**Article:**
Davillas, A. and Pudney, S. orcid.org/0000-0002-5697-0976 (2020) Biomarkers as precursors of disability. Economics and Human Biology, 36. 100814. ISSN 1570-677X

https://doi.org/10.1016/j.ehb.2019.100814

# Biomarkers as precursors of disability: Online Supplement

Table S1: Sample size for the single period prediction models.

| | Any or # difficulties | | | Mobility | | | Benefit receipt | | |
|---|---|---|---|---|---|---|---|---|---|
| | *Prediction horizon* | | | | | | | | |
| Marker | $t = 2$ | $t = 3$ | $t = 4$ | $t = 2$ | $t = 3$ | $t = 4$ | $t = 2$ | $t = 3$ | $t = 4$ |
| *Nurse measured biomarkers* | | | | | | | | | |
| Waist/height ratio | 12025 | 11423 | 7671 | 13969 | 13242 | 8915 | 14492 | 13719 | 9256 |
| Grip strength | 11552 | 10972 | 7398 | 13351 | 12655 | 8561 | 13839 | 13101 | 8875 |
| Hypertension | 9993 | 9512 | 6409 | 11624 | 11032 | 7454 | 12142 | 11496 | 7771 |
| Heart rate | 10003 | 9522 | 6415 | 11639 | 11047 | 7463 | 12163 | 11516 | 7783 |
| FVC | 10832 | 10305 | 7013 | 12518 | 11887 | 8106 | 12947 | 12281 | 8395 |
| *Blood-based biomarkers* | | | | | | | | | |
| HDL | 7904 | 7488 | 5020 | 9176 | 8671 | 5831 | 9585 | 9047 | 6097 |
| CRP | 7591 | 7184 | 4813 | 8794 | 8306 | 5583 | 9152 | 8636 | 5809 |
| HbA1c | 7495 | 7104 | 4757 | 8716 | 8241 | 5540 | 9101 | 8598 | 5789 |
| DHEA-S | 7910 | 7496 | 5022 | 9180 | 8677 | 5835 | 9588 | 9052 | 6099 |
| EGFR | 7921 | 7502 | 5033 | 9197 | 8688 | 5848 | 9605 | 9063 | 6112 |
| Hgb | 7492 | 7098 | 4753 | 8712 | 8234 | 5537 | 9096 | 8590 | 5785 |
| Albumin | 7930 | 7511 | 5040 | 9207 | 8699 | 5856 | 9616 | 9075 | 6121 |
| *Systematic risk scores* | | | | | | | | | |
| Allostatic load | 5820 | 5529 | 3705 | 6740 | 6383 | 4298 | 7028 | 6652 | 4484 |
| CVD risk | 5842 | 5550 | 3723 | 6770 | 6412 | 4321 | 7056 | 6679 | 4506 |

Table S2: Survey question design: list of functional difficulties

| | Sample prevalence at.. | | |
|---|---|---|---|
| Difficulty | $t = 2$ | $t = 3$ | $t = 4$ |
| Mobility (moving around at home and walking) | 0.040 | 0.045 | 0.053 |
| Lifting, carrying or moving objects | 0.046 | 0.048 | 0.051 |
| Manual dexterity (using your hands to carry out everyday tasks) | 0.014 | 0.015 | 0.016 |
| Continence (bladder and bowel control) | 0.010 | 0.012 | 0.011 |
| Hearing (apart from using a standard hearing aid) | 0.010 | 0.012 | 0.014 |
| Sight (apart from wearing standard glasses) | 0.008 | 0.009 | 0.009 |
| Communication or speech problems | 0.002 | 0.003 | 0.003 |
| Memory or ability to concentrate, learn or understand | 0.014 | 0.016 | 0.016 |
| Recognising when you are in physical danger | 0.002 | 0.002 | 0.002 |
| Your physical co-ordination (e.g. balance) | 0.013 | 0.015 | 0.016 |
| Difficulties with own personal care (e.g. getting dressed, taking a bath or shower) | 0.006 | 0.006 | 0.008 |
| Other health problem or disability | 0.025 | 0.029 | 0.035 |

Prevalence rates are for the individuals who report no functional difficulties at baseline. For $t = 2, 3$, prevalence relates to the combined UKHLS/BHPS sample; for $t = 4$, prevalence relates to the UKHLS sample only.

Table S3: Mean biomarker levels and systemic risk scores by disability status 4 years ahead: measures based on number of functional difficulties reported

| | Any difficulty | | | Number of difficulties | | | | |
|---|---|---|---|---|---|---|---|---|
| Biomarker | Non-disabled | Disabled | Crude effect size (%) | 0 | 1 | 2 | 3+ | Crude effect size (%) |
| *Nurse measured biomarkers* | | | | | | | | |
| Waist/height ratio | 0.55 | 0.58 | **-39.4** | 0.55 | 0.57 | 0.58 | 0.59 | **-54.7** |
| Grip strength (kg) | 35.3 | 32.4 | **25.9** | 35.3 | 33.4 | 32.5 | 29.4 | **52.0** |
| Hypertension | 0.26 | 0.40 | **-35.2** | 0.26 | 0.40 | 0.42 | 0.47 | **-46.8** |
| Heart rate (bpm) | 68.5 | 69.7 | **-12.0** | 68.5 | 69.0 | 70.8 | 70.3 | **-17.6** |
| FVC (L) | 4.00 | 3.57 | **41.2** | 4.00 | 3.64 | 3.50 | 3.46 | **51.9** |
| *Blood-based biomarkers* | | | | | | | | |
| HDL (mmol/L) | 1.59 | 1.52 | **16.7** | 1.59 | 1.50 | 1.56 | 1.52 | **14.7** |
| CRP (mg/L) | 1.80 | 2.33 | **-28.3** | 1.80 | 2.40 | 2.24 | 2.22 | **-22.9** |
| HbA1c (mmol/mol) | 36.1 | 38.7 | **-38.8** | 36.1 | 38.4 | 39.1 | 39.0 | **-45.7** |
| DHEAS (µmol/L) | 4.89 | 3.86 | **33.4** | 4.89 | 3.86 | 3.93 | 3.78 | **35.4** |
| EGFR | 92.8 | 85.7 | **38.9** | 92.8 | 86.3 | 85.1 | 84.5 | **45.9** |
| Hgb (g/L) | 137.4 | 136.3 | 8.2 | 137.4 | 136.9 | 135.9 | 135.3 | 15.9 |
| Albumin (g/L) | 47.2 | 46.3 | **30.4** | 47.2 | 46.6 | 46.1 | 45.9 | **48.1** |
| *Systematic risk scores* | | | | | | | | |
| Allostatic load | -0.21 | 1.75 | **-47.9** | -0.21 | 1.60 | 1.62 | 2.50 | **-66.5** |
| CVD risk score | -0.04 | 1.11 | **-38.7** | -0.04 | 1.07 | 0.96 | 1.52 | **-52.9** |

Notes: Crude effect size is the difference in the mean biomarker/risk score values by disability status, expressed as percentage of the standard deviation of the biomarker/risk score; the lowest (zero) and highest (3+) groups are used in the case of the "number of difficulties" disability measure. Bold type indicates statistical significance at the 1% level (bootstrap with 500 replications). A negative effect size indicates that the biomarker/risk score has a higher mean value for the more disabled group.

Table S4: Mean biomarker levels and systemic risk scores by disability status 4 years ahead: mobility and benefit disability measures

| | Mobility | | | Benefit receipt | | |
|---|---|---|---|---|---|---|
| Biomarker | Non-disabled | Disabled | Crude effect size (%) | Non-disabled | Disabled | Crude effect size (%) |
| *Nurse measured biomarkers* | | | | | | |
| Waist/height ratio | 0.55 | 0.60 | **-61.0** | 0.56 | 0.60 | **-51.9** |
| Grip strength (kg) | 34.7 | 31.0 | **32.9** | 34.4 | 29.6 | **42.3** |
| Hypertension | 0.28 | 0.49 | **-45.7** | 0.30 | 0.45 | -31.6 |
| Heart rate (bpm) | 68.6 | 70.2 | **-15.2** | 68.6 | 70.9 | **-21.3** |
| FVC (L) | 3.93 | 3.40 | **50.1** | 3.88 | 3.38 | **48.2** |
| *Blood-based biomarkers* | | | | | | |
| HDL (mmol/L) | 1.58 | 1.50 | **16.8** | 1.57 | 1.54 | **6.6** |
| CRP (mg/L) | 1.88 | 2.59 | **-37.3** | 1.92 | 2.75 | **-42.5** |
| HbA1c (mmol/mol) | 36.5 | 39.4 | **-42.3** | 36.8 | 38.7 | **-28.7** |
| DHEAS (µmol/L) | 4.69 | 3.46 | **40.0** | 4.55 | 3.71 | **27.2** |
| EGFR | 91.6 | 82.6 | **49.1** | 90.6 | 85.1 | **29.5** |
| Hgb (g/L) | 137.3 | 135.3 | **14.8** | 137.1 | 133.1 | **29.6** |
| Albumin (g/L) | 47.1 | 45.9 | **42.8** | 47.0 | 45.8 | **40.7** |
| *Systematic risk scores* | | | | | | |
| Allostatic load | -0.17 | 2.63 | **-69.1** | -0.11 | 1.59 | **-41.4** |
| CVD risk score | -0.19 | 1.72 | **-59.3** | 0.03 | 1.05 | **-34.2** |

Notes: Crude effect size is the difference in the mean biomarker/risk score values by disability status, expressed as percentage of the standard deviation of the biomarker/risk score; the lowest (zero) and highest (3+) groups are used in the case of the "number of difficulties" disability measure. Bold type indicates statistical significance at the 1% level (bootstrap with 500 replications). A negative effect size indicates that the biomarker/risk score has a higher mean value for the more disabled group.

Table S5: Definitions and summary statistics of covariates

| | *Sample of origin*[§] | | | |
|---|---|---|---|---|
| | UKHLS | | UKHLS&BHPS | |
| Covariate | Mean | s.d. | Mean | s.d. |
| *Self-assessed health* | | | | |
| 1 = respondent reports excellent health | 0.13 | 0.34 | 0.15 | 0.35 |
| 2 = respondent reports very good health | 0.39 | 0.49 | 0.39 | 0.49 |
| 3 = respondent reports good health | 0.34 | 0.47 | 0.33 | 0.46 |
| 4 = respondent reports fair or poor health | 0.14 | 0.34 | 0.14 | 0.35 |
| *Socio-economic status* | | | | |
| Degree = 1 if respondent has degree/equivalent | 0.38 | 0.49 | 0.37 | 0.49 |
| A-level = 1 if respondent has A-level/equivalent | 0.19 | 0.39 | 0.20 | 0.40 |
| O-level = 1 if respondent has O-level/basic qualification | 0.31 | 0.46 | 0.31 | 0.46 |
| No qualification = 1 if no qualifications reported | 0.12 | 0.32 | 0.11 | 0.32 |
| Homeowner=1 if respondent lives in owner-occupied property | 0.79 | 0.41 | 0.79 | 0.41 |
| Non-homeowner=1 if not in a owner-occupied property | 0.21 | 0.41 | 0.21 | 0.41 |
| Pre-disability benefits equivalised household income (log) | 7.31 | 0.60 | 7.31 | 0.60 |
| *Marital status and household structure* | | | | |
| Single=1 if respondent is single | 0.14 | 0.35 | 0.15 | 0.35 |
| Married=1 if respondent is married/cohabitating | 0.70 | 0.46 | 0.71 | 0.46 |
| Sep/Div=1 if respondent is separated/divorced | 0.09 | 0.29 | 0.09 | 0.28 |
| Widowed=1 if respondent is widowed | 0.06 | 0.24 | 0.06 | 0.24 |
| Number of household members | 2.66 | 1.25 | 2.69 | 1.26 |
| Number of children in the household | 0.53 | 0.91 | 0.54 | 0.91 |
| *Residential region and urbanization level* | | | | |
| England=1 if region is England | 0.93 | 0.26 | 0.85 | 0.36 |
| Wales=1 if region is Wales | 0.03 | 0.16 | 0.07 | 0.26 |
| Scotland=1 if region is Scotland | 0.05 | 0.21 | 0.08 | 0.27 |
| Urban=1 if urban area | 0.75 | 0.43 | 0.74 | 0.44 |
| Rural=1 if rural area | 0.25 | 0.43 | 0.26 | 0.44 |
| *Other personal characteristics* | | | | |
| Male=1 if respondent is male | 0.43 | 0.50 | 0.44 | 0.50 |
| Female=1 if respondent is female | 0.57 | 0.50 | 0.56 | 0.50 |
| Age of respondent (years) | 50.40 | 16.93 | 50.10 | 16.96 |
| Light smoker=1 if smokes< 9 cigarettes/day | 0.05 | 0.23 | 0.05 | 0.23 |
| Moderate smoker=1 if smokes 10-19 cigarettes/day | 0.08 | 0.27 | 0.08 | 0.27 |
| Heavy smoker=1 if smokes 20+ cigarettes/day | 0.04 | 0.20 | 0.04 | 0.20 |
| Ex-smoker=1 if ex-smoker | 0.36 | 0.48 | 0.35 | 0.47 |
| Never smoker=1 if never smoked cigarettes | 0.47 | 0.50 | 0.48 | 0.50 |
| Maximum possible sample size | 10,744 | | 14,247 | |

[§] Sample size corresponds to the maximum possible sample size for the case of the UKHLS sample members or the combined BHPS and UKHLS sample. Sample size varies in the main text tables depending on the biomarker and the disability measure considered.

Table S6: Two and three years ahead prediction models: % impact of nurse-collected biomarkers on mean disability prevalence.

| Marker | SAH | No. of functional difficulties reported | | | Mobility difficulty | Benefit receipt |
|---|---|---|---|---|---|---|
| | | 1 or more[§] | 2 or more[†] | 3 or more[†] | | |
| *Prediction horizon* $t = 2$ | | | | | | |
| Waist/height ratio | excluded | 18.5*** | 22.3*** | 26.0*** | 32.2*** | 32.0*** |
| | included | 8.8*** | 10.3*** | 12.0*** | 19.8*** | 21.3*** |
| Grip Strength | excluded | −17.8*** | −23.5*** | −27.4*** | −30.7*** | −46.5*** |
| | included | −14.2*** | −18.2*** | −21.1*** | −18.7*** | −34.0*** |
| Hypertension[‡] | excluded | 8.2 | 8.2 | 9.6 | 5.9 | 25.5* |
| | included | −1.0 | −3.4 | −4.0 | −6.0 | 13.5 |
| Heart rate | excluded | 9.6*** | 13.2*** | 14.3*** | 8.0** | 22.7*** |
| | included | 5.3* | 8.1** | 7.0** | 3.5 | 19.4*** |
| FVC[1] | excluded | −20.3*** | −20.6*** | −23.3*** | −31.9*** | −26.6*** |
| | included | −8.6* | −8.0* | −9.0* | −13.5** | −12.3 |
| FVC[2] | excluded | −20.0*** | −20.4*** | −23.0*** | −30.3*** | −25.0*** |
| | included | −8.5* | −7.9* | −8.9** | −12.5* | −11.3 |
| Mean $D_2$ | | 0.107 | 0.046 | 0.020 | 0.057 | 0.028 |
| *Prediction horizon* $t = 3$ | | | | | | |
| Waist/height ratio | excluded | 21.0*** | 24.6*** | 28.5*** | 35.6*** | 30.5*** |
| | included | 12.0*** | 13.4*** | 15.5*** | 24.3*** | 19.1*** |
| Grip Strength | excluded | −18.9*** | −27.2*** | −31.2*** | −33.2*** | −50.4*** |
| | included | −15.6*** | −23.0*** | −26.3*** | −25.3*** | −39.4*** |
| Hypertension[‡] | excluded | 23.2*** | 26.7*** | 31.0*** | 23.3*** | 32.2*** |
| | included | 13.0** | 14.7* | 17.0* | 10.9 | 19.7* |
| Heart rate | excluded | 10.8*** | 12.1*** | 15.4*** | 6.3* | 14.7*** |
| | included | 6.8** | 6.7** | 9.4** | 1.8 | 10.4** |
| FVC[1] | excluded | −16.8*** | −15.5*** | −17.4*** | −29.3*** | −24.8*** |
| | included | −5.3 | −3.0 | −3.6 | −12.9* | −10.2 |
| FVC[2] | excluded | −16.1*** | −15.2*** | −17.0*** | −27.7*** | −23.5*** |
| | included | −4.9 | −3.1 | −3.4 | −12.1* | −9.5 |
| Mean $D_3$ | | 0.116 | 0.051 | 0.024 | 0.065 | 0.031 |

[1] Without smoking covariate; [2] with smoking covariate; [‡] impact of switch from hypertensive to non-hypertensive
[§] Derived from binary probit model; [†] derived from ordered probit model
Statistical significance:* = 10%,** = 5%,*** = 1%.

Table S7: Two and three year ahead prediction models: % impact of blood-based biomarkers on mean disability prevalence.

| | | No. of functional difficulties reported | | | | |
|---|---|---|---|---|---|---|
| Marker | SAH | 1 or more[§] | 2 or more[†] | 3 or more[†] | Mobility difficulty | Benefit receipt |
| | | *Prediction horizon* $t = 2$ | | | | |
| HDL | excluded | −9.9*** | −12.8** | −13.9** | −19.9*** | −10.2* |
| | included | −4.6 | −6.1 | −6.5 | −12.6*** | −3.6 |
| CRP | excluded | 6.2** | 8.1** | 8.7** | 12.8*** | 14.3*** |
| | included | 1.8 | 2.8 | 3.0 | 6.8* | 9.4** |
| HbA1c | excluded | 8.7*** | 9.5*** | 10.1*** | 13.2*** | 11.5* |
| | included | 3.6 | 3.3 | 3.5 | 6.4* | 7.4 |
| DHEAS | excluded | −16.4*** | −18.6*** | −20.2*** | −13.4** | −16.7* |
| | included | −13.7*** | −14.9*** | −16.0*** | −8.4 | −10.0 |
| EGFR | excluded | 0.0 | −2.0 | −2.3 | −5.4 | 2.2 |
| | included | 1.1 | −1.0 | −1.0 | −2.5 | 3.9 |
| Hgb | excluded | −10.7* | −12.2** | −12.9** | −12.3** | −2.0 |
| | included | −9.7* | −10.6** | −11.1** | −9.7** | 0.5 |
| Albumin | excluded | −15.0*** | −19.0*** | −21.4*** | −19.3*** | −11.7** |
| | included | −11.6*** | −15.3*** | −16.3*** | −14.2*** | −7.3 |
| Mean $D_2$ | | 0.107 | 0.046 | 0.020 | 0.057 | 0.028 |
| | | *Prediction horizon* $t = 3$ | | | | |
| HDL | excluded | −10.5*** | −12.0*** | −13.8*** | −17.8*** | −16.0** |
| | included | −5.5 | −5.8 | −6.7 | −11.40** | −9.8 |
| CRP | excluded | 14.3*** | 16.7*** | 18.9*** | 20.0*** | 11.3** |
| | included | 10.4*** | 12.0*** | 13.7*** | 12.5*** | 6.4 |
| HbA1c | excluded | 10.4*** | 11.6*** | 13.3*** | 11.9*** | 5.8 |
| | included | 5.4* | 5.5 | 6.5 | 5.2 | 0.2 |
| DHEAS | excluded | −10.7** | −12.8** | −14.6** | −8.2 | −25.5*** |
| | included | −9.1* | −11.0** | −12.5** | −3.8 | −18.3** |
| EGFR | excluded | −8.7* | −11.5** | −13.3** | −4.4 | 5.9 |
| | included | −7.4 | −2.0* | −11.2* | −1.7 | 7.4 |
| Hgb | excluded | −6.9 | −8.3* | −9.4* | −9.3* | −13.3** |
| | included | −5.9 | −7.0 | −7.6 | −6.6 | −10.3 |
| Albumin | excluded | −8.2** | −10.0** | −11.3** | −12.9*** | −13.2** |
| | included | −5.5 | −6.7 | −7.5 | −8.4* | −9.1 |
| Mean $D_3$ | | 0.116 | 0.051 | 0.024 | 0.065 | 0.031 |

[§] Derived from binary probit model; [†] derived from ordered probit model
Statistical significance:* = 10%,** = 5%,*** = 1%.

Table S8: Two and three year ahead prediction models: % impact of systematic risk scores on mean disability prevalence.

| Marker | SAH | No. of functional difficulties reported | | | Mobility difficulty | Benefit receipt |
|---|---|---|---|---|---|---|
| | | 1 or more[§] | 2 or more[†] | 3 or more[†] | | |
| *Prediction horizon* $t = 2$ | | | | | | |
| Allostatic load | excluded | 16.9*** | 22.7*** | 23.0*** | 22.9*** | 23.7*** |
| | included | 7.8* | 10.9** | 11.5** | 12.8*** | 16.8** |
| CVD risk | excluded | 10.1** | 13.4*** | 14.2*** | 16.2*** | 18.7*** |
| | included | 2.5 | 4.2 | 4.0 | 7.4 | 13.2* |
| Mean $D_2$ | | 0.107 | 0.046 | 0.020 | 0.057 | 0.028 |
| *Prediction horizon* $t = 3$ | | | | | | |
| Allostatic load | excluded | 20.0*** | 24.7*** | 27.5*** | 32.1*** | 16.8*** |
| | included | 12.1*** | 15.0*** | 16.7*** | 20.7*** | 7.0 |
| CVD risk | excluded | 17.1*** | 20.6*** | 23.0*** | 26.8*** | 8.3 |
| | included | 10.4*** | 12.4** | 13.8*** | 17.3*** | −0.3 |
| Mean $D_3$ | | 0.116 | 0.051 | 0.024 | 0.065 | 0.031 |

[§] Derived from binary probit model; [†] derived from ordered probit model
Statistical significance:* = 10%,** = 5%,*** = 1%.

Table S9: Estimated mean partial impacts of deterioration in SAH ("excellent" to "poor/very poor") and biomarkers (3-standard deviation change centred on mean) on disability prevalence 4 years ahead

| Health indicator | No. of functional difficulties reported | | | Mobility difficulty | Benefit receipt |
|---|---|---|---|---|---|
| | 1 or more[§] | 2 or more[†] | 3 or more[†] | | |
| SAH | 0.208 | 0.118 | 0.061 | 0.129 | 0.076 |
| WHR | 0.042 | 0.024 | 0.012 | 0.057 | 0.026 |
| SAH | 0.213 | 0.121 | 0.063 | 0.135 | 0.078 |
| Grip strength | 0.039 | 0.027 | 0.014 | 0.022 | 0.028 |
| SAH | 0.225 | 0.127 | 0.064 | 0.152 | 0.088 |
| Hypertension[*] | 0.004 | 0.003 | 0.001 | 0.009 | 0.005 |
| SAH | 0.221 | 0.125 | 0.063 | 0.152 | 0.086 |
| HR | 0.038 | 0.022 | 0.010 | 0.026 | 0.017 |
| SAH | 0.202 | 0.114 | 0.056 | 0.124 | 0.086 |
| FVC | 0.056 | 0.026 | 0.012 | 0.036 | 0.027 |
| SAH | 0.219 | 0.125 | 0.064 | 0.160 | 0.080 |
| HDL | 0.059 | 0.028 | 0.014 | 0.032 | 0.002 |
| SAH | 0.215 | 0.120 | 0.060 | 0.158 | 0.076 |
| CRP | 0.036 | 0.016 | 0.010 | 0.024 | 0.015 |
| SAH | 0.211 | 0.120 | 0.061 | 0.158 | 0.076 |
| HbA1c | 0.042 | 0.019 | 0.009 | 0.015 | 0.004 |
| SAH | 0.224 | 0.128 | 0.065 | 0.167 | 0.080 |
| DHEAS | 0.034 | 0.015 | 0.008 | 0.015 | 0.004 |
| SAH | 0.228 | 0.129 | 0.066 | 0.167 | 0.080 |
| EGFR | 0.028 | 0.015 | 0.007 | 0.025 | 0.006 |
| SAH | 0.216 | 0.123 | 0.063 | 0.160 | 0.075 |
| Hgb | 0.013 | 0.006 | 0.003 | 0.015 | 0.017 |
| SAH | 0.228 | 0.129 | 0.066 | 0.165 | 0.078 |
| Albumin | 0.030 | 0.018 | 0.008 | 0.031 | 0.014 |
| SAH | 0.184 | 0.104 | 0.050 | 0.139 | 0.072 |
| Allostatic load | 0.069 | 0.033 | 0.015 | 0.056 | 0.016 |
| SAH | 0.196 | 0.110 | 0.052 | 0.143 | 0.073 |
| CVD risk | 0.051 | 0.025 | 0.011 | 0.049 | 0.015 |

[§] derived from binary probit model. [†] derived from ordered probit model. [*] Impact of switch from non-hypertensive to hypertensive. Statistical significance: all SAH effects significant at 1% level; for statistical significance of biomarkers, see Table 1 of the paper

Table S10: Estimated mean partial impacts of deterioration in SAH ("excellent" to "poor/very poor") and biomarkers (3-standard deviation change centred on mean) on disability prevalence 4 years ahead: models estimated after excluding individuals who were given feedback about elevated blood pressure.

| Health indicator | No. of functional difficulties reported | | | Mobility difficulty | Benefit receipt |
|---|---|---|---|---|---|
| | 1 or more[§] | 2 or more[†] | 3 or more[†] | | |
| SAH | 0.202 | 0.114 | 0.057 | 0.116 | 0.082 |
| WHR | 0.035 | 0.017 | 0.009 | 0.050 | 0.021 |
| SAH | 0.205 | 0.115 | 0.058 | 0.121 | 0.079 |
| Grip Strength | 0.048 | 0.037 | 0.016 | 0.021 | 0.027 |
| SAH | 0.206 | 0.115 | 0.058 | 0.137 | 0.089 |
| Heart rate | 0.039 | 0.020 | 0.011 | 0.032 | 0.016 |
| SAH | 0.192 | 0.105 | 0.051 | 0.110 | 0.088 |
| FVC | 0.055 | 0.026 | 0.012 | 0.033 | 0.032 |
| SAH | 0.209 | 0.121 | 0.060 | 0.142 | 0.090 |
| HDL | 0.052 | 0.026 | 0.013 | 0.028 | 0.005 |
| SAH | 0.212 | 0.120 | 0.058 | 0.136 | 0.087 |
| CRP | 0.049 | 0.021 | 0.010 | 0.033 | 0.012 |
| SAH | 0.195 | 0.110 | 0.055 | 0.134 | 0.083 |
| HbA1c | 0.044 | 0.020 | 0.010 | 0.016 | 0.001 |
| SAH | 0.215 | 0.124 | 0.062 | 0.144 | 0.090 |
| DHEAS | 0.043 | 0.018 | 0.009 | 0.019 | 0.005 |
| SAH | 0.220 | 0.126 | 0.063 | 0.144 | 0.090 |
| eGFR | 0.026 | 0.014 | 0.007 | 0.026 | 0.003 |
| SAH | 0.201 | 0.113 | 0.057 | 0.135 | 0.082 |
| Hgb | 0.006 | 0.005 | 0.003 | 0.017 | 0.018 |
| SAH | 0.220 | 0.125 | 0.063 | 0.144 | 0.089 |
| Albumin | 0.018 | 0.011 | 0.005 | 0.024 | 0.008 |
| SAH | 0.169 | 0.094 | 0.044 | 0.119 | 0.079 |
| Allostatic load | 0.064 | 0.031 | 0.015 | 0.057 | 0.012 |
| SAH | 0.182 | 0.100 | 0.047 | 0.124 | 0.081 |
| CVD risk | 0.056 | 0.030 | 0.012 | 0.046 | 0.013 |

[§] derived from binary probit model. [†] derived from ordered probit model. * Impact of switch from non-hypertensive to hypertensive.

**Algebraic structure of the LV model**

The equation for latent general health is:

$$h_{i0} = \alpha X_{i0} + \eta_{i0} \tag{1}$$

where $X_{i0}$ is a set of covariates, observed at the time of biomarker measurement, representing the observable determinants of the initial health state and $\eta_{i0}$ is an independent random error that captures the remaining unobservable influences. Observed SAH is a noisy indicator, related to $h_{i0}$ by a measurement equation:

$$S_{i0} = L\left(\beta_0 + \beta_1 h_{i0} + v_{i0}\right) \tag{2}$$

where the unobserved random variable $u_{i0}$ captures the measurement noise in SAH and $L(.)$ is the ordinal probit link function. We use a set of 12 biomarkers, $B_{1i0} \ldots B_{12i0}$, which are also noisy measures. It is possible that, in addition to $h_{i0}$, the measured biomarkers reflect some further dimension of health, $b_{i0}$, to which SAH is insensitive. To allow for this, we specify further latent health and measurement equations:

$$b_{i0} = \gamma X_{i0} + \lambda_{i0} \tag{3}$$

$$B_{ji0} = \delta_{j0} + \delta_{j1} h_{i0} + \delta_{j2} b_{i0} + w_{ji0}\,, \quad j = 1 \ldots 12 \tag{4}$$

where $\lambda_{i0}$ is a random error, and $w_{jit}$ captures the measurement noise in biomarker $j$. The random residuals for the two dimensions of latent health are independent. In this Gaussian distributional setting, there is no loss of generality in specifying a triangular system with $S_{i0}$ measuring only $h_{i0}$ and $B_{i0}$ reflecting both $h_{i0}$ and $b_{i0}$, with $h_{i0}$ and $b_{i0}$ conditionally independent. Any bivariate Gaussian distribution can be represented in that way, and it is a convenient representation for our purpose of assessing the additional informational content of the biomarker additional to SAH.

The three observed disability outcomes are related to latent health and we allow the

covariates $X_{i0}$ also to influence disability directly:

$$D_{it} = L^D\left(\theta_{0t} + \theta_{1t}h_{i0} + \theta_{2t}b_{i0} + \theta_{3t}X_{i0} + \theta_{4t}u_i + \varepsilon_{it}\right) , \qquad t = 2, 3, 4 \tag{5}$$

where $u_i$ is an unobserved random effect whose effect may vary with $t$; $\varepsilon_{i2} \ldots w_{i4}$ are random errors distributed independently of $u_i, \eta_{i0}, \lambda_{i0}, v_{i0}, w_{i0}$, which are themselves mutually independent. For the purposes of estimation we resolve the inherent indeterminacy caused by non-observability of the latent variables by normalising at 1.0 the loadings of $h_{i0}$ and $b_{i0}$ on SAH and hypertension respectively, and of $u_i$ on disability at the 4-year horizon. The complete system (1)-(5) is estimated jointly by maximum likelihood. Full parameter estimates are given in the appendix.