

Research Article

# Gender-Specific Mental Health Outcomes in Central America: A Natural Experiment

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## Abstract

The COVID-19 pandemic and subsequent restrictions have had profound impacts on mental health worldwide, with varying effects across different demographics and regions. Specifically, COVID lockdown measures are known to have had a disparate impact on women. This study aims to better understand this phenomenon by investigating the effect of COVID-19 stringency measures on depression rates among men and women in the Republic of Nicaragua and the Republic of Honduras. The two neighboring countries serve as a natural experiment: the former noted for its relaxed approach to the pandemic, and the latter implementing stricter lockdown measures. Using a Bayesian structural time series model, yearly depression rates were analyzed in both countries, utilizing various weather indicators as predictors, including yearly rainfall and average ground temperature data. In both countries, rates of depression among women were historically higher than among men. The difference in depression rates between women and men increased during the intervention period in both countries ( $p < 0.001$ ). However, the absolute effect of the intervention in Honduras was significantly higher ( $p < 0.001$ ) at 0.39 (95% CI: 0.37, 0.41) compared to Nicaragua, which was 0.26 (95% CI: 0.21, 0.31). These findings suggest that the higher stringency measures in Honduras, including prolonged lockdowns and restrictions on movement, may have disproportionately affected women's mental health. These results highlight the importance of considering women's wellbeing when designing and implementing public health policies, particularly during crises like the COVID-19 pandemic.

## Keywords

COVID-19, Bayesian Structural Time Series, Mental Health, Women's Health, Central America, Stringency, Causalimpact, Synthetic Control

## 1. Introduction

The COVID-19 pandemic has severely affected mental health worldwide since its outbreak was first confirmed by the World Health Organization (WHO) in January 2020 [1], with particularly pronounced consequences for women. Factors caused by

lockdown measures, such as increased household responsibilities, job losses, and domestic violence have resulted in a substantial rise in mental health issues among women during the COVID-19 pandemic [2, 3]. Studies from various countries have shown that

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women have been more likely to experience severe mental health declines than men during the pandemic [3]. In the United Kingdom, depressive symptoms in women rose from 11% to 19%, while in men they increased from 7% to 12% [4]. In Latin America, a 2020 survey in Brazil found that 40.5% of women reported symptoms of depression compared to 28.2% of men [5]. During the same period in Mexico, 35% of women reported severe anxiety compared to 25% of men [6]. Reduced social support and the increased incidence of domestic violence during lockdowns are recognized factors that have further exacerbated women's mental health challenges; several countries have implemented policies to address these problems, including countries in Latin America [7].

Historically, there has been a disparity in depression prevalence between men and women. Depression affects approximately 264 million people worldwide, with women consistently reporting higher rates than men [8-10]. This difference has been attributed to several factors, including disproportionate caregiving responsibilities, gender-based violence, and economic inequality. Cultural norms and unfair societal expectations can also add to the pressure and stress women experience [11, 12]. Core issues such as structural discrimination, one of the root causes of health disparities, are often neglected. [13-16]. Moreover, a substantial body of literature focuses on detection, prevention, and treatment of specific diseases, but not many studies investigate the absence of disease, specifically in women [17]. There is a need for research that examines overall health, including mental health, in the context of broader social and economic disruptions. Addressing this need can provide a more comprehensive understanding of health disparities, especially during crises. Consequently, it is essential to consider these factors when designing public health policies.

Nicaragua and Honduras present a natural experimental opportunity to investigate the effects of COVID-19 prevention measures on women's mental health. Nicaragua adopted a notably relaxed stance, refraining from imposing strict lockdown measures and maintaining minimal restrictions [18]. According to the Oxford COVID-19 Government Response Tracker, Nicaragua maintained a stringency index of approximately 20 out of 100, indicating low levels of restrictions and public health measures [19]. This approach was characterized by limited public health interventions and an emphasis on keeping the economy open, which was a controversial decision given the potential public health risks [20]. In contrast, Honduras implemented strict lockdown measures, including curfews, travel restrictions, and widespread closures of businesses and public spaces [21]. Honduras had a stringency index of approximately 96 out of 100 during the peak of the pandemic, implementing a rigorous approach to controlling the virus's spread [19]. These measures aimed to control the virus's spread and came with significant economic and social costs, particularly for vulnerable populations [22]. Despite contrasting public health strategies, both countries share similar cultural traits, ethnic composition, age de-

mographics, and geographical proximity.

What can be learned from the different COVID-19 responses of Honduras and Nicaragua? How can countries mitigate the mental health impact of future crisis policies? This paper aims to shed light on these questions by investigating the effects of COVID-19 response stringency on depression gaps between males and females. The results indicate that the higher stringency measures in Honduras, including prolonged lockdowns and restrictions on movement, may have disproportionately affected women's mental health. While no policy response could be perfect in all respects, this study calls for a more balanced approach that considers women, and ensures more equitable mental health outcomes.

## 2. Materials and Methods

### 2.1. Data Collection

Depression prevalence data from 1990 to 2021 were drawn from the Institute for Health Metrics and Evaluation (IHME) Global Burden of Disease database, operated by an independent global health research center at the University of Washington [23]. A total of 21 years of data were collected and collated as an analytical time series. Weather data of annual rainfall and mean surface air temperature were sourced from the World Bank Climate Change Knowledge Portal.

### 2.2. BSTS Model

The Bayesian Structural Time Series (BSTS) model was employed to assess the causal impact of COVID-19 lockdown measures on depression rates among men and women in Nicaragua and Honduras. This model estimates the causal effects of interventions, such as lockdown measures, by generating counterfactual forecasts that depict what would have occurred in the absence of the intervention [24]. Compared with classical methods like difference-in-difference, the BSTS model can infer temporal changes in effects, incorporate empirical prior information on parameters, and handle complex covariate structures [25]. The BSTS model integrates three statistical components: Kalman filters, spike and slab regression, and Bayesian model averaging [26]. Kalman filters estimate the trend and seasonality of the time series, spike and slab priors are used for variable selection, and Bayesian posterior averages are used for the final forecast.

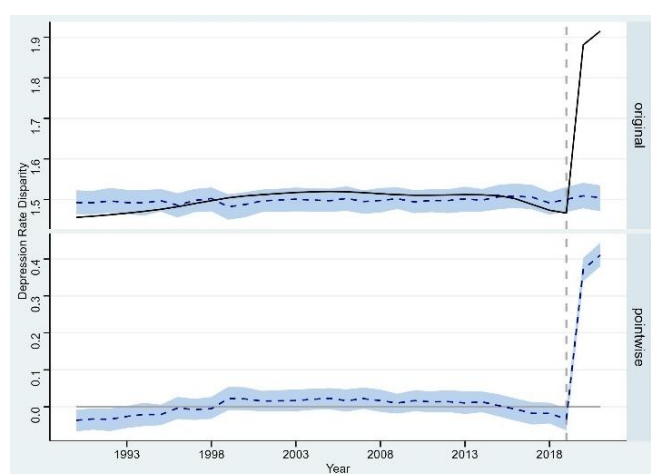
### 2.3. Statistical Process

A synthetic control model was constructed to estimate the potential impact of stringency on the difference between the proportion of men and women with depression. This model uses historical data and various predictors to create a counterfactual scenario representing what the difference between

gendered depression rates would have been in the absence of any intervention in both countries. The models were constructed using R software (Version 4.4.1, The R Project for Statistical Computing, Vienna, Austria). Annual rainfall and mean ground temperature data were used for both countries as control time series unaffected by human interventions. Moreover, these variables were not influenced by the COVID-19 pandemic. The dependent time series variable was constructed to represent the difference between depression rates of women and men (women minus men). The pre-intervention period spanned from 1990 to 2019, while the post-intervention period covered 2020 to 2021.

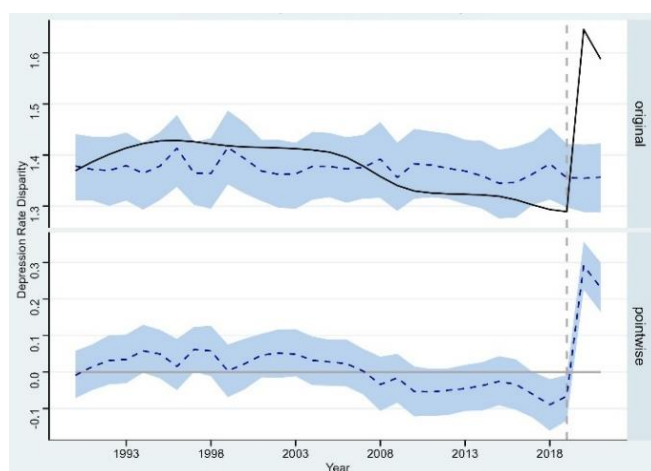
### 3. Results

A total of 31 years of depression prevalence data from 1990 to 2021 were analyzed in both Honduras and Nicaragua. The COVID-19 lockdowns increased the observed difference between depression rates in women compared to men in both countries. In Honduras, the gender disparity in depression rates increased by 26% [24%, 28%] ( $p < 0.001$ ) from 1.51 to 1.90 (Figure 1), while in Nicaragua, it increased by 19% [15%, 24%] ( $p < 0.001$ ), from 1.36 to 1.62 (Figure 2). During the post-intervention period, the average gender gap in depression rates was approximately 1.90 in Honduras and 1.62 in Nicaragua.



**Figure 1.** Depression rates gap (Women - Men) in Honduras, 1990-2021 (Solid line) and corresponding predicted values based on the BSTS model and weather data (Dashed line). The bottom panel shows the difference between actual and predicted, representing the pointwise causal impact of the intervention.

The causal impact of the intervention was 0.39 [0.37, 0.41] in Honduras and 0.26 [0.21, 0.31] in Nicaragua and can be seen in the bottom panels of Figure 1 and Figure 2 labelled pointwise. The difference in the absolute effects between the two countries was significant ( $p < 0.001$ ) at 0.13 [0.08, 0.18].



**Figure 2.** Depression rates gap (Women - Men) in Nicaragua, 1990-2021 (Solid line) and corresponding predicted values based on the BSTS model and weather data (Dashed line). The bottom panel shows the difference between actual and predicted, representing the pointwise causal impact of the intervention.

## 4. Discussion

One would be hard-pressed to identify a demographic that did not experience an increase in rates of mental health issues during the pandemic. The COVID-19 pandemic represented a drastic behavioral change for much of the population of affected countries, which has been shown to have broad effects in physical and mental health [27]. Forthcoming research indicates that the pervasive effect of the pandemic can be seen in places like the media, where language sentiment declined over the course of the pandemic and continues to be unusually negative today [28]. Disadvantaged groups are impacted more severely, leading to a disproportionate burden on these populations and the worsening of health disparities [13].

The results of this paper indicate that the mental health effects of COVID-19 lockdown measures have been disproportionately borne by women. Moreover, this study finds that stringent lockdown and preventive measures in Honduras led to a further increase in the depression rates gap between women and men relative to Nicaragua. This double-effect on women's mental health may have serious long-term consequences. These findings are consistent with the understanding that increased stringency correlates with heightened mental health challenges for women, who are more vulnerable to the economic and social disruptions caused by such measures, as compared to men. [3].

### 4.1. Age Distribution

Alongside women, young adults and children were other demographics significantly impacted by COVID-19 lockdown measures. Depression rate changes during and after lockdowns may vary significantly between countries partially due to differing age distributions. However, the age distributions in Nicaragua and Honduras are relatively similar, with both countries having relatively younger populations. The median age in Nicaragua is approximately 24 years, while in Honduras it is around 23 years [29, 30]. The percentages of the population under 20 years old in Honduras and Nicaragua are 50% and 47% respectively. The relatively young demographics in both countries potentially lowered the physical health risks from the SARS-CoV-2 virus, leading to different mental health dynamics compared to countries with older populations [31, 32]. Finally, to mitigate potential sampling bias among different age groups within each country, the analysis was done on age standardized depression prevalence data.

### 4.2. Women's Representation and Policy Decisions

#### 4.2.1. Nicaragua

Nicaragua's approach to the pandemic was notably relaxed, refraining from imposing strict lockdown measures—the Oxford COVID-19 Government Response Tracker reported that

Nicaragua had a stringency index of approximately 20 out of 100 during the peak of the pandemic [19]. The Nicaraguan government emphasized keeping the economy open with limited public health interventions [20, 21]. Specific policy decisions included keeping schools and public events open and downplaying the severity of the pandemic. This *laissez-faire* approach was aimed at minimizing economic disruption, which has been attributed to the severe economic challenges the country faced. Notably, Nicaragua has a higher proportion of female policymakers compared to Honduras. As of recent reports, women make up around 46% of the Nicaraguan parliament, one of the highest proportions globally [33]. A high representation of women in government typically suggests a greater focus on social and health issues.

#### 4.2.2. Honduras

In contrast, Honduras implemented stringent lockdown measures, including strict curfews, travel restrictions, and widespread closures of businesses and public spaces [21, 22]. These measures aimed to control the virus's spread effectively. Specific policies included nightly curfews, mandatory mask-wearing, and limits on public gatherings. The Oxford COVID-19 Government Response Tracker reported that Honduras had a stringency index of approximately 96 out of 100 during the peak of the pandemic, reflecting its rigorous approach [19]. Honduras has a lower proportion of female policymakers compared to Nicaragua, with women representing about 21% of the national congress [34]. Despite this lower representation, the stringent measures adopted by Honduras suggest a policy approach driven by public health priorities. A lesser representation of women might suggest less influence on social support policies, yet the stringent public health measures indicate a centralized decision-making process focused on containing the virus's spread. This approach, while effective in controlling the virus, had significant repercussions, particularly affecting women in informal employment and caregiving roles [35, 36].

### 4.3. Limitations

The differences in COVID-19 testing methods between Honduras and Nicaragua may complicate the analysis. Nicaragua's limited testing and reporting could lead to underestimation of the pandemic's true impact, while Honduras's comprehensive testing provides a clearer picture of the virus's spread and the efficacy of lockdown measures. In addition, the BSTS model has intrinsic limitations, including the assumption of a clearly defined pre-intervention period and the challenge of accounting for all concurrent events that may affect mental health outcomes. Finally, the difficulty in finding reliable monthly and weekly data in mental health topics for both countries reduces the number of observations in the time series, limiting the statistical power of the results.

## 5. Conclusions

The COVID-19 pandemic has significantly impacted mental health globally, with women experiencing a disproportionately higher burden of mental health issues such as depression and anxiety. This study highlights the differential impacts of COVID-19 stringency measures on depression rates among men and women in Nicaragua and Honduras. By leveraging a Bayesian structural time series model, this paper analyzed depression rates using average ground temperature and rainfall data as predictors. The model revealed that both countries experienced an increase in the gender disparity of depression rates during the intervention period, with a more pronounced effect in Honduras. Specifically, the absolute effect of the intervention in Honduras was significantly higher at 0.39 compared to 0.26 in Nicaragua. This suggests that the stringent lockdown measures in Honduras, including prolonged lockdowns and restrictions on movement, may have disproportionately affected women's mental health. A direct implication of these results is that special attention should be paid to women's well-being when designing and implementing public health policies, particularly during crises like the COVID-19 pandemic. Addressing these disparities is crucial for securing more equitable health outcomes during public health emergencies.

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## Author Contributions

**Hugo Moisés Montesinos-Yufa:** Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing

**Thea Nagasuru-McKeever:** Data curation, Formal Analysis, Investigation, Methodology, Project administration, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing

## Conflicts of Interest

The authors declare no conflicts of interest.

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