

Greenspace density and Rohingya refugee depression symptoms in Cox's Bazar, Bangladesh



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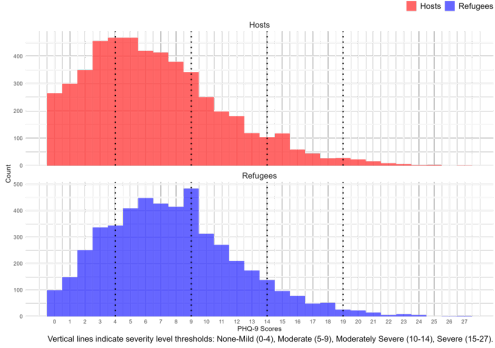
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Motivation

- Refugees have an elevated risk of developing mental health disorders compared to non-refugees [1], and many refugee camps are overpopulated, dangerous, and lack resources.
- Previous research shows that post-displacement environments can strongly influence refugee mental health [2].
- Experimental and observational evidence strongly suggests a positive relationship between nearby vegetation (greenspace) and mental health [3]. This relationship is unclear in the refugee camp setting.
- In this study, I measure the relationship between surrounding greenspace and risk of depression for Rohingya refugees in Kutupalong, Cox's Bazar, Bangladesh.

PHQ-9 Score Distributions for Refugees and Hosts in Cox's Bazar



Background

- The Rohingya are the world's largest stateless group [4]. Originally from Rakhine, Myanmar, over 600,000 Rohingya fled into the neighbouring province of Cox's Bazar, Bangladesh in 2017 after an outburst of ethnic violence [4]. This brought the total number of Rohingya living in Cox's Bazar to roughly 1 million [5].
- About 600,000 of these refugees live in the 13 square kilometer camp of Kutupalong – making it the most populated camp in the world [5].



Methodology

I model depression as a latent (unobservable) variable PHQ_i^* : that is only observed when it passes a certain depression risk threshold on the Patient Health Questionnaire-9. I estimate coefficients, marginal effects, and odds ratios using ordered logistic regression.

$$PHQ_i^* = \alpha + X^T \beta + W^T \gamma + \delta NDVI_i + \epsilon$$

$$\begin{cases} PHQ_i = 0 & \text{if } 4 \geq PHQ_i^* \\ PHQ_i = 1 & \text{if } 4 < PHQ_i^* \leq 9 \\ PHQ_i = 2 & \text{if } 9 < PHQ_i^* \leq 14 \\ PHQ_i = 3 & \text{if } 14 < PHQ_i^* \end{cases}$$

Where:

X : is a matrix of individual determinants of depression (past traumatic experiences, a food insecurity score, self-reported health status, income/employment status, age, sex, and marital status)

W : is a matrix of neighbourhood determinants of depression (crime, surrounding settlement density, and distance to amenities for each respondent)

$NDVI$: is the pixel-level mean Normalized Difference Vegetation score for a radius around each respondent. ϵ : is the error term; $\alpha, \beta, \gamma, \delta$ and ϵ are estimated coefficients

Data

Survey Data: I use survey data from the Cox's Bazar Panel Survey (CBPS), which includes socioeconomic, demographic, housing, health, trauma, and mental health data from a representative sample of over 2000 Rohingya refugee households (and 2 adults per household) [6]. I use Patient Health Questionnaire-9 data to measure depression risk levels, and use other survey data as controls. Only one wave of this data is currently available, so my analysis is cross-sectional. More waves that follow the same respondents are forthcoming.

Spatial Data: The survey collected precise geographic coordinates of each survey location – respondent's homes. This allows me to create spatial statistics unique to each respondent's local characteristics. To measure greenspace, I use Sentinel-2 satellite data to create a Normalized Difference Vegetation Index (NDVI) of the study area. NDVI uses the near-infrared and red bands from the electromagnetic spectrum to measure vegetation areas. I calculate the pixel-level mean NDVI score for a set of buffers around each respondent. I use World-Settlement Footprint (2019) data to control for settlement density within these same buffers. Additionally, I control for distance to wells and medical centres using Euclidian distance to the nearest of each facility from the respondent's location. For privacy reasons, I was not given direct access to the true points; instead, I wrote a script for the study team to run that generates the statistics associated with the true survey points. I have not yet received the true spatial statistics, so all statistics and results related to spatial statistics are based on random points within the camps (highlighted in grey). See "missing data" to sign up to see the final results when they become available.

Table 4.1: Means and Percentages of Determinants of Depression by PHQ-9 Risk Level

	None-Minimal	Mild	Moderate	Moderately Severe/Severe	Total
N	580	1,202	972	170	2,924
Mean NDVI (100m)	0.24	0.24	0.22	0.24	0.24
WSF Prop. (100m)	5.59	5.71	5.70	5.72	5.68
Dist. Nearest Well	24.59	24.31	22.70	22.14	23.86
Dist. Nearest Health Ctr.	194.08	193.04	199.07	201.91	195.27
# Perceived Crimes	2.78	3.54	3.84	4.25	3.48
# Experienced Crimes	0.49	0.66	0.64	0.63	0.61
# Experienced Traumas	2.96	3.06	3.45	4.06	3.20
# Witnessed Traumas	2.94	3.57	3.96	4.02	3.54
Food Insecurity Score	4.54	4.88	4.21	5.29	4.80
Household Income > Size	888.07	804.34	638.04	767.53	783.57
Age	25.86	30.96	34.49	38.30	31.10
Employment Status:					
Unemployed	(75.9%)	(77.0%)	(81.1%)	(88.0%)	(78.4%)
Employed	(24.1%)	(23.0%)	(18.9%)	(12.0%)	(21.6%)
Sex:					
Male	(42.2%)	(42.6%)	(47.4%)	(34.3%)	(41.9%)
Female	(57.8%)	(57.4%)	(52.6%)	(65.7%)	(58.1%)
Marital Status:					
Married	(66.2%)	(74.9%)	(70.8%)	(68.6%)	(71.5%)
Never Married	(30.3%)	(15.6%)	(13.1%)	(8.0%)	(17.9%)
Widowed	(2.6%)	(7.5%)	(13.9%)	(19.4%)	(8.5%)
Divorced/Separated	(0.9%)	(2.6%)	(2.8%)	(4.0%)	(2.1%)
Health Status:					
Very good	(3.3%)	(2.7%)	(0.3%)	(1.1%)	(2.7%)
Good	(68.1%)	(55.2%)	(43.0%)	(24.6%)	(53.3%)
Regular	(12.2%)	(17.0%)	(14.9%)	(11.4%)	(15.0%)
Bad	(13.6%)	(24.0%)	(28.5%)	(56.9%)	(27.3%)
Very bad	(0.7%)	(1.1%)	(1.3%)	(6.9%)	(1.6%)
Health Change:					
Much better	(4.3%)	(2.9%)	(1.0%)	(0.0%)	(2.6%)
Better	(43.8%)	(33.3%)	(25.2%)	(20.0%)	(33.1%)
The same	(28.1%)	(28.1%)	(28.5%)	(12.0%)	(27.4%)
Worse	(21.1%)	(36.8%)	(30.3%)	(58.9%)	(38.2%)
Much worse	(0.7%)	(0.7%)	(2.6%)	(8.6%)	(1.7%)

Data: All data is from the Cox's Bazar Panel Survey except for author generated geospatial data (Mean NDVI (100m), WSF Prop. (100m), Dist. Nearest Well, and Dist. Nearest Health Ctr.).
Abbreviations: N is the sample size. "p" is short for number. PHQ-9 risk levels are depression risk levels according to Patient Health Questionnaire-9 scores (including Moderately Severe/Severe due to small sample sizes). NDVI is the Normalized Difference Vegetation Index. WSF is the World Settlement Footprint for 2019.
Statistics: This table summarizes the relationship between depression risk levels and various demographic and environmental factors. For continuous variables, I report conditional means. For factor variables, I report relative percentages (%). For sample size (N), I report counts by PHQ-9 risk level.

Preliminary Results

Table 6.2: Ordered Logit: Average Marginal Effects on the Probability of Being in Depression Risk Categories by Depression Risk Level

	None/Minimal	Mild	Moderate	Moderately Severe/Severe
Log Mean NDVI (100m)	0.00865 (0.586)	0.00111 (0.589)	-0.00638 (0.586)	-0.0578 (0.586)
WSF Prop. (100m)	-0.00250 (0.422)	-0.00320 (0.431)	0.00184 (0.422)	0.0167 (0.422)
Dist. Nearest Well	0.000564 (0.063)	0.000723 (0.089)	-0.000416 (0.063)	-0.00377 (0.063)
Dist. Nearest Health Ctr.	-0.000131 (0.012)	-0.000168 (0.031)	0.0000966 (0.012)	0.000877 (0.012)
# Experienced Crimes	-0.0178 (0.002)	-0.00229 (0.010)	0.0124 (0.002)	0.119 (0.002)
# Perceived Crimes	-0.0151 (0.000)	-0.0193 (0.001)	0.0111 (0.000)	0.110 (0.000)
# Experienced Traumas	-0.0165 (0.000)	-0.00211 (0.001)	0.0121 (0.000)	0.110 (0.000)
# Witnessed Traumas	-0.0219 (0.000)	-0.00281 (0.000)	0.0161 (0.000)	0.146 (0.000)
Food Insecurity Score	-0.0186 (0.000)	-0.00228 (0.001)	0.0137 (0.000)	0.124 (0.000)
Age	-0.00344 (0.000)	-0.000441 (0.000)	0.00253 (0.000)	0.0230 (0.000)
Household Income > Size	0.000006 (0.415)	0.000008 (0.426)	-0.000004 (0.415)	-0.00000 (0.415)
Employment Status:				
Unemployed	0 ()	0 ()	0 ()	0 ()
Employed	0.0111 (0.496)	0.00125 (0.441)	-0.00810 (0.492)	-0.0735 (0.492)
Sex:				
Male	0 ()	0 ()	0 ()	0 ()
Female	-0.0436 (0.002)	-0.00487 (0.010)	0.0319 (0.002)	0.289 (0.002)
Marital Status:				
Married	0 ()	0 ()	0 ()	0 ()
Never Married	0.00354 (0.006)	0.00166 (0.006)	-0.00253 (0.006)	-0.225 (0.006)
Widowed	-0.0619 (0.001)	-0.0210 (0.001)	0.0524 (0.004)	0.455 (0.004)
Divorced/Separated	-0.0654 (0.004)	-0.0230 (0.020)	0.0557 (0.070)	0.484 (0.073)
Health Status:				
Very good	0.225 (0.000)	-0.0483 (0.108)	-0.130 (0.000)	-1.249 (0.000)
Good	0.0530 (0.003)	0.00545 (0.159)	-0.0406 (0.005)	-0.342 (0.004)
Regular	0 ()	0 ()	0 ()	0 ()
Bad	-0.0494 (0.007)	-0.0226 (0.009)	0.0461 (0.007)	0.378 (0.006)
Very bad	-0.0266 (0.576)	-0.00955 (0.577)	0.0237 (0.583)	0.195 (0.592)
Health Change:				
Much better	0.0182 (0.603)	0.000759 (0.493)	-0.0132 (0.685)	-0.115 (0.688)
Better	0.0211 (0.221)	0.000735 (0.514)	-0.0152 (0.223)	-0.133 (0.223)
The same	0 ()	0 ()	0 ()	0 ()
Worse	-0.0402 (0.020)	-0.00816 (0.033)	0.0323 (0.021)	0.275 (0.019)
Much worse	-0.166 (0.000)	-0.142 (0.005)	0.161 (0.000)	1.569 (0.000)

p-values in parentheses; N=2488

Cutpoints: Cutpoint 1: 1.627; Cutpoint 2: 4.185; Cutpoint 3: 6.204

Data: All data is from the Cox's Bazar Panel Survey except for author generated geospatial data (Mean NDVI (100m), WSF Prop. (100m), Dist. Nearest Well, and Dist. Nearest Health Ctr.).

Fixed Effects: Camp fixed effects included in regressions but not reported here.

Average Marginal effects (ME) interpretation: on average, a one-unit increase in an independent variable is associated with a (ME) percentage point change in being in the associated category – holding everything else constant.

Discussion: While we cannot yet interpret the results from the spatial data, the CBPS data results are promising and match up with previous research. For example, being of bad health is associated with lower probabilities of being in low depression categories and higher probabilities of being in high depression categories – higher levels of food insecurity follow a similar relationship. Interestingly, employment and income have very small marginal effects and are not statistically significant. These results may change once I include spatial data associated with true points. Using ordinary least squares on raw PHQ-9 data (bounded from 0-27) yields similar results.

Missing Data

Interested in seeing the final results? Scan the QR code and sign up for the email list. I will contact you.



References

- [1] Y. Byrow, R. Pajak, P. Specker, and A. Nickerson, "Perceptions of mental health and perceived barriers to mental health help-seeking amongst refugees: A systematic review," *Clinical Psychology Review*, vol. 75, p. 101812, 2020, Elsevier.
- [2] M. Hynie, "The social determinants of refugee mental health in the post-migration context: A critical review," *The Canadian Journal of Psychiatry*, vol. 63, no. pp. 297-303, 2018, Sage Publications Sage CA: Los Angeles, CA.
- [3] R. M. Collins, R. Spake, K. A. Brown, B. O. Ogutu, D. Smith, and F. Egenblond, "A systematic map of research exploring the effect of greenspace on mental health," *Landscape and Urban Planning*, vol. 201, p. 103823, 2020, Elsevier.
- [4] R. Lee, *Myanmar's Rohingya Genocide: Identity, History and Hate Speech*. Bloomsbury Publishing, 2021.
- [5] UNHCR, "Rohingya emergency," 2022, United Nations High Commissioner for Refugees, <https://www.unhcr.org/emergencies/rohingya-emergency/>.
- [6] Yale MacMillan Center, "Cox's Bazar panel survey," n.d., Yale MacMillan Center Program on Refugees, <https://refugee.macmillan.yale.edu/research-outputs/coxs-bazar-panel-survey/>.