Dynamics of health and mortality:
Biomarkers, self-assessments and socio-demographic characteristics

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Using four waves of longitudinal survey data from Indonesia spanning nearly 15 years, we examine the evolution of health over the life course during adulthood and later life. Exploiting both biomarker information and self-assessed health indicators, we begin with an exploration of the associations between these markers of health status and subsequent mortality. Our preliminary results establish that, in this population, very low body mass index (BMI), low hemoglobin (Hb), and elevated blood pressure are all predictive of subsequent mortality. In addition, self-assessed general health status (GHS) and activities of daily living (ADLs) are also predictive of subsequent mortality – even after controlling anthropometry and biomarker information. Special attention is paid to the dynamics of measured and self-assessed health. Importantly, relative to biometric indicators, those that are self-assessed are weaker predictors of mortality the further the temporal distance.

The second step in this research seeks to place these results in a broader context. We explore the inter-relationships between the array of health indicators collected in the survey and subsequent health status of the respondent as indicated by both biomarkers and self-assessments. We find that GHS and ADLs are significant predictors of those biometric indicators that are associated with functional disability such as timed chair stands and lung capacity. The self-assessments, however, tend to be weak predictors of biomarkers that are related to nutrition and metabolic syndrome. In contrast, biomarker information is predictive of subsequent poor health as reported by respondents as well as subsequent biological measurements.

We turn next to an exploration of the socio-economic, demographic and behavioral characteristics that mediate these associations. We examine the extent to which information differences across individuals are important. These models explore the independent roles of education, cognitive ability and health of parents and siblings of the respondent. We also explore the independent role of socio-economic status (SES) and assess the extent to which the relationships vary as the level of SES varies, as the extent to which information on health status varies in the community and as the availability of health services in the community varies. We also explore the role of family and family support by assessing the impact on the relationships among the health indicators of simultaneously adjusting observed heterogeneity within families. These characteristics include marital status, living arrangements, family size and family composition. We then proceed to estimate models that sweep out all unobserved variation at the family level that affects health outcomes in a linear and additive way. These fixed effects models highlight variation within families and identifies those population sub-groups for which biomarker and self-assessed information are most meaningful.

The research provides a more comprehensive assessment of the nature of the information contained in biomarkers and self-assessments in population-based surveys conducted in very low income settings. As such, the results highlight the nature and extent to which information contained in these markers can be construed as unique and provides insights into well-being that is not captured in other markers.

Data

The study uses data from four waves of the Indonesia Family Life Survey (IFLS), an on-going longitudinal survey of over 30,000 individuals. The first wave was conducted in 1993 with follow-ups in 1997, 2000 and 2007. Analyses of mortality are restricted to almost 6,000 adults who were born in 1967 or earlier. Between the 1993 and 1997, around 9% of these respondents died. Between 1997 and 2000, another 5% of respondents died. Data collection for the 2007 wave has not been completed. Analyses of health status span a broader spectrum of ages and include all respondents age 25 and older. (Analyses are stratified so that results can be directly compared with the mortality analyses.)

Preliminary results

Preliminary results from the first set of mortality analyses using the 1993, 1997 and 2000 waves of IFLS are displayed in Table 1. We present odds ratios from logistic regressions in which the dependent variable is whether the respondent died as of the 1997 (columns 1 and 2) or 2000 (columns 3 through 12) survey wave. Health measures from 1993 and 1997 are included as covariates along with controls for age, education and height (an indicator of health in early childhood).

The first four columns exploit data from the 1993 survey which included anthropometry and self-assessments of health. Very low BMI and poor GHS predict death by 1997 and by 2000. Among men, difficulty with carry a heavy load and possibly difficulty walking are predictive of subsequent mortality. Parallel analyses are reported for death by 2000 and health measured in 1997 in columns 5 and 6. The results are very similar.

In 1997, we substantially expanded the array of biomarkers to include blood pressure, hemoglobin (measured in the home with a Hemocue photometer), lung capacity (measured with a puff test) and timed chair stands. In addition, after completing all the physical assessments in the home, the health worker (who was a trained nurse) provided an overall assessment of the respondent's health on a scale from 1 (poor) through 10 (excellent). As shown in columns 7 and 8, low BMI, high blood pressure and, for females, iron deficiency are predictive of mortality three years after the measures were taken. These models control self-assessed health. Difficulty carrying a heavy load and poor GHS are also predictive of mortality three years later. Further, the nurse's assessment of the health of females is an additional, independent predictor of mortality conditional on all of these characteristics suggesting this may be a useful tool for health surveys.

All health assessments from both the baseline and first follow-up are included in columns 9 and 10. Low BMI and high blood pressure (measured in 1997) remain significant. Conditional on BMI in 1997, it is high BMI in 1993 that is implicated in mortality. Self-assessed health in 1997 is predictive of mortality in 2000 but none of the self-assessments collected in 1993 is significantly associated with mortality in 2000. This evidence suggests that respondents' information about their own health status tends to be more temporally proximate than biomarker information that is associated with biological and metabolic processes.

These issues are explored in more detail by examining the associations between each of the health indicators measured in 2000 and health status markers measured in 1993 and 1997. (Results are not shown.) We find that GHS and ADLs are significant predictors of those biometric indicators that are associated with functional disability such as timed chair stands and lung capacity. The self-assessment, however, tend to be weak predictors of biomarkers that are related to nutrition and metabolic syndrome. While self-assessments are also significant predictors of subsequent self-assessments, the correlations tend to be fairly small.

In contrast, biomarkers tend to be very good predictors of subsequent biological measures – which is, to a large extent, a reflection of the nature of the specific biomarkers included in the survey. (Obviously, biomarkers that are associated with short-term illness and transitory health problems would not perform in this way.) Moreover, and importantly, the biomarkers are also good predictors of subsequent poor health as reported by the respondents. This includes both GHS and the ADLs. Controlling biomarker information, self-assessed health is only modestly associated with subsequent health assessments.

Explorations of the ways in which these dynamic relationships are mediated by socio-economic and demographic characteristics will complete the paper.

Table 1: Relationship between probability of death and prior health measures

Logistic regression models: odds ratios and [t statistics]

	Pr(Die by 1997)		Probability respondent died by 2000									
	Males [1]	*Females* [2]	*Males* [3]	*Females* [4]	*Males* [5]	*Females* [6]	*Males* [7]	*Females* [8]	*Males* [9]	*Females* [10]	*Males* [11]	*Females* [12]
Biomarkers measured in 1993												
BMI≤18.5	1.696	1.242	1.768	1.753					0.733	1.325	0.702	1.185
	[3.23]	[1.13]	[4.44]	[3.54]					[1.22]	[0.86]	[1.44]	[0.55]
BMI>28	1.889	1.268	1.540	1.842					0.959	2.443	0.908	2.317
	[1.44]	[0.74]	[1.11]	[2.46]					[0.12]	[2.36]	[0.28]	[2.35]
Biomarkers measured in 1997												
BMI≤18.5					1.958	1.993	2.094	2.016	2.632	2.010	2.565	2.009
					[4.00]	[4.19]	[4.18]	[4.13]	[3.71]	[2.36]	[3.84]	[2.52]
BMI>28					1.028	1.009	0.843	0.973	0.991	0.644	1.260	0.719
					[0.05]	[0.02]	[0.35]	[0.08]	[0.02]	[0.87]	[0.43]	[0.69]
Blood pressure: High							3.058	1.848	3.042	2.264		
							[5.18]	[2.60]	[4.72]	[2.72]		
Blood pressure: Moderate							1.169	1.399	1.186	1.549		
							[0.72]	[1.62]	[0.72]	[1.56]		
Hemoglobin >12g/dl							0.778	1.016	0.783	0.844		
							[1.30]	[0.08]	[1.12]	[0.66]		
Hemoglobin <10g/dl							1.710	1.754	1.401	1.184		
							[1.91]	[2.27]	[1.02]	[0.50]		
Chair stand >10 secs							0.610	0.890	0.548	0.876		
							[2.62]	[0.64]	[2.67]	[0.56]		
Lung capacity <250							1.114	0.721	1.244	0.675		
							[0.58]	[1.89]	[1.00]	[1.82]		
Nurse evaluation							0.891	0.783	0.933	0.879		
							[1.48]	[2.77]	[0.79]	[1.17]		
Self-assessments in 1993												
Difficulty walking 5k	1.898	1.116	1.396	0.933					0.744	0.708	0.723	0.758
	[2.94]	[0.51]	[1.81]	[0.36]					[1.08]	[1.21]	[1.20]	[1.02]
Diffic carry heavy load 100m	1.746	1.128	2.060	1.085					1.398	0.853	1.333	0.813
	[2.35]	[0.55]	[3.56]	[0.45]					[1.02]	[0.57]	[0.90]	[0.75]
General health status: Good	1.313	0.634	1.357	1.030					1.376	1.430	1.308	1.392
	[1.05]	[1.07]	[1.57]	[0.11]					[1.01]	[1.00]	[0.87]	[0.93]
General health status: Poor	1.419	2.385	1.705	2.151					1.454	1.438	1.412	1.506
	[1.87]	[3.90]	[3.11]	[4.00]					[1.42]	[1.30]	[1.34]	[1.55]

Table 1 (continued): Relationship between probability of death and prior health measures
Logistic regression models: odds ratios and [t statistics]

	Pr(Die by 1997)		Probability respondent died by 2000									
	Males [1]	*Females* [2]	*Males* [3]	*Females* [4]	*Males* [5]	*Females* [6]	*Males* [7]	*Females* [8]	*Males* [9]	*Females* [10]	*Males* [11]	*Females* [12]
Self-assessments in 1997												
Difficulty walking 5k					1.567	1.167	1.480	1.232	1.680	1.205	1.800	1.094
					[1.86]	[0.64]	[1.60]	[0.85]	[1.94]	[0.61]	[2.24]	[0.30]
Diffic carry heavy load 100m					2.170	2.044	1.871	1.863	1.717	1.975	2.016	2.090
					[3.49]	[3.28]	[2.82]	[2.83]	[2.15]	[2.41]	[2.80]	[2.63]
General health status: Good					1.370	0.278	1.483	0.292	1.372	0.424	1.277	0.389
					[0.91]	[1.23]	[1.14]	[1.18]	[0.82]	[0.85]	[0.63]	[0.91]
General health status: Poor					1.949	1.710	1.690	1.584	1.425	1.982	1.705	2.046
					[3.66]	[3.56]	[2.61]	[2.81]	[1.47]	[3.04]	[2.46]	[3.61]
GHS worse then 4 years ago							1.387	1.129	1.392	1.054		
							[1.62]	[0.59]	[1.46]	[0.21]		
GHS better than 4 years ago							1.076	0.931	0.884	0.880		
							[0.25]	[0.21]	[0.37]	[0.30]		
Sample sizes	2,910	3,039	2,910	3,039	3,429	3,971	3,429	3,971	2,910	3,039	2,910	3,039

Notes: Source: 1993, 1997 and 2000 waves of IFLS. Samples are restricted to adults born in 1967 and earlier. All models control age, education and height of respondent. Variance-covariance estimates take into account clustering and arbitrary forms of heteroskedasticity.