Supplementary Material

Co-occurring depressive symptoms, malnutrition risk and fall-related mobility risk among community-dwelling older adults in Maha Sarakham Province, Thailand: a latent class analysis

Contents

Table S1. Study subdistricts, registered older population, planned and achieved sample

Table S2. Prevalence of the three conditions and their indicators: unweighted and weighted estimates, design effects and intraclass correlations

Table S3. Diagnostics of the selected three-class model: (A) bivariate residuals; (B) classification-error matrix

Table S4. Item-response probabilities and concurrent external correlates by latent class

Table S5. Sequential three-step models (Models 1–3): adjusted odds ratios (95% CI) for class membership relative to the low-burden class

Table S6. Sensitivity analyses SA1–SA10: model fit, class sizes and agreement with the main model

Table S7. Additional analyses: (A) log-linear models of the three-way interaction; (B) number of conditions by modal class assignment; (C) agreement of count-based rules with complex multidomain class membership; (D) cross-check of the bias-adjusted three-step estimates against StepMix

Table S8. Item-response probabilities of the sensitivity solutions (SA1–SA10)

Table S9. Leave-one-subdistrict-out jackknife (CR3-type) standard errors and t(38)-based 95% confidence intervals for the fully adjusted model (Model 4)

Table S10. Fully adjusted model re-estimated with the nine-item home hazard score and after omitting tooth-brushing

Table S11. Random seeds and computational environment

Table S1. Study subdistricts, registered older population, planned and achieved sample

No.	District	Subdistrict	Registered aged ≥60 (N)*	Planned n	Interviewed n	Villages	% of planned	Sampling fraction, %
1	Kantharawichai	Si Suk	2,079	335	342	23	102.1	16.5
2	Kut Rang	Nong Waeng	1,316	307	308	14	100.3	23.4
3	Kae Dam	Kae Dam (SAO)	735	259	279	7	107.7	38.0
4	Kae Dam	Kae Dam (municipality)	1,321	307	311	13	101.3	23.5
5	Kae Dam	Non Phiban	837	271	299	14	110.3	35.7
6	Kae Dam	Mittraphap	1,524	317	337	21	106.3	22.1
7	Kae Dam	Wang Saeng	1,288	305	319	20	104.6	24.8
8	Kae Dam	Nong Kung	912	278	285	15	102.5	31.2
9	Kosum Phisai	Khuean	1,252	303	331	13	109.2	26.4
10	Kosum Phisai	Phaeng	1,985	333	337	11	101.2	17.0
11	Kosum Phisai	Phon Ngam	1,536	317	342	16	107.9	22.3
12	Kosum Phisai	Yang Noi	1,334	308	330	12	107.1	24.7
13	Kosum Phisai	Nong Lek	2,014	334	424	20	126.9	21.1
14	Kosum Phisai	Hua Khwang	1,794	327	330	13	100.9	18.4
15	Chiang Yuen	Ku Thong	2,284	340	361	19	106.2	15.8
16	Chiang Yuen	Don Ngoen	1,555	318	325	15	102.2	20.9
17	Na Chueak	Po Phan	1,555	318	318	16	100.0	20.5
18	Na Chueak	San Pa Tong	826	269	271	12	100.7	32.8
19	Na Dun	Ku Santarat	788	265	382	9	144.2	48.5
20	Na Dun	Dong Bang	607	241	245	9	101.7	40.4
21	Na Dun	Phra That	631	245	250	8	102.0	39.6
22	Borabue	Don Ngua	942	281	284	6	101.1	30.1
23	Borabue	Bua Mat	809	268	258	9	96.3	31.9
24	Borabue	Yang	897	277	277	9	100.0	30.9
25	Borabue	Wang Mai	947	281	281	10	100.0	29.7
26	Phayakkhaphum Phisai	Na Si Nuan	1,140	296	299	14	101.0	26.2
27	Mueang Maha Sarakham	Khwao	3,078	354	not surveyed	—	—	—
28	Mueang Maha Sarakham	Talat (municipality)	8,920	383	357	20	93.2	4.0
29	Mueang Maha Sarakham	Tha Tum	1,214	301	300	10	99.7	24.7
30	Mueang Maha Sarakham	Nong Pling	1,115	294	315	7	107.1	28.3
31	Yang Sisurat	Dong Mueang	600	240	240	9	100.0	40.0
32	Yang Sisurat	Na Phu	1,323	307	306	17	99.7	23.1
33	Yang Sisurat	Yang Sisurat	1,333	308	298	13	96.8	22.4
34	Yang Sisurat	Waeng Dong	1,445	313	324	19	103.5	22.4
35	Yang Sisurat	Sang Saeng	810	268	268	12	100.0	33.1
36	Wapi Pathum	Khaen	1,576	319	319	17	100.0	20.2
37	Wapi Pathum	Khok Si Thonglang	1,038	289	292	11	101.0	28.1
38	Wapi Pathum	Dong Yai	1,254	303	303	7	100.0	24.2
39	Wapi Pathum	Ban Wai	1,608	320	323	17	100.9	20.1
40	Wapi Pathum	Suea Kok	2,256	340	345	20	101.5	15.3
	Total		60,478	12,039	12,115	527	103.7†	21.1†

* Department of Provincial Administration, Ministry of Interior, 30 April 2025. Planned n from Yamane's formula (e = 0.05). † Excluding Khwao (not surveyed). SAO = subdistrict administrative organisation.

Table S2. Prevalence of the three conditions and their indicators: unweighted and weighted estimates, design effects and intraclass correlations

Indicator	n	% (95% CI)	Weighted % (95% CI)†	DEFF	ICC (subdistrict)
Depressive symptoms					
9Q ≥7 (any depressive symptoms)	1,017	8.4 (6.8–10.3)	7.6 (5.7–10.1)	12.4	0.038
9Q 7–12 (mild)	846	7.0 (5.7–8.5)	6.4 (4.8–8.4)	9.3	0.027
9Q ≥13 (moderate–severe)	171	1.4 (0.9–2.2)	1.2 (0.8–2.0)	8.5	0.025
Suicidal ideation (9Q item 9 >0)	571	4.7 (3.5–6.3)	4.3 (3.0–6.2)	14.1	0.044
Malnutrition risk					
MNA-SF ≤11 (at risk or malnourished)	2,971	24.5 (22.5–26.7)	22.1 (17.7–27.2)	7.4	0.020
MNA-SF 8–11 (at risk)	2,789	23.0 (21.1–25.1)	20.7 (16.6–25.5)	7.3	0.020
MNA-SF 0–7 (malnourished)	182	1.5 (1.2–1.8)	1.4 (1.1–1.7)	1.7	0.002
Full MNA 17–23.5 (at risk)	3,384	27.9 (25.5–30.5)	26.5 (23.2–30.2)	9.7	0.027
Full MNA <17 (malnourished)	201	1.7 (1.3–2.0)	1.5 (1.1–2.0)	2.4	0.004
Calf circumference <31 cm	5,078	41.9 (38.6–45.3)	44.1 (39.3–49.0)	14.5	0.044
Fall-related mobility risk					
Fall in past 3 months	450	3.7 (2.9–4.7)	3.5 (2.6–4.8)	6.4	0.017
Gait impairment or walking aid	1,809	14.9 (13.1–17.0)	14.7 (12.9–16.7)	9.1	0.026
Fall or gait impairment (composite)	2,059	17.0 (15.0–19.3)	16.6 (14.5–19.1)	10.3	0.030
Morse Fall Scale ≥45 (sensitivity)	542	4.5 (3.8–5.2)	4.4 (3.7–5.2)	3.5	0.008
Number of the three conditions					
0	7,631	63.0 (60.3–65.6)	65.7 (59.9–71.0)	9.5	0.026
1	3,183	26.3 (24.6–28.0)	24.4 (20.9–28.2)	4.5	0.011
2	1,039	8.6 (7.5–9.8)	7.9 (6.3–10.0)	5.5	0.014
3	262	2.2 (1.7–2.8)	2.0 (1.6–2.6)	4.5	0.012
≥2 (co-occurrence)	1,301	10.7 (9.3–12.4)	10.0 (8.0–12.4)	7.9	0.022

95% CI: Taylor-linearised, cluster-robust standard errors (39 subdistricts as clusters), logit-transformed. † Weighted to the older population of the 39 study subdistricts (weight = registered population aged ≥60 ÷ sample size per subdistrict; Department of Provincial Administration, 30 April 2025, as reported in the proposal). DEFF = design effect for clustering (unweighted). ICC = one-way ANOVA estimator. MNA-SF = Mini Nutritional Assessment–Short Form. Depressive symptoms were assessed with the Thai 9-item Depression Scale (9Q) in all respondents; cut-offs 7–12 mild, ≥13 moderate–severe.

Table S3. Diagnostics of the selected three-class model: (A) bivariate residuals; (B) classification-error matrix

(A) Bivariate residuals

Indicator pair	Pearson X^2	df	BVR
Depressive symptoms (9Q) × Nutritional status (MNA-SF)	6.32	4	1.58
Depressive symptoms (9Q) × Calf circumference <31 cm	12.46	2	6.23
Depressive symptoms (9Q) × Fall in past 3 months	3.65	2	1.82
Depressive symptoms (9Q) × Gait impairment/walking aid	0.06	2	0.03
Nutritional status (MNA-SF) × Calf circumference <31 cm	12.98	2	6.49
Nutritional status (MNA-SF) × Fall in past 3 months	0.56	2	0.28
Nutritional status (MNA-SF) × Gait impairment/walking aid	0.42	2	0.21
Calf circumference <31 cm × Fall in past 3 months	3.09	1	3.09
Calf circumference <31 cm × Gait impairment/walking aid	0.17	1	0.17
Fall in past 3 months × Gait impairment/walking aid	0.59	1	0.59

(B) Classification-error matrix, P(assigned class | true class)

True class	Assigned: Low-burden	Assigned: Nutritional risk	Assigned: Complex multidomain	AvePP
Low-burden	0.946	0.049	0.005	0.984
Nutritional risk	0.000	0.959	0.041	0.740
Complex multidomain	0.183	0.259	0.558	0.775

BVR = Pearson X^2/df comparing observed and model-implied two-way tables; values >3.84 suggest residual local dependence (addressed in SA1, SA2 and SA10). Rows of the classification-error matrix sum to 1; the matrix is used by the bias-adjusted three-step estimators. AvePP = average posterior probability among participants modally assigned to the class.

Table S4. Item-response probabilities and concurrent external correlates by latent class

Characteristic	Low-burden	Nutritional risk	Complex multidomain
Class size, model-estimated %	77.3	16.2	6.5
Class size, modal assignment n (%)	9,010 (74.4)	2,540 (21.0)	565 (4.7)
Average posterior probability	0.984	0.740	0.775
Item-response probabilities, %			
Depressive symptoms (9Q)			
0–6 (none)	94.9	88.8	59.1
7–12 (mild)	4.3	10.1	31.2
≥13 (moderate–severe)	0.8	1.1	9.7
Nutritional status (MNA-SF)			
12–14 (normal)	95.1	0.0	29.8
8–11 (at risk)	4.9	99.2	49.0
0–7 (malnourished)	0.0	0.8	21.2
Calf circumference			
≥31 cm	64.3	36.6	37.6
<31 cm	35.7	63.4	62.4
Fall in past 3 months			
No	98.1	96.7	73.2
Yes	1.9	3.3	26.8
Gait impairment or walking aid			
No	91.5	79.5	21.8
Yes	8.5	20.5	78.2
Concurrent external correlates, % (95% CI)†			
Self-rated health worse than peers (MNA item P)	1.8 (1.3–2.4)	5.4 (3.6–7.3)	38.6 (32.3–46.8)
Not able to look after oneself (MNA item G)	12.0 (9.8–14.0)	14.7 (11.1–19.0)	29.1 (23.2–35.3)
Difficulty eating without help (MNA item N)	2.3 (1.7–2.9)	5.1 (3.5–6.6)	39.7 (32.4–47.3)

Item-response probabilities are conditional probabilities of each indicator category given class membership. † Concurrent external correlates were measured at the same interview and were not used to define the classes; they come from the same instrument as the nutritional indicators (shared-method variance). Item G in the Thai version asks whether the person is able to look after himself or herself; it is not a measure of dependence in activities of daily living. Class-specific prevalences were estimated with the bias-adjusted maximum-likelihood three-step approach (Bakk, Tekle & Vermunt 2013); 95% CIs from 1,000 subdistrict-cluster bootstrap replicates.

Table S5. Sequential three-step models (Models 1–3): adjusted odds ratios (95% CI) for class membership relative to the low-burden class

Covariate	Nutritional risk: Model 1	Nutritional risk: Model 2	Nutritional risk: Model 3	Complex multidomain: Model 1	Complex multidomain: Model 2	Complex multidomain: Model 3
Age 70–79 (ref 60–69)	1.98 (1.72–2.26)	1.85 (1.60–2.13)	1.90 (1.64–2.20)	2.43 (1.80–3.28)	1.67 (1.18–2.37)	1.67 (1.19–2.35)
Age ≥80	4.74 (3.76–5.97)	4.01 (3.14–5.12)	4.15 (3.21–5.35)	8.17 (5.95–11.20)	4.13 (2.64–6.44)	4.43 (2.83–6.96)
Female	1.16 (1.00–1.35)	1.06 (0.91–1.25)	1.30 (1.10–1.54)	1.42 (1.06–1.91)	1.01 (0.71–1.42)	1.30 (0.90–1.86)
Widowed (ref married)	—	1.06 (0.89–1.26)	1.05 (0.88–1.24)	—	1.25 (0.91–1.71)	1.26 (0.88–1.80)
Single/divorced/separated	—	1.59 (1.24–2.03)	1.55 (1.20–1.99)	—	1.45 (0.87–2.41)	1.77 (0.99–3.16)
Secondary education or higher (ref none/primary)	—	0.89 (0.65–1.22)	0.89 (0.65–1.22)	—	0.96 (0.61–1.52)	0.98 (0.62–1.54)
Not working (ref agriculture)	—	1.33 (1.03–1.71)	1.38 (1.05–1.82)	—	5.17 (3.17–8.43)	4.27 (2.73–6.68)
Other occupation	—	1.12 (0.73–1.72)	1.18 (0.77–1.81)	—	1.20 (0.53–2.72)	1.27 (0.54–2.96)
Personal income ≤1,000 THB (ref >5,000)	—	1.44 (1.09–1.91)	1.43 (1.06–1.93)	—	1.72 (0.92–3.20)	1.68 (0.85–3.29)
Personal income 1,001–3,000	—	1.23 (0.97–1.56)	1.22 (0.95–1.58)	—	1.46 (0.76–2.79)	1.45 (0.70–3.00)
Personal income 3,001–5,000	—	1.23 (0.86–1.77)	1.21 (0.82–1.78)	—	0.86 (0.40–1.88)	1.28 (0.60–2.70)
Insufficient income	—	1.23 (0.94–1.61)	1.16 (0.89–1.51)	—	2.70 (1.74–4.19)	2.42 (1.58–3.70)
Debt: low (ref none)	—	0.92 (0.68–1.24)	0.90 (0.69–1.19)	—	0.98 (0.58–1.65)	1.05 (0.63–1.75)
Debt: moderate	—	0.97 (0.69–1.37)	0.93 (0.68–1.28)	—	1.41 (0.74–2.68)	1.23 (0.65–2.32)
Debt: high	—	1.10 (0.71–1.72)	1.13 (0.78–1.65)	—	3.20 (1.78–5.72)	2.61 (1.45–4.69)
Living alone	—	0.84 (0.52–1.37)	0.81 (0.51–1.29)	—	0.85 (0.38–1.90)	0.72 (0.32–1.65)
No family caregiver	—	1.18 (0.73–1.91)	1.09 (0.66–1.79)	—	1.99 (0.91–4.37)	2.10 (1.04–4.26)
Holds a community role	—	0.92 (0.76–1.12)	0.93 (0.77–1.12)	—	0.74 (0.44–1.25)	0.77 (0.45–1.32)
Social participation	—	0.78 (0.62–0.97)	0.78 (0.62–0.99)	—	0.87 (0.54–1.41)	0.88 (0.55–1.42)
1 chronic condition (ref 0)	—	—	0.84 (0.70–1.01)	—	—	2.17 (1.56–3.03)
≥2 chronic conditions	—	—	0.71 (0.55–0.92)	—	—	3.53 (2.24–5.55)
Study-defined polypharmacy	—	—	1.41 (1.16–1.71)	—	—	2.48 (1.77–3.47)
Vigorous activity ≥3 days/week	—	—	0.85 (0.63–1.15)	—	—	0.98 (0.65–1.48)
Fruit/vegetables ≥5 portions ≥5 days/week	—	—	0.70 (0.55–0.89)	—	—	0.59 (0.43–0.83)
Any smoking	—	—	1.77 (1.42–2.21)	—	—	2.22 (1.29–3.83)
Any alcohol	—	—	1.18 (0.97–1.43)	—	—	1.73 (1.05–2.85)
Tooth-brushing ≥2 times daily	—	—	0.62 (0.47–0.83)	—	—	0.21 (0.13–0.35)

Model 1: age group and sex; Model 2: + socioeconomic and social factors; Model 3: + health and behavioural factors. Model 4 (+ home environment) is shown in Figure 4 of the main text. Bias-adjusted maximum-likelihood three-step multinomial logistic regression; reference class = Low-burden; 95% CIs from cluster-robust standard errors (39 subdistricts). — = covariate not included in the model. Variance inflation factors for Model 4 covariates were all <2.4.

Table S6. Sensitivity analyses SA1–SA10: model fit, class sizes and agreement with the main model

Analysis (change from main model)	K	BIC	Entropy	Low-burden, %	Nutritional risk, %	Complex multidomain, %	Agreement with main, %	Cohen's κ	Class sizes, %
SA1 Without calf circumference (3 classes) — calf circumference removed	3	35,478.3	0.658	77.1	21.0	1.9	82.1	0.441	—
SA2 Without calf circumference (4 classes) — calf circumference removed; K = 4 (lowest AIC, adequate L^2)	4	35,507.3	0.776	—	—	—	—	—	78.0 / 11.2 / 9.8 / 1.0
SA3 Adding multimorbidity and polypharmacy — + ≥2 chronic conditions, >3 drugs/day	3	75,909.8	0.677	73.2	15.1[a]	11.7	70.7	0.227	—
SA4 Design-weighted — weights = N/n per subdistrict (BIC not comparable)	3	236,717.6	0.815	79.3	14.3	6.4	99.99	0.9998	—
SA5 Excluding urban municipality — n = 11,758	3	50,285.8	0.818	76.5	16.8	6.7	100.0	1.000	—
SA6 Morse Fall Scale categories — fall + gait replaced by Morse <25 / 25–44 / ≥45	3	49,906.0	0.924	74.7	20.3	5.0	97.9	0.946	—
SA7 MNA-SF without mobility and neuropsychological items — nutrition = 4-item MNA-SF ≤7/10	3	49,433.6	0.760	84.1	7.4	8.5	87.8	0.655	—
SA8 Four-class solution — K = 4	4	51,535.1	0.738	—	—	—	—	—	74.3 / 13.8 / 8.6 / 3.3
SA9 Nonparametric multilevel LCA (M = 5 subdistrict clusters) — level-2 latent clusters of subdistricts (M by BIC with n = 39 subdistricts)	3	51,033.0	0.831	53.2	33.3	13.5	60.6	0.240	—
SA10 Local dependence relaxed (joint MNA-SF × calf item) — MNA-SF and calf combined into one 6-category item	3	51,515.0	0.746	82.6	16.5	0.9	81.0	0.403	—

Agreement and Cohen's κ compare modal class assignment with the main model; computed for three-class solutions only. Classes were aligned with the main model by maximal agreement of modal assignments, except in SA3, in which the class with the highest combined probability of depressive symptoms and gait impairment was matched to the complex multidomain class. [a] In SA3 the remaining class was a multimorbidity–polypharmacy class with low probabilities of the three conditions (shown in the nutritional-risk column; profiles in Table S8). In SA4 one of 12,115 participants was reassigned. BIC of the weighted and subset analyses is not comparable with that of the main model. Four-class solutions (SA2, SA8): class sizes listed in the last column; profiles in Table S8.

Table S7. Additional analyses: (A) log-linear models of the three-way interaction; (B) number of conditions by modal class assignment; (C) agreement of count-based rules with complex multidomain class membership; (D) cross-check of the bias-adjusted three-step estimates against StepMix

(A) Log-linear (Poisson) models of the three-way interaction among depressive symptoms, malnutrition risk and fall-related mobility risk

Model	Observed triads, n	Expected under independence, n (O/E)	Expected under homogeneous association, n (O/E)	Ratio of odds ratios (95% CI)	LR χ^2 (df = 1); P	Design effect	Cluster-bootstrap Wald P	Rao–Scott χ^2; P
Unadjusted	262	42.4 (6.18)	246.9 (1.06; 95% CI 1.01–1.12)	1.39 (1.04–1.89)	4.99; 0.025	1.05	0.030	4.77; 0.029
Adjusted for age group, sex and their interactions with each condition	262	56.7 (4.62)	245.6 (1.07)	1.43 (1.06–1.98)	5.85; 0.016	1.12	0.023	5.22; 0.022

Conditions: depressive symptoms (9Q ≥7), malnutrition risk (MNA-SF ≤11) and fall-related mobility risk (fall in the past 3 months or gait impairment/walking aid). O/E = observed-to-expected ratio for the combination of all three conditions. Homogeneous association = model with all pairwise terms but no three-way term. Ratio of odds ratios = exp(three-way coefficient); 95% CIs (percentile) and Wald P from 2,000 subdistrict cluster-bootstrap replicates. LR = unadjusted likelihood-ratio test (assumes independent observations). Design effect = cluster-bootstrap variance ÷ model-based variance of the three-way coefficient; the Rao–Scott first-order correction divides the LR statistic by this design effect. The 95% CI of the O/E ratio under independence is shown in Figure 2B. Cell counts of the 2 × 2 × 2 table (depressive symptoms/malnutrition risk/mobility risk): none 7,631; mobility risk only 979; malnutrition risk only 1,786; malnutrition + fall 702; depressive only 418; depressive + fall 116; depressive + malnutrition 221; all three 262.

(B) Number of conditions by latent class

Number of conditions	Modal assignment, n (column %)			Posterior-weighted, %		
	Low-burden	Nutritional risk	Complex multidomain	Low-burden	Nutritional risk	Complex multidomain
0	7,631 (84.7)	0 (0.0)	0 (0.0)	81.2	0.0	2.8
1	1,328 (14.7)	1,760 (69.3)	95 (16.8)	17.5	68.5	25.0
2	51 (0.6)	780 (30.7)	208 (36.8)	1.2	28.7	46.2
3	0 (0.0)	0 (0.0)	262 (46.4)	0.0	2.8	26.0
Total	**9,010 (100)**	**2,540 (100)**	**565 (100)**	**9,369 (expected n)**	**1,961 (expected n)**	**785 (expected n)**
Model-implied probability of all three conditions, %	—	—	—	0.0	2.6	24.1

Conditions as in (A). Modal assignment classifies each participant into the class with the highest posterior probability; posterior-weighted distributions use posterior class probabilities as fractional membership and account for classification error. Model-implied probabilities are the products of the class-specific probabilities of the three conditions under local independence.

(C) Agreement of count-based rules with complex multidomain class membership

Rule (number of conditions)	Flagged, %	Posterior-weighted (fractional membership), %				Modal assignment, %			
		Sensitivity	Specificity	PPV	NPV	Sensitivity	Specificity	PPV	NPV
≥1	37.0	97.2	67.2	17.0	99.7	100.0	66.1	12.6	100.0
≥2	10.7	72.2	93.5	43.5	98.0	83.2	92.8	36.1	99.1
3 (all three)	2.2	26.0	99.5	78.0	95.1	46.4	100.0	100.0	97.4

PPV/NPV = positive/negative predictive value. Because the latent classes were derived from the same indicators, these quantities describe agreement with the latent classification, not diagnostic accuracy against an independent reference standard; every member of the nutritional-risk class has at least one condition by construction. Of participants flagged by the ≥2 rule, the posterior-weighted shares were 8.9% low-burden, 47.5% nutritional risk and 43.5% complex multidomain; by modal assignment, 51 (3.9%), 780 (60.0%) and 470 (36.1%) of 1,301.

(D) Cross-check of the selected model and of the Model 4 three-step estimates against StepMix 3.0.0

Covariate	Nutritional risk vs low-burden: aOR			Complex multidomain vs low-burden: aOR		
	Purpose-written code	StepMix	Difference (log-odds)	Purpose-written code	StepMix	Difference (log-odds)
Age 70–79 (ref 60–69)	1.90	1.89	+0.0032	1.70	1.70	-0.0005
Age ≥80	4.22	4.20	+0.0051	4.39	4.39	-0.0004
Female	1.29	1.29	+0.0010	1.23	1.23	-0.0003
Widowed (ref married)	1.07	1.07	+0.0003	1.34	1.34	+0.0005
Single/divorced/separated	1.56	1.55	+0.0017	1.64	1.63	+0.0003
Secondary education or higher (ref none/primary)	0.92	0.92	-0.0016	1.01	1.01	+0.0005
Not working (ref agriculture)	1.42	1.41	+0.0014	4.23	4.23	+0.0008
Other occupation	1.23	1.23	+0.0018	1.04	1.04	+0.0000
Personal income ≤1,000 THB (ref >5,000)	1.38	1.38	+0.0021	1.53	1.53	+0.0005
Personal income 1,001–3,000	1.18	1.18	+0.0012	1.28	1.28	+0.0004
Personal income 3,001–5,000	1.21	1.21	+0.0016	1.34	1.34	+0.0006
Insufficient income	1.12	1.12	+0.0005	1.97	1.97	+0.0005
Debt: low (ref none)	0.88	0.88	-0.0009	0.99	0.98	+0.0004
Debt: moderate	0.90	0.90	-0.0012	1.20	1.20	+0.0004
Debt: high	1.10	1.10	+0.0003	2.45	2.45	+0.0005
Living alone	0.81	0.81	-0.0020	0.69	0.69	+0.0002
No family caregiver	1.06	1.06	+0.0007	2.00	2.00	+0.0001
Holds a community role	0.94	0.94	-0.0007	0.81	0.81	-0.0001
Social participation	0.78	0.79	-0.0014	0.82	0.82	+0.0004
1 chronic condition (ref 0)	0.86	0.86	-0.0001	2.25	2.25	+0.0007
≥2 chronic conditions	0.70	0.70	-0.0015	3.54	3.54	+0.0010
Study-defined polypharmacy	1.43	1.43	+0.0017	2.45	2.45	+0.0004
Vigorous activity ≥3 days/week	0.86	0.86	-0.0011	0.95	0.95	+0.0002
Fruit/vegetables ≥5 portions ≥5 days/week	0.74	0.74	-0.0011	0.68	0.68	-0.0000
Any smoking	1.74	1.73	+0.0028	1.91	1.91	+0.0000
Any alcohol	1.16	1.16	+0.0009	1.54	1.54	+0.0002
Tooth-brushing ≥2 times daily	0.63	0.63	-0.0018	0.21	0.21	-0.0007
Home hazard score (per hazard)	1.09	1.09	+0.0004	1.44	1.44	+0.0002
Cooks with charcoal	1.15	1.15	+0.0004	0.55	0.55	-0.0005

Modal class assignments of the selected three-class model were identical in the purpose-written code and StepMix for all 12,115 participants. Model 4 coefficients: bias-adjusted maximum-likelihood three-step estimator (purpose-written) vs StepMix ML-corrected three-step estimator (n_steps = 3, correction = 'ML'); maximum absolute difference 0.005 and mean absolute difference 0.0009 on the log-odds scale. Reference class = low-burden.

Table S8. Item-response probabilities of the sensitivity solutions (SA1–SA10)

(A) Three-class solutions

Analysis / indicator, %	Class 1	Class 2	Class 3
Main model	**Low-burden**	**Nutritional risk**	**Complex multidomain**
Depressive symptoms (9Q ≥7)	5.1	11.2	40.9
Malnutrition risk (MNA-SF ≤11)	4.9	100.0	70.2
Calf circumference <31 cm	35.7	63.4	62.4
Fall in past 3 months	1.9	3.3	26.8
Gait impairment/walking aid	8.5	20.5	78.2
Class size, %	77.3	16.2	6.5
SA1 Without calf circumference	**Low-burden**	**Nutritional risk**	**Complex multidomain**
Depressive symptoms (9Q ≥7)	4.1	19.9	56.3
Malnutrition risk (MNA-SF ≤11)	14.8	53.5	100.0
Fall in past 3 months	1.1	11.0	29.6
Gait impairment/walking aid	5.3	43.5	88.7
Class size, %	77.1	21.0	1.9
SA3 Adding multimorbidity and polypharmacy	**Low-burden**	**Multimorbidity–polypharmacy**	**Most similar to complex multidomain**
Depressive symptoms (9Q ≥7)	4.9	8.1	31.0
Malnutrition risk (MNA-SF ≤11)	17.1	13.0	86.2
Calf circumference <31 cm	39.9	28.4	71.9
Fall in past 3 months	1.1	7.0	15.6
Gait impairment/walking aid	6.3	23.2	58.5
≥2 chronic conditions	4.7	60.2	27.3
Study-defined polypharmacy (>3 medications/day)	18.1	77.6	50.0
Class size, %	73.2	15.1	11.7
SA4 Design-weighted	**Low-burden**	**Nutritional risk**	**Complex multidomain**
Depressive symptoms (9Q ≥7)	4.4	11.3	39.5
Malnutrition risk (MNA-SF ≤11)	4.2	100.0	69.0
Calf circumference <31 cm	39.4	62.8	61.1
Fall in past 3 months	1.6	3.8	26.9
Gait impairment/walking aid	8.5	20.2	78.9
Class size, %	79.3	14.3	6.4
SA5 Excluding urban municipality	**Low-burden**	**Nutritional risk**	**Complex multidomain**
Depressive symptoms (9Q ≥7)	5.3	11.0	40.5
Malnutrition risk (MNA-SF ≤11)	4.6	100.0	70.3
Calf circumference <31 cm	34.9	62.9	62.6
Fall in past 3 months	2.0	3.1	26.4
Gait impairment/walking aid	8.4	20.0	77.5
Class size, %	76.5	16.8	6.7
SA6 Morse Fall Scale categories	**Low-burden**	**Nutritional risk**	**Complex multidomain**
Depressive symptoms (9Q ≥7)	5.4	10.4	44.9
Malnutrition risk (MNA-SF ≤11)	0.0	100.0	83.8
Calf circumference <31 cm	35.9	57.8	67.2
Morse Fall Scale 25–44	7.3	13.0	38.7

Morse Fall Scale ≥45	2.1	3.8	42.9
Class size, %	74.7	20.3	5.0
SA7 MNA-SF without mobility and neuropsychological items	**Low-burden**	**Nutritional risk**	**Complex multidomain**
Depressive symptoms (9Q ≥7)	5.0	8.0	41.9
Nutritional risk (4-item MNA-SF ≤7)	10.8	87.6	56.1
Calf circumference <31 cm	35.7	100.0	53.3
Fall in past 3 months	1.7	2.9	24.4
Gait impairment/walking aid	9.0	26.0	63.4
Class size, %	84.1	7.4	8.5
SA9 Nonparametric multilevel LCA (M = 5)	**Low-burden**	**Nutritional risk**	**Complex multidomain**
Depressive symptoms (9Q ≥7)	5.3	3.5	32.9
Malnutrition risk (MNA-SF ≤11)	12.5	25.2	70.4
Calf circumference <31 cm	0.0	100.0	62.7
Fall in past 3 months	1.8	1.3	17.6
Gait impairment/walking aid	7.9	7.6	61.3
Class size, %	53.2	33.3	13.5
SA10 Joint MNA-SF × calf circumference item	**Low-burden**	**Nutritional risk**	**Complex multidomain**
Depressive symptoms (9Q ≥7)	4.7	22.7	81.6
Malnutrition risk (MNA-SF ≤11)	16.3	61.4	100.0
Calf circumference <31 cm	39.0	56.0	49.2
Fall in past 3 months	1.4	13.0	44.1
Gait impairment/walking aid	6.1	55.3	86.6
Class size, %	82.6	16.5	0.9

Item-response probabilities (%) given class membership; class sizes are model-estimated. Classes were aligned with the main model by maximal agreement of modal assignments, except in SA3 (profile-based matching; see Table S6). SA2 and SA8 (four classes) are shown in (B). Composition of the smaller, more severe class in SA1 and SA10: 77.2% and 86.9% of its expected members were main-model complex multidomain members, but it contained only 23.0% and 12.2% of that class's expected members. In SA3, the class most similar to the complex multidomain class comprised 489 participants modally assigned to the main complex multidomain class and 721 assigned to the main nutritional-risk class. In SA9, the second class was characterised by low calf circumference rather than malnutrition risk.

(B) Four-class solutions

Analysis / indicator, %	**Class 1**	**Class 2**	**Class 3**	**Class 4**
SA2 Without calf circumference (4 classes)				
Depressive symptoms (9Q ≥7)	4.3	4.0	38.1	87.5
Malnutrition risk (MNA-SF ≤11)	16.8	37.5	63.7	100.0
Fall in past 3 months	1.5	7.4	13.2	42.9
Gait impairment/walking aid	0.2	86.9	42.1	88.7
Class size, %	78.0	11.2	9.8	1.0
SA8 Four-class solution (main indicators)				
Depressive symptoms (9Q ≥7)	4.6	11.2	21.2	48.4
Malnutrition risk (MNA-SF ≤11)	6.8	100.0	27.5	100.0
Calf circumference <31 cm	35.9	68.6	40.1	71.4
Fall in past 3 months	1.1	3.1	18.7	25.7
Gait impairment/walking aid	6.6	21.6	50.2	81.9
Class size, %	74.3	13.8	8.6	3.3

In both four-class solutions, class 4 had the highest probabilities of depressive symptoms and gait impairment and malnutrition risk in all members (1.0% in SA2 and 3.3% in SA8).

Table S9. Leave-one-subdistrict-out jackknife (CR3-type) standard errors and t(38)-based 95% confidence intervals for the fully adjusted model (Model 4)

Covariate	Nutritional risk vs low-burden					Complex multidomain vs low-burden				
	aOR	Sandwich 95% CI	Sandwich t(38) 95% CI	Jackknife t(38) 95% CI	Jackknife P	aOR	Sandwich 95% CI	Sandwich t(38) 95% CI	Jackknife t(38) 95% CI	Jackknife P
Age 70–79 (ref 60–69)	1.90	1.63–2.20	1.63–2.21	1.642–2.190	<0.001	1.70	1.22–2.36	1.21–2.39	1.192–2.416	0.004
Age ≥80	4.22	3.27–5.44	3.25–5.49	3.267–5.454	<0.001	4.39	2.68–7.18	2.64–7.30	2.574–7.476	<0.001
Female	1.29	1.09–1.54	1.08–1.54	1.079–1.546	0.006	1.23	0.86–1.76	0.85–1.78	0.842–1.809	0.273
Widowed (ref married)	1.07	0.90–1.27	0.89–1.28	0.889–1.283	0.471	1.34	0.94–1.91	0.93–1.94	0.932–1.926	0.111
Single/divorced/separated	1.56	1.21–2.00	1.20–2.02	1.189–2.037	0.002	1.64	0.89–3.00	0.87–3.06	0.858–3.117	0.131
Secondary education or higher (ref none/primary)	0.92	0.67–1.26	0.66–1.27	0.656–1.280	0.600	1.01	0.66–1.55	0.65–1.57	0.654–1.557	0.965
Not working (ref agriculture)	1.42	1.08–1.85	1.07–1.87	1.070–1.875	0.016	4.23	2.59–6.90	2.55–7.01	2.454–7.293	<0.001
Other occupation	1.23	0.82–1.86	0.81–1.88	0.776–1.957	0.367	1.04	0.45–2.39	0.44–2.45	0.429–2.504	0.934
Personal income ≤1,000 THB (ref >5,000)	1.38	1.03–1.85	1.02–1.87	0.999–1.902	0.051	1.53	0.77–3.03	0.75–3.09	0.738–3.157	0.246
Personal income 1,001–3,000	1.18	0.91–1.52	0.90–1.53	0.894–1.548	0.238	1.28	0.62–2.67	0.60–2.73	0.586–2.816	0.522
Personal income 3,001–5,000	1.21	0.83–1.76	0.82–1.79	0.764–1.915	0.407	1.34	0.65–2.77	0.63–2.83	0.609–2.932	0.460
Insufficient income	1.12	0.86–1.45	0.86–1.46	0.846–1.481	0.422	1.97	1.28–3.04	1.26–3.08	1.245–3.123	0.005
Debt: low (ref none)	0.88	0.67–1.15	0.67–1.16	0.656–1.183	0.390	0.99	0.59–1.64	0.58–1.67	0.568–1.707	0.956
Debt: moderate	0.90	0.66–1.23	0.65–1.24	0.643–1.263	0.536	1.20	0.64–2.23	0.63–2.28	0.608–2.352	0.595
Debt: high	1.10	0.76–1.59	0.75–1.61	0.741–1.627	0.632	2.45	1.29–4.65	1.26–4.75	1.222–4.911	0.013
Living alone	0.81	0.50–1.29	0.50–1.31	0.495–1.316	0.381	0.69	0.31–1.52	0.31–1.56	0.283–1.693	0.410
No family caregiver	1.06	0.64–1.74	0.63–1.77	0.630–1.777	0.826	2.00	0.99–4.04	0.97–4.13	0.942–4.262	0.070
Holds a community role	0.94	0.77–1.14	0.77–1.15	0.767–1.152	0.542	0.81	0.47–1.39	0.47–1.41	0.457–1.441	0.466
Social participation	0.78	0.62–0.99	0.62–1.00	0.611–1.006	0.055	0.82	0.50–1.34	0.49–1.36	0.485–1.385	0.448
1 chronic condition (ref 0)	0.86	0.71–1.03	0.71–1.04	0.709–1.035	0.107	2.25	1.61–3.16	1.59–3.19	1.579–3.220	<0.001
≥2 chronic conditions	0.70	0.54–0.92	0.53–0.93	0.532–0.926	0.014	3.54	2.23–5.64	2.19–5.72	2.172–5.783	<0.001
Study-defined polypharmacy	1.43	1.18–1.73	1.18–1.74	1.168–1.754	<0.001	2.45	1.73–3.47	1.71–3.51	1.689–3.553	<0.001
Vigorous activity ≥3 days/week	0.86	0.64–1.14	0.64–1.15	0.631–1.164	0.315	0.95	0.62–1.47	0.61–1.49	0.600–1.504	0.823
Fruit/vegetables ≥5 portions ≥5 days/week	0.74	0.59–0.93	0.58–0.94	0.575–0.957	0.023	0.68	0.49–0.94	0.49–0.95	0.479–0.967	0.032
Any smoking	1.74	1.39–2.18	1.38–2.19	1.366–2.207	<0.001	1.91	1.07–3.41	1.05–3.48	1.005–3.647	0.048
Any alcohol	1.16	0.96–1.41	0.95–1.42	0.953–1.423	0.133	1.54	0.97–2.46	0.95–2.50	0.920–2.590	0.098
Tooth-brushing ≥2 times daily	0.63	0.47–0.83	0.47–0.84	0.458–0.855	0.004	0.21	0.13–0.33	0.13–0.33	0.127–0.340	<0.001
Home hazard score (per hazard)	1.09	1.03–1.16	1.03–1.17	1.023–1.168	0.009	1.44	1.29–1.61	1.28–1.61	1.280–1.619	<0.001
Cooks with charcoal	1.15	0.85–1.54	0.84–1.56	0.825–1.591	0.406	0.55	0.38–0.79	0.37–0.80	0.368–0.812	0.004

Model 4: bias-adjusted maximum-likelihood three-step multinomial logistic regression with all covariates entered simultaneously; reference class = low-burden. Sandwich = cluster-robust standard errors with normal critical values (as in the originally submitted Figure 4); t(38) = same standard errors with t-distribution critical values (38 degrees of freedom; 39 subdistricts); jackknife = leave-one-subdistrict-out (CR3-type) standard errors with t(38) critical values. Jackknife limits are shown to three decimals where they lie close to 1.

Table S10. Fully adjusted model re-estimated with the nine-item home hazard score and after omitting tooth-brushing

Covariate	Nutritional risk vs low-burden: aOR (95% CI)			Complex multidomain vs low-burden: aOR (95% CI)		
	Model 4	Nine-item hazard score	Without tooth-brushing [% change]	Model 4	Nine-item hazard score	Without tooth-brushing [% change]
Age 70–79 (ref 60–69)	1.90 (1.63–2.20)	1.89 (1.63–2.19)	1.90 (1.64–2.20) [+0.1%]	1.70 (1.22–2.36)	1.69 (1.21–2.35)	1.79 (1.29–2.46) [+5.2%]
Age ≥80	4.22 (3.27–5.44)	4.21 (3.26–5.43)	4.33 (3.36–5.57) [+2.5%]	4.39 (2.68–7.18)	4.31 (2.64–7.05)	5.29 (3.31–8.45) [+20.5%]
Female	1.29 (1.09–1.54)	1.29 (1.09–1.53)	1.30 (1.09–1.55) [+0.7%]	1.23 (0.86–1.76)	1.23 (0.86–1.75)	1.22 (0.84–1.78) [-0.8%]
Widowed (ref married)	1.07 (0.90–1.27)	1.07 (0.90–1.27)	1.07 (0.90–1.28) [+0.2%]	1.34 (0.94–1.91)	1.36 (0.95–1.94)	1.31 (0.92–1.86) [-2.3%]
Single/divorced/separated	1.56 (1.21–2.00)	1.56 (1.21–2.01)	1.56 (1.21–2.01) [+0.1%]	1.64 (0.89–3.00)	1.66 (0.91–3.02)	1.51 (0.80–2.85) [-7.6%]
Secondary education or higher (ref none/primary)	0.92 (0.67–1.26)	0.92 (0.67–1.26)	0.92 (0.68–1.26) [+0.9%]	1.01 (0.66–1.55)	1.04 (0.68–1.60)	1.11 (0.72–1.71) [+10.1%]
Not working (ref agriculture)	1.42 (1.08–1.85)	1.42 (1.08–1.85)	1.42 (1.09–1.85) [+0.2%]	4.23 (2.59–6.90)	4.13 (2.54–6.70)	4.07 (2.48–6.70) [-3.8%]
Other occupation	1.23 (0.82–1.86)	1.23 (0.81–1.86)	1.22 (0.81–1.84) [-0.9%]	1.04 (0.45–2.39)	1.01 (0.43–2.36)	0.91 (0.42–1.97) [-11.9%]
Personal income ≤1,000 THB (ref >5,000)	1.38 (1.03–1.85)	1.37 (1.02–1.85)	1.42 (1.07–1.88) [+2.9%]	1.53 (0.77–3.03)	1.55 (0.79–3.05)	1.66 (0.85–3.22) [+8.6%]
Personal income 1,001–3,000	1.18 (0.91–1.52)	1.17 (0.91–1.51)	1.18 (0.92–1.51) [+0.1%]	1.28 (0.62–2.67)	1.30 (0.62–2.72)	1.34 (0.67–2.71) [+4.7%]
Personal income 3,001–5,000	1.21 (0.83–1.76)	1.20 (0.83–1.75)	1.20 (0.82–1.75) [-1.0%]	1.34 (0.65–2.77)	1.32 (0.64–2.71)	1.25 (0.61–2.57) [-6.5%]
Insufficient income	1.12 (0.86–1.45)	1.12 (0.86–1.44)	1.14 (0.88–1.48) [+1.7%]	1.97 (1.28–3.04)	1.96 (1.28–3.01)	2.13 (1.41–3.21) [+8.0%]
Debt: low (ref none)	0.88 (0.67–1.15)	0.88 (0.68–1.15)	0.89 (0.69–1.17) [+1.5%]	0.99 (0.59–1.64)	1.00 (0.60–1.67)	1.04 (0.62–1.75) [+5.4%]
Debt: moderate	0.90 (0.66–1.23)	0.90 (0.67–1.23)	0.92 (0.67–1.25) [+1.6%]	1.20 (0.64–2.23)	1.20 (0.64–2.24)	1.21 (0.64–2.27) [+0.9%]
Debt: high	1.10 (0.76–1.59)	1.10 (0.76–1.58)	1.09 (0.74–1.60) [-0.6%]	2.45 (1.29–4.65)	2.47 (1.28–4.77)	2.69 (1.47–4.93) [+9.8%]
Living alone	0.81 (0.50–1.29)	0.80 (0.50–1.28)	0.82 (0.52–1.30) [+1.4%]	0.69 (0.31–1.52)	0.71 (0.32–1.56)	0.80 (0.38–1.72) [+16.1%]
No family caregiver	1.06 (0.64–1.74)	1.05 (0.64–1.72)	1.06 (0.65–1.72) [+0.3%]	2.00 (0.99–4.04)	1.77 (0.89–3.51)	1.76 (0.86–3.59) [-12.2%]
Holds a community role	0.94 (0.77–1.14)	0.94 (0.78–1.14)	0.94 (0.78–1.15) [+0.3%]	0.81 (0.47–1.39)	0.80 (0.46–1.38)	0.82 (0.50–1.35) [+1.5%]
Social participation	0.78 (0.62–0.99)	0.79 (0.62–0.99)	0.78 (0.61–0.98) [-1.0%]	0.82 (0.50–1.34)	0.82 (0.50–1.34)	0.75 (0.47–1.19) [-8.2%]
1 chronic condition (ref 0)	0.86 (0.71–1.03)	0.86 (0.72–1.03)	0.85 (0.71–1.02) [-0.3%]	2.25 (1.61–3.16)	2.24 (1.62–3.10)	2.11 (1.49–2.98) [-6.6%]
≥2 chronic conditions	0.70 (0.54–0.92)	0.70 (0.54–0.91)	0.70 (0.54–0.92) [+0.3%]	3.54 (2.23–5.64)	3.46 (2.19–5.48)	3.32 (2.06–5.35) [-6.4%]
Study-defined polypharmacy	1.43 (1.18–1.73)	1.43 (1.19–1.73)	1.44 (1.19–1.74) [+0.6%]	2.45 (1.73–3.47)	2.47 (1.76–3.48)	2.40 (1.69–3.40) [-2.2%]
Vigorous activity ≥3 days/week	0.86 (0.64–1.14)	0.86 (0.65–1.14)	0.87 (0.65–1.16) [+1.8%]	0.95 (0.62–1.47)	0.97 (0.62–1.52)	0.98 (0.63–1.52) [+3.5%]
Fruit/vegetables ≥5 portions ≥5 days/week	0.74 (0.59–0.93)	0.75 (0.60–0.94)	0.72 (0.57–0.90) [-3.6%]	0.68 (0.49–0.94)	0.71 (0.51–0.99)	0.55 (0.41–0.76) [-18.5%]
Any smoking	1.74 (1.39–2.18)	1.74 (1.39–2.17)	1.75 (1.39–2.21) [+1.0%]	1.91 (1.07–3.41)	1.91 (1.06–3.44)	2.02 (1.11–3.66) [+5.3%]
Any alcohol	1.16 (0.96–1.41)	1.16 (0.96–1.41)	1.19 (0.98–1.44) [+1.9%]	1.54 (0.97–2.46)	1.56 (0.97–2.50)	1.66 (1.03–2.66) [+7.4%]
Tooth-brushing ≥2 times daily	0.63 (0.47–0.83)	0.63 (0.47–0.83)	—	0.21 (0.13–0.33)	0.21 (0.14–0.33)	—
Home hazard score (per hazard)	1.09 (1.03–1.16)	1.11 (1.04–1.19)	1.10 (1.03–1.17) [+0.3%]	1.44 (1.29–1.61)	1.51 (1.33–1.72)	1.42 (1.29–1.57) [-1.1%]
Cooks with charcoal	1.15 (0.85–1.54)	1.14 (0.85–1.52)	1.14 (0.85–1.54) [-0.3%]	0.55 (0.38–0.79)	0.53 (0.37–0.77)	0.54 (0.38–0.78) [-0.3%]

Model 4 with cluster-robust (sandwich) 95% CIs; small-sample-corrected CIs for Model 4 are given in Table S9 and Figure 4. Nine-item hazard score: home hazard score excluding the two most common items (no bathroom grab bar, 83.7%; door thresholds, 66.9%); in this column only the hazard-score row changes definition, and all other covariates are re-estimated alongside it. Without tooth-brushing: Model 4 re-estimated after omitting twice-daily tooth-brushing; % change = relative change in the aOR compared with Model 4. — = covariate omitted.

Table S11. Random seeds and computational environment

Descriptive cluster bootstrap (prevalence CIs, observed-to-expected ratios; 2,000 replicates; 02_step1_2_tables.py): seed 20260928

Class enumeration, K = 1–6 (500 random starts per model; 04_lca_enumeration.py): seed 100 + K

Bootstrap likelihood ratio test, K−1 vs K classes (100 bootstrap samples; 04_lca_enumeration.py): seed K

Nonparametric multilevel LCA, K lower-level and M higher-level classes (05b_mlca_select.py): seed 1000K + M (single-level starting values: seed K)

Selected three-class model re-estimated with 1,000 random starts (05c_final_model.py; 14_revision_analyses.py): seed 2026

StepMix cross-check (StepMix 3.0.0; 14_revision_analyses.py): random_state 2026

Sensitivity solutions SA1–SA10 (300 random starts; 06_step3_distal_sensitivity.py; 15_revision3_analyses.py; 15b_sa_profiles_k4.py): seed 77

Log-linear models, subdistrict cluster bootstrap (2,000 replicates; 14_revision_analyses.py; 15_revision3_analyses.py): seed 11

Distal outcomes (concurrent external correlates), bias-adjusted ML three-step, cluster bootstrap (1,000 replicates; 16_figure3_revised.py): seed 5

Leave-one-subdistrict-out jackknife (Table S9): deterministic (no random seed)

Computational environment (original analyses): Python 3.10–3.11 with NumPy, SciPy, pandas and statsmodels 0.15.0; StepMix 3.0.0 for the cross-check; LCA, multilevel LCA, BLRT, bivariate residuals and three-step estimators implemented in lca_core.py.

Reproduction check (revision, November 2026): Python 3.13.18, NumPy 2.5.3, SciPy 1.18.1, pandas 3.0.5. Re-estimating the selected three-class model (05c_final_model.py settings: 1,000 random starts, seed 2026) reproduced the log-likelihood (−25,646.7), class sizes (77.3%, 16.2%, 6.5%) and the modal class assignment of all 12,115 participants; the maximum absolute difference in posterior probabilities from the archived values was <0.0001.

Analysis scripts, a data dictionary and a synthetic dataset (with the structure of the analytic dataset but no real records) are available from the corresponding author on request.