Food insecurity, state fragility and youth mental health: A global perspective

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ABSTRACT

Youth in fragile settings face disproportionate risks of experiencing food insecurity and poor mental health. Cross-national evidence is lacking on the association between food insecurity and mental health in youth populations, and on state fragility as a social determinant of these experiences. We analysed data from six cycles of the Gallup World Poll (2014–2019), an annual survey that contains multi-item scales of food insecurity, mental health problems and positive wellbeing. The analytic sample included 164,118 youth aged 15–24 years in 160 states. We linked individual responses to state-level data from the Fragile States Index—an aggregate measure of state vulnerability to collapse or conflict (coded: sustainable, stable, warning, or alert) and estimated adjusted relative risk (RR) of food insecurity as a function of state fragility. We then used linear regression to examine associations of state fragility and food insecurity with mental health and wellbeing. The prevalence of moderate or severe food insecurity rose from 22.93% in 2014 to 37.34% in 2019. State fragility (alert vs. sustainable) was related to an increased risk of food insecurity (RR = 2.28 [95% CI 1.30 to 4.01]), more mental health symptoms (b = 6.36 [95% CI 1.79 to 10.93]), and lower wellbeing (b = −4.49 [95% CI -8.28 to −0.70]) after controlling for state wealth and household income. Increased food insecurity (severe vs. none or mild) was uniquely related to more mental health symptoms (b = 18.44 [95% CI 17.24 to 19.64]) and reduced wellbeing (b = −9.85 [95% CI -10.88 to −8.83]) after state fragility was also controlled. Globally, youth experience better mental health where states are more robust and food access is more secure. The findings underscore the importance of strong governance and coordinated policy actions that may improve youth mental health.

1. Introduction

More than 2 billion people lack reliable access to safe, sufficient and nutritious food (Food and Agricultural Organisation, 2020). Household food insecurity shortens lives, stunts growth in childhood and adolescents and increases the risk of various physical health problems throughout life including iron deficiency, respiratory illness, diabetes, hypertension and cardiovascular disease (Gundersen et al., 2018). Additionally, the experiences associated with food insecurity—chronic hunger, skipping meals, having limited access to food, or relying on donated or discarded food—celicit extreme psychological stress and contribute to mental health problems and reduced wellbeing in children and youth (McLaughlin et al., 2012; Pryor et al., 2016). The association of food insecurity with mental health has been observed in adult samples throughout the Global South (Dewing et al., 2013; Isaura et al., 2019; Seino et al., 2008). However, cross-national evidence on the associations with youth mental health is limited. International school-based surveys such as the Health Behaviour in School-aged Children study and Global School-based Health Survey have examined the social and emotional correlates of hunger in several countries (Koyanagi et al., 2019; Pickett et al., 2015). These efforts, although useful, lacked valid measures of household food insecurity and involved different age groups and health assessments across countries and regions, further complicating efforts to synthesise the available evidence on a global level.

Another gap in the literature concerns the social determinants of food insecurity. Difficulties with food access tend to be overshadowed by problems with infrastructure, forced migration, income poverty or economic shock and, with few exemptions, are not afforded a specific and sustained policy focus (Jessiman-Perreault & McIntyre, 2017). Previous reports on food shortages, food insecurity and malnutrition described flashpoints of political and economic instability, war, and environmental degradation as well as natural causes such as drought, flooding and rapid population growth (Food and Agricultural Organisation, 2020; Sousa et al., 2019). Examples that highlight the association between food insecurity and state levels of conflict and instability include the 2008 food crisis when soaring commodity prices sparked violent protests in 14 African countries (Berazneva & Lee, 2013), the prolonged political conflicts in Yemen, Democratic Republic of the Congo and Afghanistan that brought these countries to the brink of famine (Loewenberg, 2015; Food Security Information Network, 2020) and present food crises in South Sudan and Venezuela (Doocy et al., 2019). The Food Security Information Network (2020) classified 55 states in "food crisis or worse" and identified violence or economic collapse or as the main drivers in 30 of these.

Collectively, such threats to the social, economic or political stability of nation states are indicators of *state fragility,* an expansive theoretical construct that was popularised by the World Bank in the 1990s to describe a lack of capacity or willingness among some states to implement economic reforms (Fund for Peace, 2017); Ziaja, 2012). Contemporary definitions of state fragility emphasise a state's physical control over its territory, a robust economy free of corruption, and a monopoly on the legitimate use of force (Ferreira, 2017). The Organization for Economic Cooperation and Development (2020) described fragile states as being unable to maintain security, grow the economy or ensure that the essential needs of the population are met. A fragile state is not merely poor or corrupt but lacking the institutional capacity needed to fulfil its basic functions as a state (Haar & Rubenstein, 2012). While the term itself remains disputed in the literature (Ziaja, 2012), the evidence shows that fragile states lag far behind comparably poor countries in terms of child and maternal health, mortality and life expectancy. The epidemiological data on mental health are scarce as state fragility also impacts health surveillance efforts. However, research on asylum-seeking youth from Afghanistan, Syria, Eritrea and Iraq found persistently high prevalence of emotional and behavioural problems (Bronstein et al., 2013) posttraumatic stress symptoms (Müller et al., 2019) and hair cortisol concentrations (Sierau et al., 2019) after resettlement in Europe. A study of Kosovar Albanians shortly after the 1998-99 Kosovo war found that 17% of youth and adults over age 15 suffered from posttraumatic stress disorder (Lopes Cardozo et al., 2000). Similar findings are reported from other conflict zones including Chechnya, Lebanon, Gaza, Rwanda, Somalia and South Sudan (Haar & Rubenstein, 2012). Youth in fragile settings also face the disproportionate risk of experiencing food insecurity – a problem that simultaneously results from and contributes to state fragility (Brück & d'Errico, 2019). Still, the triad of associations of state fragility with cross-national differences in youth food insecurity and mental health has not been examined previously.

Our goal in this study was to investigate contemporaneous associations between state fragility, food insecurity, and self-reported mental health in a global sample of youth (15–24 years) that participated in the Gallup World Poll from 2014 to 2019. Our objectives were to (1) investigate the association between state fragility and food insecurity and (2) examine associations of mental health and wellbeing with state fragility and food insecurity (net of economic wealth) both globally and across regions. Ultimately, our aim was to identify regions where youth are at greatest risk for poor mental health and low wellbeing due to their geopolitical context as well as limited access to sufficient and nutritious food.

2. Methods

2.1. Study design

In this observational study, we adopted the United Nation's (2020) definition of youth (15–24 years) and conceptualised state fragility and food insecurity as both determinants and pathways to poor mental health. While these constructs are known to co-occur with poverty, we hypothesised that each has unique pathways to youth mental health and wellbeing after economic differences are considered. Therefore, we controlled for state differences in wealth (income per capita) and for individual differences in household income in order to statistically isolate the associations of state fragility with mental health and wellbeing.

2.2. Data sources

Six consecutive annual survey cycles of the Gallup World Poll (2014–2019) supplied data on food insecurity and mental health and wellbeing from representative samples of youth in 160 sovereign states and dependent territories (hereinafter collectively referred to as states). According to Gallup (2015), the survey used two-stage probability sampling to identify clusters of households stratified by region within states and community size and then households within these clusters. At least 1000 individuals were surveyed per state and survey cycle either by telephone (in 36 countries with >80% telephone coverage) or face-to-face (in the remaining 124 countries) and larger samples were recruited in larger states such as India and China. The final sampling stage for both interview modes used age and Kish's (1965) grid method to select one respondent per household. Random digit dialling or nationally representative lists of phone numbers were used to select individuals for telephone surveys, each taking approximately 30 min to complete. Face-to-face interviews lasted about 60 min. Gallup obtained informed consent from all survey participants and survey protocols were approved by the required state governing bodies (Gallup, 2015). The Institutional Review Board of the Faculty of Medicine, McGill University approved this study in March 2019.

The Fund for Peace (2020) provided annual state-level data on state fragility for the period 2014 to 2019. The World Bank (2020) provided annual state-level data on gross national income (US dollars, Atlas method) per person. We applied the United Nations M49 classifications to identify 5 UN regions and 19 UN subregions in our sample for stratified analyses (United Nations, 2019). To help ensure the results would be globally representative, the survey weights provided by Gallup were multiplied by state populations of youth 15–24 years (provided by the United Nations [2019] World Population Prospects report) and then scaled to an average weight of 1.

2.3. Measures

2.3.1. State fragility

The Fund for Peace (2017) developed the Fragile States Index using multiple data sources on social, economic and political pressures faced by states. State vulnerability to collapse or conflict is measured in 12 composite indicators derived from over 100 sub-indicators: demographic pressures, refugees and internally displaced persons, group grievance, human flight and brain drain, uneven economic development, poverty and economic decline, state legitimacy, public services, human rights and rule of law, security apparatus, factionalised elites and external intervention. The data used for each indicator are summarised in Appendix A and correlations between the indicators are shown in Appendix B.1. For the states represented in our sample, we found these indicators to be highly internally consistent ($\alpha = 0.97$) and intercorrelated ($r = 0.50$ to 0.93). Therefore, a summary score of state fragility was based on equal weighting of the 12 indicators. This Fragile States Index total score has a theoretical range of 0–120, is normally distributed, and

can be interpreted either on a continuum of fragility (lower is better) or using its suggested cut-points: sustainable (0–30), stable (30–60), warning (60–90), and alert (90–120) (Fund for Peace, 2017).

2.3.2. Food insecurity

Since 2014, the Voices of the Hungry Project of the Food and Agricultural Organization has commissioned Gallup to field the Food Insecurity Experience Scale (Cafiero et al., 2014; 2018). Its primary purpose is to supply comparable and valid prevalence estimates of food insecurity for monitoring progress towards Target 2.1 of the 2030 Agenda for Sustainable Development (United Nations General Assembly, 2015). The Food Insecurity Experience Scale has eight items (α = 0.80) that were translated into over 200 languages and dialects and validated for youth and adult assessments. Its items are ordered from mild to severe indicators of food insecurity: *"In the past 12 months: You were worried you would run out of food because of a lack of money or other resources? You were unable to eat healthy and nutritious food because of a lack of money or other resources? You ate only a few kinds of foods because of a lack of money or other resources? You had to skip a meal because there was not enough money or other resources to get food? You ate less than you thought you should because of a lack of money or other resources? Your household ran out of food because of a lack of money or other resources? You were hungry but did not eat because there was not enough money or other resources for food? You went without eating for a whole day because of a lack of money or other resources?"* Each item is scored dichotomously (yes = 1, no = 0) and summed to yield a continuous index ranging from 0 to 8 points. The severity of food insecurity is determined using cut-points in the distribution of affirmative responses (0–3: none or mild; 4 to 6: moderate; 7 to 8: severe; Cafiero et al., 2018).

2.3.3. Mental health and positive wellbeing

The Gallup World Poll contained a five-item scale (Negative Experience Index) that dichotomously measured the presence of five common mental health symptoms experienced during the previous day (anxiety; sadness; stress; anger; pain). The proportion of affirmative responses are multiplied by 100 to yield a summary score that ranges from 0 to 100. Another 5-item scale (Positive Experience Scale) dichotomously measured five indicators of positive wellbeing during the previous day (well-rested; treated with respect; smiled or laughed a lot; learnt or did something interesting; enjoyment). Similarly, the proportion of affirmative responses is multiplied by 100 to produce a summary score from 0 to 100. These scales have no clinical cut-points and to our knowledge were not subjected to validation testing. Their scores are interpreted on continua of emotional distress and wellbeing. In our subsample of youth, we found the mental health symptoms scale has moderate internal consistency across states (α = 0.67 at the individual level; α = 0.83 when aggregated at the state level) as does the positive wellbeing scale (α = 0.60 at the individual level; α = 0.80 when aggregated at the state level). Their negative correlation ($r = -0.35$) and divergent correlations with life satisfaction scores in the Gallup World Poll ($r = -0.21$ for mental health symptoms; $r = 0.13$ for positive wellbeing) suggest they have moderate content validity.

2.3.4. Covariates

The Gallup World Poll measured household income in local currencies and converted these values to state/year-specific quintile groups. We used this variable to control for socioeconomic differences at the individual level. We also controlled for gender (male/female), age (years), community size (rural, small town, suburb, city) and survey year. We controlled for differences in state wealth by including gross national income per person at the state level. This variable represented the gross income of a state divided by its midyear population and was converted to thousands of current US dollars using the World Bank Atlas method (World Bank, 2020).

2.4. Data analysis

The analyses were carried out using Stata/SE 16.1 (StataCorp, College Station, Texas, USA). We estimated bivariate and mutually adjusted relative risk (RR) of moderate or severe food insecurity using multilevel Poisson regression with a robust variance estimator. Compared to odds ratios from logistic regression, the Poisson model provides less biased estimates of associations with dichotomous outcomes that are more prevalent, typically >10% (McNutt et al., 2003; Sedgwick, 2014). We tested associations between state fragility and mental health symptoms and positive wellbeing using multilevel linear regressions. All regressions were weighted and adjusted for unmeasured differences between survey cycles using dummy variables. Standard errors and confidence intervals were adjusted for the two-stage sampling design using Stata's *svy* tools. Changes in model goodness-of-fit were tested using a likelihood ratio test. Stata's postestimation tools were used to estimate states' adjusted prevalence of food insecurity and average scores in mental health symptoms and positive wellbeing in order to graphically show their correlations with state fragility.

Linear regression analyses were 90% powered (α = 0.05; 2-sided) to detect slope coefficients larger than 0.01 with the pooled sample and 80% powered to detect slope coefficients larger than 0.10 with regional samples (ns = 520 to 19,863). Poisson regression of food insecurity in the pooled sample was 90% powered to detect adjusted risk ratios of 1.02–1.04 (α = 0.05, 2-sided) in outcomes that ranged in prevalence from 5 to 50%.

3. Results

3.1. Descriptive statistics

An overview of sample characteristics and descriptive statistics on key variables are presented in Table 1. This table stratifies the results by UN region. Further stratification of these results by UN subregions is provided in Appendix B.2. A total of 164,118 youth in 160 states participated in the Gallup World Poll between March 2014 and February 2020. The number of states included per year was 147 in 2014 and 2017, 141 in 2015 and 2016, and 102 in 2018 and 2019. We removed 14,785 individual cases (8.26%) from the analysis due to missing data on the Food Insecurity Experience Scale. Missingness on other variables was less than 1%. Approximately one-quarter (28.03 [95% CI 26.65 to 29.41] percent) of the remaining 164,118 cases reported moderate or severe food insecurity and this figure increased 62.84% during the study period, from 22.93 (95% CI 19.88 to 25.97) percent in 2014 to 37.34 (95% CI 32.94 to 41.74) percent in 2019.

The composition of the sample was evenly distributed across gender groups and household income quintiles (Table 1). Intraclass correlations (ICC) at the state level indicated some clustering in the data within states: ICCs = 0.27 (95% CI 0.23 to 0.32) in food insecurity, 0.06 (95% CI 0.05 to 0.08) in mental health symptoms and 0.08 (95% CI 0.06 to 0.10) in positive wellbeing. Across UN regions, the prevalence of moderate or severe food insecurity ranged from 6.53 (95% CI 5.82 to 7.31) percent in Europe to 54.45 (95% CI 52.92 to 55.97) percent in Africa (Table 1). Across the 19 subregions, the prevalence of moderate or severe food insecurity ranged from 4.87 (95% CI 3.42 to 6.89) percent in Western Europe to 70.00 (95% CI 67.43 to 72.46) percent in Middle Africa (Appendix B.2).

Mental health symptoms (measured on a 0–100 scale) ranged from an average score of 19.04 (95% CI 18.08 to 20.00) in Europe to 27.36 (95% CI 26.73 to 27.99) in Africa (Table 1). Positive wellbeing (measured on a 0–100 scale) ranged from an average score of 70.39 (95% CI 69.56 to 71.21) in Africa to 83.52 (95% CI 81.00 to 86.04) in Oceania (Australia and New Zealand). Across subregions, mental health symptoms ranged from 12.50 (95% CI 11.65 to 13.65) in Eastern Europe to 30.81 (95% CI 27.46 to 34.15) in North America and positive wellbeing ranged from 63.86 (95% CI 62.25 to 65.47) in Western Asia to

Table 1

Characteristics of the sample and summary statistics on key variables by UN region.

Variable	Africa	Americas	Asia	Europe	Oceania	Total
	% or mean (95% CI)	% or mean (95% CI)	% or mean (95% CI)	% or mean (95% CI)	% or mean (95% CI)	% or mean (95% CI)
Gender (%)						
Male	49.42	51.85	53.01	49.07	58.28	51.85
	(48.64,50.19)	(50.47,53.22)	(51.92,54.09)	(47.59,50.55)	(53.79,62.64)	(51.14,52.56)
Female	50.58	48.15	46.99	50.93	41.72	48.15
	(49.81,51.36)	(46.78,49.53)	(45.91,48.08)	(49.45,52.41)	(37.36,46.21)	(47.44,48.86)
Age (mean)	19.27	19.44	19.52	19.79	18.81	19.47
	(19.21, 19.32)	(19.35, 19.54)	(19.44, 19.59)	(19.66, 19.91)	(18.38, 19.24)	(19.42, 19.52)
Town size (%)						
City	16.23	38.28	19.65	35.47	9.00	21.91
	(14.69,17.91)	(34.40,42.30)	(17.60,21.87)	(32.83,38.19)	(5.90,13.49)	(20.48,23.41)
Small town	38.69	32.04	30.15	39.11	12.19	32.77
	(36.90,40.51)	(29.17,35.05)	(27.92,32.49)	(36.90,41.36)	(8.30,17.56)	(31.30,34.28)
Suburb	9.72	13.23	6.42	9.09	68.96	8.23
	(8.68,10.86)	(9.99,17.31)	(5.49,7.50)	(7.97,10.36)	(60.90,76.01)	(7.42,9.12)
Rural	35.36	16.46	43.78	16.33	9.85	37.09
	(33.12,37.67)	(14.50,18.63)	(40.78,46.83)	(14.29,18.60)	(6.50,14.66)	(34.99,39.24)
Household income quintile (%)						
1 (lowest)	19.78	23.36	17.39	26.67	31.72	19.17
	(18.95,20.63)	(21.65,25.15)	(15.90,18.99)	(25.16,28.23)	(26.30,37.69)	(18.22,20.15)
2	19.72	21.72	19.31	19.98	20.43	19.72
	(18.92,20.54)	(20.19,23.32)	(18.22,20.44)	(18.79,21.23)	(16.01,25.71)	(19.01,20.45)
3	20.97	20.34	19.79	18.8	14.34	20.06
	(20.25,21.70)	(18.97,21.79)	(18.91,20.70)	(17.79,19.86)	(11.27,18.08)	(19.48,20.65)
4	19.87	18.74	21.76	18.36	16.65	20.78
	(19.26,20.49)	(17.55,19.99)	(20.63,22.93)	(17.31,19.45)	(12.65,21.60)	(20.07,21.50)
5 (highest)	19.67	15.85	21.76	16.19	16.86	20.28
	(18.91,20.45)	(14.68,17.09)	(20.18,23.43)	(14.99,17.46)	(13.33,21.09)	(19.30,21.29)
Food insecurity (%)						
None or mild	45.55	76.08	79.17	93.47	92.49	71.97
	(44.03,47.08)	(73.96,78.08)	(77.11,81.09)	(92.69,94.18)	(88.74,95.06)	(70.57,73.33)
Moderate	23.51	12.55	11.98	4.45	4.75	14.24
	(22.69,24.34)	(11.43,13.76)	(10.91,13.14)	(3.87,5.10)	(2.74,8.13)	(13.52,15.00)
Severe	30.95	11.37	8.85	2.08	2.76	13.79
	(29.65,32.27)	(10.19,12.67)	(7.78,10.06)	(1.68,2.58)	(1.47,5.12)	(12.98,14.63)
Mental health symptoms (mean)	27.36	26.68	23.15	19.04	26.60	24.31
	(26.73, 27.99)	(25.55, 27.81)	(21.06, 23.24)	(18.08, 20.00)	(23.83, 29.37)	(23.62, 25.00)
Positive wellbeing (mean)	70.39	81.54	73.98	78.87	83.52	74.34
	(69.56, 71.21)	(80.71, 82.38)	(72.95, 75.02)	(78.12, 79.62)	(81.00, 86.04)	(73.66, 75.01)
N (individuals)	67,209	24,170	49,478	22,741	520	164,118
N (states)	48	25	46	39	2	160

Note: Percentages, means and 95% confidence intervals (CI) are based on weighted data. Sample characteristics by UN subregion are shown in Appendix B.2.

83.52 (95% CI 81.00 to 86.04) in Oceania (Appendix B.2).

State wealth also ranged widely across states, from an annual per person income of $260 (Burundi, 2015) to $104,540 (Norway, 2014). State fragility ranged from 17.70 (Finland, 2015) to 114.50 (South Sudan, 2015) and was strongly and negatively correlated with state wealth, r (159) = −0.79, p < 0.0001. Correlations between the indicators of the Fragile State Index and state wealth are shown in Appendix B.1.

3.2. Regression analysis

The regression analysis of food insecurity is summarised in Table 2. Model 1 is a series of bivariate regressions with no controls and Model 2 is a fully adjusted regression model. Relative risk (RR) estimates were similar in direction and strength between these models, indicating that the associations with state fragility were not an artefact of collinearity. With the other variables controlled (Model 2), state fragility was related to higher risk of moderate or severe food insecurity at "warning" (RR = 2.27 (95% CI 1.32 to 3.93)) and "alert" levels (RR = 2.28 (95% CI 1.30 to 4.01)) compared to the "sustainable" level of state fragility. Food insecurity was negatively but weakly related to female gender (RR = 0.98 [95% CI 0.96, 1.00]) and positively related to older age (RR = 1.03 (95% CI 1.02 to 1.03)) and living in either a small town (RR = 1.10 [95%

CI 1.07 to 1.13]), suburb (RR = 1.05 [95% CI 1.02 to 1.09]), or rural area (RR = 1.14 [95% CI 1.10 to 1.18]) as compared to cities. The relative risk of moderate or severe food security was progressively greater in lower income quintiles. The association of food insecurity and state wealth was marginally significant (RR = 0.99 [95% CI 0.97 to 1.00] per $1000 of income), which was not surprising given the strong correlations found between state fragility and state wealth (r = −0.79, p < 0.001; Appendix B.1). The results shown in Table 2 also reflect an upward trend in food insecurity during the study period, from an overall prevalence of 22.93 (95% CI 19.88 to 25.97) percent in 2014 to a prevalence of 37.34 (95% CI 32.94 to 41.74) percent in 2019 (RR = 1.33 [95% CI 1.23 to 1.43]).

Multilevel regression analyses of mental health symptoms and positive wellbeing are shown in Tables 3 and 4 respectively. Two regression models are shown in each table. Food insecurity is omitted in Model 1 and included in Model 2. Tables 3 and 4 show that state fragility was positively related to mental health symptoms and negatively related to wellbeing after controlling for state wealth and individual characteristics. Between the "sustainable" and "alert" levels of state fragility, we observed more mental health symptoms (b = 6.36 [95% CI 1.79 to 10.93]) and less positive wellbeing (b = −4.49 [95% CI -8.28 to −0.70]). The inclusion of food insecurity in these models improved goodness-of-fit to the data. With state fragility and all other variables

Table 2
Poisson regression of moderate or severe food insecurity.

Variable	Bivariate models			Mutually adjusted model		
	Relative risk	95% CI	P-value	Relative risk	95% CI	P-value
Gender						
Male	1	(ref)		1	(ref)	
Female	1.01	0.98, 1.03	0.56	0.98	0.96, 1.00	0.03
Age	1.02	1.02, 1.02	<0.001	1.03	1.02, 1.03	<0.001
Town size						
City	1	(ref)		1	(ref)	
Small town	1.17	1.13, 1.20	<0.001	1.10	1.07, 1.13	<0.001
Suburb	1.07	1.04, 1.11	<0.001	1.05	1.02, 1.09	0.001
Rural	1.26	1.21, 1.30	<0.001	1.14	1.10, 1.18	<0.001
Income quintile						
1 (lowest)	1.29	1.22, 1.35	<0.001	1.28	1.22, 1.35	<0.001
2	1.14	1.11, 1.17	<0.001	1.13	1.10, 1.16	<0.001
3	1	(ref)		1	(ref)	
4	0.87	0.84, 0.90	<0.001	0.86	0.84, 0.88	<0.001
5 (highest)	0.69	0.66, 0.73	<0.001	0.69	0.65, 0.73	<0.001
Year						
2014	1	(ref)		1	(ref)	
2015	1.06	1.02, 1.10	<0.001	1.07	1.02, 1.11	0.002
2016	1.16	1.10, 1.22	<0.001	1.18	1.11, 1.24	<0.001
2017	1.23	1.16, 1.30	<0.001	1.24	1.18, 1.32	<0.001
2018	1.25	1.18, 1.33	<0.001	1.26	1.19, 1.34	<0.001
2019	1.30	1.20, 1.40	<0.001	1.33	1.23, 1.43	<0.001
State wealth	0.97	0.96, 0.98	<0.001	0.99	0.97, 1.00	<0.001
State fragility						<0.001
Sustainable	1	(ref)		1	(ref)	
Stable	1.54	0.90, 2.64	0.22	1.67	1.01, 2.76	0.04
Warning	1.83	1.00, 3.37	0.10	2.27	1.32, 3.93	0.003
Alert	1.74	0.92, 3.28	0.16	2.28	1.30, 4.01	0.004
State-level variance				0.81		
Goodness-of-fit:						
-2 log likelihood				-102,167.6		
AIC				204,373.3		
BIC				204,563.4		

Note: Shown are relative risks and 95% confidence intervals (CI) of moderate or severe food insecurity estimated from bivariate unadjusted Poisson regressions (left column) and a mutually adjusted Poisson regression (right column). State wealth (gross national income) is measured in thousands of US dollars per person. AIC: Akaike's information criterion. BIC: Bayesian information criterion.

held constant, we found more mental health symptoms at moderate (b = 11.32 [95% CI 10.41 to 12.23]) and severe levels of food insecurity (b = 18.44 [95% CI 17.24 to 19.64]). Conversely, positive wellbeing negatively related to moderate (b = −6.77 [95% CI -7.48 to −6.06]) and severe (b = −9.85 [95% CI -10.88 to −8.83]) food insecurity. State wealth was marginally related to mental health symptoms (b = 0.10 [95% CI 0.04 to 0.17]) and not related to positive wellbeing. With regard to the other individual characteristics, we observed more mental health symptoms and lower wellbeing in females compared to males, older adolescents, cities compared to small towns and rural areas and lower income groups (Tables 3 and 4).

The associations of food insecurity with mental health and positive wellbeing were consistent across geographic location (Figs. 1 and 2). Stratified analysis of mental health symptoms and positive wellbeing across the 19 UN subregions are shown in Appendices B.3 and B.4. In summary, moderate and severe food insecurity related to more mental health symptoms and lower wellbeing (with the exception of Australia and New Zealand where moderate food insecurity did not relate to positive wellbeing but severe food insecurity did). The associations with mental health and wellbeing were generally stronger in North America and Western Europe compared to other subregions. With regard to trends over time, a marginally significant increase in mental health symptoms was found in the pooled sample from 2014 to 2019 (b = 1.37 [95% CI -0.02 to 2.75]). Stratified analyses revealed that the largest increase in mental health symptoms during this period occurred in Middle Africa (b = 8.21 [95% CI 4.57 to 11.85]) and the largest decrease in mental health symptoms occurred in the Caribbean (b = −6.01 [95% CI -9.79 to −2.22]; Appendix B.3). No overall trend was found in positive wellbeing in the pooled sample, however the largest increase in positive

wellbeing occurred in Eastern Asia (b = 7.06 [95% CI 4.20 to 9.92]) and the largest decrease was found in Northern Europe (b = −15.79 [95% CI -22.54 to −9.04]; Appendix B.4). Similar gender and age differences in mental health symptoms and positive wellbeing were found in most subregions, however differences by town size and income group were less consistent.

These associations resemble those displayed in Fig. 3 between state fragility and regression-based predictions of moderate or severe food insecurity (r = 0.66, p < 0.001), average mental health symptoms (r = 0.31, p < 0.001) and average positive wellbeing (r = −0.58, p < 0.001). These scatterplots illustrate the robust associations at the state level—net of economic factors, individual characteristics and state and survey cycle differences. They also reveal wide regional disparities, especially between African and European youth whom were clustered at opposing ends of the range in state fragility.

Finally, we recreated these predictions for each state and survey year in the sample in order to describe changes in the correlations during the study period. Fig. 4 reveals that the global rise in food insecurity was most pronounced in Africa and some Asian countries, despite showing no change or modest improvements in state fragility. Increases in mental health symptoms and decreases in positive wellbeing appears to have been more equally distributed across regions.

4. Discussion

This analysis of youth mental health and wellbeing provides the first comprehensive view of its associations with food insecurity and state fragility in diverse geopolitical contexts. It replicates associations of food insecurity and mental health found in adult populations (Jones,

Table 3
Linear regression analysis of mental health symptoms.

Variable	Model 1			Model 2		
	b	95% CI	P-value	b	95% CI)	P-value
Constant	12.26	8.59, 15.93		11.03	7.96, 14.10	
Gender						
Male	-	(ref)		-	(ref)	
Female	1.82	1.24, 2.40	<0.001	1.82	1.27, 2.38	<0.001
Age	1.00	0.92, 1.09	<0.001	0.85	0.77, 0.93	<0.001
Town size						
City	-	(ref)		-	(ref)	
Small town	-0.77	-1.35, -0.19	0.009	-1.17	-1.70, -0.63	<0.001
Suburb	-0.56	-1.29, 0.16	0.13	-0.62	-1.33, 0.09	0.09
Rural	-0.98	-1.62, -0.35	0.002	-1.57	-2.15, -0.99	<0.001
Income quintile						
1 (lowest)	3.47	2.71, 4.24	<0.001	1.68	1.01, 2.35	<0.001
2	1.07	0.47, 1.67	0.005	0.25	-0.32, 0.81	0.39
3	-	(ref)		-	(ref)	
4	-1.74	-2.35, -1.14	<0.001	-0.91	-1.46, -0.35	0.001
5 (highest)	-2.86	-3.61, -2.10	<0.001	-1.10	-1.72, -0.48	0.001
Year						
2014	-	(ref)		-	(ref)	
2015	0.30	-0.63, 1.24	0.53	0.11	-0.79, 1.01	0.81
2016	1.81	0.62, 3.00	0.003	1.10	0.04 2.16	0.04
2017	2.14	0.89, 3.39	0.001	1.08	-0.03, 2.19	0.06
2018	2.42	0.90, 3.94	0.002	1.21	-0.18, 2.60	0.09
2019	2.93	1.29, 4.57	<0.001	1.37	-0.02, 2.75	0.05
State wealth	0.04	-0.03, 0.14	0.20	0.10	0.04, 0.17	0.001
State fragility						
Sustainable	-	(ref)	<0.001		(ref)	
Stable	3.57	2.22, 4.92	<0.001	2.71	1.23, 4.20	<0.001
Warning	7.38	4.41, 10.35	<0.001	4.78	2.36, 7.20	<0.001
Alert	6.36	1.79, 10.93	<0.001	3.39	-0.45, 7.23	0.08
Food insecurity						
None or mild				-	(ref)	
Moderate				11.32	10.41, 12.23	<0.001
Severe				18.44	17.24, 19.64	<0.001
State-level variance	53.30			36.50		
Goodness-of-fit:						
-2 log likelihood	-947,848			-942,763		
AIC	1,895,738			1,885,569		
BIC	1,895,952			1,885,804		

Notes: Shown are linear regression coefficients (b) and 95% confidence intervals (CI) of mental health symptoms. AIC = Akaike's information criterion. BIC = Bayesian information criterion. State wealth (gross national income) is measured in thousands of US dollars per person. Reference categories are: gender: male, community size: city, household income quintile: 3, year: 2014, state fragility: sustainable, food insecurity: none or mild. A likelihood ratio test indicated better model fit with the inclusion of food insecurity (Model 2 vs. Model 1): χ^2=10,172.92, P<0.001.

2017) and those reported in smaller observational studies of in North American adolescents (McLaughlin et al., 2012; Pryor et al., 2016) and school-based surveys of hunger (Koyanagi et al., 2019; Pickett et al., 2015).

The study adds two key findings to the literature. First, food insecurity was strongly and consistently related to poorer psychological functioning in every region in our sample. The associations corresponded to 10–30% differences in mental health symptoms and positive wellbeing (Figs. 1 and 2) and held up to numerous controls including state wealth and relative household income, which indicates that their underlying pathways are partially psychosocial in nature and not only a function of income poverty and material deprivation. The associations were somewhat weaker than were found in a previous analysis of food insecurity and mental health in the 2014 Gallup World Poll (Jones, 2017), although that paper did not control for state wealth or state fragility and included mostly adults in its analysis. These results may be explained by previous research that found that food insecurity, and resulting malnutrition, affects brain development and psychiatric problems through gut microbiota and other biological factors (Owen & Corfe, 2017; Shankar, Chung, & Frank, 2017). Other explanations are found in longitudinal research where food insecurity in early-life disrupted parental behaviour and parent-child attachment, which elicited parental distress and increased the risk of emotional and behavioural problems in childhood (McIntyre et al., 2013; Whitaker et al., 2006).

Similar to this study's findings, a systematic review by Shankar et al. (2017) concluded that food insecurity predicted worse psychological, cognitive, and academic outcomes in children and youth in every culture in which it has been investigated. Consistently strong associations were also reported between hunger and suicide ideation in five UN regions among youth populations in 32 states in the Global South (McKinnon et al., 2016). According to Firth et al. (2020), the inability to afford food and the social stigma and shame that is tied to accepting food charity all elicit chronic psychological stress which compromises mental health through increased allostatic load (i.e., long-term activation of the hypothalamic-pituitary adrenal axis). While we could not investigate these mechanisms given the cross-sectional design and nature of the data used, we can conclude that food insecurity is a universal risk factor for youth mental health. Worse still, we also observed a rising trend in youth-reported food insecurity since 2014, especially in the most fragile and conflict-affected regions of Africa and Asia.

Second, cross-national differences in state fragility tracked with differences in youth mental health and wellbeing—both directly and independently of food insecurity and state wealth, and indirectly through the increased likelihood that youth will experience food insecurity. To our knowledge, this is the first evidence to establish state fragility as a global social determinant of youth mental health. Previous research had linked developmental or health outcomes to specific dimensions of state fragility, including poverty (Reiss, 2013), economic

Table 4
Linear regression analysis of positive wellbeing.

Variable	Model 1			Model 2		
	b	95% CI	P-value	b	95% CI)	P-value
Constant	81.24	77.40, 85.09		81.20	78.66, 85.74	
Gender						
Male	-	(ref)		-	(ref)	
Female	0.26	-0.14, 0.66	0.20	0.19	-0.20, 0.58	0.34
Age	-0.79	-0.88, -0.71	<0.001	-0.71	-0.79, -0.62	<0.001
Town size						
City	-	(ref)		-	(ref)	
Small town	-0.77	-1.27, -0.27	0.003	-0.53	-1.01, -0.04	0.03
Suburb	0.06	-0.68, 0.56	0.85	0.01	-0.61, 0.62	0.98
Rural	-1.16	-1.80, -0.53	<0.001	-0.80	-1.40, -0.20	0.001
Income quintile						
1 (lowest)	-3.33	-3.88, -2.79	<0.001	-2.41	-2.90, -1.92	<0.001
2	-1.32	-1.76, -0.87	<0.001	-0.88	-1.31, -0.46	<0.001
3	-	(ref)		-	(ref)	
4	1.41	0.97, 1.85	<0.001	0.96	0.54, 1.38	<0.001
5 (highest)	3.42	2.84, 4.00	<0.001	2.38	1.85, 2.91	<0.001
Year						
2014	-	(ref)		-	(ref)	
2015	0.98	0.24, 1.72	0.01	1.12	0.40, 1.84	0.002
2016	0.35	-0.51, 1.21	0.42	0.78	-0.02 1.59	0.06
2017	0.35	-0.39, 1.27	0.30	1.07	0.27, 1.88	0.001
2018	0.97	-0.12, 2.06	0.08	1.65	0.59, 2.71	0.002
2019	-0.15	-1.66, 1.36	0.85	0.73	-0.64, 2.10	0.29
State wealth	0.08	-0.01, 0.16	0.07	0.05	-0.03, 0.12	0.22
State fragility						
Sustainable	-	(ref)		-	(ref)	
Stable	-1.15	-2.57, 0.27	0.11	-0.86	-2.32, 0.61	0.25
Warning	-4.76	-7.77, -1.75	0.002	-3.58	-6.21, -0.95	0.008
Alert	-4.49	-8.28, -0.70	0.02	-3.05	-6.53, 0.43	0.09
Food insecurity						
None or mild				-	(ref)	
Moderate				-6.77	-7.48, -6.06	<0.001
Severe				-9.85	-10.88, -8.83	<0.001
State-level variance	49.77			45.56		
Goodness-of-fit:						
-2 log likelihood	-763,632.0			-762,159.9		
AIC	1,527,306			1,524,366		
BIC	1,527,516			1,524,596		

Notes: Shown are linear regression coefficients (b) and 95% confidence intervals (CI) of positive wellbeing. AIC = Akaike's information criterion. BIC = Bayesian information criterion. State wealth (gross national income) is measured in thousands of US dollars per person. Reference categories: gender: male, community size: city, household income quintile: 3, year: 2014, state fragility: sustainable, food insecurity: none or mild. A likelihood ratio test indicated better model fit with the inclusion of food insecurity (Model 2 vs. Model 1): χ^2=2,944.10, p<0.001.

inequality (Ribeiro et al., 2017), political violence (Lavi & Solomon, 2005), and the uneven protection of human rights (Spencer et al., 2019) in one or a small number of countries. Although such evidence derived from a more piecemeal approach might better inform policy interventions (Diaconu et al., 2020), our more parsimonious approach shows that state fragility accounts for cross-national differences in youth mental health and wellbeing. The adversities encompassed by the concept of state fragility (e.g., forced migration, famine, displacement, economic decline, corruption, violence) are not only toxic to mental health and wellbeing but they undercut food production and distribution efforts as well (Food Security Information Network, 2020).

The data also revealed two disconcerting trends: a rise in food insecurity between 2014 and 2019 and a rise in mental health symptoms in Northern, Middle and Western Africa. These regions include states with a long history of food shortages, violence and brutal, ethnocentric governments. We also observed large differences in fragility between African states—some that have benefited from recent economic reforms and development (e.g., Ethiopia, Kenya, The Gambia; Food and Agricultural Organisation, 2020). Still, it is difficult to envision sustained global progress in these areas without coordinated policy action across Sustainable Developmental Goals pertaining to poverty reduction and economic growth as well as peace, justice and robust governance (United Nations General Assembly, 2015). It seems unlikely that such global disparities in youth mental health and the capacity of nation

states to support youth have improved during the COVID-19 pandemic.

The strengths of our study include a large and diverse sample of youth, the use of a validated, multi-item scale of food insecurity, and comparable self-assessments of positive and negative dimensions of mental health. These features supported complementary analyses of negative and positive dimensions of mental health and a powerful multilevel analysis of data that represented 98% of the global population. Several limitations should also be noted. First, our analyses were limited by the lack of contextual information about protective factors that mitigate the psychological effects of state fragility and food insecurity. Second, state wealth measured in per capita income might have been underestimated in some lower income states that have more informal subsistence activities or where there are remittances that are not accounted for at the state level. Third, due to the cross-sectional design we could not explore mutual influences on state fragility and food insecurity over time, nor examine the potential consequences of poor youth mental health in perpetuating state fragility. It was not feasible to incorporate time lags or cross-lagged panel associations in our models given the time period for which we had data. We acknowledge other research that examined reverse causality between state fragility and food security using longer panels (Brück & d'Errico, 2019; Martin-Shields & Stojetz, 2018). Furthermore, while not a limitation per se, our results cannot be generalised to psychiatric disorders as the assessments used to measure mental health and wellbeing are brief and
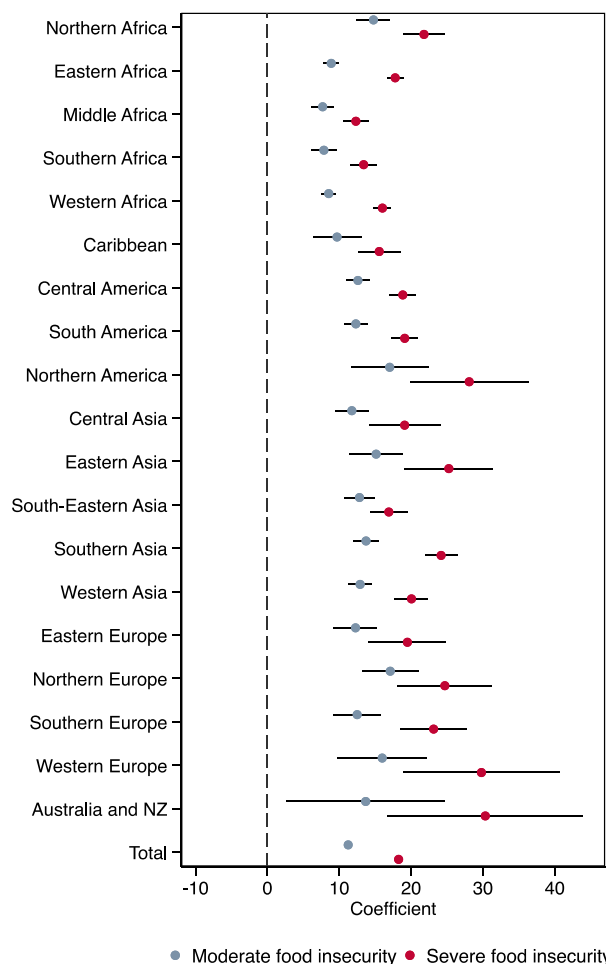
Fig. 1. Mental health symptoms in youth who experience moderate or severe food insecurity, by UN subregion.
Regression coefficients representing differences in mental health symptoms experienced by youth in moderate or severe food insecurity versus none or mild food insecurity (adjusted for gender, age, town size, income, and state and survey cycle differences). Error bars represent 95% confidence intervals. Complete regression results are shown in Appendix B.3. NZ: New Zealand.

Fig. 2. Positive wellbeing in youth who experience moderate or severe food insecurity, by UN subregion.
Regression coefficients representing differences in positive wellbeing experienced by youth in moderate or severe food insecurity versus none or mild food insecurity (adjusted for gender, age, town size, income, and state and survey cycle differences). Error bars represent 95% confidence intervals. Complete regression results are shown in Appendix B.4. NZ: New Zealand.

offer no diagnostic information.

Additionally, while state fragility is clearly deterministic of youth mental health on a global level, tools like the Fragile State Index have received criticism for their perceived lack of transparency and conceptual ambiguity (Ferreira, 2017; Ziaja, 2012). Details about its data sources and scale development are not publicly available. Furthermore, the Fragile States Index adopts a *formative* measurement model where the composite total score is causally related to each indicator, which themselves are not necessarily interdependent (Fleuren et al., 2018). This feature differs from many other multi-item scales, including the Food Insecurity Experience Scale, that adopt a *reflective* measurement model and have indicators that are causally related to a latent variable. This aspect of the Fragile States Index hinders validity testing and policy relevance because interventions could improve scores in one indicator while having no impact on the others. For some readers, this feature challenges the very notion of a latent construct of state fragility.

5. Conclusion

Social disparities in youth mental health compel states to improve the social and economic conditions that create them. This study found that state fra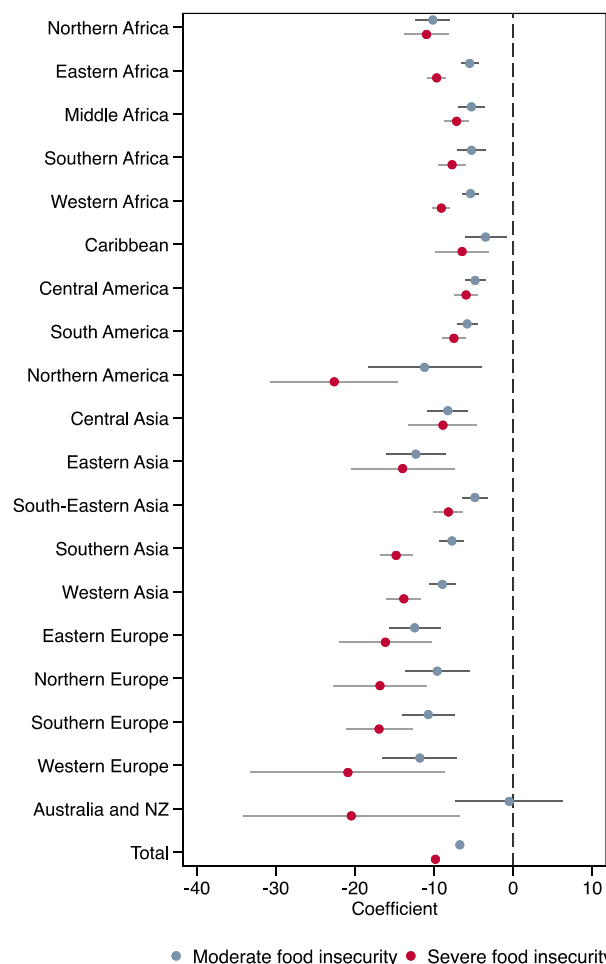gility and food insecurity are both associated with poor mental health in youth and are closely related to one another. Food insecurity is not only foundational to youth mental health but is also more prevalent where states lack the capacity to reduce it. These findings support the United Nations Sustainable Development Agenda, which recognises the interdependent nature of policies that support health and wellbeing, food access, and peace, justice and strong institutions (United Nations General Assembly, 2015). Mental health problems during the transition to adulthood can, if left untreated, have lasting and negative consequences on the individual's socioemotional development, academic success, employment and life opportunities (World Health Organisation [WHO], 2015) and, over time, undermine future economic growth and security of nations due to their associations with poverty, violence, unemployment, economic and gender inequality and other global challenges (Brück & d'Errico, 2019). Reducing food insecurity first can support mental health and health equity and become a fulcrum of broad social and economic development. This approach is reflected in the WHO's multisectoral policy agendas that tackle the social determinants of mental health and wellbeing in youth, including the elimination of malnutrition in all its forms (WHO, 2013; 2015). Our findings support such efforts by demonstrating that tackling food insecurity will support youth mental health and wellbeing regardless of its economic and geopolitical context.
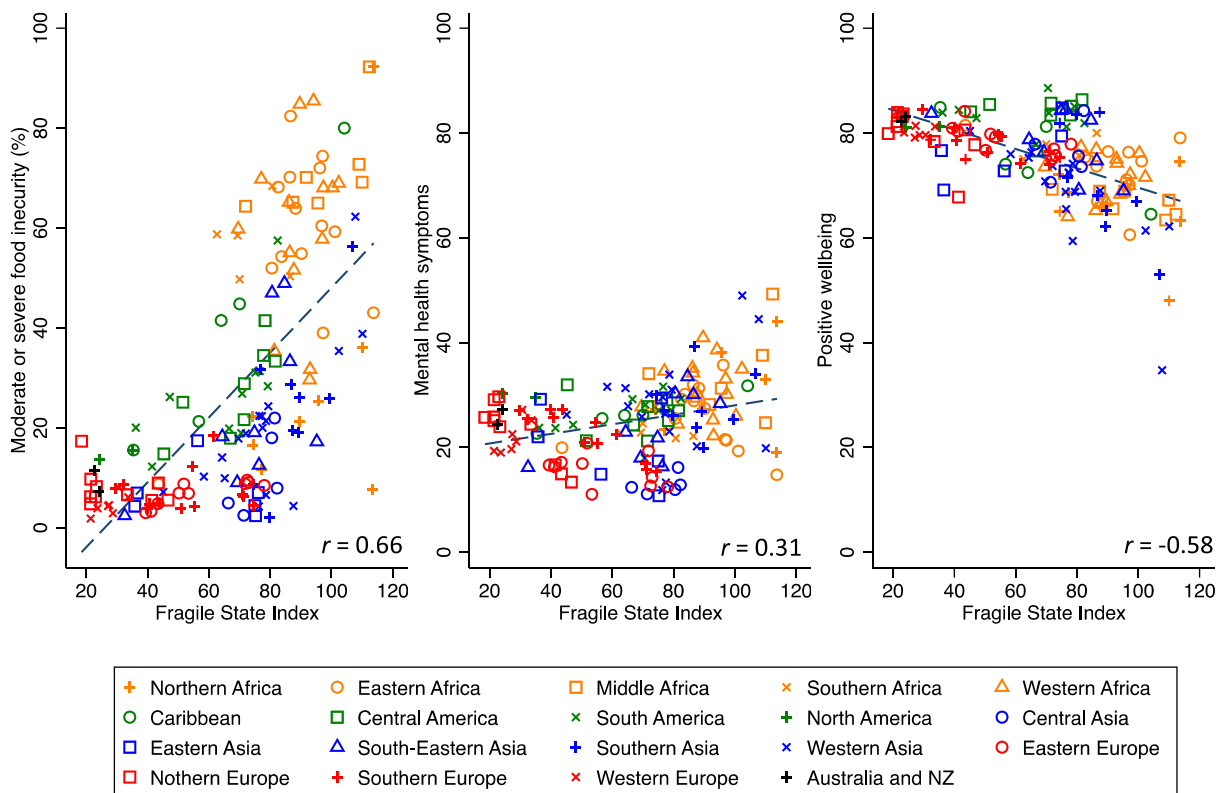
Fig. 3. Food insecurity, mental health symptoms, and positive wellbeing in relation to state fragility in 160 states.
Charts show correlations of state fragility (Fragile State Index) with the predicted prevalence of moderate or severe food insecurity (left panel), mental health symptoms (centre panel) and positive wellbeing (right panel) in 15- to 24-year-olds. Each point represents a state. Predicted values are weighted and adjusted for gender, age, town size, household income quintile, and survey year (see Tables 2–4). NZ: New Zealand.
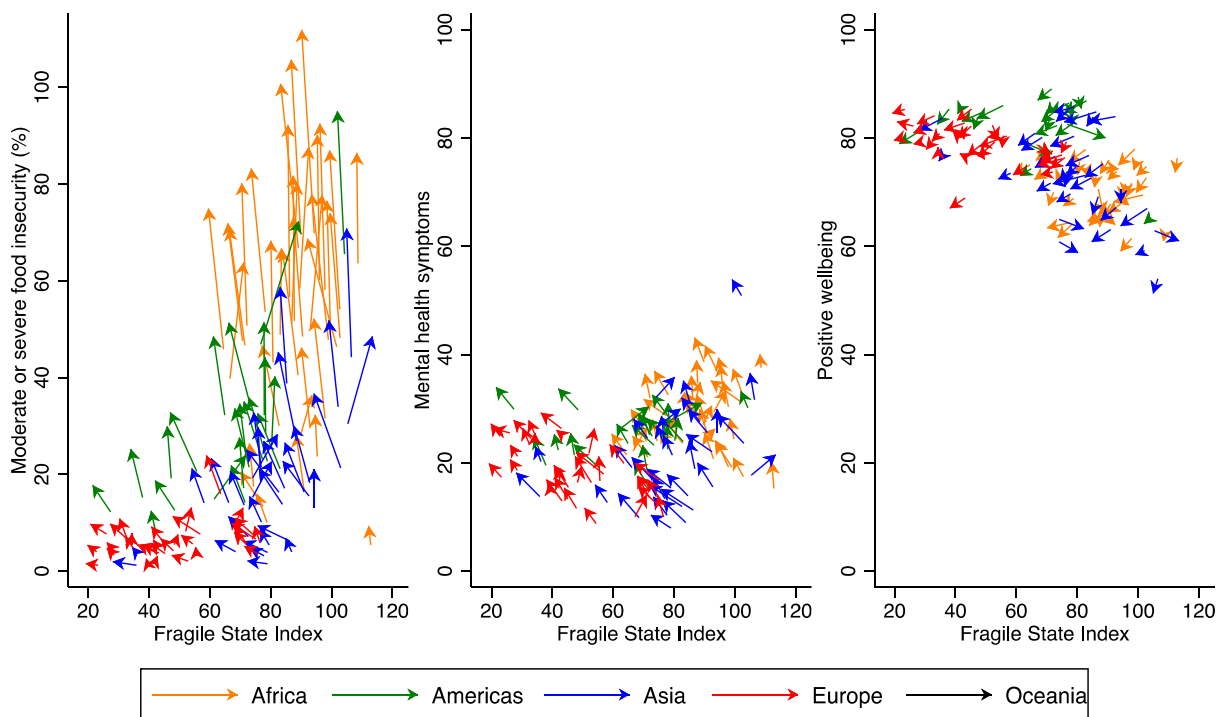
Fig. 4. Associations of state fragility and food insecurity, mental health symptoms, and positive wellbeing in 125 countries, 2014 to 2019.
Charts show changes over time in the correlations of state fragility (Fragile State Index) with the predicted prevalence of moderate or severe food insecurity (left panel), mental health symptoms (centre panel) and positive wellbeing (right panel) in 15- to 24-year-olds. Each arrow represents a state. Predicted values are weighted and adjusted for gender, age, town size, household income quintile, and survey year (see Tables 2–4).

Ethical statement

Gallup Inc. obtained informed consent from all survey participants and its survey protocols for the Gallup World Poll were approved by the required state governing bodies. The current study was subject to review by the Institutional Review Board of the Faculty of Medicine, McGill University and approved on March 12, 2019.

Financial disclosure statement

CRediT authorship contribution statement

Frank J. Elgar: Conceptualization, Methodology, Formal analysis, Data curation, Writing – original draft, Writing – review & editing, Visualisation, Funding acquisition, Supervision. **Akankasha Sen:** Methodology, Formal analysis, Writing – review & editing. **Geneviève Gariépy:** Methodology, Formal analysis, Writing – review & editing. **William Pickett:** Methodology, Writing – original draft, Writing – review & editing. **Colleen Davison:** Writing – review & editing. **Kathy Georgiades:** Writing – review & editing. **Nour Hammami:** Formal analysis, Writing – review & editing. **Marine Azevedo Da Silva:** Writing – review & editing. **David Gordon:** Methodology, Writing – review & editing. **Hugo Ramiro Melgar-Quiñonez:** Resources, Writing – review & editing, Project administration.

Declaration of competing interest

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ssmph.2021.100764.

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