

Supplementary Materials:

Frailty Index as a Predictor of Migraine Risk Across the Life Course: A Multi-Level Study from Global Spatial Patterns to Individual Longitudinal Associations

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Contents

Details of data sources2

 Table S1: Detailed data sources and participants2

Extracted indicators in three databases2

 GBD database2

 Table S2: 37 items of recognized in 20172

 NHANES database3

 Table S3: Variables and scorings in the 39-Item frailty index from 1999–20043

 CHARLS database4

 Table S4: Detailed description of 32 items in four waves4

Detail of Baseline characteristics5

 NHANES data5

 Table S5: Baseline characteristics of the study population in the NHANES 1999–2004 5

 CHARLS data6

 Table S6: Baseline characteristics of the study population in the CHARLS wave1-46

Individually and commonly dominant countries and regions of frailty index and migraine9

 Incidence9

 Table S7: Detailed presentations of frailty index and incidence of migraine 9

 Prevalence10

 Table S8: Detailed presentations of frailty index and prevalence of migraine10

Subtypes analysis and logistic regression11

Table S9: The result subtype analyses and interaction tests of the participants from NHANES 1999-2004 data	11
Table S10 The different statistic values of the continuous variables and categorical variables	12

Details of data sources

Table S1. Detailed data sources and participants.

Data Source	Participants
Global Burden of Disease Study (GBD)	Population in 204 countries
National Health and Nutrition Examination Survey (NHANES)	5015 American adults and adolescents
China Health and Retirement Longitudinal Study (CHARLS)	3852 middle-aged and elderly Chinese aged 45 and above

Extracted indicators in three databases

GBD database

Table S2. 37 items of recognized in 2017 aged 70 years and older.

No.	Causes
1.	Diarrheal diseases
2.	Protein-energy malnutrition
3.	Neoplasms
4.	Ischemic heart disease
5.	Stroke
6.	Non-rheumatic valvular heart disease
7.	Cardiomyopathy and myocarditis
8.	Atrial fibrillation and flutter
9.	Peripheral artery disease
10.	Other cardiovascular and circulatory diseases
11.	Heart failure
12.	High systolic blood pressure
13.	Chronic respiratory diseases
14.	Peptic ulcer disease
15.	Gallbladder and biliary diseases
16.	Alzheimer's disease and other dementias
17.	Parkinson's disease
18.	Major depressive disorder
19.	Diabetes mellitus
20.	Chronic kidney disease
21.	Skin and subcutaneous diseases
22.	Hearing loss
23.	Blindness and vision impairment
24.	Other sense organ diseases
25.	Rheumatoid arthritis
26.	Osteoarthritis
27.	Low back pain
28.	Gout
29.	Low bone mineral density
30.	Urinary diseases and male infertility
31.	Genital prolapse
32.	Endocrine, metabolic, blood, and immune disorders

33.	High LDL cholesterol
34.	Edentulism and severe tooth loss
35.	Falls
36.	Low physical activity

$$GBD:FI = \frac{\sum 36 - \text{Items frailty index}}{36}$$

NHANES database

Table S3. Variables and scorings in the 39-Item frailty index from 1999–2004.

Items	Scores
Cognition	
1.experience confusion/memory problems	yes=1, no=0
Dependence	
2.managing money difficulty	no difficulty=0, Some difficulty=0.33, much difficulty=0.66, unable to do/ do not do this activity=1
3.walking for a quarter mile difficulty	no difficulty=0, Some difficulty=0.33, much difficulty=0.66, unable to do/ do not do this activity=1
4.walking up ten steps difficulty	no difficulty=0, Some difficulty=0.33, much difficulty=0.66, unable to do/ do not do this activity=1
5.stooping, crouching, kneeling difficulty	no difficulty=0, Some difficulty=0.33, much difficulty=0.66, unable to do/ do not do this activity=1
6.lifting or carrying difficulty	no difficulty=0, Some difficulty=0.33, much difficulty=0.66, unable to do/ do not do this activity=1
7.house chore difficulty	no difficulty=0, Some difficulty=0.33, much difficulty=0.66, unable to do/ do not do this activity=1
8.preparing meals difficulty	no difficulty=0, Some difficulty=0.33, much difficulty=0.66, unable to do/ do not do this activity=1
9.standing up from armless chair difficulty	no difficulty=0, Some difficulty=0.33, much difficulty=0.66, unable to do/ do not do this activity=1
10.getting in and out of bed difficulty	no difficulty=0, Some difficulty=0.33, much difficulty=0.66, unable to do/ do not do this activity=1
11.using fork, knife, drinking from cup difficulty	no difficulty=0, Some difficulty=0.33, much difficulty=0.66, unable to do/ do not do this activity=1
12.dressing yourself difficulty	no difficulty=0, Some difficulty=0.33, much difficulty=0.66, unable to do/ do not do this activity=1
13.standing for long periods difficulty	no difficulty=0, Some difficulty=0.33, much difficulty=0.66, unable to do/ do not do this activity=1
14.grasp/holding small objects difficulty	no difficulty=0, Some difficulty=0.33, much difficulty=0.66, unable to do/ do not do this activity=1
15.attending social event difficulty	no difficulty=0, Some difficulty=0.33, much difficulty=0.66, unable to do/ do not do this activity=1
16.leisure activity at home difficulty	no difficulty=0, Some difficulty=0.33, much difficulty=0.66, unable to do/ do not do this activity=1
Comorbidities	
17.doctor ever said you had arthritis	yes = 1, no = 0
18.ever told you had thyroid problem	yes = 1, no = 0
19.ever told you had chronic bronchitis	yes = 1, no = 0
20.ever told you had cancer or malignancy	yes = 1, no = 0
21.ever told had congestive heart failure	yes = 1, no = 0
22.ever told you had coronary heart disease	yes = 1, no = 0
23.ever told you had angina/angina pectoris	yes = 1, no = 0
24.ever told you had heart attack	yes = 1, no = 0
25.ever told you had a stroke	yes = 1, no = 0

26. ever told you had high blood pressure	yes = 1, no = 0
27. doctor told you have diabetes	yes = 1, borderline=0.5, no =0
28. ever told you had weak/failing kidneys	yes = 1, no =0
Hospital and Care	
29. general health condition	excellent, very good, good = 0, fair, poor = 1
30. health now compared with 1 year ago	worse =1, about the same, better = 0
31. overnight hospital patient in last year	yes =1, no =0
32. number of prescription medicines taken	no =0, 1-4=0.5, ≥5 =1
Physical Anthropometry	
33. body mass index (kg/m ²)	<18.5, ≥30=1 ≥25, <30=0.5 ≥18.5, <25=0
Laboratory values	
34. glycohemoglobin (%)	0%-5.7%=0, >5.7%=1
35. red blood cell count (million cells/ul)	M: ≥4.7, <6.1=0, Other=1; F: ≥4.2, <5.4=0, Other=1
36. hemoglobin (g/dl)	M: ≥13.5, <18 =0, Other =1; F: ≥12, <16 =0, Other=1
37. red cell distribution width (%)	≥11.6, <14.6=0, Other=1
38. lymphocyte percent (%)	≥20, <40=0, Other=1
39. segmented neutrophils percent (%)	≥40, <80=0, Other=1

$$NHANES:FI = \frac{\sum 39 - \text{Items frailty index}}{39}$$

CHARLS database

Table S4. Detailed variables description and respective scorings of 32 items in four waves.

No	Description of the items	Cut-off value
1	Self-reported physician diagnosed hypertension	Yes = 1, No = 0
2	Self-reported physician diagnosed diabetes	Yes = 1, No = 0
3	Self-reported physician diagnosed heart disease	Yes = 1, No = 0
4	Self-reported physician diagnosed stroke	Yes = 1, No = 0
5	Self-reported physician diagnosed cancer	Yes = 1, No = 0
6	Self-reported physician diagnosed arthritis	Yes = 1, No = 0
7	Self-reported physician diagnosed chronic lung disease	Yes = 1, No = 0
8	Self-reported physician diagnosed asthma	Yes = 1, No = 0
9	Self-reported physician diagnosed any emotional, nervous, or psychiatric problems	Yes = 1, No = 0
10	Self-reported physician diagnosed memory-related disease	Yes = 1, No = 0
11	Self-reported vision problems	Yes = 1, No = 0
12	Self-reported hearing problems	Yes = 1, No = 0
13	Self-reported general health status	Fair/poor/very poor = 1, very good/good = 0
14	Difficulty with dressing	Yes = 1, No = 0
15	Difficulty with bathing or showering	Yes = 1, No = 0
16	Difficulty with eating	Yes = 1, No = 0
17	Difficulty with getting in and out of bed	Yes = 1, No = 0
18	Difficulty with using the toilet	Yes = 1, No = 0
19	Difficulty with managing money	Yes = 1, No = 0
20	Difficulty with taking medications	Yes = 1, No = 0
21	Difficulty with shopping for groceries	Yes = 1, No = 0
22	Difficulty with preparing meals	Yes = 1, No = 0
23	Difficulty with doing housework	Yes = 1, No = 0
24	Mobility: difficulty with walking 100 yards	Yes = 1, No = 0

25	Mobility: difficulty with getting up from a chair after sitting for long periods	Yes = 1, No = 0
26	Mobility: difficulty with climbing several flights of stairs without resting	Yes = 1, No = 0
27	Mobility: difficulty with lifting or carrying weights over 10 pounds/jins	Yes = 1, No = 0
28	Mobility: difficulty with picking up a coin from the table	Yes = 1, No = 0
29	Mobility: difficulty with stooping, kneeling, or crouching	Yes = 1, No = 0
30	Mobility: difficulty with reaching arms above shoulder level	Yes = 1, No = 0
31	Depression: CESD-10 questionnaire	CESD-10: >10 =1, ≤10 =0
32	Cognition: {[(10-immediate word recall score) + (10-delayed word recall score)]/2+ (4-orientation test score)}/ 14	Continuous, ranging from 0 to 1

$$CHARLS:FI = \frac{\sum 32 - \text{Items frailty index}}{32}$$

Detail of Baseline characteristics

NHANES data

Table S5. Baseline characteristics of the study population in the NHANES, 1999-2004.

Characteristic	N	Overall, N = 5015 (100%) ¹	No N = 4067 (77%) ¹	Yes N = 948 (23%) ¹	p-value ²
Age (years)	5,015	59.47 ± 16.13	62.59 ± 15.02	49.15 ± 15.36	<0.001
PIR	5,015	2.72 ± 1.58	2.84 ± 1.57	2.33 ± 1.55	<0.001
BMI	5,015	28.76 ± 6.47	28.51 ± 6.01	29.56 ± 7.76	0.011
Age_group	5,015				<0.001
>=20-39		444 (14%)	229 (9.5%)	215 (29%)	
40-59		813 (26%)	492 (21%)	321 (43%)	
60-80+		3,758 (60%)	3,346 (70%)	412 (28%)	
Gender	5,015				<0.001
Female		2,546 (55%)	1,955 (52%)	591 (64%)	
Male		2,469 (45%)	2,112 (48%)	357 (36%)	
Race	5,015				0.014
Non-Hispanic White		2,877 (79%)	2,410 (81%)	467 (72%)	
Mexican American		984 (3.8%)	775 (3.5%)	209 (4.9%)	
Non-Hispanic Black		827 (8.9%)	640 (8.3%)	187 (11%)	
Other Hispanic		179 (4.5%)	130 (4.0%)	49 (6.0%)	
Other race		148 (4.2%)	112 (3.6%)	36 (5.9%)	
BMI_group	5,015				<0.001
<25		1,416 (29%)	1,153 (29%)	263 (31%)	
>30		1,677 (35%)	1,314 (33%)	363 (40%)	
25-30		1,922 (36%)	1,600 (38%)	322 (29%)	
PIR_group	5,015				<0.001
<1.30		1,611 (26%)	1,215 (24%)	396 (35%)	
>=3.50		1,369 (35%)	1,178 (37%)	191 (27%)	
1.30-3.49		2,035 (39%)	1,674 (39%)	361 (38%)	
Educational_Level	5,015				0.022
College or above			1,884 (46%)	1,579 (47%)	305 (41%)
High school or GED			2,064 (44%)	1,622 (42%)	442 (49%)

Less than high school		1,067 (10%)	866 (11%)	201 (9.9%)	
Marital_Status	5,015				<0.001
Living alone		2,001 (37%)	1,595 (37%)	406 (39%)	
Living with a partner		154 (3.7%)	88 (2.5%)	66 (7.4%)	
Married		2,860 (59%)	2,384 (61%)	476 (54%)	
Smoking_status	5,015				<0.001
Current smoker		921 (22%)	657 (19%)	264 (32%)	
Former smoker		1,831 (34%)	1,565 (36%)	266 (26%)	
Never smoker		2,263 (44%)	1,845 (45%)	418 (42%)	
Drinking_status	5,015				>0.9
Yes		3,192 (65%)	2,608 (65%)	584 (65%)	
No		1,823 (35%)	1,459 (35%)	364 (35%)	
Physical_activity	5,015				0.3
Yes		2,112 (47%)	1,750 (48%)	362 (46%)	
No		2,903 (53%)	2,317 (52%)	586 (54%)	
hypertension_status	5,015				<0.001
Yes		3,171 (57%)	2,648 (60%)	523 (49%)	
No		1,844 (43%)	1,419 (40%)	425 (51%)	
Diabetes_status	5,015				0.027
Yes		842 (13%)	693 (14%)	149 (11%)	
No		4,173 (87%)	3,374 (86%)	799 (89%)	
FI	5,015		0.13 (0.08, 0.21)	0.17 (0.11, 0.27)	<0.001
FI_group	5,015				
Frail		1,114 (20%)	806 (17%)	308 (29%)	
Pre-frail		2,464 (48%)	2,009 (48%)	455 (48%)	
Robust		1,437 (32%)	1,252 (35%)	185 (23%)	

¹ mean $\pm$ SD for Age, PIR, BMI; median (IQR) for frailty index (FI); n (%) for categorical. ² Design-based Kruskal Wallis test; Pearson's χ^2 : Rao & Scott adjustment.

CHARLS data

Table S6. Baseline characteristics of the study population in the CHARLS, wave 1-4 (wave 1: 2011; wave 2: 2013; wave 3: 2015; wave 4: 2018).

Wave 1		Frail	Pre-frail	Robust	P test
n		431	1673	1748	
r1agey (mean (SD))		61.67 (8.05)	58.57 (8.17)	56.64 (8.10)	<0.001
gender (%)	Female	333 (77.3)	1187 (71.0)	1062 (60.8)	<0.001
	Male	98 (22.7)	486 (29.0)	686 (39.2)	
r1marital_status (%)	Married or partnered	369 (85.6)	1479 (88.4)	1600 (91.5)	<0.001
	Other marital status	62 (14.4)	194 (11.6)	148 (8.5)	
r1education (%)	College or above	3 (0.7)	33 (2.0)	54 (3.1)	<0.001
	Elementary school or below	370 (85.8)	1240 (74.1)	1114 (63.7)	
	Middle school	58 (13.5)	400 (23.9)	580 (33.2)	
r1hukou (%)	Rural	384 (89.1)	1425 (85.2)	1469 (84.0)	0.03
	Urban	47 (10.9)	248 (14.8)	279 (16.0)	
r1mbmi (mean (SD))		23.98 (3.93)	24.15 (4.14)	23.41 (3.44)	<0.001
r1bmi (%)	Obesity	68 (15.8)	278 (16.6)	159 (9.1)	<0.001
	Overweight	123 (28.5)	518 (31.0)	528 (30.2)	
	Underweight or normal weight	240 (55.7)	877 (52.4)	1061 (60.7)	

r1smoke (%)	Current Smoker	46 (10.7)	224 (13.4)	332 (19.0)	<0.001
	Former Smoker	17 (3.9)	70 (4.2)	60 (3.4)	
	Never Smoked	368 (85.4)	1379 (82.4)	1356 (77.6)	
r1drink (%)	Current Drinker	62 (14.4)	357 (21.3)	451 (25.8)	<0.001
	Former Drinker	40 (9.3)	127 (7.6)	89 (5.1)	
	Never Drinker	329 (76.3)	1189 (71.1)	1208 (69.1)	
r1lipid (%)	No	343 (79.6)	1452 (86.8)	1646 (94.2)	<0.001
	Yes	88 (20.4)	221 (13.2)	102 (5.8)	
r1hypertension (%)	No	240 (55.7)	1109 (66.3)	1528 (87.4)	<0.001
	Yes	191 (44.3)	564 (33.7)	220 (12.6)	
r1diabetes (%)	No	377 (87.5)	1536 (91.8)	1719 (98.3)	<0.001
	Yes	54 (12.5)	137 (8.2)	29 (1.7)	
r1F (median (IQR))		0.32 (0.27,0.39)	0.15 (0.11,0.19)	0.05 (0.04,0.08)	<0.001

Wave 2

	Level	Frail	Pre-frail	Robust	P test
n		542	1671	1639	
r2agey (mean (SD))		62.72 (7.84)	60.46 (8.32)	58.77 (8.14)	<0.001
gender (%)	Female	416 (76.8)	1167 (69.8)	999 (61.0)	<0.001
	Male	126 (23.2)	504 (30.2)	640 (39.0)	
r2marital_status (%)	Married or partnered	451 (83.2)	1464 (87.6)	1489 (90.8)	<0.001
	Other marital status	91 (16.8)	207 (12.4)	150 (9.2)	
r1education (%)	College or above	6 (1.1)	30 (1.8)	54 (3.3)	<0.001
	Elementary school or below	448 (82.7)	1219 (73.0)	1057 (64.5)	
	Middle school	88 (16.2)	422 (25.3)	528 (32.2)	
r2hukou (%)	Rural	467 (86.2)	1410 (84.4)	1362 (83.1)	0.218
	Urban	75 (13.8)	261 (15.6)	277 (16.9)	
r2mbmi (mean (SD))		24.52 (4.20)	24.26 (3.91)	23.74 (3.41)	<0.001
r2bmi (%)	Obesity	117 (21.6)	263 (15.7)	165 (10.1)	<0.001
	Overweight	147 (27.1)	572 (34.2)	546 (33.3)	
	Underweight or normal weight	278 (51.3)	836 (50.0)	928 (56.6)	
r2smoke (%)	Current Smoker	61 (11.3)	233 (13.9)	298 (18.2)	<0.001
	Former Smoker	50 (9.2)	141 (8.4)	119 (7.3)	
	Never Smoked	431 (79.5)	1297 (77.6)	1222 (74.6)	
r2drink (%)	Current Drinker	118 (21.8)	390 (23.3)	525 (32.0)	<0.001
	Former Drinker	61 (11.3)	156 (9.3)	111 (6.8)	
	Never Drinker	363 (67.0)	1125 (67.3)	1003 (61.2)	
r2lipid (%)	No	414 (76.4)	1404 (84.0)	1524 (93.0)	<0.001
	Yes	128 (23.6)	267 (16.0)	115 (7.0)	
r2hypertension (%)	No	270 (49.8)	1026 (61.4)	1427 (87.1)	<0.001
	Yes	272 (50.2)	645 (38.6)	212 (12.9)	
r2diabetes (%)	No	445 (82.1)	1501 (89.8)	1600 (97.6)	<0.001
	Yes	97 (17.9)	170 (10.2)	39 (2.4)	
r2FI (median (IQR))		0.32 (0.27,0.39)	0.15 (0.12,0.19)	0.05 (0.04, 0.08)	<0.001
r2migraine (%)	No	509 (93.9)	1659 (99.3)	1635 (99.8)	<0.001
	Yes	33 (6.1)	12 (0.7)	4 (0.2)	

Wave 3

	Level	Frail	Pre-frail	Robust	P test
n		721	1800	1331	
r3agey (mean (SD))		64.68 (7.80)	62.17 (8.38)	60.40 (8.00)	<0.001
gender (%)	Female	566 (78.5)	1237 (68.7)	779 (58.5)	<0.001
	Male	155 (21.5)	563 (31.3)	552 (41.5)	
r3marital_status (%)	Married or partnered	570 (79.1)	1558 (86.6)	1202 (90.3)	<0.001

	<i>Other marital status</i>	151 (20.9)	242 (13.4)	129 (9.7)	
<i>r1education (%)</i>	<i>College or above</i>	8 (1.1)	33 (1.8)	49 (3.7)	<0.001
	<i>Elementary school or below</i>	619 (85.9)	1275 (70.8)	830 (62.4)	
	<i>Middle school</i>	94 (13.0)	492 (27.3)	452 (34.0)	
<i>r3hukou (%)</i>	<i>Rural</i>	618 (85.7)	1508 (83.8)	1099 (82.6)	0.183
	<i>Urban</i>	103 (14.3)	292 (16.2)	232 (17.4)	
<i>r3mbmi (mean (SD))</i>		24.42 (4.28)	24.00 (3.73)	23.56 (3.31)	<0.001
<i>r3bmi (%)</i>	<i>Obesity</i>	137 (19.0)	239 (13.3)	128 (9.6)	<0.001
	<i>Overweight</i>	237 (32.9)	604 (33.6)	442 (33.2)	
	<i>Underweight or normal weight</i>	347 (48.1)	957 (53.2)	761 (57.2)	
<i>r3smoke (%)</i>	<i>Current Smoker</i>	62 (8.6)	241 (13.4)	238 (17.9)	<0.001
	<i>Former Smoker</i>	91 (12.6)	208 (11.6)	153 (11.5)	
	<i>Never Smoked</i>	568 (78.8)	1351 (75.1)	940 (70.6)	
<i>r3drink (%)</i>	<i>Current Drinker</i>	162 (22.5)	445 (24.7)	426 (32.0)	<0.001
	<i>Former Drinker</i>	80 (11.1)	199 (11.1)	94 (7.1)	
	<i>Never Drinker</i>	479 (66.4)	1156 (64.2)	811 (60.9)	
<i>r3lipid (%)</i>	<i>No</i>	494 (68.5)	1413 (78.5)	1184 (89.0)	<0.001
	<i>Yes</i>	227 (31.5)	387 (21.5)	147 (11.0)	
<i>r3hypertension (%)</i>	<i>No</i>	320 (44.4)	1067 (59.3)	1123 (84.4)	<0.001
	<i>Yes</i>	401 (55.6)	733 (40.7)	208 (15.6)	
<i>r3diabetes (%)</i>	<i>No</i>	574 (79.6)	1568 (87.1)	1300 (97.7)	<0.001
	<i>Yes</i>	147 (20.4)	232 (12.9)	31 (2.3)	
<i>r3FI (median (IQR))</i>		0.33 (0.29,0.42)	0.15 (0.12,0.20)	0.05 (0.04,0.08)	<0.001
<i>r3migraine (%)</i>	<i>No</i>	691 (95.8)	1784 (99.1)	1328 (99.8)	<0.001
	<i>Yes</i>	30 (4.2)	16 (0.9)	3 (0.2)	

Wave 4

	Level	Frail	Pre-frail	Robust	P test
n		1029	1670	1153	
<i>r4agey (mean (SD))</i>		67.74 (8.03)	64.77 (8.23)	62.96 (7.90)	<0.001
<i>gender (%)</i>	<i>Female</i>	786 (76.4)	1118 (66.9)	678 (58.8)	<0.001
	<i>Male</i>	243 (23.6)	552 (33.1)	475 (41.2)	
<i>r4marital_status (%)</i>	<i>Married or partnered</i>	788 (76.6)	1399 (83.8)	998 (86.6)	<0.001
	<i>Other marital status</i>	241 (23.4)	271 (16.2)	155 (13.4)	
<i>r1education (%)</i>	<i>College or above</i>	15 (1.5)	36 (2.2)	39 (3.4)	<0.001
	<i>Elementary school or below</i>	853 (82.9)	1164 (69.7)	707 (61.3)	
	<i>Middle school</i>	161 (15.6)	470 (28.1)	407 (35.3)	
<i>r4hukou (%)</i>	<i>Rural</i>	889 (86.4)	1375 (82.3)	947 (82.1)	0.009
	<i>Urban</i>	140 (13.6)	295 (17.7)	206 (17.9)	
<i>r4smoke (%)</i>	<i>Current Smoker</i>	106 (10.3)	237 (14.2)	186 (16.1)	0.002
	<i>Former Smoker</i>	124 (12.1)	202 (12.1)	120 (10.4)	
	<i>Never Smoked</i>	799 (77.6)	1231 (73.7)	847 (73.5)	
<i>r4drink (%)</i>	<i>Current Drinker</i>	168 (16.3)	400 (24.0)	363 (31.5)	<0.001
	<i>Former Drinker</i>	169 (16.4)	200 (12.0)	127 (11.0)	
	<i>Never Drinker</i>	692 (67.2)	1070 (64.1)	663 (57.5)	
<i>r4lipid (%)</i>	<i>No</i>	649 (63.1)	1275 (76.3)	1010 (87.6)	<0.001
	<i>Yes</i>	380 (36.9)	395 (23.7)	143 (12.4)	
<i>r4hypertension (%)</i>	<i>No</i>	395 (38.4)	914 (54.7)	902 (78.2)	<0.001
	<i>Yes</i>	634 (61.6)	756 (45.3)	251 (21.8)	
<i>r4diabetes (%)</i>	<i>No</i>	752 (73.1)	1431 (85.7)	1112 (96.4)	<0.001
	<i>Yes</i>	277 (26.9)	239 (14.3)	41 (3.6)	
<i>r4FI (median (IQR))</i>		0.36 (0.30,0.46)	0.16 (0.13,0.20)	0.06 (0.04,0.08)	<0.001
<i>r4migraine (%)</i>	<i>No</i>	794 (77.2)	1515 (90.7)	1121 (97.2)	<0.001
	<i>Yes</i>	235 (22.8)	155 (9.3)	32 (2.8)	
n		1029	1670	1153	

Age (mean (SD))		67.74 (8.03)	64.77 (8.23)	62.96 (7.90)	<0.001
gender (%)	Female	786 (76.4)	1118 (66.9)	678 (58.8)	<0.001
	Male	243 (23.6)	552 (33.1)	475 (41.2)	

Individually and commonly dominant countries and regions of frailty index and migraine

Incidence

Table S7. Detailed presentations of frailty index and incidence of migraine. List of 204 countries and territories by co-dominance pattern of frailty index and disease incidence.

Incidence	Countries
FI-dominated	Andorra, Antigua and Barbuda, Argentina, Australia, Austria, Bahamas, Bangladesh, Belarus, Belgium, Bermuda, Bolivia (Plurinational State of), Brunei Darussalam, Bulgaria, Burundi, Canada, Chile, Colombia, Cook Islands, Costa Rica, Croatia, Cuba, Cyprus, Czechia, Denmark, Dominica, Ecuador, El Salvador, Equatorial Guinea, Estonia, Finland, France, Germany, Greece, Greenland, Guinea, Haiti, Hungary, Iceland, Ireland, Israel, Italy, Jamaica, Kuwait, Lao People's Democratic Republic, Lebanon, Lithuania, Malaysia, Mauritania, Monaco, Mozambique, Netherlands, New Zealand, Norway, Palau, Panama, Paraguay, Puerto Rico, Republic of Korea, Republic of Moldova, Romania, San Marino, Serbia, Singapore, Somalia, South Sudan, Sweden, Switzerland, Thailand, Turkmenistan, United States of America, United States Virgin Islands, Uruguay, Venezuela (Bolivarian Republic of)
Migraine-dominated	Afghanistan, Albania, Algeria, American Samoa, Armenia, Bahrain, Benin, Bhutan, Botswana, Brazil, Burkina Faso, Cambodia, Cameroon, Central African Republic, China, Comoros, Congo, Côte d'Ivoire, Democratic People's Republic of Korea, Democratic Republic of the Congo, Ethiopia, Fiji, Gabon, Gambia, Grenada, Guinea-Bissau, Guyana, India, Indonesia, Iran (Islamic Republic of), Jordan, Kenya, Kiribati, Kyrgyzstan, Latvia, Lesotho, Libya, Madagascar, Maldives, Mali, Marshall Islands, Mauritius, Micronesia (Federated States of), Mongolia, Montenegro, Morocco, Myanmar, Nepal, Nigeria, Niue, Northern Mariana Islands, Oman, Pakistan, Papua New Guinea, Philippines, Poland, Saint Vincent and the Grenadines, Samoa, Sao Tome and Principe, Saudi Arabia, Seychelles, Solomon Islands, South Africa, Sri Lanka, Sudan, Suriname, Taiwan (Province of China), Togo, Tonga, Trinidad and Tobago, Turkey, Tuvalu, Uganda, United Republic of Tanzania, Uzbekistan, Vanuatu, Viet Nam, Yemen, Zambia, Zimbabwe
Coexistence	Angola, Azerbaijan, Barbados, Belize, Bosnia and Herzegovina, Cabo Verde, Chad, Djibouti, Dominican Republic, Egypt, Eritrea, Eswatini, Georgia, Ghana, Guam, Guatemala, Honduras, Iraq, Japan, Kazakhstan, Liberia, Luxembourg, Malawi, Malta, Mexico, Namibia, Nauru, Nicaragua, Niger, North Macedonia, Palestine, Peru, Portugal, Qatar, Russian Federation, Rwanda, Saint Kitts and Nevis, Saint Lucia, Senegal, Sierra Leone, Slovakia, Slovenia, Spain, Syrian Arab Republic, Tajikistan, Timor-Leste, Tokelau, Tunisia, Ukraine, United Arab Emirates, United Kingdom

Prevalence

Table S8. Detailed presentations of frailty index and prevalence of migraine. List of 204 countries and territories by co-dominance pattern of frailty index and disease prevalence.

Prevalence	Countries
FI-dominated	Andorra, Angola, Antigua and Barbuda, Argentina, Australia, Austria, Bahamas, Bangladesh, Barbados, Bermuda, Bolivia (Plurinational State of), Brunei Darussalam, Bulgaria, Burundi, Chile, Colombia, Cook Islands, Costa Rica, Cuba, Cyprus, Denmark, Djibouti, Dominica, Ecuador, Egypt, El Salvador, Equatorial Guinea, Eritrea, Estonia, Eswatini, Finland, France, Germany, Greece, Greenland, Guatemala, Guinea, Haiti, Iceland, Israel, Jamaica, Kenya, Kuwait, Lebanon, Lithuania, Malawi, Malaysia, Mauritania, Monaco, Mozambique, Namibia, Netherlands, New Zealand, Nicaragua, Norway, Panama, Paraguay, Puerto Rico, Qatar, Republic of Korea, Republic of Moldova, Romania, Rwanda, San Marino, Senegal, Serbia, Singapore, Somalia, South Sudan, Sweden, Switzerland, Syrian Arab Republic, Tunisia, Turkmenistan, United Arab Emirates, United States of America, United States Virgin Islands, Uruguay
Migraine-dominated	Afghanistan, Albania, Algeria, American Samoa, Armenia, Bahrain, Benin, Bhutan, Bosnia and Herzegovina, Botswana, Brazil, Burkina Faso, Cambodia, Cameroon, Central African Republic, China, Côte d'Ivoire, Democratic People's Republic of Korea, Democratic Republic of the Congo, Fiji, Gabon, Gambia, Grenada, Guinea-Bissau, Guyana, India, Indonesia, Iran (Islamic Republic of), Jordan, Kiribati, Kyrgyzstan, Latvia, Libya, Maldives, Malta, Marshall Islands, Mauritius, Micronesia (Federated States of), Mongolia, Montenegro, Morocco, Myanmar, Nepal, Nigeria, Niue, North Macedonia, Northern Mariana Islands, Oman, Pakistan, Papua New Guinea, Philippines, Poland, Portugal, Russian Federation, Samoa, Saudi Arabia, Seychelles, Slovakia, Slovenia, Solomon Islands, Spain, Sri Lanka, Sudan, Suriname, Taiwan (Province of China), Timor-Leste, Togo, Tonga, Turkey, Tuvalu, Ukraine, United Kingdom, Uzbekistan, Vanuatu, Viet Nam
Coexistence	Azerbaijan, Belarus, Belgium, Belize, Cabo Verde, Canada, Chad, Comoros, Congo, Croatia, Czechia, Dominican Republic, Ethiopia, Georgia, Ghana, Guam, Honduras, Hungary, Iraq, Ireland, Italy, Japan, Kazakhstan, Lao People's Democratic Republic, Lesotho, Liberia, Luxembourg, Madagascar, Mali, Mexico, Nauru, Niger, Palau, Palestine, Peru, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Sao Tome and Principe, Sierra Leone, South Africa, Tajikistan, Thailand, Tokelau, Trinidad and Tobago, Uganda, United Republic of Tanzania, Venezuela (Bolivarian Republic of), Yemen, Zambia, Zimbabwe

Subtypes analysis and logistic regression

Table S9. Results of subtype analyses and interaction tests in NHANES 1999-2004. (A) Forest plot for subgroup analyses of the association between FI and migraine (red: confidence intervals; blue dots: magnitude of OR). (B) Detailed data for all subgroup variables.

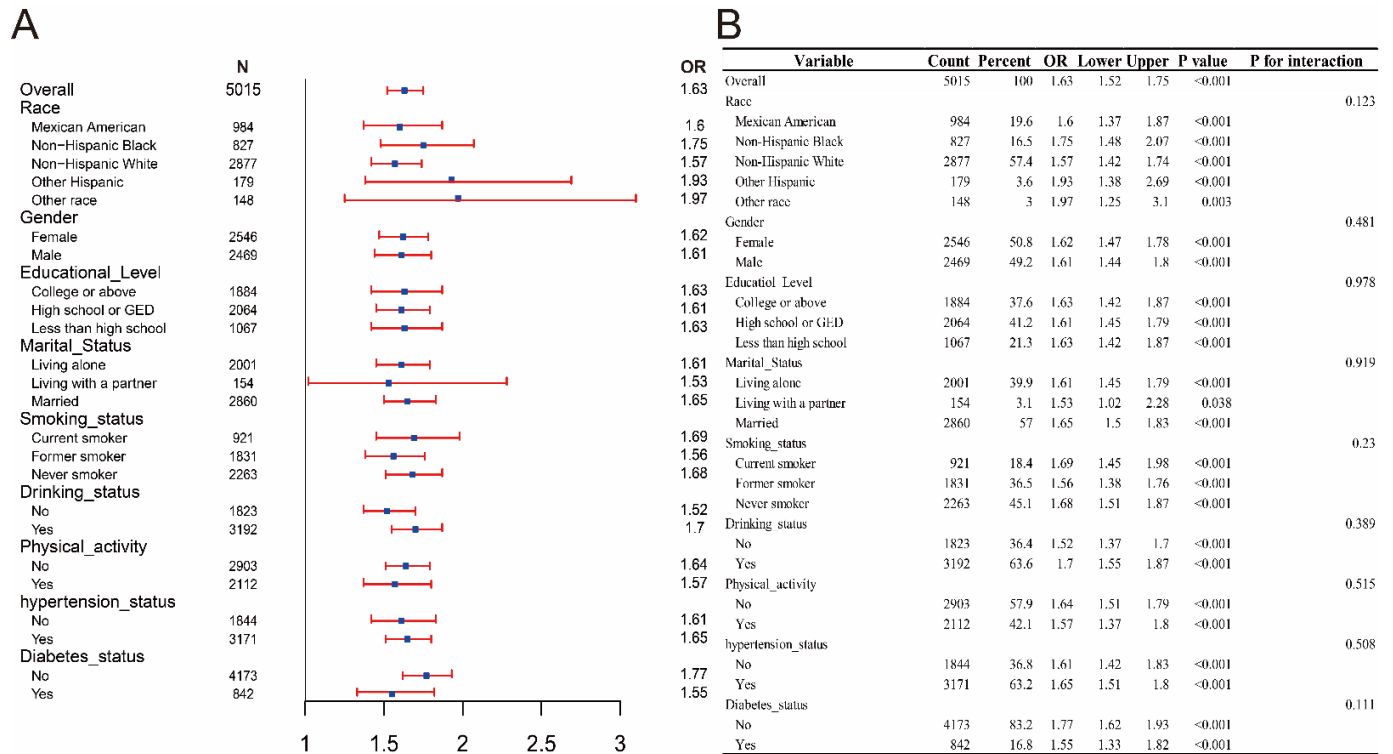


Table S10. The different statistic values of the continuous variables and categorical variables.

Variables	Univariate					Multivariate				
	β	S.E	Z	p	OR (95%CI)	β	S.E	Z	p	OR (95%CI)
Gender										
Male					1.00(Reference)					1.00(Reference)
Female	0.58	0.07	7.85	<0.01	1.79(1.55~2.07)	0.56	0.09	6.24	<0.01	1.75(1.47~2.09)
Age	-0.05	0.00	-22.09	<0.01	0.95(0.94~0.95)	-0.05	0.01	-7.42	<0.01	0.95(0.94~0.97)
Race										
Mexican American					1.00(Reference)					1.00(Reference)
Non-Hispanic White	-0.33	0.09	-3.56	<0.01	0.72(0.60~0.86)	-0.13	0.12	-1.08	0.28	0.88(0.70~1.11)
Non-Hispanic Black	0.08	0.11	0.70	0.48	1.08(0.87~1.35)	-0.16	0.14	-1.14	0.25	0.85(0.65~1.12)
Other Hispanic	0.33	0.18	1.81	0.07	1.40(0.97~2.00)	0.11	0.21	0.51	0.61	1.12(0.73~1.68)
Other race	0.18	0.21	0.85	0.4	1.19(0.79~1.77)	-0.04	0.23	-0.19	0.85	0.96(0.60~1.51)
PIR	-0.21	0.03	-8.50	<0.01	0.81(0.77~0.85)	-0.20	0.08	-2.44	0.01	0.82(0.70~0.96)
BMI	0.02	0.01	4.37	<0.01	1.02(1.01~1.04)	-0.01	0.01	-0.57	0.57	0.99(0.97~1.02)
Age group										
60-80+					1.00(Reference)					1.00(Reference)
>=20-39	2.03	0.11	18.75	<0.01	7.62(6.17~9.43)	0.44	0.27	1.62	0.11	1.55(0.91~2.63)
40-59	1.67	0.09	18.79	<0.01	5.30(4.45~6.31)	0.71	0.16	4.43	<0.01	2.03(1.49~2.78)
BMI group										
25-30					1.00(Reference)					1.00(Reference)
<25	0.13	0.09	1.37	0.17	1.13(0.95~1.36)	0.06	0.12	0.47	0.64	1.06(0.84~1.33)
>30	0.32	0.09	3.72	<0.01	1.37(1.16~1.62)	-0.13	0.13	-0.97	0.33	0.88(0.68~1.14)
PIR group										
<1.30					1.00(Reference)					1.00(Reference)
1.30-3.49	-0.41	0.08	-5.04	<0.01	0.66(0.56~0.78)	0.36	0.14	2.52	0.01	1.43(1.08~1.89)
>=3.50	-0.70	0.10	-7.19	<0.01	0.50(0.41~0.60)	0.59	0.32	1.83	0.07	1.80(0.96~3.38)
Educational Level										
Less than high school					1.00(Reference)					1.00(Reference)
High school or GED	0.16	0.09	1.69	0.09	1.17(0.98~1.42)	-0.19	0.12	-1.63	0.10	0.82(0.65~1.04)
College or above	-0.18	0.10	-1.83	0.07	0.83(0.68~1.01)	-0.42	0.13	-3.14	<0.01	0.66(0.51~0.85)
Marital Status										
Married					1.00(Reference)					1.00(Reference)
Living alone	0.24	0.07	3.24	<0.01	1.27(1.10~1.48)	-0.12	0.09	-1.33	0.18	0.89(0.74~1.06)
Living with a partner	1.32	0.17	7.77	<0.01	3.76(2.68~5.24)	0.54	0.20	2.71	<0.01	1.71(1.16~2.52)
Smoking status										
Former smoker					1.00(Reference)					1.00(Reference)
Current smoker	0.86	0.10	8.73	<0.01	2.36(1.95~2.87)	-0.03	0.12	-0.21	0.83	0.97(0.77~1.23)
Never smoker	0.29	0.09	3.36	<0.01	1.33(1.13~1.58)	-0.02	0.10	-0.22	0.83	0.98(0.81~1.19)
Drinking status										
Yes					1.00(Reference)					1.00(Reference)
No	0.11	0.07	1.45	0.15	1.11(0.96~1.29)	0.10	0.09	1.06	0.29	1.10(0.92~1.32)
Physical activity										
No					1.00(Reference)					1.00(Reference)
Yes	-0.20	0.07	-2.72	<0.01	0.82(0.71~0.95)	-0.01	0.09	-0.13	0.90	0.99(0.83~1.17)

Hypertension status										
Yes					1.00(Reference)					1.00(Reference)
No	0.42	0.07	5.69	<0.01	1.52(1.31~1.75)	-0.05	0.09	-0.52	0.60	0.95(0.79~1.15)
Diabetes status										
Yes					1.00(Reference)					1.00(Reference)
No	0.10	0.10	0.98	0.33	1.10(0.91~1.34)	0.28	0.12	2.39	0.02	1.32(1.05~1.65)
FI group										
Frail					1.00(Reference)					1.00(Reference)
Robust	-0.95	0.10	-9.19	<0.01	0.39(0.32~0.47)	-1.42	0.14	-10.49	<0.01	0.24(0.19~0.31)
Pre-frail	-0.52	0.08	-6.17	<0.01	0.59(0.50~0.70)	-0.80	0.10	-7.87	<0.01	0.45(0.37~0.55)