort, 2 003 participants attended a clinical examination between 2001 and 2004 (4), and 1 999 participants of these formed the sample used in the current study. The CAMB is a Danish cohort study conducted between 2009 and 2011. In CAMB (5), originally 5 519 Danish adults aged 48 to 62 years took part in clinical examination as part of a wider biobank data collection effort, and of these, 5 302 were used for the analysis. For this study, participants aged less than 30 years, and with missing data in the relevant variables (see '*Health indicators and other variables at baseline*') were excluded, and analyses were conducted using complete cases only within each cohort. The percentage of individuals excluded from the final analytic sample was 2% in SALT, 17% in H2000, 19% in FH17, <1% in HBCS, and 4% in CAMB.

Additional information for health indicators and other variables

All cohorts included a baseline measure of SRH with a question concerning current general health and, in all, there were five response options. In H2000 and FH17, the response alternatives were *good, fairly good, average, fairly poor,* and *poor*, in HBCS and CAMB they were *excellent, very good, good, fair,* and *poor,* and in SALT *excellent, good, average, not so good,* and *bad*. We kept the order of the five responses and rephrased them as (1) 'good', (2) 'fairly good', (3) 'Moderate', (4) 'fair' and (5) 'poor' SRH in the five cohorts throughout the study. The two worst SRH-response options ([4]'fair' and [5] 'poor') were combined in all analyses.

Baseline health information in all cohorts was primarily self-reported, except for registry-based medication reimbursements (used for diseases diagnoses in HBCS) and objectively measured variables, including blood biomarkers (Laboratory test results, Supplementary Table 1) and physiological measures (Clinical measurements, Supplementary Table 1).

Supplementary Table 1. List of FI items in SALT, H2000, HBCS, FH17 and CAMB

Category	Item	SALT (44-item)	H2000 (30-item)	HBCS (40-item)	FH17 (30-item)	CAMB (34-item)
Chronic disease	Diabetes	Yes	Yes	Yes	Yes	Yes
Chronic disease	Hypertension	Yes	Yes	Yes	Yes	Yes
Chronic disease	Myocardial infarction	Yes	Yes	Yes	Yes	Yes
Chronic disease	Stroke	Yes	Yes	Yes	Yes	Yes
Chronic disease	Heart insufficiency	Yes	Yes	Yes	Yes	
Chronic disease	Coronary artery disease/angina pectoris	Yes	Yes	Yes	Yes	
Chronic disease	Venous thrombosis	Yes				
Chronic disease	Intermittent claudication	Yes		Yes		
Chronic disease	TIA attack	Yes				
Chronic disease	Irregular cardiac rhythm/atrial fibrillation	Yes		Yes		
Chronic disease	Asthma	Yes	Yes	Yes	Yes	Yes
Chronic disease	Chronic bronchitis, emphysema	Yes		Yes		Yes
Chronic disease	Chronic obstructive pulmonary disease		Yes		Yes	
Chronic disease	Allergy	Yes				
Chronic disease	Severe infections in a year (other than respiratory)	Yes				
Chronic disease	Cancer	Yes	Yes	Yes	Yes	Yes
Chronic disease	Peptic ulcer					Yes
Chronic disease	Gallstones	Yes				Yes
Chronic disease	Chronic intestinal inflammation	Yes				Yes
Chronic disease	Arthritis/arthropaty, other spinal disease	Yes	Yes		Yes	Yes
Chronic disease	Osteoarthritis					Yes
Chronic disease	Osteoporosis	Yes		Yes		Yes
Chronic disease	Knee joint problem	Yes				
Chronic disease	Hip joint problem	Yes				
Chronic disease	Back disease					Yes

Category	Item	SALT (44-item)	H2000 (30-item)	HBCS (40-item)	FH17 (30-item)	CAMB (34-item)
Chronic disease	Gout	Yes				
Chronic disease	Sciatica	Yes				
Chronic disease	Depression/anxiety	Yes	Yes	Yes	Yes	Yes
Chronic disease	Other mental disorder		Yes		Yes	Yes
Chronic disease	Cataract					Yes
Chronic disease	Glaucoma			Yes		
Chronic disease	Migraine	Yes				Yes
Chronic disease	Kidney stones					Yes
Chronic disease	Kidney disease	Yes				
Chronic disease	Recurring urinary tract problems	Yes				
Chronic disease	Glandural diseases, excluding goiter	Yes				
Chronic disease	Goiter	Yes				
Chronic disease	Liver disease (e.g. cirrhosis)	Yes				
Chronic disease	Lipid disorder (e.g. high cholesterol or high triglycerides)	Yes				
Clinical measurements	Body mass Index	Yes	Yes	Yes	Yes	Yes
Clinical measurements	Waist-to-hip ratio			Yes		
Clinical measurements	Blood pressure			Yes		
Clinical measurements	Heart rate			Yes		
Functional ability	Able to run a short distance		Yes		Yes	Yes
Functional ability	Able to walk 0.4-0.5km		Yes		Yes	Yes
Functional ability	Able to climb stairs		Yes	Yes	Yes	Yes
Functional ability	Physical health limits activities	Yes		Yes		
Functional ability	Physical handicap	Yes				
Functional ability	Health limits vigorous activities			Yes		
Functional ability	Health limits moderate activities			Yes		
Functional ability	Health limits lifting or carrying groceries			Yes		

Category	Item	SALT (44-item)	H2000 (30-item)	HBCS (40-item)	FH17 (30-item)	CAMB (34-item)
Functional ability	Health limits bending, kneeling, or stooping			Yes		
Functional ability	Health limits walking more than a kilometre			Yes		
Functional ability	Health limits walking more than 100 metres			Yes		
Functional ability	Health limits bathing or dressing			Yes		
General health	Low physical activity			Yes		
General health	Self-rated dental health		Yes		Yes	
General health	Health compared to one year ago			Yes		
Laboratory test results	Total cholesterol >5mmol/l		Yes	Yes	Yes	Yes
Laboratory test results	Fasting blood glucose ≥ 6.1 mmol/l			Yes		
Laboratory test results	High-density lipoprotein men < 1.00 mmol/l, women < 1.20 mmol/l)			Yes		
Laboratory test results	Alanine amino or aspartate transferase; ALT > 50 U/l for men and > 35 U/l for women; AST > 45 U/l for men and > 35 U/l for women			Yes		
Laboratory test results	Low grade inflammation hs-crp >3		Yes		Yes	Yes
Laboratory test results	Interleukin(IL)-6 quartiles					Yes
Symptoms	Recurrent periods of coughing	Yes				
Symptoms	Nausea/stomach problems	Yes	Yes		Yes	
Symptoms	Back/hip/ankle pain	Yes	Yes		Yes	Yes
Symptoms	Neck pain	Yes				
Symptoms	General bodily pain			Yes		
Symptoms	Insomnia		Yes	Yes	Yes	Yes
Symptoms	Fatigue			Yes		Yes
Symptoms	Energetic/lack of energy		Yes		Yes	Yes
Symptoms	Decreased appetite			Yes		
Symptoms	Weight loss			Yes		
Symptoms	Problems with memory		Yes		Yes	
Symptoms	Hearing	Yes	Yes		Yes	
Symptoms	Tinnitus	Yes				Yes
Symptoms	Vision	Yes				
Symptoms	Dizziness	Yes	Yes		Yes	
Symptoms	Difficulty urinating					Yes
Symptoms	Incontinence		Yes		Yes	Yes
Wellbeing	Feeling fit					Yes
Wellbeing	Quality of life		Yes		Yes	

Category	Item	SALT (44-item)	H2000 (30-item)	HBCS (40-item)	FH17 (30-item)	CAMB (34-item)
Wellbeing	Hopefulness		Yes		Yes	
Wellbeing	Feelings of happiness	Yes		Yes		
Wellbeing	Feelings of loneliness	Yes				
Wellbeing	Less interested in others			Yes		
Wellbeing	Enjoyment over daily routines		Yes		Yes	

Abbreviations. crp, C-reactive protein; hs-crp, high-sensitivity crp; FI, frailty index; SALT, the Screening Across the Lifespan Twin Study; H2000, the Health 2000 Study; HBCS, the Helsinki Birth Cohort Study; FH17, the National FinHealth 2017 Study; CAMB, Copenhagen Aging and Midlife Biobank

Supplementary Table 2. List of multimorbidity items in SALT, H2000, HBCS, FH17 and CAMB

Item	SALT	H2000	HBCS	FH17	CAMB
Stroke	Yes	Yes	Yes	Yes	Yes
Diabetes	Yes	Yes	Yes	Yes	Yes
Hypertension	Yes	Yes	Yes	Yes	Yes
Heart insufficiency	Yes	Yes	Yes	Yes	
Myocardial infarction	Yes	Yes	Yes	Yes	Yes
Coronary artery disease/angina pectoris	Yes	Yes	Yes	Yes	
Intermittent claudication	Yes		Yes		
Venous thrombosis	Yes				
TIA attack	Yes				
Irregular cardiac rhythm/atrial fibrillation	Yes				
Chronic obstructive pulmonary disease		Yes		Yes	
Chronic lung disease (including bronchitis and emphysema)	Yes		Yes		
Asthma	Yes	Yes	Yes	Yes	Yes
Arthritis/other joint or back disease	Yes	Yes		Yes	Yes
Cancer	Yes	Yes	Yes	Yes	Yes
Depression		Yes	Yes	Yes	Yes
Other psychiatric disorder		Yes		Yes	Yes
High cholesterol level		Yes		Yes	
Emphysema					Yes
Cataract					Yes
Back disease					Yes
Incontinence					Yes
Migraine	Yes				Yes
Kidney stones					Yes
Kidney disease	Yes				
Liver disease	Yes				
Gallstones	Yes				
Goiter	Yes				
Glandural diseases, excluding goiter	Yes				Yes
Osteoporosis	Yes		Yes		Yes
Osteoarthritis					Yes
Peptic ulcer					Yes
Lipid disorder, for example high cholesterol or high triglycerides	Yes				

Abbreviations. SALT, the Screening Across the Lifespan Twin Study; H2000, the Health 2000 Study; HBCS, the Helsinki Birth Cohort Study; FH17, the National FinHealth 2017 Study; CAMB, Copenhagen Aging and Midlife Biobank

Supplementary Table 3. Mortality associations and predictive accuracies of SRH, FI and number of diseases in the four cohorts

Cohort	Population	n	Indicator	MODEL	coef	HR	se	p	C	AIC	BIC
SALT	All	43072	FI	Adjusted for age and sex	0.35	1.42	0.023	9E-51	0.819	34791	34808
SALT	All	43072	MM	Adjusted for age and sex	0.18	1.20	0.010	5E-66	0.821	34740	34756
SALT	All	43072	SRH	Adjusted for age and sex	0.55	1.73	0.027	2E-92	0.832	34513	34529
H2000	All	6108	FI	Adjusted for age and sex	0.41	1.51	0.053	4E-15	0.881	3546	3557
H2000	All	6108	MM	Adjusted for age and sex	0.27	1.31	0.042	1E-10	0.876	3567	3577
H2000	All	6108	SRH	Adjusted for age and sex	0.41	1.51	0.076	7E-08	0.873	3575	3585
FH17	All	4389	FI	Adjusted for age and sex	0.42	1.52	0.074	1E-08	0.818	2009	2017
FH17	All	4389	MM	Adjusted for age and sex	0.18	1.19	0.063	5E-03	0.801	2031	2040
FH17	All	4389	SRH	Adjusted for age and sex	0.53	1.71	0.109	9E-07	0.815	2014	2023
HBCS	All	1999	FI	Adjusted for age and sex	0.53	1.68	0.105	3E-07	0.745	860	866
HBCS	All	1999	MM	Adjusted for age and sex	0.31	1.36	0.099	2E-03	0.692	874	880
HBCS	All	1999	SRH	Adjusted for age and sex	0.68	1.98	0.143	2E-06	0.726	859	865
SALT	All	43072	FI	Unadjusted	0.53	1.70	0.020	6E-158	0.656	37090	37095
SALT	All	43072	MM	Unadjusted	0.29	1.34	0.009	9E-238	0.682	36837	36842
SALT	All	43072	SRH	Unadjusted	0.70	2.02	0.024	6E-189	0.689	36724	36730
H2000	All	6108	FI	Unadjusted	0.79	2.20	0.042	3E-80	0.812	3771	3775
H2000	All	6108	MM	Unadjusted	0.57	1.78	0.036	1E-56	0.749	3886	3889
H2000	All	6108	SRH	Unadjusted	0.90	2.45	0.071	4E-37	0.732	3908	3911
FH17	All	4389	FI	Unadjusted	0.68	1.97	0.065	2E-25	0.723	2120	2123
FH17	All	4389	MM	Unadjusted	0.43	1.53	0.057	6E-14	0.659	2163	2166
FH17	All	4389	SRH	Unadjusted	0.84	2.31	0.101	8E-17	0.692	2140	2143
HBCS	All	1999	FI	Unadjusted	0.52	1.71	0.106	9E-07	0.672	876	878
HBCS	All	1999	MM	Unadjusted	0.32	1.38	0.101	1E-03	0.604	888	890
HBCS	All	1999	SRH	Unadjusted	0.65	1.92	0.144	6E-06	0.652	876	878

Note. Table shows age- and sex-adjusted hazard ratios (HRs) and 95% confidence intervals for four-year all-cause-mortality per one-unit- change in SRH, one-unit-change in number of diseases (MM) and 10% increase in the FI. The three health indicators were analysed in separate models in each cohort. The Cox models were either adjusted for age and sex or unadjusted. Harrel's C-index, AIC and BIC are shown for each model. *Abbreviations.* SRH, self-rated health; FI, frailty-index; MM, multimorbidity; SALT, the Screening Across the Lifespan Twin Study; H2000, the Health 2000 Study; HBCS, the Helsinki Birth Cohort Study; FH17, the National FinHealth 2017 Study; AIC, Akaike Information Criterion; BIC, Bayesian Information Criterion; C, Harrel's c-index; se, standard error.

Supplementary Table 4. Model performance metrics and model fit comparisons in the four cohorts

SALT, n=43072 (1766 deaths, 4%); age range 41 - 98 years

Model	c-index	AIC	BIC
Null (age + sex)	0.81	34997	35008
SRH (+ age + sex)[a]	0.83	34513	34529
Number of diseases (+ age + sex)	0.82	34740	34756
FI (+ age + sex)	0.82	34791	34808

Model	p-values for model fit comparisons	Model: Null (age + sex)	Model: SRH (+ age +sex)	Model: Number of diseases (+ age + sex)	Model: FI (+ age + sex)
Null (age + sex)					
SRH (+ age + sex)	1.13E-23*				
Number of diseases (+ age + sex)	4.10E-14*	9.12E-07*			
FI (+ age + sex)	8.97E-12*	2.65E-11*	0.00462*		

Health 2000, n=6108 (235 deaths, 4%); age range 30 - 98 years

Model	c-index	AIC	BIC
Null (age + sex)	0.86	3604	3611
SRH (+ age + sex)	0.87	3575	3586
Number of diseases (+ age + sex)	0.88	3567	3577
FI (+ age + sex)[a]	0.88	3546	3557

Model	p-values for model fit comparisons	Model: Null (age + sex)	Model: SRH (+ age +sex)	Model: Number of diseases (+ age + sex)	Model: FI (+ age + sex)
Null (age + sex)					
SRH (+ age + sex)	4.54E-07*				
Number of diseases (+ age + sex)	4.73E-09*	0.5779			
FI (+ age + sex)	8.29E-09*	0.0319*	0.09285		

HBCS, n=1999 (59 deaths, 3%); age range 57-69 years

		c-index	AIC	BIC
Model	Null (age + sex)	0.65	880	884
	SRH (+ age + sex)	0.73	859	865
	Number of diseases (+ age + sex)	0.69	874	880
	FI (+ age + sex)[a]	0.74	860	866

		Model			
	p-values for model fit comparisons	Null (age + sex)	SRH (+ age +sex)	Number of diseases (+ age + sex)	FI (+ age + sex)
Model	Null (age + sex)				
	SRH (+ age + sex)	1.53E-05*			
	Number of diseases (+ age + sex)	2.19E-03*	0.2069		
	FI (+ age + sex)	3.64E-07*	0.9029	0.1255	

FH17, n=4389 (132 deaths, 3%); age range 30-98 years

		c-index	AIC	BIC
Model	Null (age + sex)	0.80	2037	2043
	SRH (+ age + sex)	0.82	2014	2023
	Number of diseases (+ age + sex)	0.80	2031	2040
	FI (+ age + sex)[a]	0.82	2009	2017

		Model			
	p-values for model fit comparisons	Null (age + sex)	SRH (+ age +sex)	Number of diseases (+ age + sex)	FI (+ age + sex)
Model	Null (age + sex)				
	SRH (+ age + sex)	7.38E-07*			
	Number of diseases (+ age + sex)	0.00619*	<2E-16*		
	FI (+ age + sex)	3.78E-08*	<2E-16*	<2E-16*	

Note. [a]Best performing Cox regression model in each cohort according to Harrel's c-index, AIC and BIC. ** statistically significant difference in model fit, p<0.05*
Abbreviations. SRH, self-rated health; FI, frailty-index; MM, multimorbidity; SALT, the Screening Across the Lifespan Twin Study; H2000, the Health 2000 Study; HBCS, the Helsinki Birth Cohort Study; FH17, the National FinHealth 2017 Study; AIC, Akaike Information Criterion; BIC, Bayesian Information Criterion.

Supplementary Table 5. Number of individuals who died or survived during the four-year follow-up by SRH, frailty or MM (a), and specificity and sensitivity of poor SRH, MM and frailty for the mortality (b)

a	SALT		H2000		HBCS		FH17	
Number of individuals	**Died**	**Alive**	**Died**	**Alive**	**Died**	**Alive**	**Died**	**Alive**
Fair/Poor SRH	523	3873	91	565	36	625	32	260
Very good/Good/moderate SRH	1243	37433	144	5308	23	1315	100	3997
Frail	396	3861	176	1389	35	601	82	1176
Non-frail	1370	37445	59	4484	24	1343	50	3081
MM	1178	15831	214	3642	28	585	99	1898
Non-MM	588	25475	21	2231	31	1359	33	2705

b	SALT	H2000	HBCS	FH17	Mean	Min	Max
sensitivity (SRH)	0.3	0.4	0.6	0.2	0.38	0.24	0.61
specificity (SRH)	0.9	0.9	0.7	0.9	0.86	0.68	0.94
sensitivity (MM)	0.7	0.9	0.5	0.8	0.70	0.47	0.91
specificity (MM)	0.6	0.4	0.7	0.6	0.57	0.38	0.70
sensitivity (frailty)	0.2	0.7	0.6	0.6	0.55	0.22	0.75
specificity (frailty)	0.9	0.8	0.7	0.7	0.77	0.69	0.91

Note. The health indicators were used as dichotomized variables (Poor SRH: poor or fair SRH; Frailty: FI ≥ 0.25; MM: 2+ diseases). Number of individuals who died or survived during the four-year follow-up by SRH, frailty or MM (a), and the following formulas were used to calculate sensitivity and specificity values (b): Sensitivity = TP / (TP + FN), and Specificity = TN / (TN + FP), where TP represents true positives, FN false negatives, TN true negatives, and FP false positives. *Abbreviations.* SRH, self-rated health; MM, multimorbidity; SALT, the Screening Across the Lifespan Twin Study; H2000, the Health 2000 Study; HBCS, the Helsinki Birth Cohort Study; FH17, the National FinHealth 2017 Study

Supplementary Table 6. Mortality associations and predictive accuracies of SRH, FI and number of diseases in the four cohorts stratified by age, sex and education

Cohort	Population	n	Deaths, n	4-year mortality, %	Model	coef	HR	se	p	C	AIC	BIC
SALT	Women	23007	770	3	SRH	0.52	1.69	0.042	3E-36	0.83	14167	14177
SALT	Women	23007	770	3	MM	0.17	1.18	0.015	7E-30	0.82	14245	14255
SALT	Women	23007	770	3	FI	0.32	1.38	0.033	7E-22	0.81	14270	14280
SALT	Men	20065	996	5	SRH	0.57	1.77	0.035	2E-58	0.83	17925	17935
SALT	Men	20065	996	5	MM	0.19	1.21	0.015	1E-37	0.82	18072	18082
SALT	Men	20065	996	5	FI	0.39	1.47	0.033	3E-31	0.82	18098	18108
SALT	EDU mid	8025	241	3	SRH	0.68	1.97	0.072	8E-21	0.83	3897	3908
SALT	EDU mid	8025	241	3	MM	0.22	1.25	0.032	4E-12	0.81	3955	3966
SALT	EDU mid	8025	241	3	FI	0.42	1.52	0.068	7E-10	0.81	3965	3976
SALT	EDU low	20701	1224	6	SRH	0.47	1.59	0.033	2E-46	0.81	22515	22530
SALT	EDU low	20701	1224	6	MM	0.15	1.16	0.012	1E-36	0.80	22611	22626
SALT	EDU low	20701	1224	6	FI	0.30	1.35	0.027	2E-28	0.80	22639	22654
SALT	EDU hi	14346	301	2	SRH	0.74	2.09	0.063	1E-31	0.84	5161	5173
SALT	EDU hi	14346	301	2	MM	0.28	1.32	0.027	6E-25	0.82	5228	5240
SALT	EDU hi	14346	301	2	FI	0.54	1.72	0.065	9E-17	0.82	5251	5262
SALT	All	43072	1766	4	SRH	0.55	1.73	0.027	2E-92	0.83	34513	34529
SALT	All	43072	1766	4	MM	0.18	1.20	0.010	5E-66	0.82	34740	34756
SALT	All	43072	1766	4	FI	0.35	1.42	0.023	9E-51	0.82	34791	34808
SALT	60+	16959	1457	9	SRH	0.51	1.66	0.030	2E-64	0.76	26801	26817
SALT	60+	16959	1457	9	MM	0.16	1.17	0.011	2E-47	0.75	26949	26964
SALT	60+	16959	1457	9	FI	0.31	1.36	0.026	6E-34	0.75	26995	27011
SALT	<60	26113	309	1	SRH	0.72	2.06	0.060	8E-34	0.73	6061	6072
SALT	<60	26113	309	1	MM	0.31	1.37	0.026	8E-34	0.70	6123	6134
SALT	<60	26113	309	1	FI	0.57	1.77	0.054	4E-26	0.69	6139	6150

Cohort	Population	n	Deaths, n	4-year mortality, %	Model	coef	HR	se	p	C	AIC	BIC
H2000	Women	3337	105	3	SRH	0.45	1.57	0.117	1E-04	0.90	1417	1422
H2000	Women	3337	105	3	MM	0.22	1.25	0.064	5E-04	0.90	1421	1426
H2000	Women	3337	105	3	FI	0.30	1.35	0.080	2E-04	0.90	1419	1424
H2000	Men	2771	130	5	SRH	0.38	1.46	0.100	1E-04	0.84	1829	1834
H2000	Men	2771	130	5	MM	0.30	1.36	0.055	4E-08	0.85	1816	1822
H2000	Men	2771	130	5	FI	0.49	1.64	0.069	8E-13	0.86	1797	1802
H2000	EDU mid	1975	42	2	SRH	0.78	2.19	0.189	3E-05	0.84	562	567
H2000	EDU mid	1975	42	2	MM	0.34	1.40	0.111	2E-03	0.84	572	577
H2000	EDU mid	1975	42	2	FI	0.56	1.75	0.132	2E-05	0.84	564	569
H2000	EDU low	2376	167	7	SRH	0.41	1.50	0.094	2E-05	0.85	2310	2319
H2000	EDU low	2376	167	7	MM	0.26	1.29	0.049	1E-07	0.85	2304	2313
H2000	EDU low	2376	167	7	FI	0.40	1.50	0.062	6E-11	0.86	2288	2297
H2000	EDU hi	1757	26	1	SRH	-0.16	0.85	0.220	5E-01	0.89	324	328
H2000	EDU hi	1757	26	1	MM	0.24	1.27	0.135	7E-02	0.89	322	326
H2000	EDU hi	1757	26	1	FI	0.09	1.09	0.211	7E-01	0.89	325	329
H2000	All	6108	235	4	SRH	0.41	1.51	0.076	7E-08	0.87	3575	3585
H2000	All	6108	235	4	MM	0.27	1.31	0.042	1E-10	0.88	3567	3577
H2000	All	6108	235	4	FI	0.41	1.51	0.053	4E-15	0.88	3546	3557
H2000	60+	1772	194	11	SRH	0.39	1.48	0.085	4E-06	0.77	2771	2781
H2000	60+	1772	194	11	MM	0.25	1.28	0.045	5E-08	0.78	2766	2775
H2000	60+	1772	194	11	FI	0.37	1.45	0.057	4E-11	0.78	2752	2761
H2000	<60	4336	41	1	SRH	0.48	1.61	0.168	5E-03	0.78	599	604
H2000	<60	4336	41	1	MM	0.53	1.71	0.124	1E-05	0.80	591	596
H2000	<60	4336	41	1	FI	0.64	1.89	0.134	2E-06	0.80	588	593

Cohort	Population	n	Deaths, n	4-year mortality, %	Model	coef	HR	se	p	C	AIC	BIC
HBCS	Women	1071	16	1	SRH	0.75	2.12	0.297	1E-02	0.69	218	220
HBCS	Women	1071	16	1	MM	0.36	1.43	0.198	7E-02	0.68	222	224
HBCS	Women	1071	16	1	FI	0.65	1.91	0.200	1E-03	0.71	216	217
HBCS	Men	928	43	5	SRH	0.66	1.94	0.164	5E-05	0.66	573	576
HBCS	Men	928	43	5	MM	0.29	1.34	0.114	1E-02	0.60	584	587
HBCS	Men	928	43	5	FI	0.49	1.63	0.124	8E-05	0.68	576	580
HBCS	EDU mid	512	24	5	SRH	1.10	3.00	0.259	2E-05	0.80	275	278
HBCS	EDU mid	512	24	5	MM	0.15	1.16	0.163	4E-01	0.68	295	298
HBCS	EDU mid	512	24	5	FI	0.47	1.61	0.161	3E-03	0.76	288	292
HBCS	EDU low	711	18	3	SRH	0.31	1.36	0.266	2E-01	0.66	236	239
HBCS	EDU low	711	18	3	MM	0.14	1.15	0.193	5E-01	0.65	237	240
HBCS	EDU low	711	18	3	FI	0.38	1.46	0.200	6E-02	0.69	234	237
HBCS	EDU hi	773	17	2	SRH	0.57	1.77	0.252	2E-02	0.74	218	220
HBCS	EDU hi	773	17	2	MM	0.59	1.81	0.171	5E-04	0.77	212	215
HBCS	EDU hi	773	17	2	FI	0.72	2.05	0.209	6E-04	0.77	213	215
HBCS	All	1999	59	3	SRH	0.68	1.98	0.143	2E-06	0.73	859	865
HBCS	All	1999	59	3	MM	0.31	1.36	0.099	2E-03	0.69	874	880
HBCS	All	1999	59	3	FI	0.53	1.71	0.105	3E-07	0.74	860	866
HBCS	60+	1278	34	3	SRH	0.67	1.95	0.196	7E-04	0.74	465	470
HBCS	60+	1278	34	3	MM	0.18	1.20	0.139	2E-01	0.69	476	480
HBCS	60+	1278	34	3	FI	0.50	1.64	0.146	7E-04	0.75	467	472
HBCS	<60	721	25	3	SRH	0.64	1.89	0.207	2E-03	0.75	312	316
HBCS	<60	721	25	3	MM	0.42	1.52	0.141	3E-03	0.75	314	318
HBCS	<60	721	25	3	FI	0.49	1.64	0.152	1E-03	0.76	313	316

Cohort	Population	n	Deaths, n	4-year mortality, %	Model	coef	HR	se	p	C	AIC	BIC
FH17	Women	2423	58	2	SRH	0.45	1.57	0.171	8E-03	0.84	797	801
FH17	Women	2423	58	2	MM	0.20	1.22	0.095	4E-02	0.84	800	804
FH17	Women	2423	58	2	FI	0.34	1.41	0.113	2E-03	0.85	795	799
FH17	Men	1966	74	4	SRH	0.58	1.78	0.142	5E-05	0.78	1036	1041
FH17	Men	1966	74	4	MM	0.15	1.16	0.085	8E-02	0.76	1050	1055
FH17	Men	1966	74	4	FI	0.47	1.60	0.099	6E-10	0.78	1033	1037
FH17	EDU mid	1449	32	2	SRH	0.55	1.74	0.223	1E-02	0.77	436	440
FH17	EDU mid	1449	32	2	MM	0.30	1.35	0.118	1E-02	0.76	436	441
FH17	EDU mid	1449	32	2	FI	0.43	1.54	0.157	8E-03	0.77	435	439
FH17	EDU low	1363	54	4	SRH	0.56	1.75	0.184	2E-03	0.85	685	691
FH17	EDU low	1363	54	4	MM	0.02	1.02	0.105	9E-01	0.83	695	701
FH17	EDU low	1363	54	4	FI	0.37	1.45	0.123	2E-03	0.85	686	692
FH17	EDU hi	1577	46	3	SRH	0.46	1.59	0.170	8E-03	0.81	608	614
FH17	EDU hi	1577	46	3	MM	0.24	1.28	0.107	2E-02	0.81	610	616
FH17	EDU hi	1577	46	3	FI	0.43	1.54	0.119	3E-04	0.83	603	609
FH17	All	4389	132	3	SRH	0.53	1.71	0.109	9E-07	0.82	2014	2023
FH17	All	4389	132	3	MM	0.18	1.19	0.063	5E-03	0.80	2031	2040
FH17	All	4389	132	3	FI	0.42	1.52	0.074	1E-08	0.82	2009	2017
FH17	60+	2009	114	6	SRH	0.57	1.78	0.121	2E-06	0.75	1633	1641
FH17	60+	2009	114	6	MM	0.20	1.22	0.066	3E-03	0.72	1647	1656
FH17	60+	2009	114	6	FI	0.42	1.53	0.079	1E-07	0.75	1629	1637
FH17	<60	2380	18	1	SRH	0.33	1.40	0.270	2E-01	0.73	274	277
FH17	<60	2380	18	1	MM	-0.07	0.93	0.236	8E-01	0.71	276	278
FH17	<60	2380	18	1	FI	0.33	1.39	0.237	2E-01	0.72	274	277

Note. Table shows age- and sex-adjusted hazard ratios (HRs) and 95% confidence intervals for four-year all-cause-mortality per one-unit- change in SRH, one-unit-change in number of diseases (MM) and 10% increase in the FI. The three health indicators were analysed in separate Cox regression models in each cohort and population. Harrel's C-index, AIC and BIC are shown for each model. *Abbreviations.* SRH, self-rated health; FI, frailty-index; MM, multimorbidity; SALT, the Screening Across the Lifespan Twin Study; H2000, the Health 2000 Study; HBCS, the Helsinki Birth Cohort Study; FH17, the National FinHealth 2017 Study; EDUmid, intermediate education; EDUlow, low education; EDUhi, high education; AIC, Akaike Information Criterion; BIC, Bayesian Information Criterion; C, Harrel's c-index; se, standard error.

Supplementary Table 7. Mortality associations for combinations of frailty and SRH, and MM and SRH in SALT, H2000 and FH17

Cohort	Population	Population Size, n	Model	Variable categories	Survived, n	4-year mortality, n (%) within category	HR	HR Lower CI	HR Upper CI	C-index
SALT	All	43072	Frailty by SRH	Non-frail - Good SRH	35220	1071 (3)	1.00	1.00	1.00	0.83
SALT	All		Frailty by SRH	Non-frail - Poor SRH	2225	299 (12)	3.31	2.89	3.79	
SALT	All		Frailty by SRH	Frail - Good SRH	2213	172 (7)	1.56	1.33	1.84	
SALT	All		Frailty by SRH	Frail - Poor SRH	1648	224 (12)	3.22	2.77	3.73	
SALT	All	43072	MM by SRH	Non-MM - Good SRH	24354	492 (2)	1.00	1.00	1.00	0.83
SALT	All		MM by SRH	Non-MM - Poor SRH	1121	96 (8)	3.60	2.88	4.51	
SALT	All		MM by SRH	MM - Good SRH	13079	751 (5)	1.72	1.53	1.93	
SALT	All		MM by SRH	MM - Poor SRH	2752	427 (13)	4.35	3.79	5.00	

Cohort	Population	Population Size, n	Model	Variable categories	Survived, n	4-year mortality, n (%) within category	HR	HR Lower CI	HR Upper CI	C-index
H2000	All	6108	Frailty by SRH	Non-frail - Good SRH	4375	58 (1)	1.00	1.00	1.00	0.88
H2000	All		Frailty by SRH	Non-frail - Poor SRH	109	1 (1)	0.49	0.07	3.51	
H2000	All		Frailty by SRH	Frail - Good SRH	933	86 (8)	2.23	1.56	3.20	
H2000	All		Frailty by SRH	Frail - Poor SRH	456	90 (16)	3.90	2.72	5.60	
H2000	All	6108	MM by SRH	Non-MM - Good SRH	2191	19 (1)	1.00	1.00	1.00	0.88
H2000	All		MM by SRH	Non-MM - Poor SRH	40	2 (5)	1.89	0.44	8.16	
H2000	All		MM by SRH	MM - Good SRH	3117	125 (4)	1.93	1.19	3.13	
H2000	All		MM by SRH	MM - Poor SRH	525	89 (14)	4.02	2.41	6.69	

Cohort	Population	Population Size, n	Model	Variable categories	Survived, n	4-year mortality, n (%) within category	HR	HR lower CI	HR upper CI	C-index
FH17	All	4389	Frailty by SRH	Non-frail - Good SRH	3048	49 (2)	1.00	1.00	1.00	0.81
FH17	All		Frailty by SRH	Non-frail - Poor SRH	33	1 (3)	1.79	0.25	12.95	
FH17	All		Frailty by SRH	Frail - Good SRH	949	51 (5)	1.93	1.28	2.90	
FH17	All		Frailty by SRH	Frail - Poor SRH	227	31 (12)	4.09	2.55	6.55	
FH17	All	4389	MM by SRH	Non-MM - Good SRH	1867	31 (2)	1.00	1.00	1.00	0.81
FH17	All		MM by SRH	Non-MM - Poor SRH	31	2 (6)	3.16	0.74	13.43	
FH17	All		MM by SRH	MM - Good SRH	2130	69 (3)	1.09	0.71	1.67	
FH17	All		MM by SRH	MM - Poor SRH	229	30 (12)	3.01	1.79	5.07	

Note. Table shows age- and sex-adjusted hazard ratios and 95% confidence intervals for four-year all-cause-mortality per one-unit- change in variable representing combinations of frailty and SRH, or MM and SRH. The mortality analysis was performed using Cox regression. Individuals were considered as frail with Rockwood FI ≥ 0.25, and multimorbid with two or more diseases. For the analysis, we created two mismatch variables, 'Frailty by SRH' and 'MM by SRH' to represent discrepancies between SRH (levels: 'Good' [good or fairly good or moderate] and 'Poor' [fair or poor]) and frailty (FI≥0.25) or MM (two or more diseases). A mismatch refers to individuals who have good SRH but have frailty or MM. In contrast, concordant categories refer to individuals who have good SRH and are non-frail or non-MM, or poor SRH and are frail or MM. *Abbreviations.* SRH, self-rated health; FI, frailty-index; MM, multimorbidity; SALT, the Screening Across the Lifespan Twin Study; H2000, the Health 2000 Study; FH17, the National FinHealth 2017 Study; HR, Hazard Ratio; CI Confidence Interval; C-index, Harrel's c-index

Supplementary Table 8. Mortality associations for combinations of frailty and SRH, and MM and SRH in SALT stratified by age, sex and education

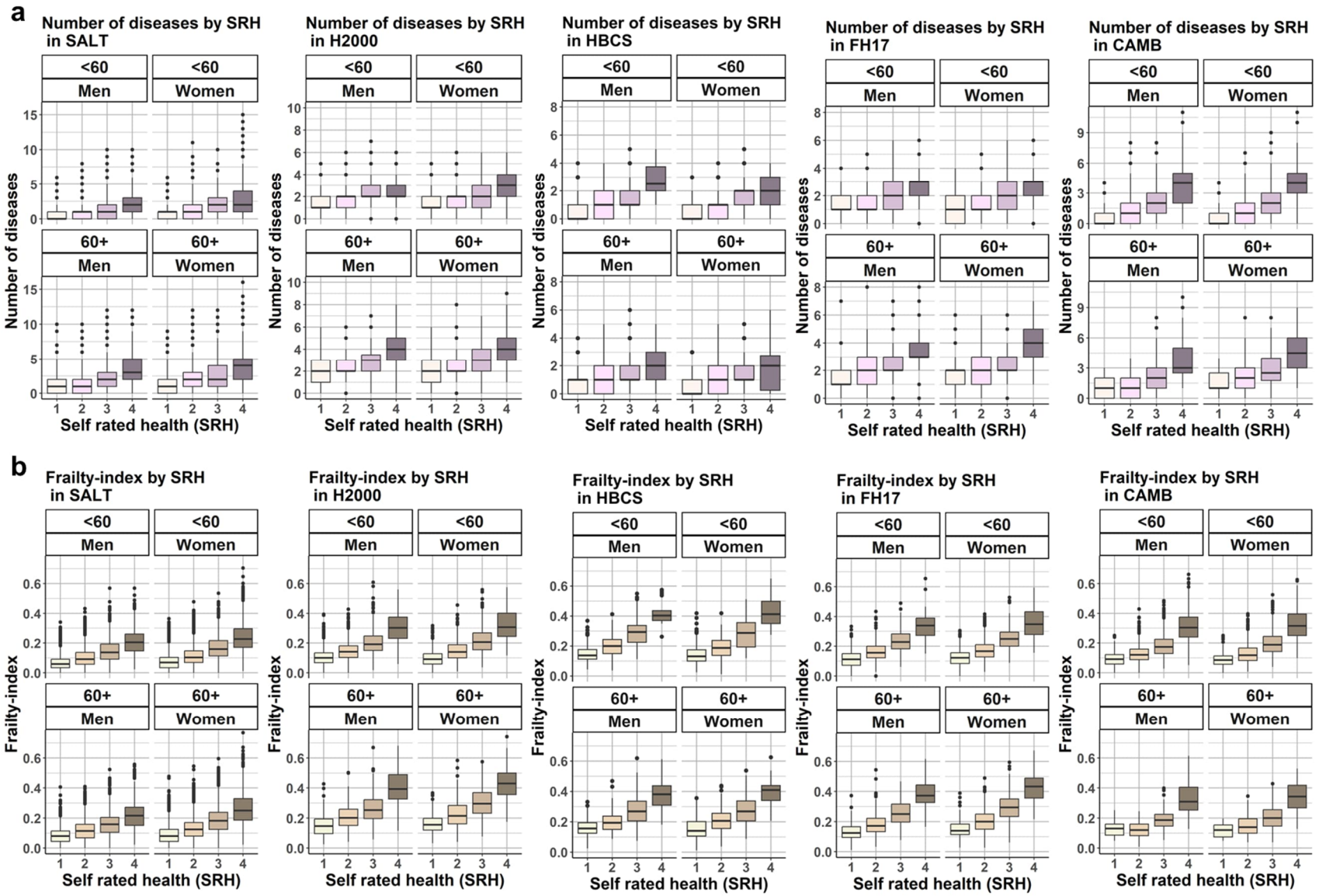
Population	Population Size, n	Model	Variable categories	Survived, n	4-year mortality, n (%) within category	HR	HR Lower CI	HR Upper CI	C-index
Age < 60	26113	Frailty by SRH	Non-frail - Good SRH	22637	191 (1)	1.00	1.00	1.00	0.72
Age < 60		Frailty by SRH	Non-frail - Poor SRH	1305	65 (5)	5.68	4.27	7.55	
Age < 60		Frailty by SRH	Frail - Good SRH	1000	16 (2)	1.90	1.14	3.18	
Age < 60		Frailty by SRH	Frail - Poor SRH	862	37 (4)	5.04	3.54	7.16	
Age < 60	26113	MM by SRH	Non-MM - Good SRH	17264	119 (1)	1.00	1.00	1.00	0.73
Age < 60		MM by SRH	Non-MM - Poor SRH	795	27 (3)	5.01	3.30	7.62	
Age < 60		MM by SRH	MM - Good SRH	6373	88 (1)	1.95	1.47	2.59	
Age < 60		MM by SRH	MM - Poor SRH	1372	75 (5)	7.57	5.62	10.20	
Age ≥ 60	16959	Frailty by SRH	Non-frail - Good SRH	12583	880 (7)	1.00	1.00	1.00	0.76
Age ≥ 60		Frailty by SRH	Non-frail - Poor SRH	920	234 (20)	2.92	2.52	3.39	
Age ≥ 60		Frailty by SRH	Frail - Good SRH	1213	156 (11)	1.50	1.26	1.79	
Age ≥ 60		Frailty by SRH	Frail - Poor SRH	786	187 (19)	2.96	2.52	3.48	
Age ≥ 60	16959	MM by SRH	Non-MM - Good SRH	7090	373 (5)	1.00	1.00	1.00	0.76
Age ≥ 60		MM by SRH	Non-MM - Poor SRH	326	69 (17)	3.17	2.43	4.13	
Age ≥ 60		MM by SRH	MM - Good SRH	6706	663 (9)	1.64	1.44	1.86	
Age ≥ 60		MM by SRH	MM - Poor SRH	1380	352 (20)	3.86	3.32	4.49	

Population	Population Size, n	Model	Variable categories	Survived, n	4-year mortality, n (%) within category	HR	HR lower CI	HR upper CI	C-index
Women	23007	Frailty by SRH	Non-frail - Good SRH	18209	435 (2)	1.00	1.00	1.00	0.82
Women		Frailty by SRH	Non-frail - Poor SRH	1305	116 (8)	2.92	2.35	3.62	
Women		Frailty by SRH	Frail - Good SRH	1547	85 (5)	1.37	1.08	1.74	
Women		Frailty by SRH	Frail - Poor SRH	1176	134 (10)	3.23	2.65	3.94	
Women	23007	MM by SRH	Non-MM - Good SRH	11758	191 (2)	1.00	1.00	1.00	0.83
Women		MM by SRH	Non-MM - Poor SRH	655	31 (5)	2.61	1.76	3.88	
Women		MM by SRH	MM - Good SRH	7998	329 (4)	1.45	1.21	1.74	
Women		MM by SRH	MM - Poor SRH	1826	219 (11)	3.90	3.18	4.79	
Men	20065	Frailty by SRH	Non-frail - Good SRH	17011	636 (4)	1.00	1.00	1.00	0.83
Men		Frailty by SRH	Non-frail - Poor SRH	920	183 (17)	3.60	3.02	4.27	
Men		Frailty by SRH	Frail - Good SRH	666	87 (12)	1.78	1.41	2.23	
Men		Frailty by SRH	Frail - Poor SRH	472	90 (16)	3.13	2.49	3.92	
Men	20065	MM by SRH	Non-MM - Good SRH	12596	301 (2)	1.00	1.00	1.00	0.83
Men		MM by SRH	Non-MM - Poor SRH	466	65 (12)	4.30	3.25	5.68	
Men		MM by SRH	MM - Good SRH	5081	422 (8)	1.91	1.64	2.22	
Men		MM by SRH	MM - Poor SRH	926	208 (18)	4.61	3.83	5.54	

Population	Population Size, n	Model	Variable categories	Survived, n	4-year mortality, n (%) within category	HR	HR lower CI	HR upper CI	C-index
EDU low	20701	Frailty by SRH	Non-frail - Good SRH	15846	743 (4)	1.00	1.00	1.00	0.80
EDU low		Frailty by SRH	Non-frail - Poor SRH	1261	195 (13)	2.74	2.33	3.23	
EDU low		Frailty by SRH	Frail - Good SRH	1318	132 (9)	1.47	1.22	1.78	
EDU low		Frailty by SRH	Frail - Poor SRH	1052	154 (13)	2.63	2.21	3.13	
EDU low	20701	MM by SRH	Non-MM - Good SRH	10305	333 (3)	1.00	1.00	1.00	0.81
EDU low		MM by SRH	Non-MM - Poor SRH	597	68 (10)	3.21	2.46	4.19	
EDU low		MM by SRH	MM - Good SRH	6859	542 (7)	1.66	1.44	1.90	
EDU low		MM by SRH	MM - Poor SRH	1716	281 (14)	3.46	2.94	4.08	
EDU Medium	8025	Frailty by SRH	Non-frail - Good SRH	6697	145 (2)	1.00	1.00	1.00	0.83
EDU Medium		Frailty by SRH	Non-frail - Poor SRH	413	40 (9)	3.68	2.55	5.30	
EDU Medium		Frailty by SRH	Frail - Good SRH	369	19 (5)	1.69	1.05	2.72	
EDU Medium		Frailty by SRH	Frail - Poor SRH	305	37 (11)	4.69	3.17	6.93	
EDU Medium	8025	MM by SRH	Non-MM - Good SRH	4581	72 (2)	1.00	1.00	1.00	0.83
EDU Medium		MM by SRH	Non-MM - Poor SRH	216	12 (5)	3.57	1.84	6.94	
EDU Medium		MM by SRH	MM - Good SRH	2485	92 (4)	1.46	1.06	2.03	
EDU Medium		MM by SRH	MM - Poor SRH	502	65 (11)	5.11	3.56	7.34	
EDU High	14346	Frailty by SRH	Non-frail - Good SRH	12677	183 (1)	1.00	1.00	1.00	0.83
EDU High		Frailty by SRH	Non-frail - Poor SRH	551	64 (10)	6.16	4.56	8.34	
EDU High		Frailty by SRH	Frail - Good SRH	526	21 (4)	1.77	1.12	2.79	
EDU High		Frailty by SRH	Frail - Poor SRH	291	33 (10)	5.72	3.92	8.35	
EDU High	14346	MM by SRH	Non-MM - Good SRH	9468	87 (1)	1.00	1.00	1.00	0.84
EDU High		MM by SRH	Non-MM - Poor SRH	308	16 (5)	5.39	3.12	9.31	
EDU High		MM by SRH	MM - Good SRH	3735	117 (3)	2.16	1.61	2.89	
EDU High		MM by SRH	MM - Poor SRH	534	81 (13)	9.56	6.88	13.28	

Note. Table shows age- and sex-adjusted hazard ratios and 95% confidence intervals for four-year all-cause-mortality per one-unit- change in variable representing combinations of frailty and SRH, and MM and SRH. Individuals were considered as frail with Rockwood FI ≥ 0.25, and multimorbid with two or more diseases. The analysis was performed using Cox regression, stratified by age, sex and education level in SALT only. For the analysis, we created two mismatch variables, 'Frailty by SRH' and 'MM by SRH' to represent discrepancies between SRH (levels: 'Good' [good or fairly good or moderate] and 'Poor' [fair or poor]) and frailty (FI≥0.25) or MM (two or more diseases). A mismatch refers to individuals who have good SRH but have frailty or MM. In contrast, concordant categories refer to individuals who have good SRH and are non-frail or non-MM, or poor SRH and are frail or MM. *Abbreviations.* SRH, self-rated health; FI, frailty-index; MM, multimorbidity; SALT, the Screening Across the Lifespan Twin Study; HR, Hazard Ratio; CI Confidence Interval; C-index, Harrel's c-index; EDU, education.

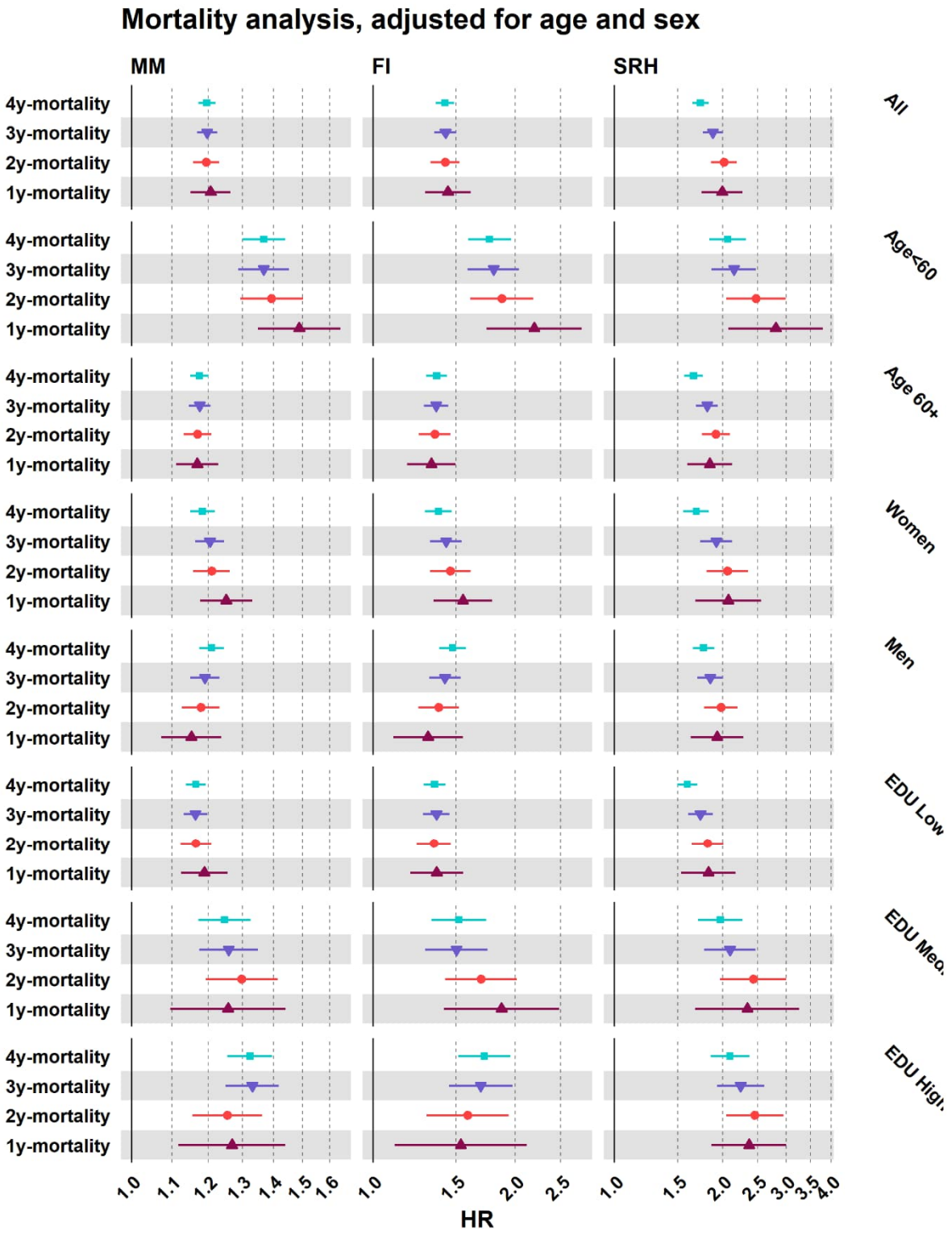
Supplementary Figure 1. Number of diseases (a) or Frailty-index (b) by SRH in the five cohorts stratified by age (<60 or 60+ years of age) and sex, visualized as boxplots



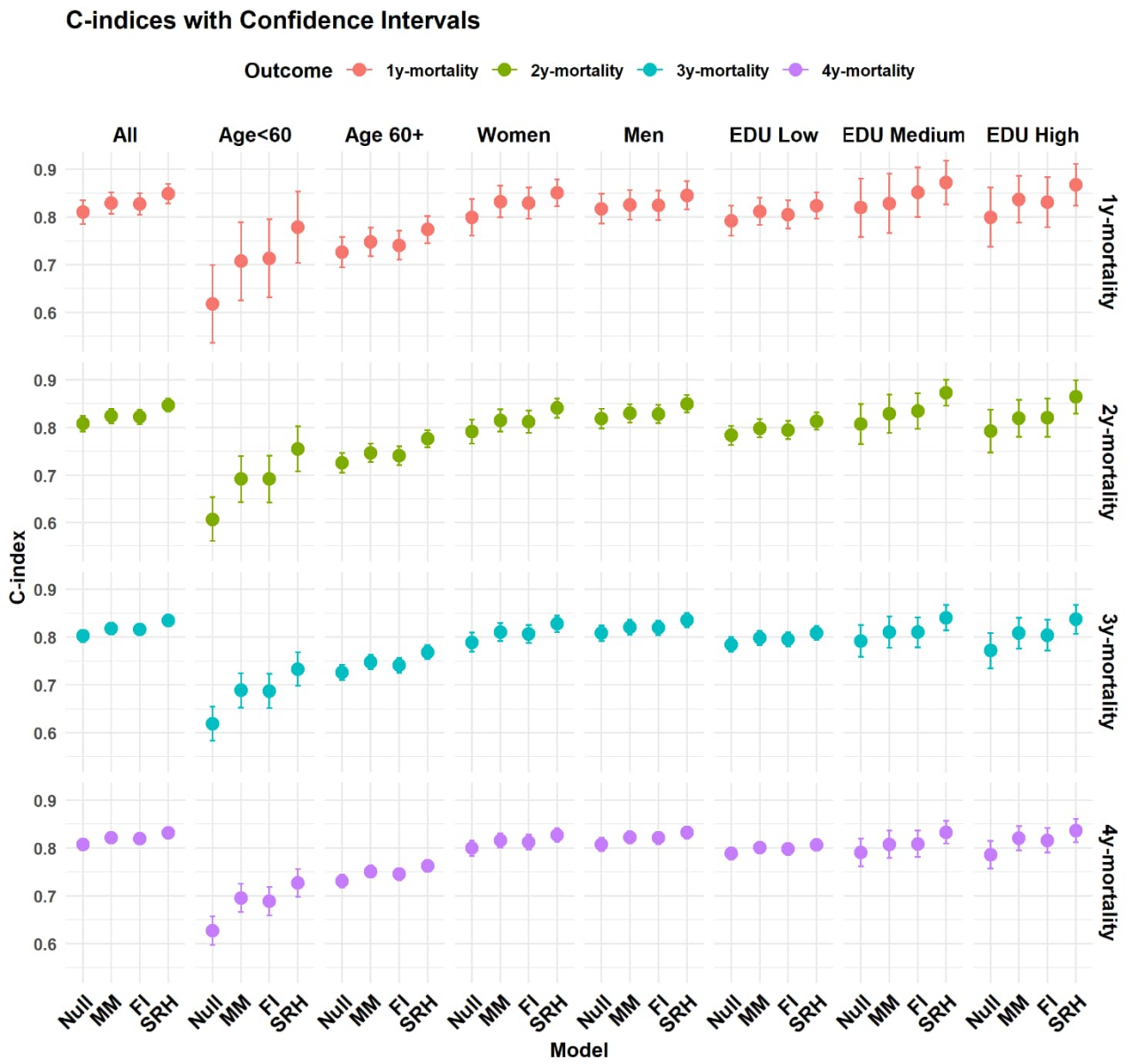
Note. The numbers on the x-axis of the boxplots are: 1='good', 2='fairly good', 3='Moderate', 4='fair or poor' SRH. *Abbreviations.* SRH, self-rated health, FI, frailty-index; SALT, the Screening Across the Lifespan Twin Study; H2000, the Health 2000 Study; HBCS, the Helsinki Birth Cohort Study; FH17, the National FinHealth 2017 Study; CAMB, Copenhagen Aging and Midlife Biobank

Supplementary Figure 2. Repeating the main mortality Cox models in SALT using different follow-up times, also stratified by age, sex and education

a

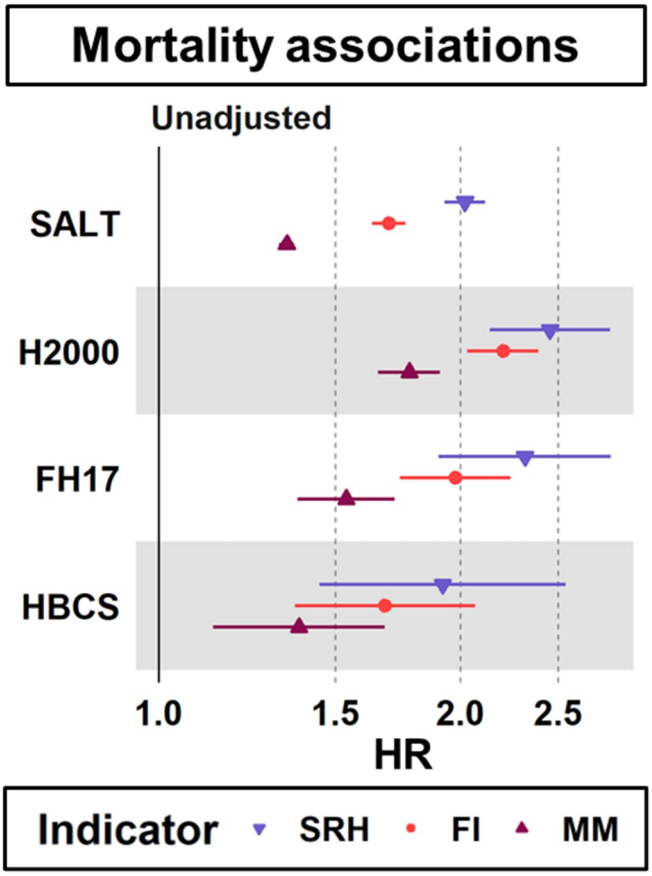


b



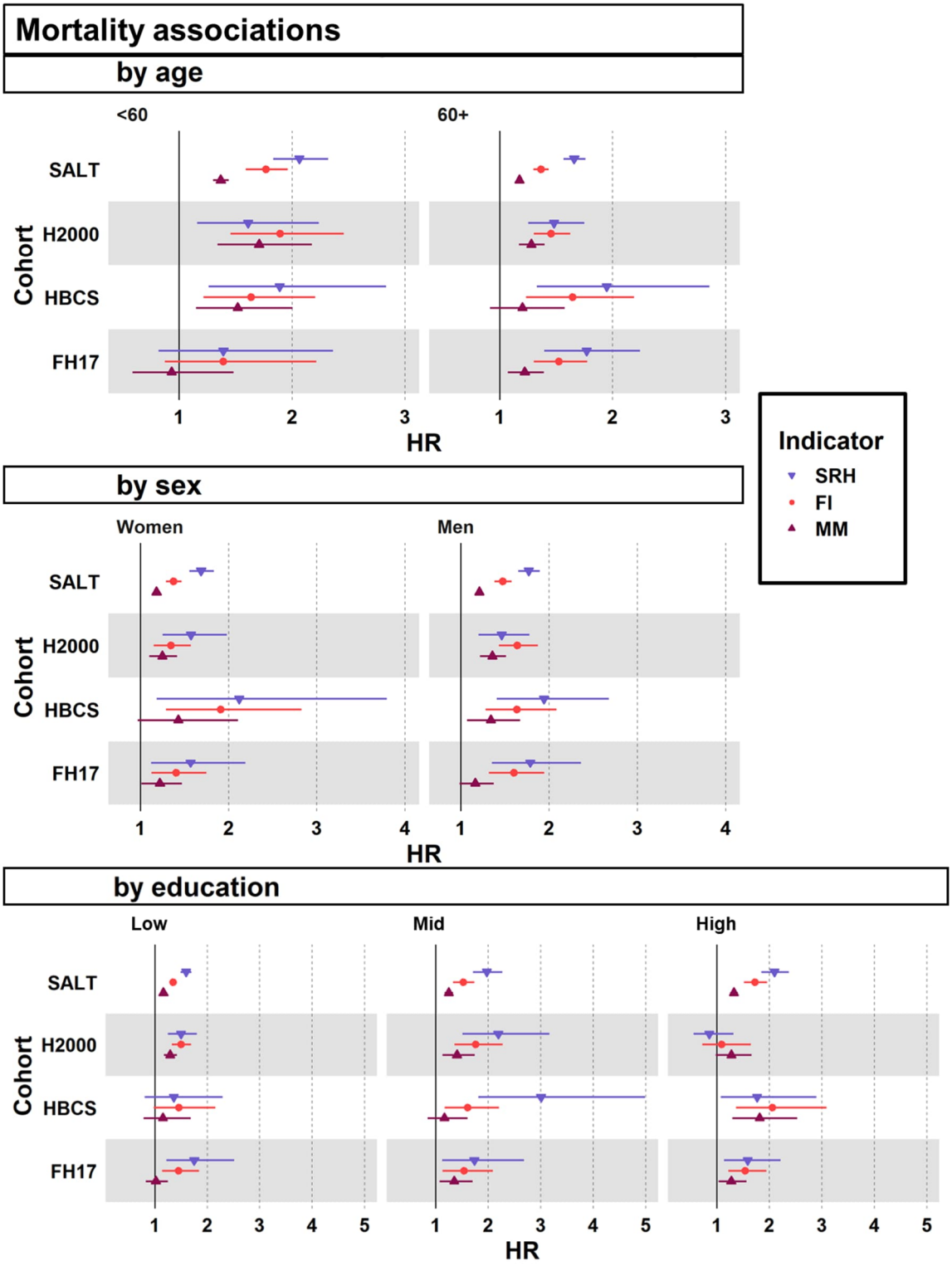
Note. In panel a, the age- and sex-adjusted hazard ratios (HRs) and 95% Confidence intervals (CIs) are shown for MM (number of diseases), FI (frailty index) and SRH (self-rated health) and the corresponding C-indices for each model are shown in panel b. Models in panel a (panel headings) and b (on the x-axis): ***Null***=model including age and sex only, ***MM***=model including number of diseases, age and sex, ***FI***=model including FI, age and sex, and ***SRH***=model including SRH, age and sex. The models were repeated also stratified by age, sex and education (panel a and b). *Abbreviations.* SALT, the Screening Across the Lifespan Twin Study

Supplementary Figure 3. Unadjusted mortality associations of SRH, FI and number of diseases in the four cohorts



Note. The forestplot shows unadjusted hazard ratios (HRs) and 95% confidence intervals for four-year all-cause-mortality per one-unit- change in self-rated health (SRH), one-unit-change in number of diseases (MM) and 10% increase in the frailty-index (FI). The three health indicators were analysed in separate models in each cohort (SALT n=47 072, H2000 n=6 108, HBCS n=1 999, FH17 n=4 389 and CAMB n=5 302). Numeric estimates are shown in Supplementary Table 3. *Abbreviations.* SALT, the Screening Across the Lifespan Twin Study; H2000, the Health 2000 Study; HBCS, the Helsinki Birth Cohort Study; FH17, the National FinHealth 2017 Study.

Supplementary Figure 4. Mortality associations of SRH, FI and number of diseases in different subgroups in the four cohorts



Note. The forestplot visualizes age- and sex-adjusted hazard ratios (HRs) and 95% confidence intervals for four-year all-cause-mortality per one-unit-change in self-rated health (SRH), 10% increase in the FI and one-unit-change in number of diseases (MM). The three health indicators were analyzed in separate models in each cohort (SALT n=47 072, H2000 n=6 108, HBCS n=1 999, FH17 n=4 389) stratified by age, sex and education level. Mortality and group sizes in each population are described in Table 1. Numeric estimates of the models are shown in Supplementary Table 6. *Abbreviations*. SALT, the Screening Across the Lifespan Twin Study; H2000, the Health 2000 Study; HBCS, the Helsinki Birth Cohort Study; FH17, the National FinHealth 2017 Study.

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