Biological Age in Taiwan: Measurement and Prediction

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  - Compare BA measures to self-rated health and biomarker composite of physiological dysregulation
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Research objectives:
  ▶ Evaluate different methods for calculating biological age (BA) in predicting performance assessment and mortality
  ▶ Compare BA measures to self-rated health and biomarker composite of physiological dysregulation
  ▶ Consider whether these measure offer additional information above and beyond chronological age (CA)
Data

- Social Environment and Biomarkers of Aging Study (SEBAS) in Taiwan
- Nationally representative longitudinal survey of Taiwanese older adults aged 54+ in 2000 with survey and biomarker assessments in 2000 and 2006 and mortality follow-up through 2014
- Biomarkers measured at hospital exams across biological systems including cardiometabolic, inflammatory, and HPA/SNS
<table>
<thead>
<tr>
<th>Data - Predictors</th>
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<tbody>
<tr>
<td><strong>Klemera and Doubal method</strong></td>
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<td>Klemera &amp; Doubal 2006</td>
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<tr>
<td>Algorithm parameters based on CA regressed on each biomarker derived from NHANES (Levine 2013)</td>
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<tr>
<td>Apply to set of biomarker measures from SEBAS that overlap</td>
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| **Principal components analysis** |
| Nakamura, Miyao & Ozeki 1988 |
| First principal component used to signify BA score |
| Transform BA score to years |

| **Multiple linear regression** |
| Hollingsworth et al. 1965 |
| Regress CA on biomarkers |
| Predicted value is BA |

| **Physiological dysregulation** |
| Seeman et al. 1997; Mitnitski et al. 2015 |
| Biomarker composite score |
| Top and/or bottom decile defined as high risk |

| **Self-rated health** |
| Current state of health |
| Excellent, good, average, not so good, poor |
Data - Biomarker selection

- Three sets of markers:
  1. Overlap with those in NHANES Klemera-Doubal algorithm parameterization (n=8)
  2. Correlated in SEBAS with CA > .10 (n=17)
  3. Cross-system markers (cardiometabolic, inflammatory, HPA/SNS) akin to allostatic load (n=26)
Data - Outcomes

- Performance assessment measured in 2006:
  - Peak expiratory flow
  - Grip strength
  - Chair stand
  - Walk speed

- Mortality through 2014:
  - Vital status verified with Ministry of Health and Welfare death certificate registration system
  - 432 deaths to 965 respondents interviewed in 2000
• Predicting performance assessments:
  ▶ Correlation
  ▶ Partial correlation controlling for CA

• Predicting mortality:
  ▶ Logit predicting death during 14 year followup (AUC) controlling for sex
  ▶ Cox proportional hazards controlling for CA (Harrell’s concordance index) and sex
Descriptives

Age: 0.91, 0.73, 0.42, 0.38, 0.67
KlemeraDoubal: 0.79, 0.64, 0.31, 0.72
PCA8: 0.69, 0.11, 0.64
MLR8: 0.018, 0.60
PCA17: 0.011
MLR17:
Descriptives
Performance assessment correlations - compared to CA
Do BA measures predict performance assessment better than CA?

- Peak
- Grip
- Chair
- Walk

CA
KD
PCA8
MLR8
PCA17
MLR17
PD
SRH
Performance assessment correlations - compared to CA
Do BA measures predict performance assessment better than CA?
Performance assessment correlations - compared to CA
Do BA measures with more biomarkers predict better?
Performance assessment correlations - compared to CA

How do physiological dysregulation and self-rated health compare?
Performance assessment correlations - improvements over CA
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Performance assessment - summary

- Klemera and Doubal biological age measure most predictive of performance assessments compared to CA
- Physiological dysregulation offers most information in addition to CA
Mortality ROC curves - compared to CA
Do BA measures predict performance assessment better than CA?
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Mortality ROC curves - compared to CA
How do physiological dysregulation and self-rated health compare?

The graph shows ROC curves for various indicators compared to CA. The performance of each indicator is quantified by an AUC score, with CA having an AUC of 0.772, KD 0.795, MLR8 0.705, PCA8 0.764, MLR17 0.761, PCA17 0.584, PD 0.761, and SRH 0.553.
Mortality - improvement over CA
Cox regression hazard ratios and concordance index improvements
Mortality - summary

- Klemera and Doubal biological age measure most predictive of mortality compared to CA
- Physiological dysregulation offers most information in addition to CA
Conclusions

• Pattern of measures consistent for performance assessment and mortality
• More is not always better
• Klemera-Doubal method performs the best - despite algorithm derived in US population
• Biomarker composite score of physiological dysregulation offers greatest additional information over CA
• Next steps should incorporate change in measures, training algorithm with more markers, in Asian population
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