

Appendix A Biomarker Levels

Table A1: Cut-off values to indicate normal/adequate ranges for nutritional biomarkers.

Biomarker	Cut-Off Value
<i>B-Vitamins</i>	
Serum folate ¹	> 10 nmol/L
Red blood cell folate ²	
Plasma pyridoxal-5-phosphate (vitamin B6) ³	> 30 nmol/L
EGRac (riboflavin) ⁴	< 1.40
<i>Vitamin B12 biomarkers</i>	
Serum total vitamin B12 ⁵	> 221 pmol/L
Serum holotranscobalamin ⁶	> 40 pmol/L
Serum methylmalonic acid ⁷	< 0.27 μ mol/L
<i>Other</i>	
Serum total homocysteine ⁸	< 16 μ mol/L
Serum 25(OH)D (vitamin D) ⁹	> 50 nmol/L

Table A2: Normal ranges for ‘hospital-measured’ biomarkers (routine clinical bloods). All ranges were obtained from standard lab blood specimen request/result forms.

Biomarker	Cut-Off Value
C-reactive protein (CRP)	0.1 – 5.0 mg/L
<i>Full Blood Profile</i>	
White cell count (WCC)	4 – 11 109/L
Haemoglobin (Hb)	130 – 180 g/L
Mean corpuscular volume (MCV)	96 – 100 fL
Platelet count (PLT)	150 – 450 109/L
Hematocrit (HCT)	0.4 – 0.54
<i>Liver and Kidney Function Tests</i>	
Albumin	35 – 50 g/L
Gamma GT	10 – 50 U/L
Urea	2.5 – 7.8 mmol/L
Creatinine	59 – 104 μ mol/L
Alkaline phosphatase (AlkPhos)	30 – 130 U/L
Glomerular filtration rate (GFR)	$\geq$ 60 ml/min/1.73m2
<i>Electrolyte Profile</i>	
Sodium (Na)	133 – 146 mmol/L
Potassium (K)	3.5 – 5.3 mmol/L
<i>Bone Profile</i>	
Calcium (Ca)	2.2 – 2.6 mmol/L
Phosphate (Po3)	0.8 – 1.5 mmol/L
Parathyroid hormone (PTH)	14 – 65 pg/ml
<i>Lipid Profile</i>	
Cholesterol	2.8 – 5.0 mmol/L
Low-density lipoprotein (LDL)	1.0 – 3.0 mmol/L
High-density lipoprotein (HDL)	1.0 – 2.5 mmol/L
Triglycerides	0.40 – 1.70 mmol/L
<i>Blood Glucose</i>	
Glucose	3.9 – 6.4 mmol/L
Glycated haemoglobin (HbA1c)	leq 6.5%

Appendix B Covariate Features

Table B1: The features contained in the mental health view.

Group	Name	Type
CES-D	Bothered by things	Ordinal (4 levels)
	Felt depressed	Ordinal (4 levels)
	Felt the blues	Ordinal (4 levels)
	Everything is an effort	Ordinal (4 levels)
	Hopeful about future	Ordinal (4 levels)
	Worse than others	Ordinal (4 levels)
	Trouble concentrating	Ordinal (4 levels)
	Happy	Ordinal (4 levels)
	Felt life a failure	Ordinal (4 levels)
	Talk less than usual	Ordinal (4 levels)
	Felt fearful	Ordinal (4 levels)
	Felt lonely	Ordinal (4 levels)
	People are unfriendly	Ordinal (4 levels)
	Enjoyed life	Ordinal (4 levels)
	Crying spells	Ordinal (4 levels)
	Couldn't get going	Ordinal (4 levels)
	People dislike me	Ordinal (4 levels)
HADS	Feel something awful coming	Ordinal (4 levels)
	Butterflies in stomach	Ordinal (4 levels)
	Tense and wound up	Ordinal (4 levels)
	Restless on the move	Ordinal (4 levels)
	Unable to sit at ease	Ordinal (4 levels)
	Sudden feeling of panic	Ordinal (4 levels)
	Worrying thoughts	Ordinal (4 levels)

Table B2: The features contained in the cognitive health view.

Group	Name	Type
RBANS	Semantic fluency	Continuous
	Figure copying	Continuous
	List learning	Continuous
	Coding	Continuous
	Picture naming	Continuous
	Story memory	Continuous
	List recall	Continuous
	List recognition	Continuous
	Line orientation	Continuous
	Figure recall	Continuous
	Digit span	Continuous
	Story recall	Continuous
FAB	Prehension behaviour	Ordinal (4 levels)
	Similarities conceptualisation	Ordinal (4 levels)
	Lexical fluency	Ordinal (4 levels)
	Motor series programming	Ordinal (4 levels)
	Sensitivity to interference	Ordinal (4 levels)
	Inhibitory control	Ordinal (4 levels)
MMSE 1	Repeat phrase	Binary
	Copy the design	Binary
	Close your eyes	Binary
	Write a sentence	Binary
MMSE 2	Name three common objects	Ordinal (4 levels)
	Follow three-stage command	Ordinal (4 levels)
	Recall three objects	Ordinal (4 levels)
MMSE 3	Year/Season/Date	Ordinal (6 levels)
	Where are we	Ordinal (6 levels)
	Serial sevens	Ordinal (6 levels)
	Spell WORLD backwards	Ordinal (6 levels)

Table B3: The features contained in the illness and medications view.

Group	Name	Type
Diagnoses	Hypertension	Binary
	Heart attack	Binary
	Diabetes	Binary
	Hyperlipidaemia	Binary
	Stroke	Binary
	Ischaemic heart disease	Binary
	TIA	Binary
	Angina	Binary
	Peripheral artery disease	Binary
	Atrial fibrillation	Binary
	ABI/Carotidartery doppler	Binary
	Other serious disease	Binary
	Carotid endarterectomy	Binary
	Osteoporosis	Binary
	Bypass operation	Binary
	Atrophic gastritis	Binary
	Rheumatoid arthritis	Binary
	GI disease	Binary
	Epilepsy	Binary
Medications	Statins medications	Binary
	Anxiety medications	Binary
	Antipsychotic medications	Binary
	Lipid medications	Binary
	Antidepressant medications	Binary
	Dementia medications	Binary
	Vitamin D supplements	Binary

Table B4: The features contained in the lifestyle and nutrition view.

Group	Name	Type
Deprivation	Deprivation quintiles	Ordinal (5 levels)
Living Status	Living With	Binary
	Marital status	Binary
Smoke/Drink	Smoking	Binary
	Drinking	Binary
	White cell count	Binary
	Haemoglobin	Binary
	Cholesterol	Binary
	Creatinine	Binary
	Albumin	Binary
	Mean corpuscular volume	Binary
	Hematocrit	Binary
	Gamma GT	Binary
	Sodium	Binary
	Urea	Binary
	Triglycerides	Binary
	Low-density lipoprotein	Binary
	Potassium	Binary
	Total homocysteine	Binary
	Glomerular filtration rate	Binary
	High-density lipoprotein	Binary
	Phosphate	Binary
	Serum holotranscobalamin	Binary
	Vitamin D	Binary
	Glucose	Binary
	Alkaline phosphatase	Binary
	Serum methylmalonic acid	Binary
	Total serum B12	Binary
	Parathyroid hormone	Binary
	Platelet count	Binary
	C-reactive protein	Binary
	Glycated haemoglobin	Binary
	Riboflavin	Binary
	Serum folate	Binary
	Red blood cell folate	Binary
	Plasma pyridoxal-5-phosphate (vitamin B6)	Binary

Table B5: The features contained in the physical health view.

Group	Name	Type
Female	Female	Binary
Age	Age	Continuous
TUG	TUG	Continuous
BMI	BMI	Continuous
PSMS	Fallen in last year	Binary
	Dizzy when standing	Binary
	Trouble getting to the bathroom on time	Binary
	Care taken when rising	Binary
	Fainted in the past year	Binary
	Dizzy when rising	Binary
	Eat with help	Binary
	Afraid of falling	Binary
	Dress with help	Binary
	Limit household activities	Binary
	Take care of appearance	Binary
	Limit outside activities	Binary
	Get around the house without help	Binary
	Get in and out of bed	Binary
	Able to bathe	Binary
	Visual impairments	Binary
IADL	Get to places outside walking distance	Ordinal (4 levels)
	Do own handyman work	Ordinal (4 levels)
	Manage own money	Ordinal (4 levels)
	Shop for groceries	Ordinal (4 levels)
	Use the telephone	Ordinal (4 levels)
	Prepare own meals	Ordinal (4 levels)
	Take own medicine	Ordinal (4 levels)
	Do own housework	Ordinal (4 levels)
	Do own laundry	Ordinal (4 levels)

Appendix C Model Selection

The estimation strategy of the MVLBM follows that of [52]. Considering the TUDA dataset consisting of 5 views, it is infeasible to exhaustively explore the entire model space for different numbers of row clusters and column clusters. As such, we first estimate single-view LBMs for each view $\mathbf{x}_v$ using the method of [51]. The hypothesis testing procedure is applied to each pair of views to determine if a relationship exists between them. As the MVLBM model places no requirements on the dependence between the latent row cluster memberships in each view, if the row clusters in view v exhibit dependence with a least one other view in the dataset, it is retained for the MVLBM estimation. Beginning with the partitions from the single-view LBMs, we estimate the full MVLBM model using the SEM-Gibbs algorithm and compute the ICL for the model. To explore the model space, it is proposed to produce clusterings first increasing and then decreasing the number of row clusters in each view by 1, and subsequently increasing and then decreasing the number of column clusters in each view by 1. The clustering with the highest ICL is retained to initialize the next iteration. The process is terminated if the ICL does not improve and the final MVLBM is the clustering with the highest ICL value. Algorithm 1 outlines the steps for determining the (locally) optimal combination of (K_v, L_v) for $v = 1, \dots, V$.

Algorithm 1 Pseudo Code for the Multi-View Latent Block Model

Input: The multi-view dataset.

Output: The MVLBM with the row-cluster memberships, column-cluster memberships, and block cluster parameters.

```
1: for each view in the dataset do
2:   Apply the LBM of [51] on each data view.
3:   Extract row-cluster memberships and column-cluster memberships for the views independently.
4: end for
5: for each pair of views do
6:   Test the hypothesis of no association between the views.
7:   if the null hypothesis is rejected then
8:     Retain both views.
9:   end if
10: end for
11: Let the multi-view dataset be the set of retained views.
12: Initialize the MVLBM with the independent co-clusterings from each view.
13: Update the MVLBM using the SEM-Gibbs algorithm and obtain the ICL value.
14: loop
15:   for each view do
16:     Increase the number of row clusters by 1. Apply the SEM-Gibbs and obtain the ICL value.
17:     Repeat, instead increasing the number of column clusters by 1.
18:   end for
19:   Retain the maximum ICL value attained.
20:   if the ICL increases from the last iteration: then
21:     Update the MVLBM with the one having the maximum ICL value.
22:   else
23:     Break.
24:   end if
25: end loop
```

Appendix D Block-cluster Parameters

Table D1: Block-cluster parameters for the mental health features. Given the ordinal nature of the data, each block is modeled using a Binary Ordinal Search (BOS) distribution, characterized by a position parameter μ and a precision parameter $\beta \in [0, 1]$. Higher values of μ indicate a greater frequency of symptoms. A β value closer to 1 suggests that the data are more tightly concentrated around the position parameter μ .

		CES-D (μ, β)			
		Col C1	Col C2	Col C3	Col C4
	n	8	8	3	1
Row C1	152	(0, 0.45)	(0, 0.88)	(1, 0.56)	(1, 0.56)
Row C2	315	(0, 0.33)	(0, 0.57)	(1, 0.23)	(3, 0.12)
Row C3	1088	(0, 0.35)	(0, 0.67)	(1, 0.35)	(1, 0.33)
Row C4	602	(0, 0.89)	(0, 0.90)	(0, 0.77)	(0, 0.23)
Row C5	3029	(0, 0.90)	(0, 0.91)	(0, 0.88)	(0, 0.57)

		HADS (μ, β)			
		Col C1	Col C2	Col C3	Col C4
	n	2	2	2	1
Row C1	152	(0, 0.91)	(0, 0.92)	(0, 0.78)	(0, 0.92)
Row C2	315	(0, 0.23)	(0, 0.44)	(1, 0.34)	(1, 0.12)
Row C3	1088	(0, 0.45)	(0, 0.66)	(1, 0.34)	(0, 0.56)
Row C4	602	(0, 0.45)	(0, 0.56)	(1, 0.57)	(1, 0.34)
Row C5	3029	(0, 0.88)	(0, 0.89)	(0, 0.67)	(0, 0.77)

Table D2: Block-cluster parameters for the cognitive health features. The continuous data is modeled with a Gaussian distribution with mean parameter μ and standard deviation parameter σ . The ordinal is modeled using a BOS distribution, characterized by a position parameter μ and a precision parameter $\beta \in [0, 1]$. The binary data is modeled using a Binomial distribution characterised by the parameter (p).

		RBANS (μ, σ)			FAB (μ, β)	
		Col C1	Col C2	Col C3	Col C1	Col C2
	n	4	3	5	1	5
Row C1	1693	(0.66, 0.17)	(0.16, 0.12)	(0.43, 0.17)	(3, 0.92)	(3, 0.56)
Row C2	1234	(0.81, 0.14)	(0.27, 0.20)	(0.57, 0.18)	(3, 0.92)	(2, 0.23)
Row C3	2259	(0.49, 0.17)	(0.08, 0.07)	(0.28, 0.16)	(3, 0.92)	(3, 0.78)

		MMSE					
		(p)		(μ, β)		(μ, β)	
		Col C1	Col C2	Col C1	Col C2	Col C3	Col C1
	n	3	1	1	1	1	4
Row C1	1693	0.07	0.26	(1, 1.00)	(3, 0.89)	(1, 0.23)	(5, 0.67)
Row C2	1234	0.14	0.63	(1, 0.92)	(3, 0.78)	(1, 0.34)	(5, 0.44)
Row C3	2259	0.02	0.07	(1, 1.00)	(3, 0.91)	(2, 0.34)	(5, 0.79)

Table D3: Block-cluster parameters for the illness and medications features. As the data is binary, it is modeled using a Binomial distribution characterised by the parameter (p).

		Diagnoses (p)			Medications (p)		
		Col C1	Col C2	Col C3	Col C1	Col C2	Col C3
	n	2	9	8	3	2	2
Row C1	1905	0.60	0.09	0.23	0.54	0.27	0.08
Row C2	3281	0.65	0.04	0.16	0.51	0.10	0.01

Table D4: Block-cluster parameters for the lifestyle and nutrition features. The ordinal is modeled using a BOS distribution, characterized by a position parameter μ and a precision parameter $\beta \in [0, 1]$.

		Deprivation (μ, β)	Living/Marital (p)		Drink/Smoke (p)
		Col C1	Col C1	Col C2	Col C1
	n	1	1	1	2
Row C1	3281	(1, 0.01)	0.72	0.63	0.38
Row C2	1905	(5, 0.23)	0.57	0.35	0.29

		Nutrition (p)			
		Col C1	Col C2	Col C3	Col C4
	n	11	6	6	9
Row C1	3281	0.94	0.03	0.64	0.79
Row C2	1905	0.91	0.06	0.55	0.73

Table D5: Block-cluster parameters for the physical health features. The continuous data is modeled with a Gaussian distribution with mean parameter μ and standard deviation parameter σ . The ordinal is modeled using a BOS distribution, characterized by a position parameter μ and a precision parameter $\beta \in [0, 1]$. The binary data is modeled using a Binomial distribution characterised by the parameter (p).

		Female (p)	Age (μ, σ)	TUG (μ, σ)	BMI (μ, σ)
		Col C1	Col C1	Col C1	Col C1
	n	1	1	1	1
Row C1	1905	0.69	(79.7, 7.7)	(21.4, 11.0)	(27.5, 5.9)
Row C2	3281	0.66	(70.7, 6.6)	(9.9, 3.8)	(28.1, 5.0)

		IADL (p)			PSMS (μ, β)		
		Col C1	Col C2	Col C3	Col C1	Col C2	Col C3
	n	6	9	1	5	1	3
Row C1	1905	0.65	0.17	0.73	(1, 0.12)	(0, 0.79)	(2, 0.66)
Row C2	3281	0.31	0.03	0.86	(2, 0.88)	(2, 0.23)	(2, 0.92)

Appendix E Feature Clusterings

Table E1: Column-clusters for the cognitive health features.

	RBANS			
	Col C1		Col C2	Col C3
n	4		3	5
	Semantic fluency	Figure copying	List learning	
	Coding	Picture naming	Story memory	
	List recall	List recognition	Line orientation	
	Figure recall		Digit span	
			Story recall	
	FAB			
	Col C1		Col C2	
n	1		5	
	Prehension behaviour	Similarities conceptualisation		
		Lexical fluency		
		Motor series programming		
		Sensitivity to interference		
		Inhibitory control		
	MMSE			
	Col C1		Col C2	
n	1		5	
	Repeat phrase	Copy the design		
	Close your eyes			
	Write a sentence			
	MMSE			
	Col C1	Col C2	Col C3	Col C1
n	1	1	1	4
	Name three common objects	Follow three stage command	Recall three objects	Year/Season/Date
				Where are we
				Serial sevens
				Spell WORLD backwards

Table E2: Column-clusters for the illness and medication features.

	Diagnoses		
	Col C1	Col C2	Col C3
n	2	9	8
	Hypertension	Heart attack	Diabetes
	Hyperlipidaemia	Stroke	Ischaemic heart disease
		TIA	Angina
		Peripheral artery disease	Atrial fibrillation
		ABI/Carotidartery doppler	Other serious disease
		Carotid endarterectomy	Osteoporosis
		Bypass operation	Atrophic gastritis
		Rheumatoid arthritis	GI disease
		Epilepsy	
	Medications		
	Col C1	Col C2	Col C3
n	3	2	2
	Statins medications	Anxiety medications	Antipsychotic medications
	Lipid medications	Antidepressant medications	Dementia medications
	Vitamin D supplements		

Table E3: Column-clusters for the lifestyle and nutrition features.

	Deprivation Col C1	Living/Marital Col C1	Col C2	Drink/Smoke Col C1
<i>n</i>	1	1	1	2
	Deprivation quintiles	Living With	Marital status	Smoking Drinking
	Nutrition Col C1	Col C2	Col C3	Col C4
<i>n</i>	11	6	6	9
	White cell count Albumin Sodium Potassium Phosphate Alkaline phosphatase Platelet count Glycated haemoglobin Serum folate Red blood cell folate Plasma pyridoxal-5-phosphate (vitamin B6)	Haemoglobin Mean corpuscular volume Urea Total homocysteine Serum holotranscobalamin Serum methylmalonic acid	Cholesterol Hematocrit Triglycerides Glomerular filtration rate Vitamin D Total serum B12	Creatinine Gamma GT Low-density lipoprotein High-density lipoprotein Glucose Parathyroid hormone C-reactive protein Riboflavin

Table E4: Column-clusters for the physical health features.

	Female Col C1	Age Col C1	TUG Col C1	BMI Col C1
<i>n</i>	1	1	1	1
	Female	Age	TUG	BMI
	IADL Col C1	Col C2	Col C3	
<i>n</i>	6	9	1	
	Fallen in last year Care taken when rising Dizzy when rising Afraid of falling Limit household activities Limit outside activities	Dizzy when standing Fainted in past year Eat with help Dress with help Take care of appearance Get around house without help Get in and out of bed Able to bathe Visual impairments	Trouble getting to bathroom on time	
	PSMS Col C1	Col C2	Col C3	
<i>n</i>	5	1	3	
	Get to places outside walking distance Shop for groceries Prepare own meals Do own housework Do own laundry	Do own handymanwork	Manage own money Use the telephone Take own medicine	