After the Dust has Settled: Covid-19 outcomes, preparedness, strategy, and structural determinants

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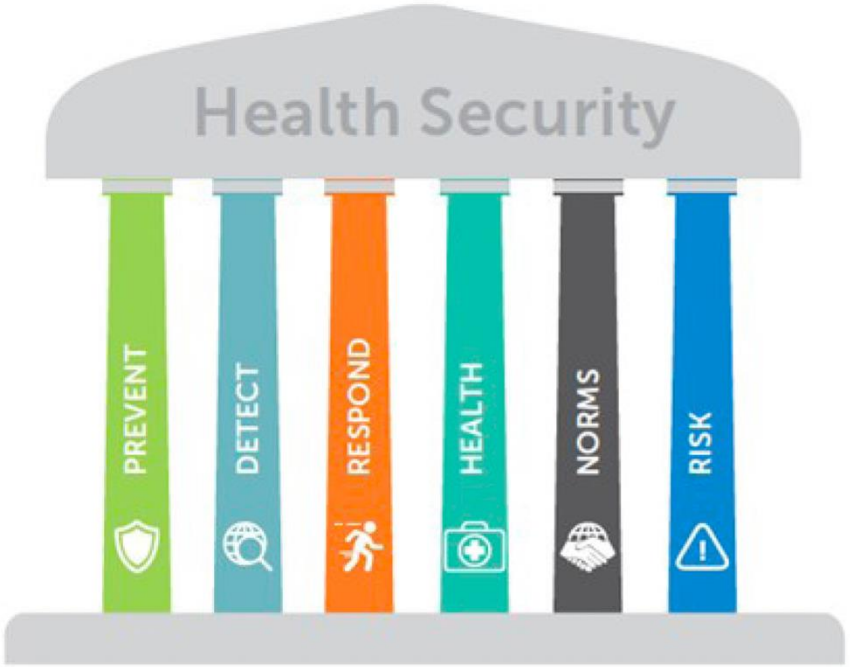
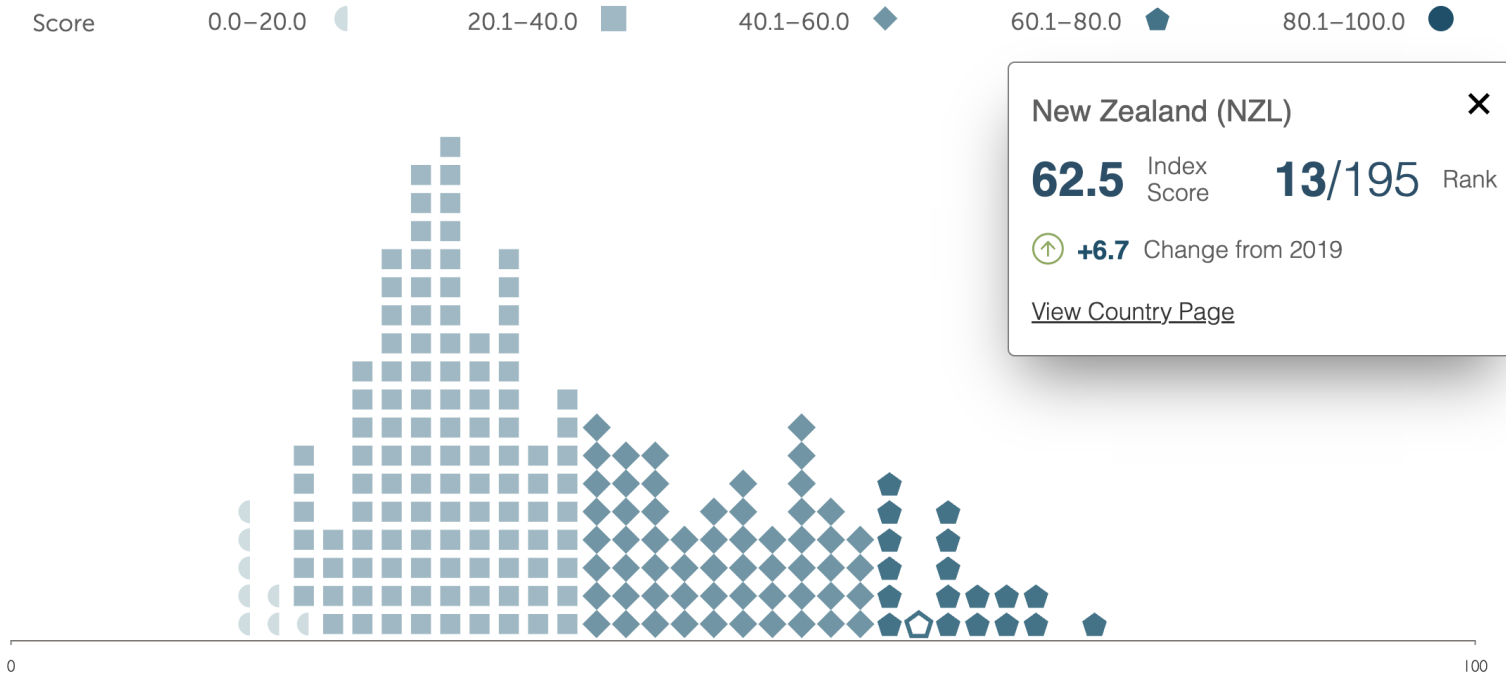
Adapt Research
As we build our world we build our minds

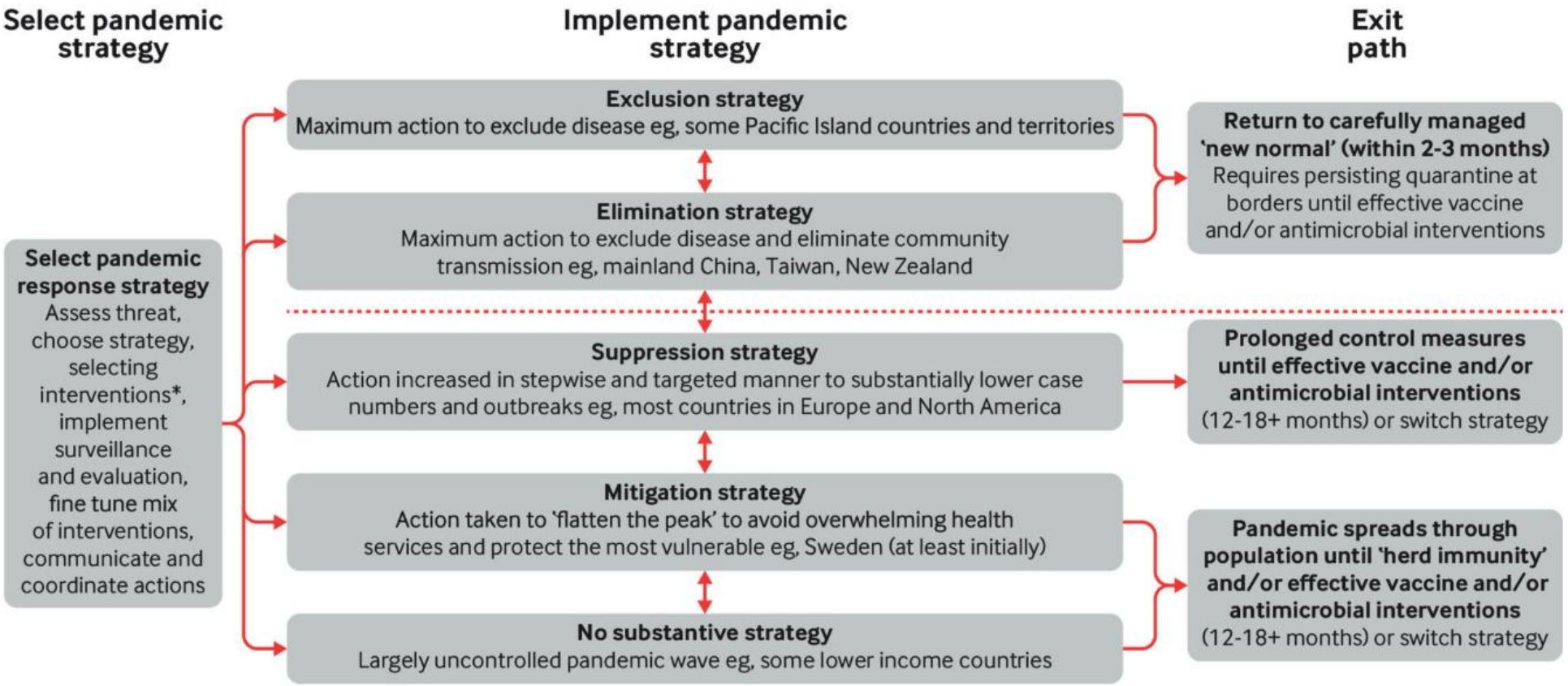
University of Otago
ŌTĀKOU WHAKAIHU WAKA

Preparedness: The Global Health Security (GHS) Index





Strategy choice & borders



Baker, Wilson & Blakely 2020

Structure: Democracy, inequality & health

Democracy explains variance in health outcomes

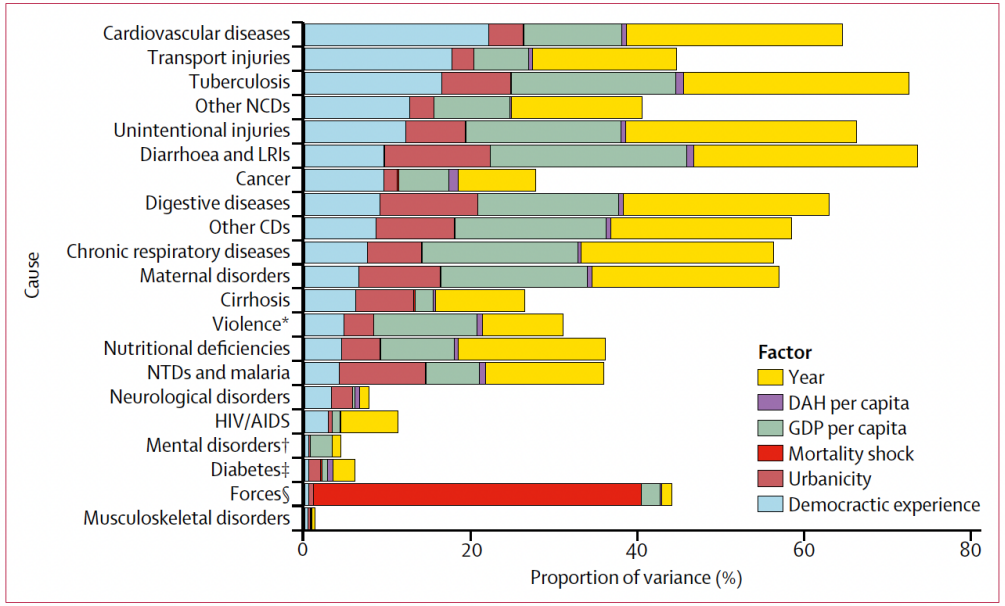
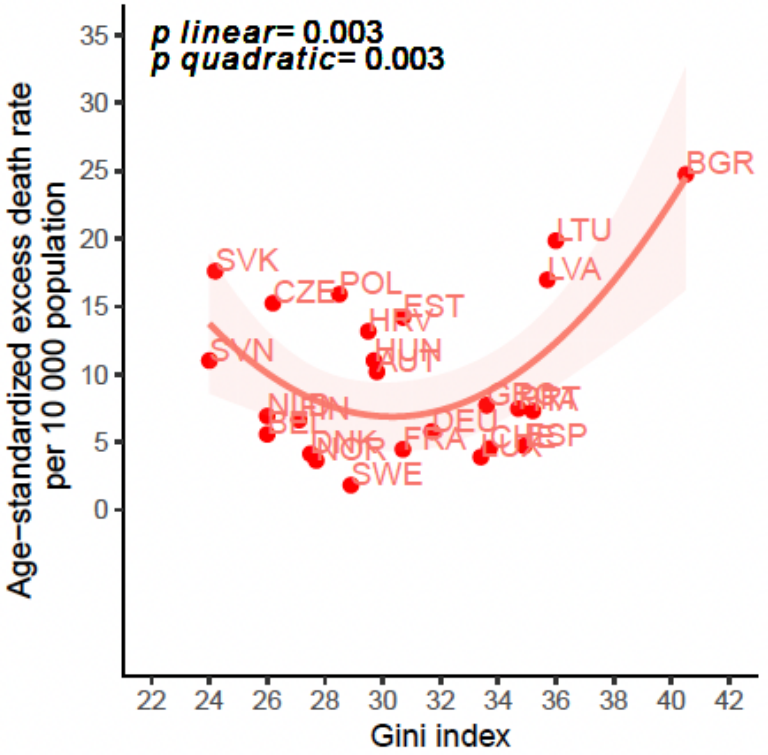


Figure 2: **Changes in mortality due to democracy and other determinants of health**

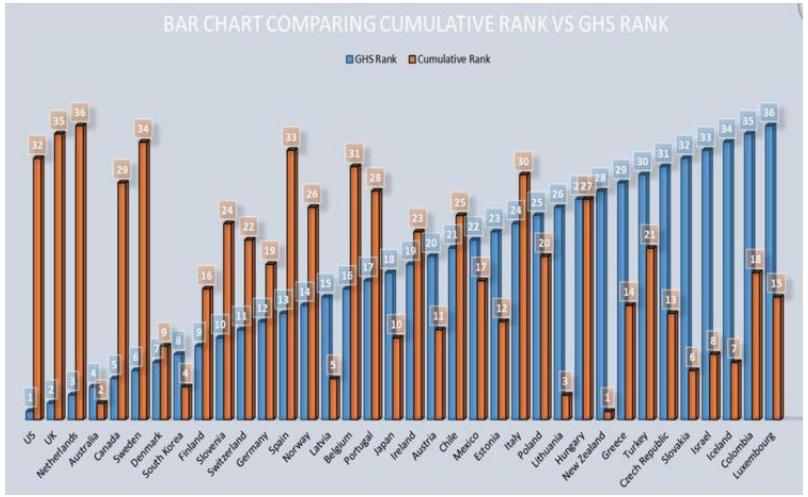
Bollyky et al. 2019

Inequality: a mixed picture in Covid-19



Pizatto et al. 2024

Preparedness: Early Covid-19 data, GHS Index had ‘no explanatory power’*

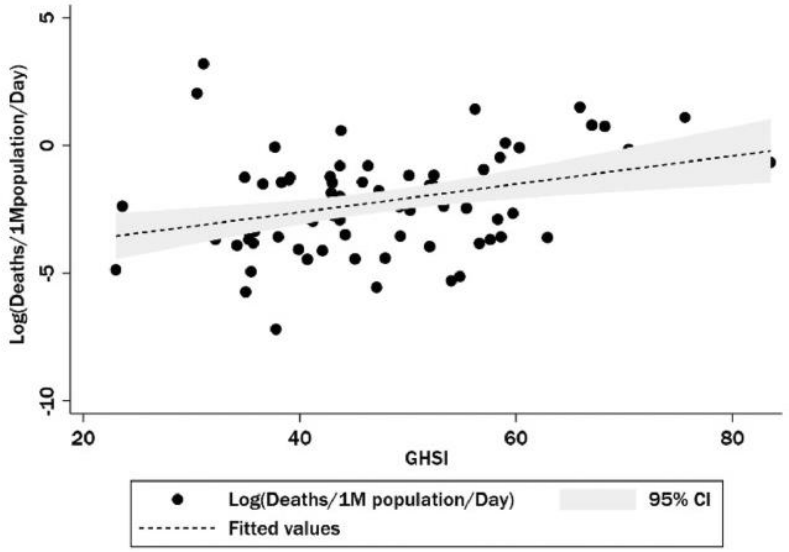


Abbey et al. 2020; OECD

Correlation results of some epidemiological indices and health service indicators

Correlated variables	Pearson correlation coefficient	P-value
Cumulative confirmed cases Vs GHSI	0.519	<0.01
Confirmed cases Vs Health Expenditure	0.120	0.422
Cumulative deaths Vs GHSI	0.495	<0.01
Cumulative deaths Vs Health Expenditure	0.142	0.342
Cumulative fatality rate Vs GHSI	0.035	0.816
Cumulative fatality rate Vs Health Expenditure	0.113	0.450
Attack rate Vs GHSI	0.177	0.239
Attack rate Vs Health Expenditure	0.024	0.873

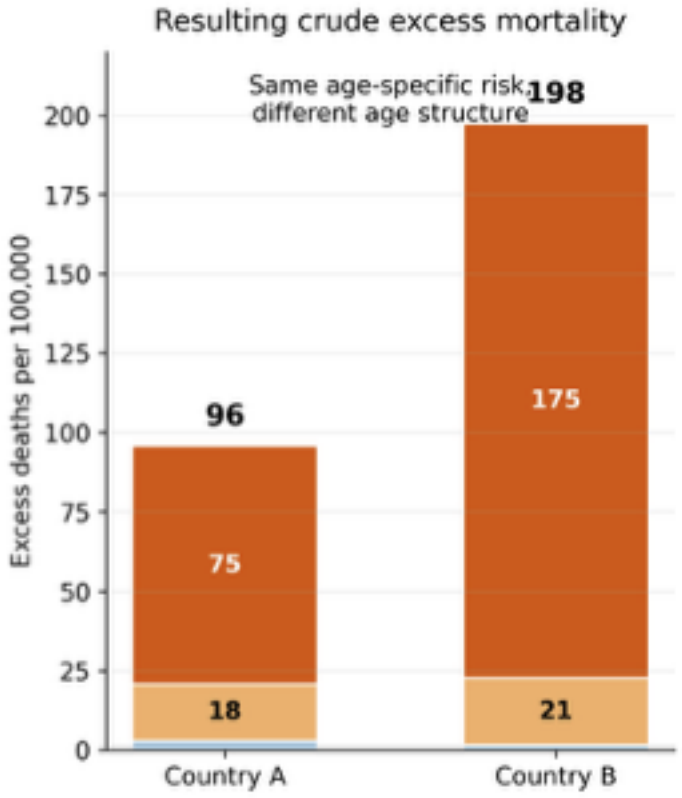
Okoroiwu et al. 2021; Africa



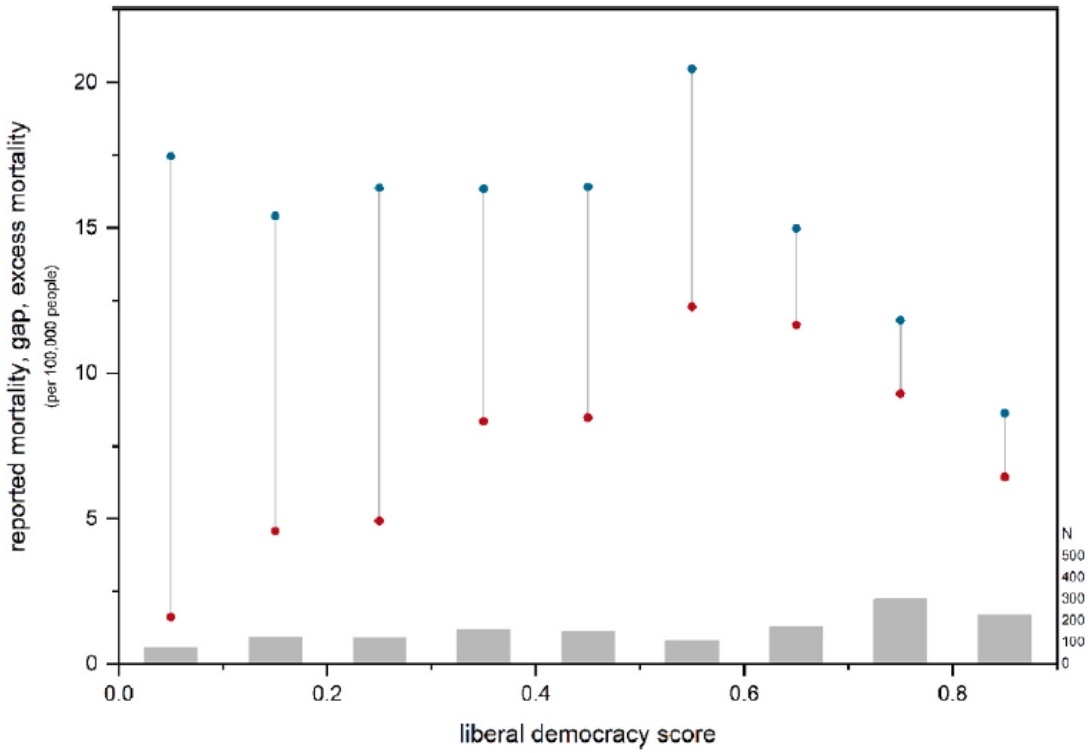
Aitken et al. 2020; n=100 countries

* König & Winkler (2021)

Age structure & data problems in Covid-19

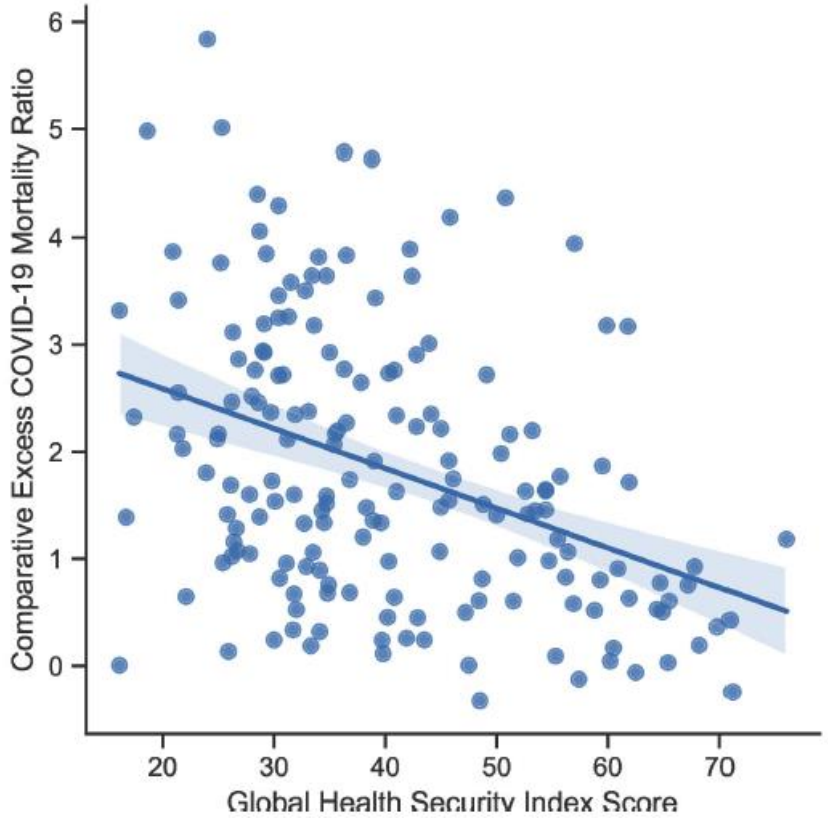


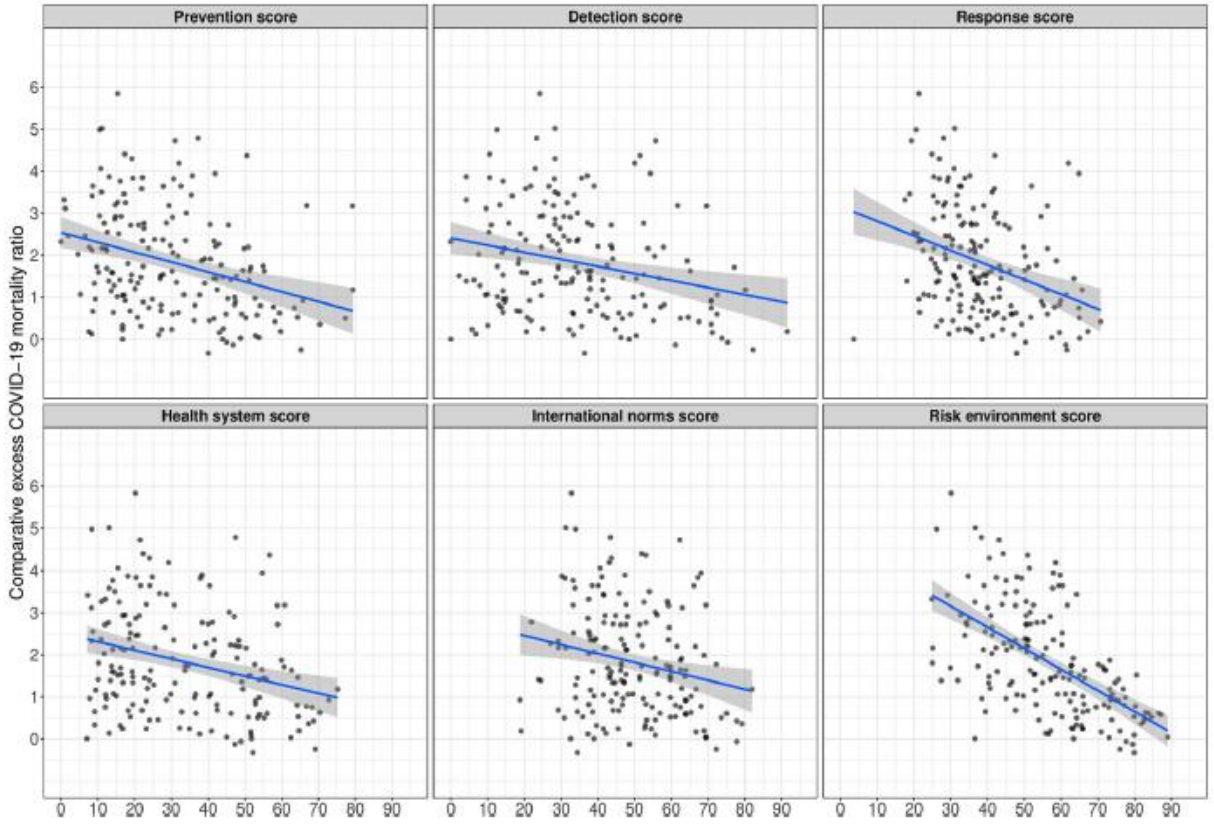
ChatGPT: illustrative



Neumayer et al 2022

Ledesma et al 2023: GHS Index predicts outcomes (CMRs)

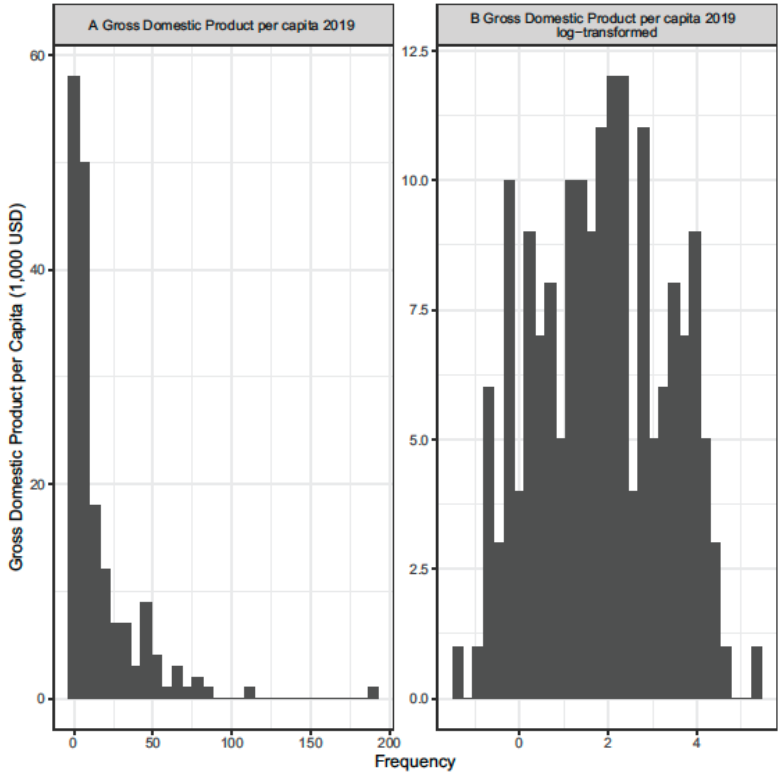


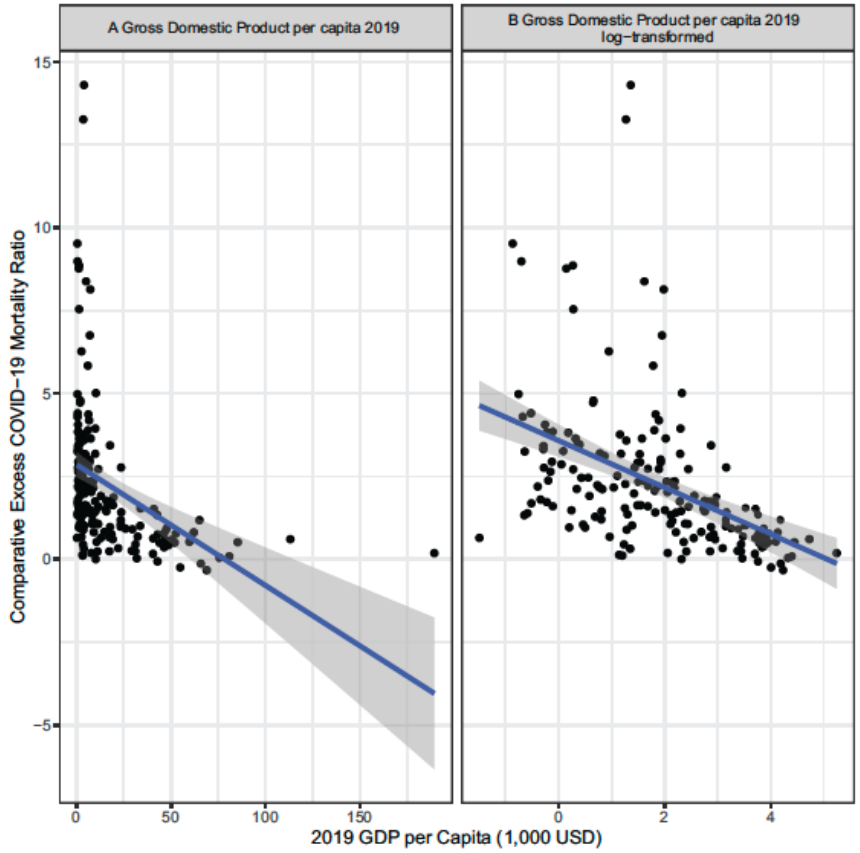


Correcting for mortality reporting issues & population age structure

Ledesma et al. 2023

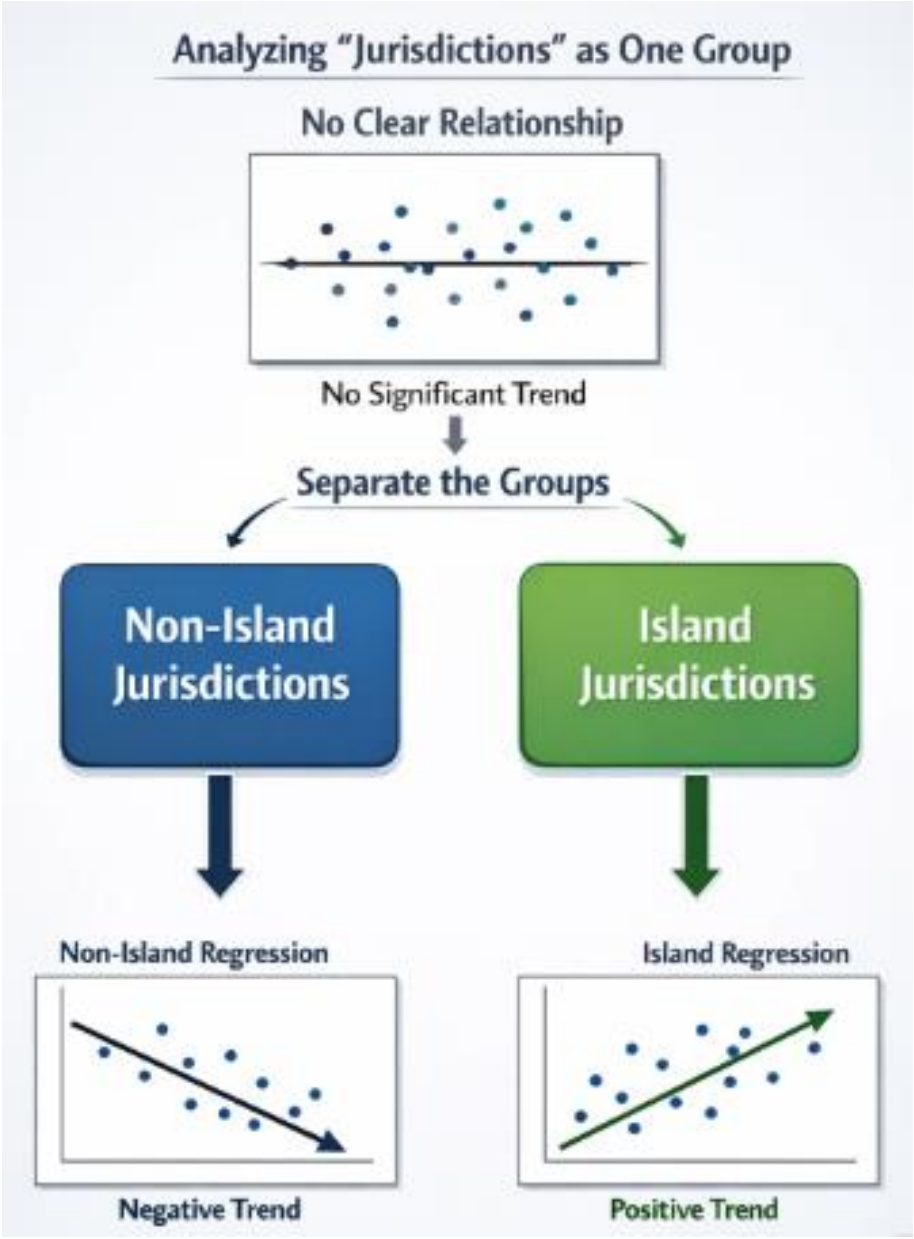
Dieleman et al 2024: No, you need to transform the data first…





Dieleman et al. (2024)

Is it something else?
Islands might systematically differ from non-islands



ChatGPT

Research questions

Do preparedness index scores (or strategy, border controls, democracy, inequality scores) predict excess mortality due to Covid-19, when using quality data and analytic methods?

If we analyse island and non-island jurisdictions separately, are there new or important patterns?

Our method

All countries (as many jurisdictions as possible in each analysis)
Cumulative excess mortality 2020–2021 (Global Burden of Disease collaboration)
Age-standardization (to compare across jurisdictions)
Log-transform skewed variables (GDP, population)
Cube-root transform excess mortality (due to negative values)
Separate islands and non-islands (theory-based differences)
Evaluate GDP (PPP) growth as well as health outcomes
Theory-based controls (wealth, corruption/effectiveness, population size, preparedness, trust)

Regression results

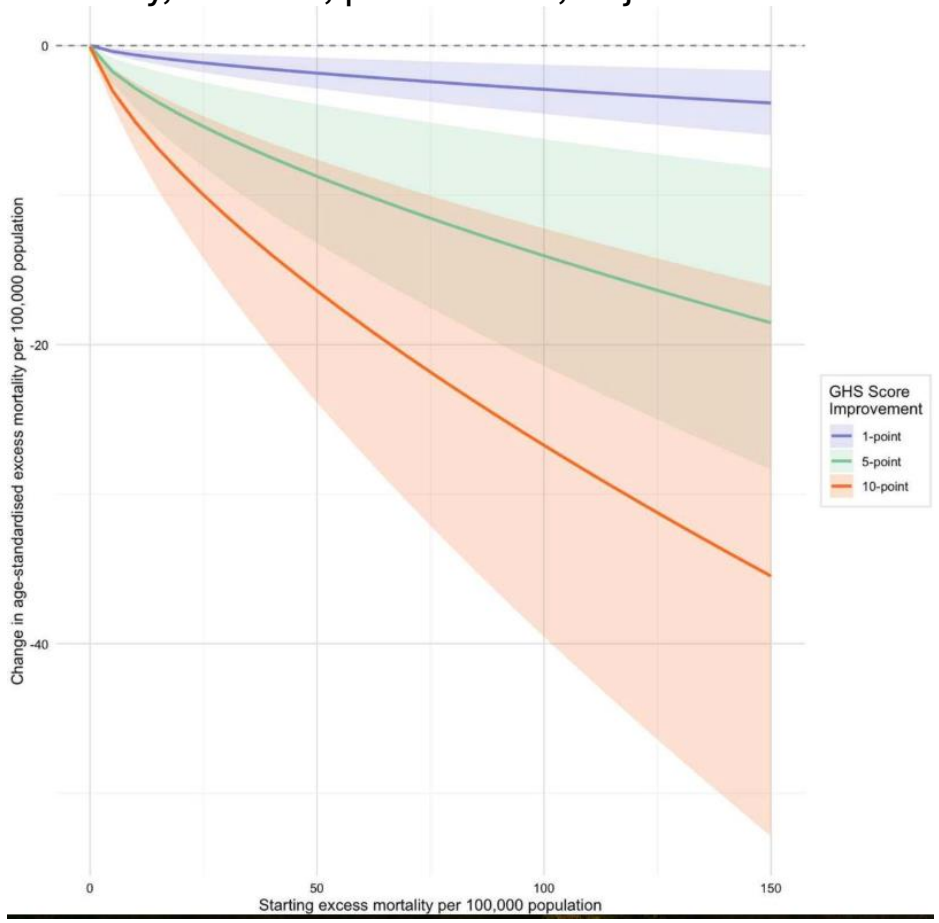
We replicated Ledesma et al.'s findings, and Dieleman et al.'s critiques using different data sets…

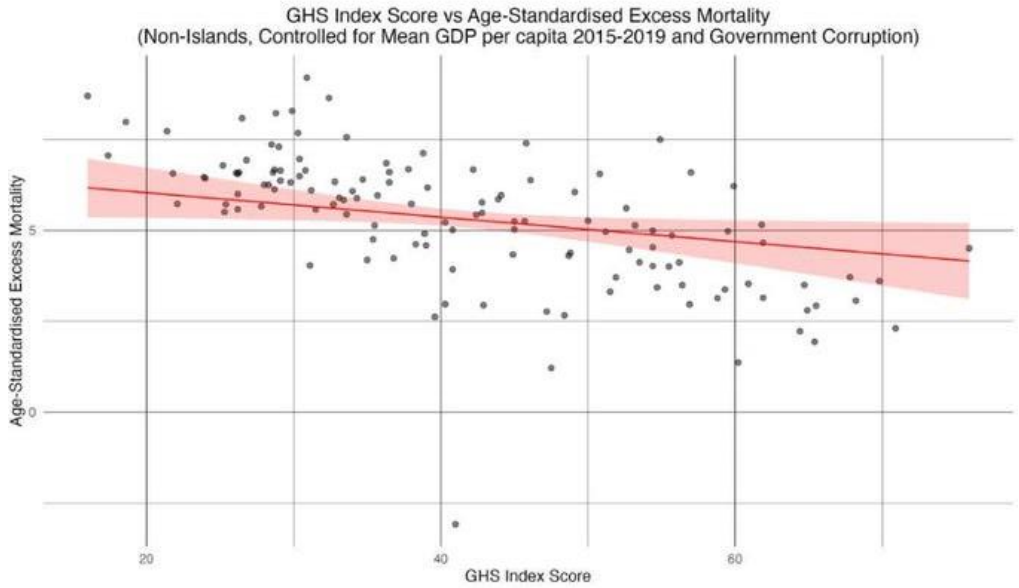
Group	Model	Depend. Variable	Indep. Variable	Control Variables	Coefficient (SE)[#]	T-Value	P-Value (unadjusted)	R^2	Adj. R^2	N
Age-standardised excess mortality 2020–2021										
All	1	EM	GHSI 2021	GDP	-3.091 (0.86)	-3.61	0.000387*	0.22	0.21	189
All	2	$\sqrt[3]{EM}$	GHSI 2019	ln(GDP)	0.011 (0.01)	0.79	0.432050	0.20	0.19	182
All	3	$\sqrt[3]{EM}$	GHSI 2019	ln(GDP)+ corruption	-0.005 (0.01)	-0.38	0.704835	0.46	0.45	155
Islands	1	EM	GHSI 2021	GDP	0.647 (1.53)	0.42	0.675088	0.10	0.06	47
Islands	2	$\sqrt[3]{EM}$	GHSI 2019	ln(GDP)	0.027 (0.04)	0.75	0.458671	0.06	0.01	45
Islands	3	$\sqrt[3]{EM}$	GHSI 2019	ln(GDP)+ corruption	0.012 (0.03)	0.34	0.733720	0.53	0.46	27
Non-Islands	1	EM	GHSI 2021	GDP	-5.353 (0.89)	-5.99	<0.000001*	0.36	0.35	142
Non-Islands	2	$\sqrt[3]{EM}$	GHSI 2019	ln(GDP)	-0.050 (0.01)	-4.46	0.000017*	0.46	0.45	137
Non-Islands	3	$\sqrt[3]{EM}$	GHSI 2019	ln(GDP)+ corruption	-0.046 (0.01)	-3.48	**0.000683***	0.49	0.48	128

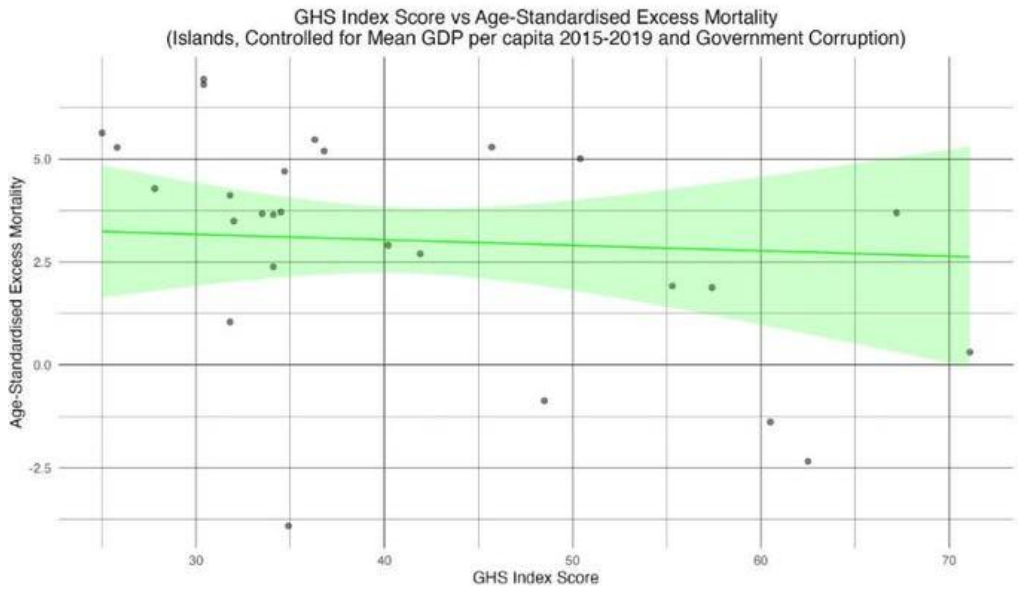
…and then demonstrated that GHS Index predicts Covid-19 deaths in non-islands, once islands are analyzed separately

GHS Index overall score

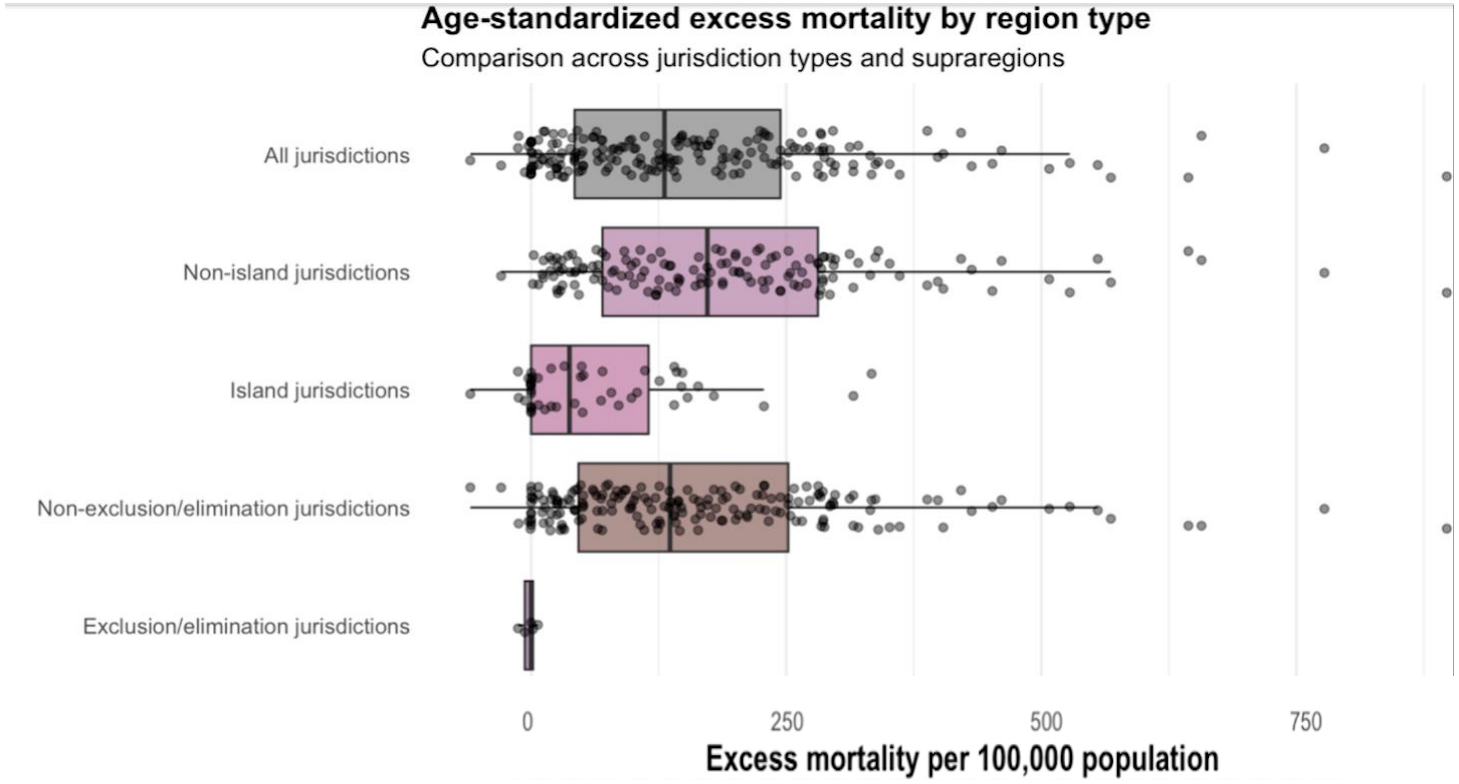
Non-islands: Predicted change in excess mortality, n = 128, p = 0.00068, adj R2 = 0.45







Covid-19 control strategy



Exclusion/elimination (explicit):

- Australia, China, New Zealand, Singapore, Taiwan

Border control strategy

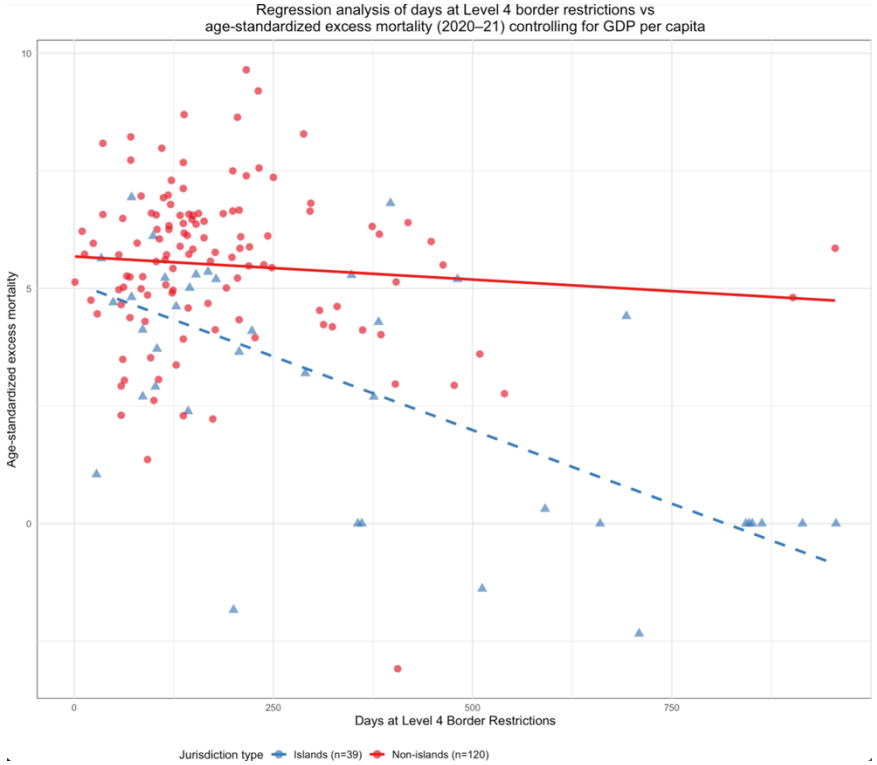


Table 3: Correlations between border restrictions and outcomes by jurisdiction type (only for the 159 (83%) of jurisdictions that enacted the highest level of border restrictions ie. Oxford Stringency Index 'level 4')

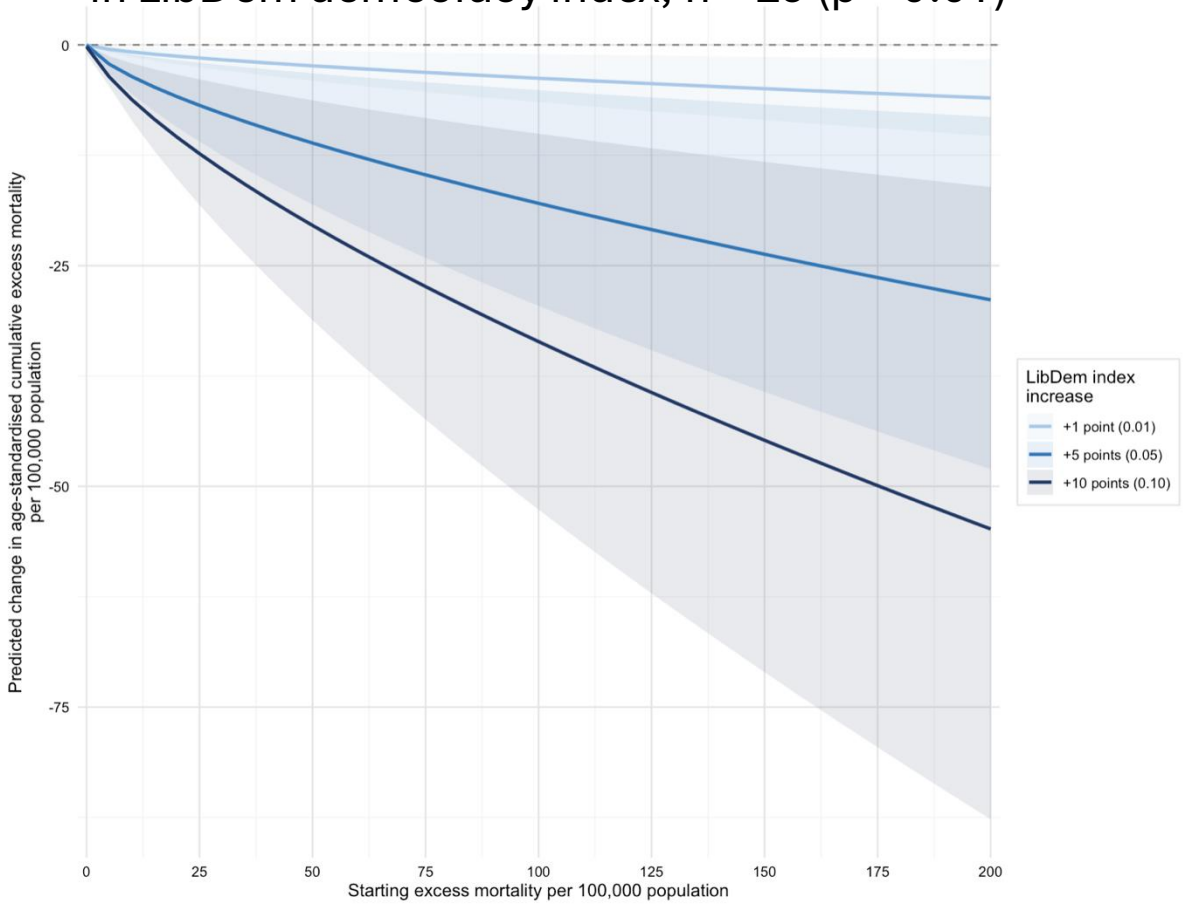
Measure	Outcome	All jurisdictions	Islands	Non-islands
Age-standardized excess mortality				
Days until level 4	Age-standardized excess mortality	0.031 (n=159)	-0.256 (n=39)	0.112 (n=120)
Days at level 4	Age-standardized excess mortality	-0.473*** (n=159)	-0.624*** (n=39)	-0.127 (n=120)
Days until relaxation	Age-standardized excess mortality	-0.363*** (n=159)	-0.639*** (n=39)	-0.031 (n=120)

Table 4: Regression analysis of jurisdictions reaching level 4 border restrictions and outcomes (excess mortality and GDP growth)

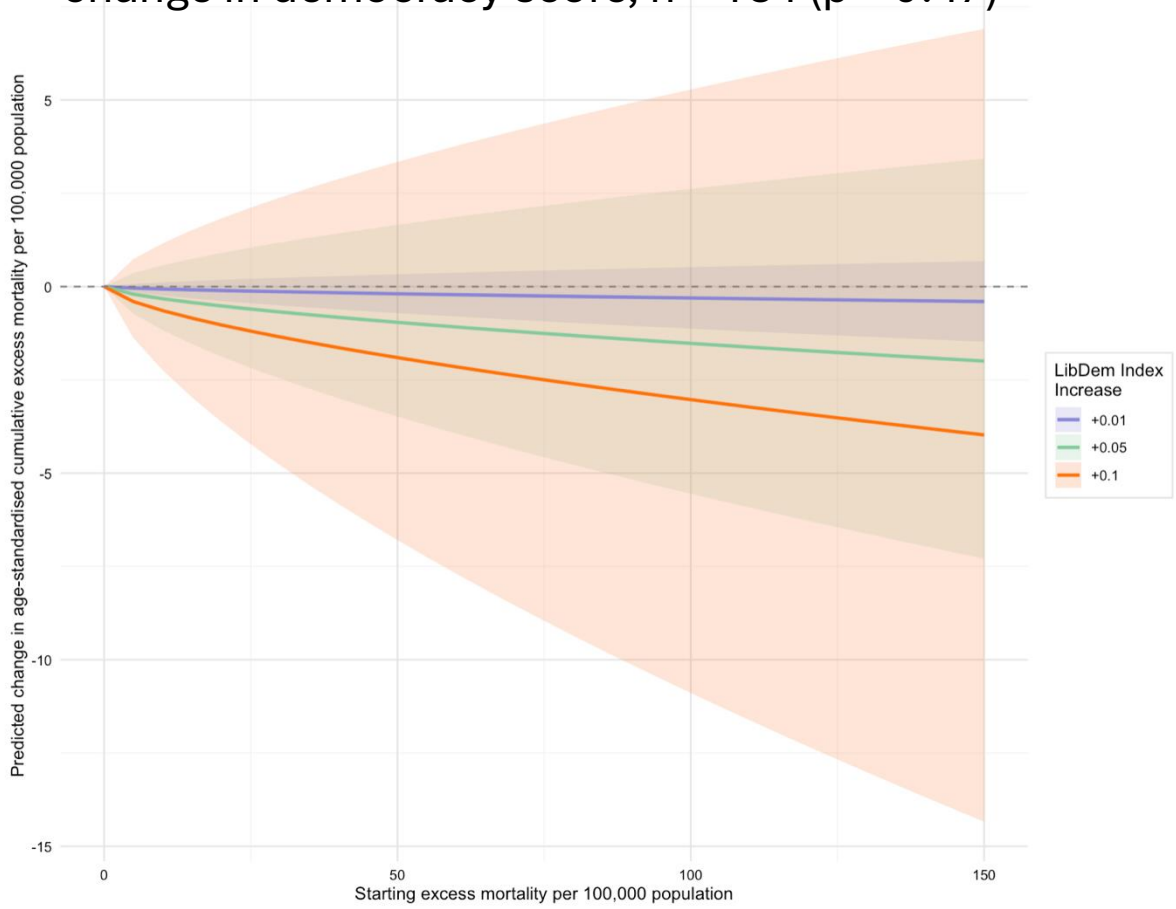
Measure	Outcome	Main effect	Island interaction	N
Age-standardized excess mortality				
Days until level 4	Age-standardized EM	-0.002	-0.012	151
Days at level 4	Age-standardized EM	-0.004***	-0.005***	151
Days until relaxation	Age-standardized EM	-0.003***	-0.005***	151

Democracy's crisis advantage is conditional

Islands: predicted change in mortality by change in LibDem democracy index, n = 29 (p = 0.01)

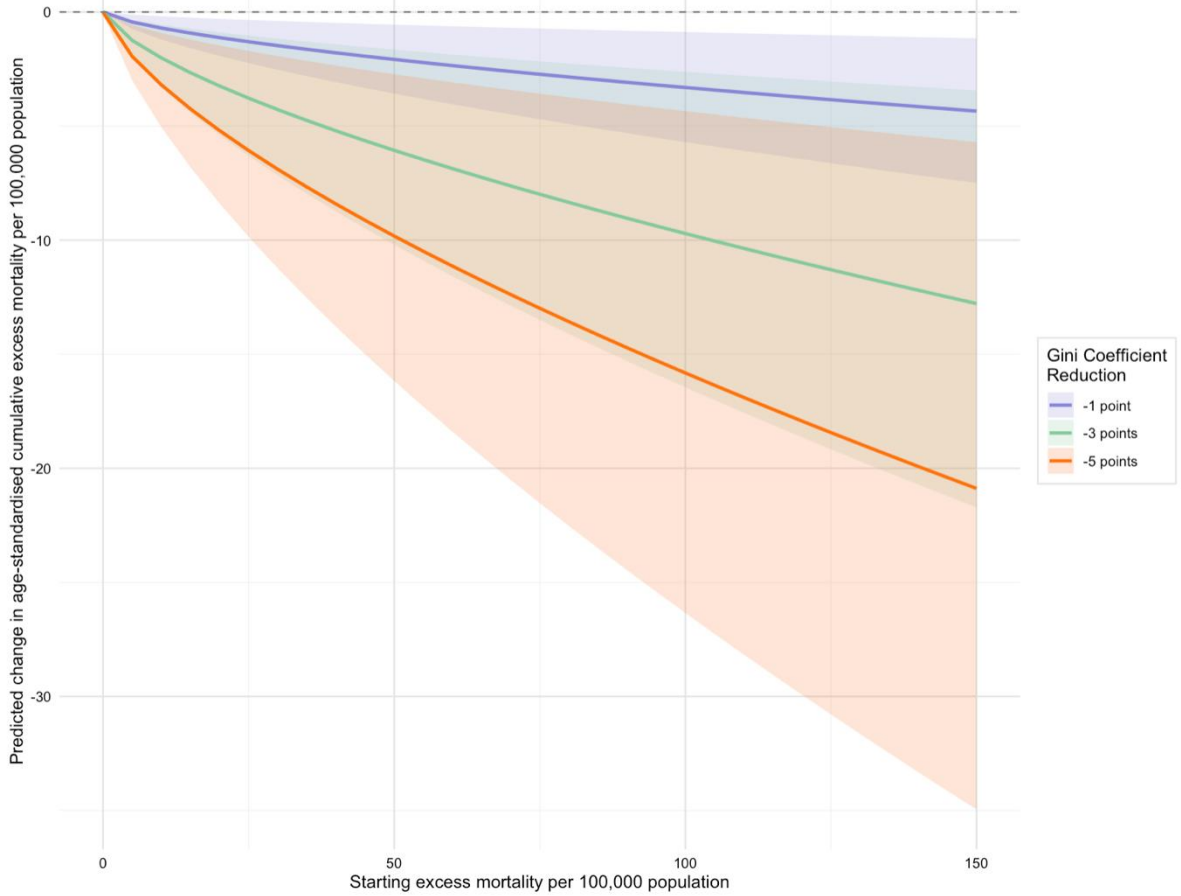


Non-islands: predicted change in mortality by change in democracy score, n = 134 (p = 0.47)

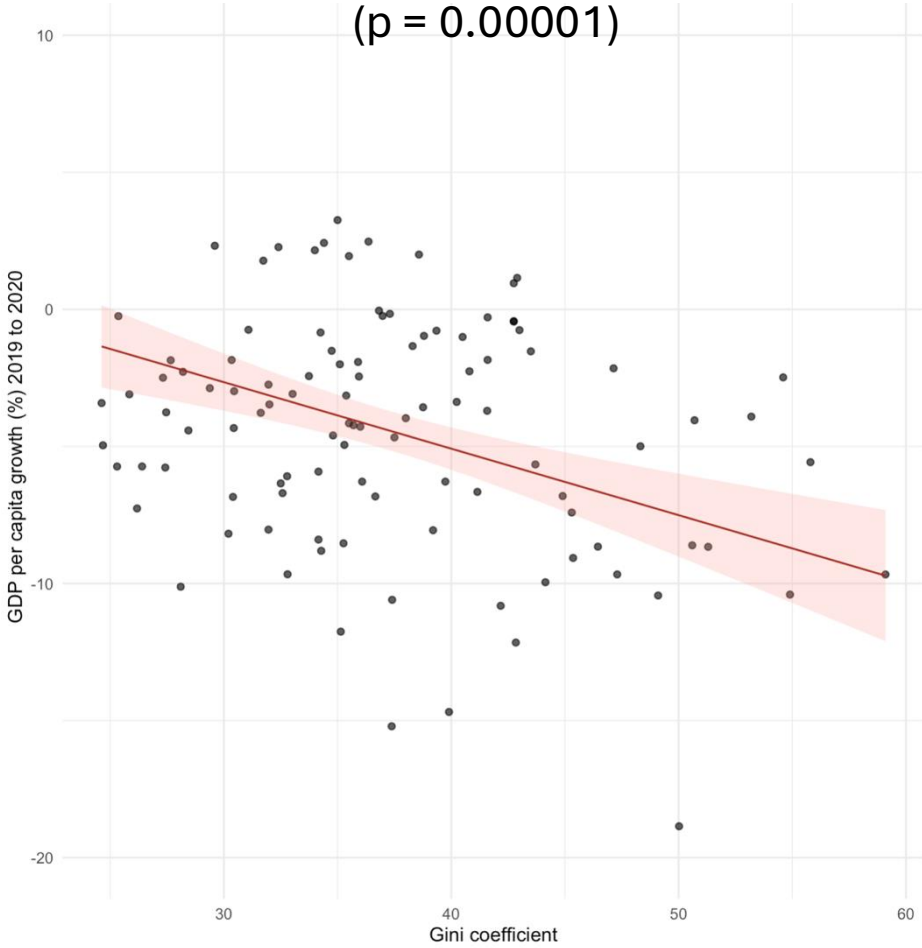


Inequality (Gini coefficient) predicts mortality and early pandemic GDP contraction

Non-islands: predicted change in mortality by change in Gini inequality index, n = 99 (p = 0.01)



Non-islands: Gini & GDP growth 2019-2020, n = 99 (p = 0.00001)



Conclusions

Methodology: Data quality and appropriate analyses matter immensely

Preparedness as measured by GHS Index (and categories) important for non-islands

Future iterations of GHS Index may need to treat islands differently (border control, quarantine/elimination)

Features of politics and society appear to show major correlations with pandemic outcomes: GDP/wealth, Trust, Democracy/corruption, Inequality

All means the ability to *implement* strategy (eg border controls, exclusion/elimination strategy, governance) is an important component of preparedness (and constraint on *what* to prepare)

Citations for key papers

Boyd, M., Baker, M., & Wilson, N. (2025). **Global Health Security Index and COVID-19 pandemic mortality 2020–2021: a comparative study of islands and non-islands across 194 jurisdictions**. *BMJ Open*. doi:10.1136/bmjopen-2025-107918

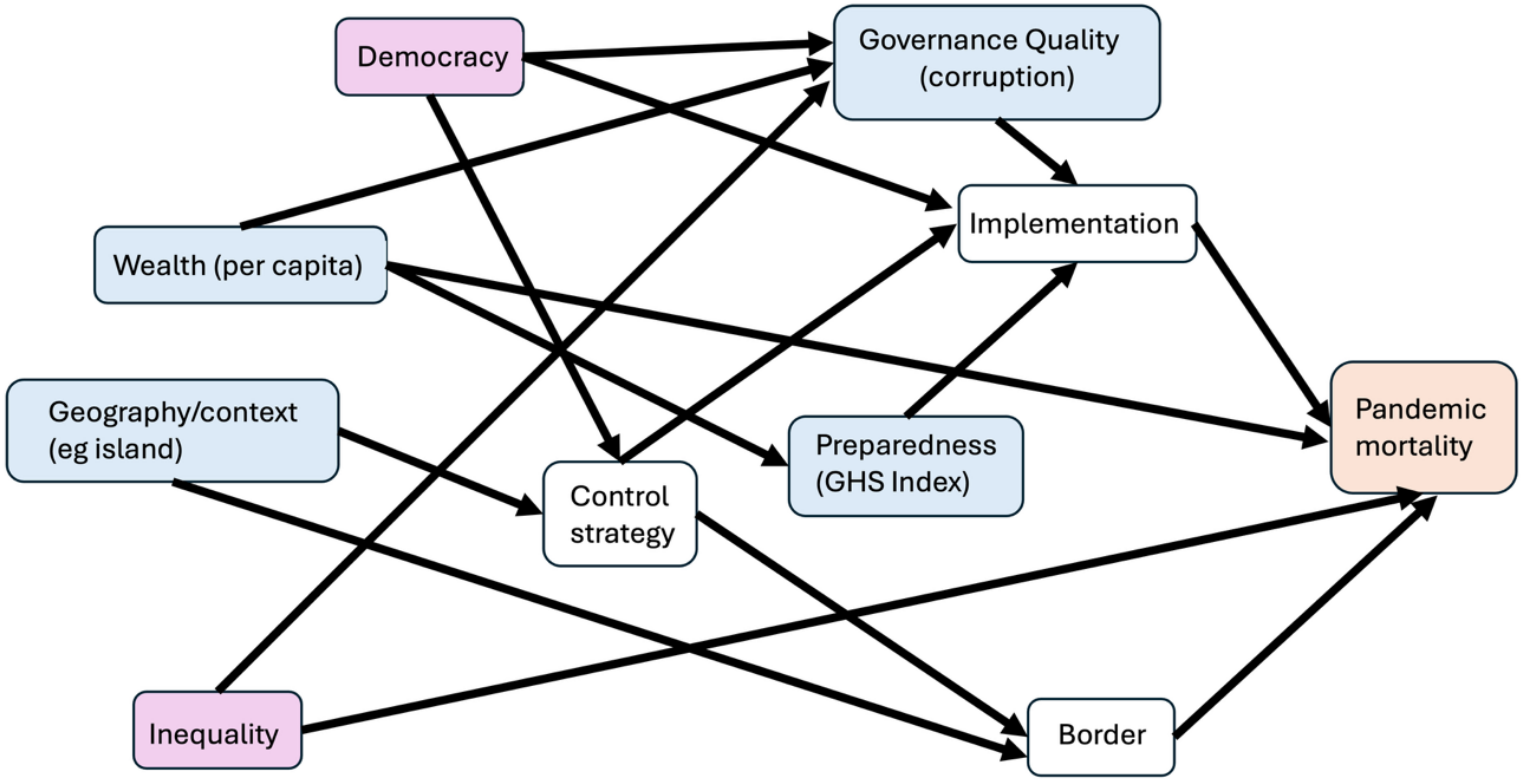
Boyd, M., Baker, M., Kvalsvig, A., & Wilson, N. (2025). **Impact of Covid-19 Control Strategies on Health and GDP Growth Outcomes in 193 Sovereign Jurisdictions**. *PLoS Global Public Health*. doi:10.1371/journal.pgph.0004554

Boyd, M., Baker, M. G., & Wilson, N. (2026). **Democracy, Inequality and Covid-19 Pandemic Outcomes: Age-standardised excess mortality and GDP growth in island and non-island jurisdictions**. *MedRxiv*, doi:10.64898/2026.01.22.26344652 [updated version available on request to authors: matt@adaptresearchwriting.com]

Boyd, M., Wilson, N., & Nelson, C. (2020). **Validation analysis of global health security index (GHSI) scores 2019**. *BMJ Glob Health*. doi: 10.1136/bmjgh-2020-003276

Additional slides in case relevant to any questions

We now have a structural model

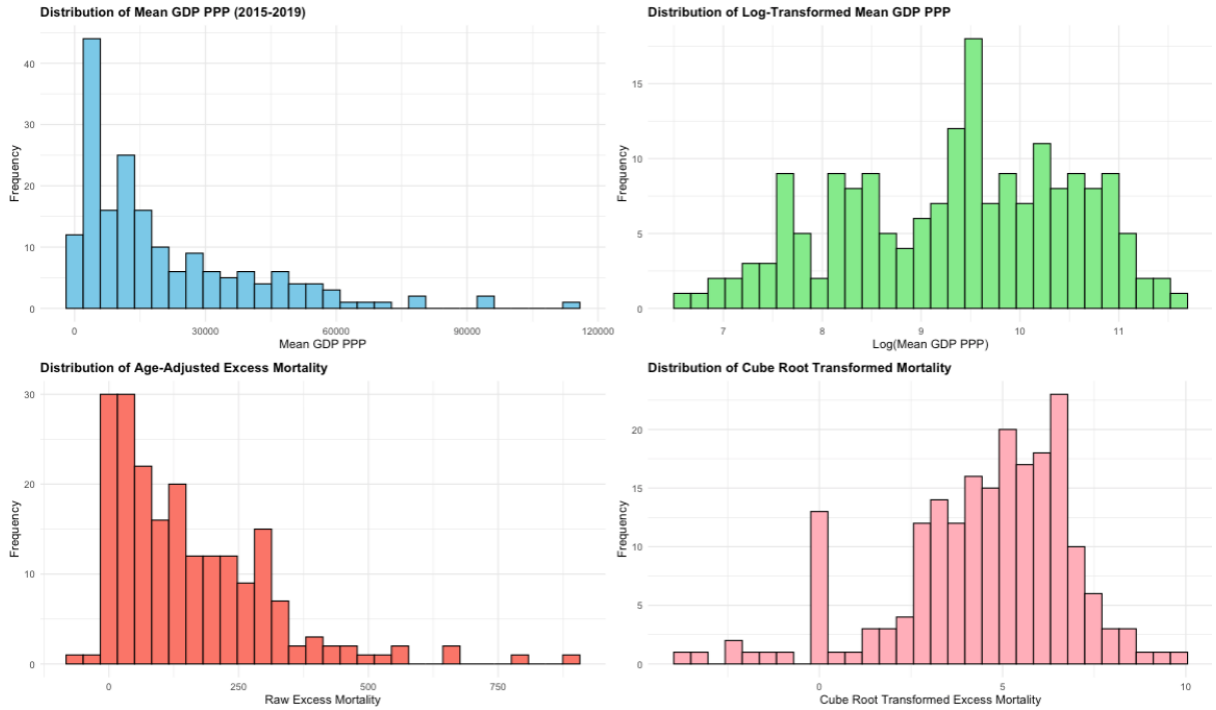


Data coverage & skew

Table S1: Number of jurisdictions with available data for each variable

	All Jurisdictions (n)	Non-Islands (n)	Islands (n)
Age-standardised excess mortality (2020-21)	204	146	58
GDP per capita growth 2020–2021	183	136	47
GHS Index scores (2019, 2021)	194	145	49
Control variables			
GDP per capita mean 2015–2019 (PPP, 2017)	184	137	47
GDP per capita + government corruption	155	128	27
GDP per capita + government corruption + trust in government	105	89	16
GDP per capita + government corruption + trust in government + trust in individuals	64	56	8

Pre- (L) and post- (R) transformation data



GHS Index 2019 category scores

Table 3: Second-level hierarchical analysis (2019 GHS Index Category Scores): Regression results (Model 3) for those jurisdictions and dependent variables showing statistical significance at first-level analysis

Group	Depend. Variable	Indep. Variable	Control Variables	Coeff. (SE)	T-Value	Corrected P-Value	R^2	Adj. R^2	N
Non-island jurisdictions: category scores vs age-standardised excess mortality 2020-2021									
Non-Islands	$\sqrt[3]{EM}$	2019 Overall Score	ln(GDP) + corrupt	-0.046 (0.01)	-3.48	Meets Bonferroni threshold at level 1 (see above)	0.49	0.48	128
Non-Islands	$\sqrt[3]{EM}$	Prevention	ln(GDP) + corrupt	-0.024 (0.01)	-2.20	0.044551*	0.46	0.45	128
Non-Islands	$\sqrt[3]{EM}$	Detection	ln(GDP) + corrupt	-0.019 (0.01)	-2.99	0.014004*	0.48	0.47	128
Non-Islands	$\sqrt[3]{EM}$	Response	ln(GDP) + corrupt	-0.029 (0.01)	-2.88	0.014004*	0.48	0.46	128
Non-Islands	$\sqrt[3]{EM}$	Health System	ln(GDP) + corrupt	-0.027 (0.01)	-2.57	0.022846*	0.47	0.46	128
Non-Islands	$\sqrt[3]{EM}$	Compliance	ln(GDP) + corrupt	-0.018 (0.01)	-1.60	0.135899	0.45	0.44	128
Non-Islands	$\sqrt[3]{EM}$	Risk Environment	ln(GDP) + corrupt	-0.058 (0.02)	-2.57	0.022846*	0.47	0.46	128

This tells the story you would have expected *a priori* (in non-islands at least)

Limitations

Sample sizes are modest in some fully adjusted models for islands or when trust is included.
Possibly as yet unknown systematic differences between jurisdictions with data and without.
Ultimately, a correlation study and we can’t infer causation.
Model fit in macroeconomic analyses was poor and GDP has limitations as a metric.
Focus on 2020–2021 (before widespread vaccination, late waves, & Russian invasion of Ukraine)
Have not accounted for geographic clustering (eg Kim 2025)

Methodological strengths & uniqueness

- global data coverage of relatively high-impact pandemic
- appropriately age-standardized and cumulative excess mortality
- appropriate data transformations
- theoretically grounded controls and a plausible causal diagram
- explicit island stratification
- extension to democracy and inequality as predictors
- >> No prior work jointly satisfies all these conditions, particularly linking to both health and macroeconomic outcomes