The Impact of Isolation and Quarantine Policy Strategy on the Prevention of COVID-19 Transmission and Death: A Segmented Regression Analysis of Interrupted Time Series Data in Scandinavia and the American South

by

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1. Introduction

The goal of this study is to examine the imact of policy aimed at preventing both the transmission of SARS-CoV-2, the virus responsible for COVID-19, and the deaths directly attributable to this disease.

On December 31, 2019, the Wuhan Municipal Health Commission described a cluster of unidentified pneumonia cases. The world would soon come to know these cases as the first reported cases of COVID-19 in the world, a novel Coronavirus that would soon turn into a pandemic affecting humanity on a global scale.

As a fast-spreading virus with global impact, countries worldwide were forced to respond to COVID-19, and they implemented a wide range of policies in doing so. Some of the starkest contrasts among jurisdictions were drawn along policy lines: whether they utilized a more physically restrictive strategy, focusing policy on physical distancing and isolation and quarantine, or a more laissez-faire approach.

Sweden is one country that notably utilized this laissez-faire strategy. In the first three months of the pandemic, Swedish primary schools and most workplaces remained open, and there was no strict shuttering of business or mandated quarantine policy. Its neighbor, Norway, mandated physical distancing and closed schools at all levels, closed restaurants, mandated quarantine policies for those diagnosed with COVID-19 and in close contact, and more from the beginning of March. At the end of the three-month period from the first case of COVID-19 in the country through the end of May, Sweden had a significantly greater number of COVID-19 cases and deaths than Norway. However, this evidence alone is not enough to conclude that the differing impact on real

COVID-19 measurements such as cases and deaths was due strictly to the policy difference.

In order to discuss a policy's impact and effectiveness in of itself, one must isolate the factors affecting the shape and course of a policy. These factors can be categorized into three groups: foundational, structural, and cultural. To assess a policy's effectiveness based off its foundational factors, one must control for structural and cultural factors. To form this control, I expanded my study to include a comparison group of two states in the United States: Arkansas and Louisiana. Like Sweden, Arkansas did not instate a stay-at-home or shelter-in-place order during the first three months of the pandemic. In neighboring Louisiana, however, the governor shuttered businesses and issued a statewide stay-at-home order in mid-March which remained in place through mid-May along with school closures.

Through the comparison of policies implemented in Sweden, Norway, Arkansas, and Louisiana and respective data regarding COVID-19 case and death counts, I will assess the impact of stricter isolation and quarantine-oriented COVID-19 policies to observe whether they made a significant difference in the health outcomes of affected populations.

According to the World Health Organization, at the start of a pandemic, "early surveillance data will inform public health interventions aimed at slowing transmission. These will include non-pharmaceutical interventions, such as movement restrictions, cancelling mass gatherings and social distancing" (World Health Organization, 2017). Based on this, we could hypothesize that jurisdictions that responded earlier to COVID-19 by implementing policy which aimed to prevent the transmission of COVID-19 and further emphasized physical distancing and isolation and quarantine policies would slow the spread of the virus faster and lead to better health outcomes.

To draw a formal conclusion, I will perform a segmented regression analysis of interrupted time series COVID-19 case and death data to assess the impact a policy had on each jurisdiction's health outcomes.

2. The Context of COVID-19 and Public Policy Implementation

2.1 COVID-19 Background

The Wuhan Municipal Health Commission published a description of a cluster of unidentified pneumonia cases on December 31, 2019. Less than a month later, the World Health Organization had identified these cases as COVID-19 and declared a Public Health Emergency of International Concern. On March 11, 2020, just 10 weeks after the first report of cases in Wuhan, the WHO characterized COVID-19 as a pandemic (World Health Organization, n.d.). As defined by WHO, a pandemic is an outbreak that affects a large proportion of the world and which is comprised of three factors: a novel virus surfaces that is transmittable among human populations, the virus causes disease, and the human population has little to no immunity against the virus (World Health Organization, 2017).

The impact of a pandemic on a population is hugely variable depending on many factors, including the nature of the virus. As of March 28, 2021, there have been 126,359,540 confirmed cases of COVID-19 and 2,769,473 confirmed deaths attributable to COVID-19 in 223 countries, areas, or territories (World Health Organization, 2021). The most common symptoms include fever, dry cough, and fatigue, and more severe symptoms include shortness of breath, loss of appetite, confusion, persistent pain or pressure in the chest, and high temperature. Complications including respiratory failure, acute respiratory distress syndrome, sepsis and septic shock, thromboembolism, and/or multiorgan failure, including injury of the heart, liver, or kidneys could lead to death (World Health Organization, 2021). According to WHO, approximately 5% of people who get COVID-19 and develop symptoms become critically ill and need intensive care, and the most at-risk groups include people aged 60 years and older and those with underlying medical conditions such as high blood pressure, obesity, or cancer.

2.2 Public Policy and Factors Affecting Implementation

Public policy response to COVID-19 varied – and continues to vary – widely, and in many different respects. As defined by Encyclopedia Britannica, public policy "generally consists of the set of actions – plans, laws, and behaviors – adopted by a government" (Bevir, 2016). Further condensed, public policy can be defined as a decision the government implements. Policy impact is the consequence of a policy decision (Van Meter & Van Horn, 1975). These definitions implicate several actors which shape a policy and its impact. The first such actor is the decision-maker – the government or entity that formulates the policy. There is next the mechanism for implementing or enforcing the policy. Finally, there are those who are on the receiving end of the effects of the policy decision.

A myriad of considerations come into play with each actor and along the route from a policy's formulation to its implementation to its reception. To account for and compare a specific policy's effectiveness, context and external factors must be evaluated (HM Treasury, 2020). There are many factors that influence the shape, course, and impact of a policy. In order to measure the direct impact of the policy on the course of

COVID-19 in a given area, there were certain outside factors to account for. Drawing on discussions in existing literature, these factors can be grouped into three categories: foundational, structural, and cultural.

2.2.1 Foundational Factors

Foundational factors are those which pertain to the decisionmaker - or policymaker - which shape the essence of a policy. One major foundational factor is a policy's goals. Van Meter and Van Horn assert that a policy should "elaborate on the overall goals of the policy decision. . .to provide concrete and more specific standards for assessing performance" (Van Meter & Van Horn, 1975). Clear goals have the added advantage of aiding in the identification of criteria for evaluation of a policy's implementation, "those actions by public and private individuals (or groups) that are directed at the achievement of objectives set forth in prior policy decisions" (Van Meter & Van Horn, 1975), and subsequent impact. In a report jointly by the World Health Organization, European Commission, and European Observatory on Health Systems and Policies, countries' policy responses were broken down into six categories, which were demarcated according to the goals of the policy: preventing transmission, ensuring sufficient physical infrastructure and workforce capacity, providing health services effectively, paying for services, governance, and measures in other sectors (Saunes, Skau, Byrkjeflot, Lindahl, & Bråten, 2021). This study is narrowed to examine principally policies whose goals were categorized as preventing transmission of COVID-19.

Another foundational factor is the policymaking entity itself. The policymaker brings with it an inherent set of external considerations when formulating policy. These considerations could have a positive effect on policymaking, such as bringing a different or new perspective to the approach, or they could distort the form of the policy because of secondary or tertiary goals which depart from the primary goal. However, external considerations excluded, there are many ways to formulate policy aimed at accomplishing the same goal. For this reason, the WHO, European Commission, and European Observatory on Health Systems and Policies' report of Norway and Sweden's COVID-19 policy response isolates policies which pursue the goal of preventing COVID-19 transmission and breaks it down into five different policy strategies. These strategies include health communication, physical distancing, isolation and quarantine, monitoring and surveillance, and testing (Saunes, Skau, Byrkjeflot, Lindahl, & Bråten, 2021). This study will examine the way physical distancing and isolation and quarantine strategies were utilized through policy in each state. According to the World Health Organization, "early detection of the start of a pandemic is crucial, to allow countries to rapidly implement measures to control the outbreak at its source or to mitigate the impacts by slowing the spread of the virus" (World Health Organization, 2017). Based on this, we could hypothesize that jurisdictions that responded earlier to COVID-19 by implementing policy which aimed to prevent the transmission of COVID-19 and further emphasized physical distancing and isolation and quarantine policies would slow the spread of the virus faster and lead to better health outcomes.

Because the focus of this study will center on physical distancing and isolation and quarantine policies with a goal of preventing transmission, other factors must be controlled. These are external factors outside of these foundational factors that might affect the implementation or impact of these policies and cloud a causal analysis, and they comprise the structural and cultural categories.

2.2.2 Structural Factors

Structural factors are those which shape the course of a policy's implementation. In the case of public health policy as it relates to COVID-19, they cannot be extricated from the system of public health that a particular jurisdiction already has in place. Structural factors also include the compliance of subordinated governments' implementation of policy and education and communication regarding public health and citizens' access to health care.

In reality, total compliance with a policy is very rare (Hu, 2012). Those implementing the policy – subordinate governments or organizations, bureaucrats, or even business owners – have their own volition, which may or may not be in accordance with the goals set by the policymakers. Policy could be intentionally more or less prescriptive, and it is usually not one-size-fits-all. This discretionary power can also, though, result in uneven and even inequitable application of policy: "Policemen decide who to arrest and whose behavior to overlook. Judges decide who shall receive a suspended sentence and who shall receive maximum punishment. Teachers decide who will be suspended and who will remain in school," (Lipsky, 1980) and business owners decide whether to comply with mandated occupancy limits aimed at preventing the transmission of COVID-19, et cetera. Room for discretion in a policy allows policy implementers the power to make decisions regarding the policy on their own, and this can be an asset which allows them to best adapt a policy in their jurisdiction. At its worst, though, it allows policy implementation to diverge from its intended goals. For these reasons, it is important to know who is making what policies.

Within Scandinavia, the Norwegian and Swedish states are responsible for health care policy and services. They also regulate the quality of health care through budgets, laws, and regulations. Both also took direction from multiple European organizations including the European Commission. In Norway, the Trygdeetaten, or the National Insurance Administration, runs the State National Insurance Scheme, which guarantees a basic level of health care. Hospitals are organized as health trusts which are run by regional authorities who have a great deal of discretion in the operation of public health services. These regional authorities are primarily limited by budgetary considerations. Municipalities are responsible for primary care, and general practitioners are the gatekeepers of care in the health system (HealthManagement, 2010). In Sweden, the central government establishes the principles and guidelines for care via laws and regulations and agreements with the health councils (HealthManagement, 2010). This body is called the Socialstyrelsen, or the National Board of Health and Welfare. The Folkhälsomyndigheten, or the Public Health Agency, also sets public health policy and implements the national plan. Health care is run by 21 councils at the county and regional levels which oversee the planning and delivery of care. Key decisions in the statewide strategy, though, were largely dictated by epidemiologist Anders Tegnell from the start of the pandemic.

In the United States, the federal government sets some public health policies and standards, passes laws and regulations, and allocates finances to support state and local health systems through the president, Congress, and the Department of Health and Human Services, which includes organizations such as the Centers for Disease Control and Prevention. States, as sovereign governments, are the principal governmental entity responsible for protecting public health in the United States (Institute of Medicine (US) Committee for the Study of the Future of Public Health, 1988). Governors, state legislatures, and state departments of health are the primary policymaking and implementing bodies. In Louisiana, “the Louisiana Department of Health is to protect and promote health and to ensure access to medical, preventive and rehabilitative services for all citizens of the State of Louisiana” (Louisiana Department of Health, 2021). In Arkansas, a similar body is named the Arkansas Department of Health. Governors in each state played a crucial role because of broader powers granted to them in light of the emergency nature of the pandemic. They were able to make more sweeping and decisive mandates than the state legislatures, and it was their policy that governed much of the physical distancing and isolation and quarantine policies during the first months of the pandemic.

While both regions have a central body and multiple local bodies in place to develop and implement public health policy, the Scandinavian system could be characterized as more centralized and having less room for discretion than the United States as a whole, but individual states in America might have more concentrated decision-making power within themselves.

Another structural factor affecting policy implementation is the educational and communicative system in place which informs the given population about health care and public health policy in their jurisdiction. Similarly, the health care systems and even broader social systems in place impact policy implementation. For example, starting April 1, 2020, people in Norway who were diagnosed with COVID-19 or those waiting for test results were mandated to remain in isolation for at least eight days after the onset of symptoms and an additional three days after symptoms disappeared. Without accessible, affordable health care, an individual may not have the opportunity to be tested and treated for COVID-19, or they may be less likely to seek care if a high financial burden may be implicated. Without access to quality care, a patient may be misdiagnosed, or their symptoms may be poorly treated. Without a robust social safety net, an individual might resist seeking a diagnosis of COVID-19 regardless of symptoms for fear of missing 11 days' pay. All these are structural factors which may impact the implementation and overall effectiveness of a policy.

In Norway, private health care does not play a major role. the State National Insurance Scheme (NIS) guarantees all citizens a basic level of health care and welfare, including disability, unemployment, and pension services. There are relatively few fees for using the state health care system, and inpatient hospital treatment is free. There are 3.5 physicians per 1,000 inhabitants (HealthManagement, 2010). In Sweden, the National Board of Health and Welfare is the central government's key authority which establish principles and guidelines for care, and "the Swedish State finances the bulk of health care costs (about 95%), with the patient paying a small nominal fee for examination" (HealthManagement, 2010). There are 3.3 physicians per 1,000 inhabitants, the highest in the European Union, though lagging slightly behind Norway (HealthManagement, 2010).

The American health care system is the only high-income country without nearly universal health care coverage. As of 2019, 9.1% of people in Arkansas and 8.9% of people in Louisiana are uninsured (Keisler-Starkey & Bunch, 2020). Of those who are insured, 68.0% have a private plan and 34.1% have a public plan nationally, with public coverage split almost evenly between Medicare and Medicaid (Keisler-Starkey & Bunch, 2020). According to a report by the World Health Organization, "compared with their counterparts in other high-income countries, patients in the USA are much more likely to forgo medications and to skip care – especially preventive care – because of costs. Gaps in health coverage, problems with access to health care and unhealthy lifestyles are thought to contribute to the many disappointingly poor health outcomes recorded in the USA" as a result of many factors, including poverty, a lack of universal health coverage, a general lack of focus on primary care and public health, and poor behaviors (Rice, et al., 2014). These negative results are further exacerbated in the American South, which is poorer and has even less access to health care. Southern states' health outcomes and disparities are some of the worst in the nation, and Louisiana and Arkansas are no exception. Louisiana has 1.85 physicians per 1,000 inhabitants while Arkansas has 1.69, both lower than the national average of 1.98 physicians per inhabitant (Health Resources and Services Administration Bureau of Health Professions, 2000).

On the grounds of public health and welfare systems in place, Scandinavians would be more likely to have better health outcomes than Americans.

2.2.3 Cultural Factors

The final category of factors affecting policy implementation and effectiveness that I established is one of cultural factors. Cultural factors pertain to communities and individuals who are impacted by a particular policy and how they respond to it. These factors include behavioral changes to align with a policy goal and the population's trust in government.

Van Meter and Van Horn argue that policy "implementation will be most successful where only marginal change is required and goal consensus is high" (Van

Meter & Van Horn, 1975). This is true across jurisdictions. The inertia of an individual's decisions and routine is strong, and therefore, the greater behavioral change that a policy requires, the less likely it is for individuals to comply with the policy. It is also for this reason that implicating major changes in policy decisions and implementations is "more likely to incur resistance or boycott from the parties with vested interests. It is more difficult to achieve the goals which bring about a significant reform to the current systems than those which indicate only incremental change" (Hu, 2012). This cultural factor, then, may be tempered by setting a feasible goal in policy formulation. An individual's compliance with a policy may also be argued to have much to do with whether and how a policy is implemented or enforced. Regardless though, physical distancing and isolation and quarantine policies require a significant behavioral change for most individuals. Whether mandated stay-at-home orders or the closure of schools or businesses, more than marginal change is required. This requirement may affect a policy's implementation and ultimately its impact.

One way to measure whether a population will be likely to comply with certain policies regardless of the proposed behavioral change is their overall level of trust in government. In a study led by Robert Blair, Brown University's Watson Institute for International and Public Affairs found that trust in government is a key determinant of citizens' compliance with public health policies, especially in times of crisis. They also found that citizens who expressed more trust in government were more likely to support and comply with social distancing restrictions designed to contain the spread of a virus and were much more likely to take precautions to prevent transmission in the home

(Blair, Morse, & Tsai, 2017). A population's overall level of trust in government is a cultural factor that may affect a policy's implementation.

According to a study by the Pew Research Center, only 20% of Americans trust the government (Pew Research Center, 2020). By contrast, 45% of Norwegians and 61% of Swedes agree or strongly agree that they trust their government (Helsingen, et al., 2020). On this basis, Scandinavian residents would be more likely to comply with policy measures than American residents.

3. Methodology

3.1 Comparison Groups

This study focuses on COVID-19 policies with the goal of preventing transmission, and further emphasizes policies which the World Health Organization, European Commission, and European Observatory on Health Systems and Policies categorize as utilizing a strategy of physical distancing and particularly isolation and quarantine. Other external factors that may affect the implementation and effectiveness of these policies are controlled by analyzing this kind of policy in four jurisdictions: European nation-states Norway and Sweden and U.S. states Louisiana and Arkansas.

Norway and Sweden are sovereign entities, but they are comparable to subnational divisions Arkansas and Louisiana in several key ways that allow for a functional comparison in the context of this study. Importantly, the European Union functions in some ways as a supranational organization above Sweden and has even been dubbed "the United States of Europe." The E.U. did implement a common response to COVID-19, much in the same way the U.S. government did, and most common policy actions taken by both the E.U. and the U.S. almost exclusively utilized health communication, monitoring and surveillance, and testing strategies (European Commission, 2021). Policy implementation of physical distancing and isolation and quarantine strategies was left largely to member states in the E.U. as it was to states in the U.S. Though Norway is not an official member of the E.U., though it is the E.U.'s most integrated non-E.U. country and is a member of the European Economic Area, and much current legislation in Norway comes from the E.U. (Haugan, 2019). The E.U.'s influence in Norway's policy is not to be understated, and certainly came into play regarding COVID-19 policy. Ultimately, since both the E.U. and the U.S. played so little role in enacting physical distancing and isolation and quarantine policy, this difference is negligible. In addition, because of the sheer size of their geographic area and population, regions and states in the U.S. are more comparable to regions and states in Europe.

Data collection and analysis in four jurisdictions facilitates a comparative analysis by ensuring a larger sample and controlling for external factors. Comparison groups are formed utilizing a matrix with two metrics: regional and strategic.

The regional group is split into two categories: Scandinavia, comprised of Norway and Sweden, and the American South, comprised of Louisiana and Arkansas. Dividing the jurisdictions into these two categories allows for a mock control of some structural and cultural factors. Policymaking bodies, health care and welfare systems, and trust in government are comparable within these categories.

The strategic group is divided into two groups: Treatment and Control. Norway and Louisiana comprise the Treatment Group and Sweden and Arkansas comprise the Control Group. In the Treatment Group, the treatment in this experiment is the isolation and quarantine policy strategy implemented in the jurisdictions. Norway and Louisiana utilized this more physically restrictive policy strategy to address COVID-19, enacting strict policies in physical distancing and isolation and quarantine. Sweden and Arkansas, on the other hand, form the Control Group. These jurisdictions had few if any isolation and quarantine policies in place. The relationship between these two categories is the focus of the analysis in this study.

To assess the impact of physical distancing and isolation and quarantine policies, we must return to the policy goal: reducing the transmission of COVID-19. This goal is operationalized in terms of COVID-19 cases and, by extension, deaths from COVID-19. Through the comparison of the timelines of policies implemented in Sweden, Norway, Arkansas, and Louisiana in conjunction with the timeline of data regarding COVID-19 case and death counts, I will assess the real impact of stricter, distancing- and isolation and quarantine-oriented COVID-19 policies on the health outcomes of impacted populations.

3.2 Data Collection

This study required two different types of data for each jurisdiction: COVID-19 policy documentation and quantitative COVID-19 case and death data. As much as possible, data was collected from the World Health Organization for as much homogeneity across methods as possible. In a report jointly by the World Health Organization, European Commission, and European Observatory on Health Systems and Policies, countries' policy responses were broken down into six categories, which were demarcated according to the goals of the policy: preventing transmission, ensuring sufficient physical infrastructure and workforce capacity, providing health services effectively, paying for services, governance, and measures in other sectors (Saunes, Skau, Byrkjeflot, Lindahl, & Bråten, 2021). This study is narrowed to examine principally policies whose goals were categorized as preventing transmission of COVID-19. A report was published each for Sweden and Norway, with the authors of each report independently categorizing each country's policies into the six categories. Data for each U.S. state came from the Johns Hopkins University & Medicine Coronavirus Resource Center, which chronicled each state's policy response to COVID-19. According to the precedent set by the World Health Organization's categorization of Sweden and Norway's policies, I similarly categorized Arkansas and Louisiana's policies and parsed out those that would have been designated as physical distancing or isolation and quarantine. Each state's policies were then put into a table and in chronological order, and each policy was given a label to designate its type. Either (D) to represent physical distancing, or (Q) to represent isolation and quarantine. A special designation of (ND) or (NQ) was rendered for policies enacted in Arkansas and Louisiana on a national level, still representing either physical distancing policy or isolation and quarantine, as indicated. Each policy has a number corresponding to when it was enacted. Therefore, a policy labeled (D1) indicates that it was the first physical distancing COVID-19 policy enacted in that state.

Another policy distinction that had to be made was between recommendations and mandates. For the purposes of this study, I narrowed my analysis strictly to government mandates, ensuring roughly equal application across all populations. I also parsed down mandates to include their inception and their broadest points. Mandates simply continuing a previous mandate were not included, as the upper bound of these policies' timeline is not examined in this study. I also did not include mandates which eased restrictions, as this study analyzes restrictive policies as they're put into effect. For these reasons, the tables chronicling each states' policy decisions by design is not all-inclusive of every mandate announced by any of these governments.

Quantitative data regarding case and death data for Sweden and Norway also came from the World Health Organization's WHO Coronavirus Dashboard. Data for each U.S. state came from the Centers for Disease Control and Prevention's COVID Data Tracker. Each data set was adjusted to the respective state's population, per 100,000 residents, so as to compare numbers across borders. The 7-day average was also calculated to smooth over any reporting irregularities that may have skewed daily data, as was common especially during the first few months of the pandemic. This data was then organized into bar graphs for each state, and markers indicating when a particular (D) or (Q) policy was enacted are superimposed onto the data to easily see when it was announced and what data trends followed the announcement and implementation.

3.3 Linear Regression Analysis

For each jurisdiction, I perform a segmented regression analysis of interrupted time series data to assess the impact a policy had on each jurisdiction's public health outcomes via COVID-19 case and death counts using Microsoft Excel. This method "is the strongest, quasi-experimental approach for evaluating longitudinal effects of interventions" and is key to evaluating these policies and drawing a more formal conclusion regarding the impact of the policy (Wagner, Soumerati, Zhang, & Ross-Degnan, 2002).

The roughly three-month period from each jurisdiction's first COVID-19 case or death is split into two periods: Pre-Policy and Post-Policy. Sweden and Arkansas will serve as control groups, as Norway and Louisiana received the treatment – quarantine policy.

The two time periods – Pre-Policy and Post-Policy – are split according to when the quarantine policy was enacted. This split date is referred to as the change point and represents the point at which "the values of the time series may exhibit a change from the previously established pattern because of an identifiable real-world event, a policy change" (Wagner, Soumerati, Zhang, & Ross-Degnan, 2002). The Pre-Policy period begins from the date of a jurisdiction's first COVID-19 case or death. On the linear regression graph, this date is labeled "1" and subsequent days are numbered sequentially until the change point. The Post-Policy period begins from the change point, labeled "1," and subsequent days are numbered sequentially until May 31, the upper time bound of this study.

The change point of either case or death data in each regional group is calculated based off the date an isolation and quarantine policy was enacted in the stricter strategic group. Therefore, the change point for the Scandinavian group is calculated based on the enactment date of isolation and quarantine policy in Norway, and the change point for the Southern American group is calculated based on the enactment date of isolation and quarantine policy in Louisiana.

From the first day enacted, a two-week buffer period is accounted for between when a policy is enacted and when its effects might begin to be reflected in case data based on the method established by the Public Affairs Research Council of Louisiana (Beekman, 2021). This accounts for a slight lag in the implementation of the policy and the time it takes for behavioral changes to impact the momentum of the spread of the virus. Therefore, the date two weeks after a policy is implemented serves as the change point between the Pre-Policy and Post-Policy time periods for case data.

There is an additional two-week buffer period that one can observe between an increase in COVID-19 cases and an increase in COVID-19 deaths (Beekman, 2021). This is due in part to the fact that deaths from COVID-19 are not directly of the disease itself, but of complications caused by the disease, including respiratory failure, acute respiratory distress syndrome (ARDS), sepsis and septic shock, thromboembolism, and/or multiorgan failure, including injury of the heart, liver, or kidneys (World Health Organization, 2021). These complications take time to develop and result in this phenomenon. Therefore, I account for a four-week buffer period between the date a COVID-19 mitigation policy is enacted and when its impact is reflected in the state's death count, and this date serves as the change point between Pre- and Post-Policy periods for death data.

From the linear regression analysis, the equation, R Squared value, and P-value are utilized to draw conclusions. The date serves as x, my independent variable, the sequential days in each period. New case or death numbers serve as y, my dependent variable. The linear regression equation yields the slope of the regression line, which indicates the rate of change for the case or death count as the date changes. The R Squared value is the coefficient of determination, and it indicates how well the regression line fits the data. The closer an R Squared value is to 100, the closer the chosen independent variable is to explaining 100% of the results of a dependent variable. The P-value indicates how statistically significant the model of the variable is and how likely the results are to occur due to random chance. For the purposes of this study, the significance level is set to 0.01, which is standard. Therefore, if the p-value of my *x* variable is less than 0.01, the model is considered statistically significant.

4. Analysis

4.1 Norway

4.1.1 Policy

As demonstrated in the table below, Norway had the greatest number of policy announcements or changes of the four jurisdictions in this study. Norway enacted a physical distancing policy on February 12, exactly two weeks before its first case of COVID-19, which restricted health care professionals from traveling abroad. By March 1, Norway had already required persons arriving in Norway with symptoms of COVID-19 to undergo isolation in an area designated by the municipal medical officer and subjected every individual who had been abroad to quarantine in their home for 14 days. They also barred any symptomatic individual from utilizing public transport.

During the first few months of COVID-19, Norway mandated three physical distancing policies and three isolation and quarantine policies, which are detailed in *Table 1* below.

COVID-19 Physical Distancing and Isolation and Quarantine Policy - Norway (Saunes, Skau, Byrkjeflot, Lindahl, & Bråten, 2021)		
Date	**(D) Physical Distancing**	**(Q) Isolation and Quarantine**
Prior to March 2020	**02-12-20** Healthcare professionals working in patient care were restricted from travelling abroad.	**02-2020** Persons who have symptoms upon their arrival in Norway must immediately undergo isolation in a place designated by the municipal medical officer. Symptomatic persons may not use public transport to reach the place designated for their isolation. Everybody who has been abroad is

		subject to home quarantine for 14 days.
03-01-20		**Q1** Employees in the health care sector who have visited COVID-19 afflicted areas are required to quarantine at home for 14-days after their return from these areas. This is effective for everybody who returned from these areas after 17 February. Employees who develop symptoms must be isolated at home for 14 days.
03-07-20		**Q2** On March 7, home quarantine was extended to all travelers who have visited COVID-19 afflicted areas.
03-12-20	**D1** • People must maintain physical distance from one another, practice good hand hygiene and cough in paper tissues or their elbow. Indoors, people should keep at least two meters distance from one another, though this does not apply to family or household members. When outside, there should be no more than five people in a group (except for members of a family or the same household). Distance of at least one meter from other people should be observed in public spaces. • All day-care centers, primary schools, lower- and upper-secondary schools, universities and university colleges and other educational institutions; cultural events, sporting events and organized sporting activities, both indoors and outdoors; restaurants, bars, pubs and other social establishments; fitness centers, swimming pools, water parks and similar establishments; establishments that provide hairdressing, skin care, massage, body care, tattooing, piercing and	**Q3** On March 12, a list of official measures with immediate effect was published: • Those who have been in close contact with someone who tested positive for coronavirus (SARSCoV-2) must quarantine for 14 days. This is longer than the 7 days allowed by §4.1 in the Act on the control of communicable diseases (which remains in force). • People must immediately quarantine for 14 days after returning from travel abroad (from any country exempt for Sweden and Finland). Persons diagnosed with coronavirus (SARS-CoV-2) or those being tested for it, are to be isolated.

	similar services; stay at holiday properties; and drivers and vehicle licensing offices are closed.	
03-14-20	**D2** All visits to LTC facilities (by relatives and friends) are banned and visits to hospitals are also restricted. The list of institutions to be closed is extended to physiotherapy and manual therapy offices, chiropractors offices, opticians offices, chiropody offices, speech therapy offices, psychologists offices, and facilities performing complementary and alternative medicine. Dentists were requested to close their clinics for all nonacute patients.	
03-17-20	**D3** Borders are closed for foreign nationals who do not have a residence permit to stay in Norway (exemptions for people coming from Finland or Sweden are abolished). Temporary entry and exit controls will be introduced at the internal Schengen border. Norwegian airports remain open.	

Table 1: COVID-19 Physical Distancing and Isolation and Quarantine Policy - Norway
(Saunes, Skau, Byrkjeflot, Lindahl, & Bråten, 2021)

Norway took strong, early action in enacting physical distancing policies. By March 12, the jurisdiction had closed all schools and most nonessential businesses in addition to enacting some travel restrictions. By the middle of March, closures had extended to Long Term Care facilities and some other nonessential doctors' offices, and the borders were closed to foreign nationals, including those from Finland and Sweden, who had previously been exempt from these restrictions.

The sheer number of isolation and quarantine policies enacted sets Norway apart from the other three states. In addition to being many, the policies were also expansive.

The policies were enacted early on, with the first isolation and quarantine policy going into effect just four days after Norway's first case of COVID-19. Norway's first case of COVID-19 was on February 26, and its first COVID-19 death was recorded on March 13. On March 12, they included mandatory isolation of anyone who tested positive for COVID-19, been in close contact, or traveled from outside the country. This date serves as my enactment date for quarantine policy in the country. Two weeks from March 12 was March 26, which serves as the change point between Pre- and Post-Policy periods for case data. Two weeks later, April 9, serves as the change point between Pre- and Post-Policy periods for death data. Therefore, in terms of COVID-19 cases, Norway's Pre-Policy period runs from February 26 until March 26, and its Post-Policy period runs from March 27 until May 31. In terms of COVID-19 deaths, Norway's Pre-Policy period runs from March 13 until April 9, and its Post-Policy period runs from April 10 until May 31.

4.1.2 Cases

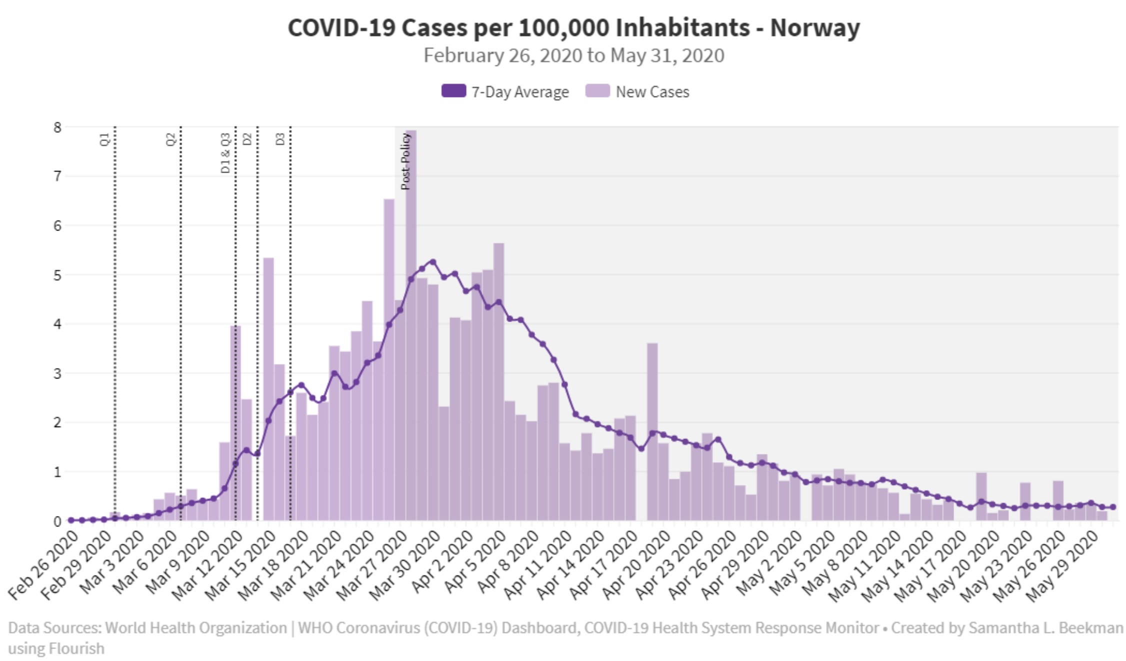

Figure 1: COVID-19 Cases per 100,000 Inhabitants – Norway
(World Health Organization, 2021)

In *Figure 1* above, the timeline of Norway's physical distancing and isolation and quarantine policies is overlayed atop the timeline of new cases of COVID-19 per 100,000 inhabitants. The Pre-Policy period is in white, and the Post-Policy period is demarcated by a light gray highlight. Here, you can begin to observe case trends and how they may have been shaped by policy as it was enacted.

4.1.2.1 Pre-Policy Period

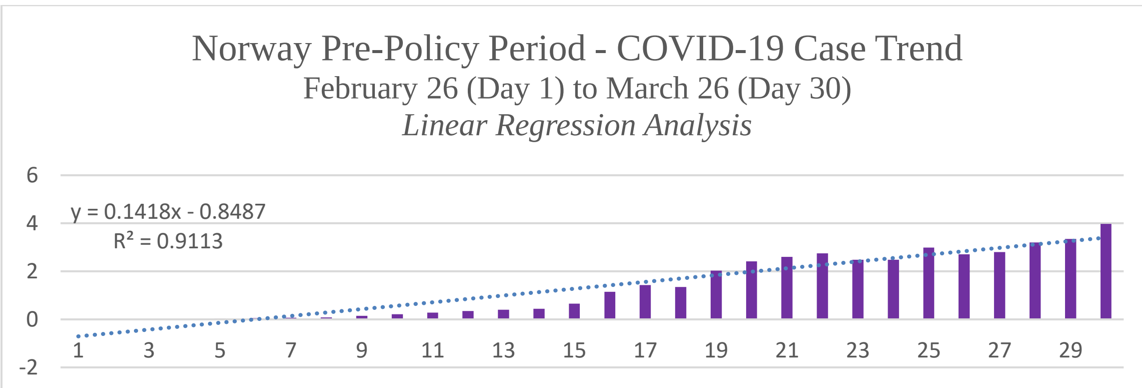

Figure 2: Norway Pre-Policy Period - COVID-19 Case Trend
(World Health Organization, 2021)

During the Pre-Policy period as shown in *Figure 2* above, the linear regression is defined by the equation $y = 0.1418x - 0.8487$. The slope of this line is 0.1418, meaning that each day, the model predicts an additional 0.1418 new cases per 100,000 inhabitants. The R Squared value is 0.91, indicating that the data is a good fit for the regression line and that 91% of the variation in new COVID-19 cases might be explained by the passage of time after Norway's first case of COVID-19. This makes sense, as we would expect the virus to spread over time, increasing the number of cases. The P-value is 2.93×10^{-16}. Because this number is less than the significance level of .01, the variable is considered statistically significant, and the results are unlikely due to random chance.

4.1.2.2 Post-Policy Period

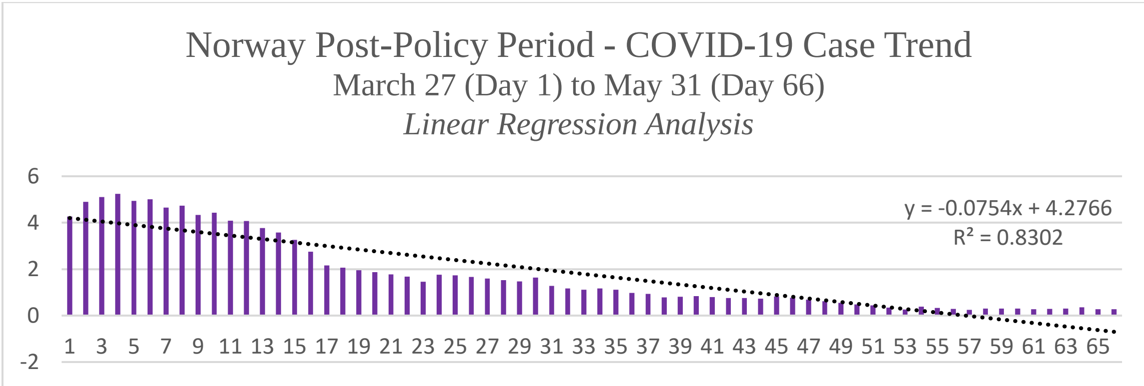

Figure 3: Norway Post-Policy Period – COVID-19 Case Trend
(World Health Organization, 2021)

During the Post-Policy period as shown in *Figure 3* above, the linear regression is defined by the equation $y = -0.0754x + 4.2766$. The slope of this line is -0.0754, meaning that each day, the model predicts 0.0754 fewer new cases per 100,000 inhabitants. The R Squared value is 0.83, indicating that the data is a good of a fit for the regression line and 83% of the variation in new COVID-19 cases can be explained by the passage of time after the implementation of Norway's isolation and quarantine policy. The P-value is 2.47×10^{-26}, indicating that the model is well within statistical significance.

4.1.3 Deaths

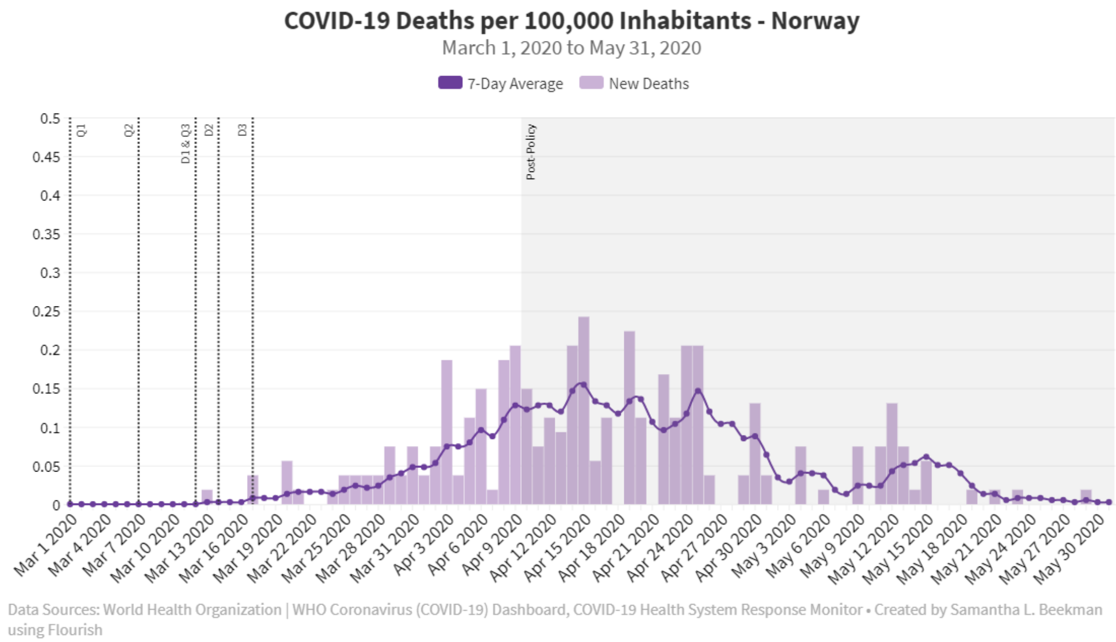

Figure 4: COVID-19 Deaths per 100,000 Inhabitants – Norway (World Health Organization, 2021)

In *Figure 4* above, the timeline of Norway's physical distancing and isolation and quarantine policies is overlayed atop the timeline of new COVID-19 deaths per 100,000 inhabitants. The Pre-Policy period is in white, and the Post-Policy period is highlighted in a light gray. Here, you can begin to observe death trends and how they may have been shaped by policy as it was enacted, keeping in mind that COVID-19 deaths lag behind case trends by about two weeks.

4.1.3.1 Pre-Policy Period

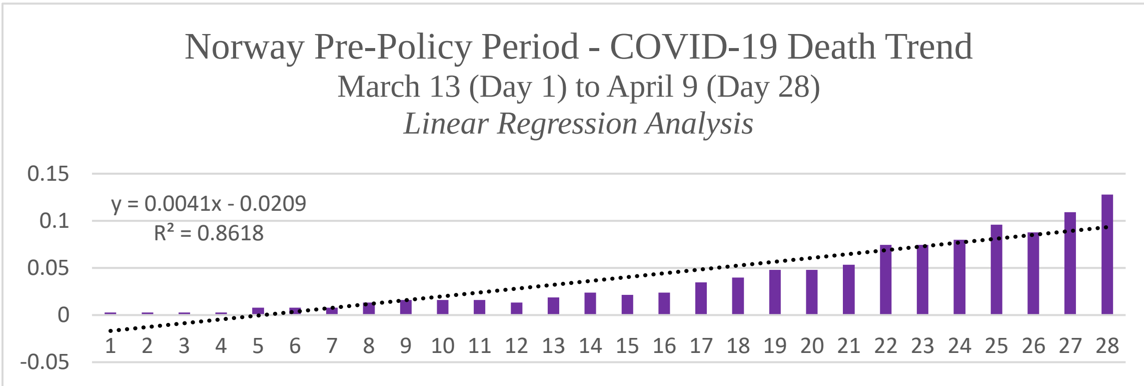

Figure 5: Norway Pre-Policy Period – COVID-19 Death Trend
(World Health Organization, 2021)

During the Pre-Policy period as shown in *Figure 5* above, the linear regression is defined by the equation $y = 0.0041x - 0.0209$. The slope of this line is 0.0041, meaning that each day, the model predicts an additional 0.0041 new deaths per 100,000 inhabitants. The R Squared value is 0.86, indicating that the data is a good fit for the regression line and that 86% of the variation in new COVID-19 deaths might be explained by the passage of time after Norway's first COVID-19 death. This makes sense, as we would expect deaths to increase as the number of cases increases; the more the virus spreads, the more people get sick and may die. The P-value is 3.51×10^{-21}. Because this number is less than the significance level of .01, the variable is considered statistically significant, and the results are unlikely due to random chance.

4.1.3.2 Post-Policy Period

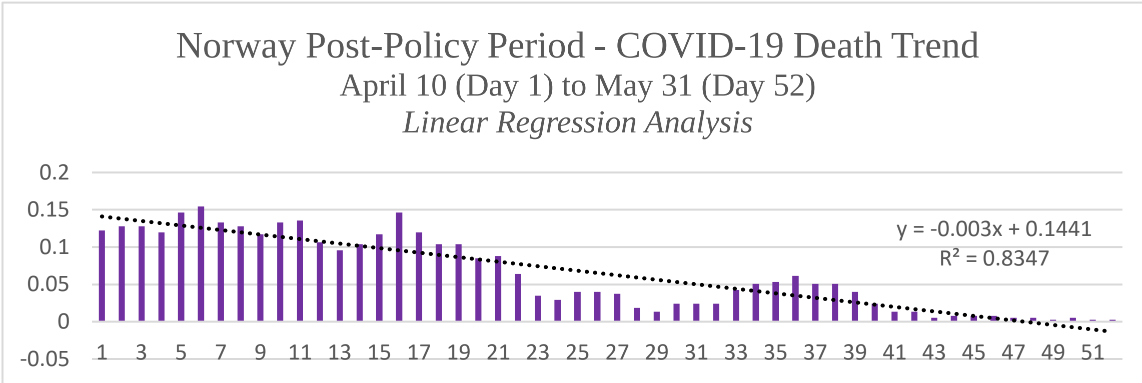

Figure 6: Norway Post-Policy Period – COVID-19 Death Trend
(World Health Organization, 2021)

During the Post-Policy period as shown in *Figure 6* above, the linear regression is defined by the equation $y = -0.003x + 0.1441$. The slope of this line is -0.003, meaning that each day, the model predicts 0.003 fewer new deaths per 100,000 inhabitants. The R Squared value is 0.83, indicating that the data is a good of a fit for the regression line and 83% of the variation in new COVID-19 deaths can be explained by the passage of time after the implementation of Norway's isolation and quarantine policy. The P-value is 3.51×10^{-21}, indicating that the model is well within statistical significance.

4.2 Sweden

4.2.1 Policy

In stark contrast to Norway's approach, Sweden's policies put in place to prevent the transmission of COVID-19 do not involve involuntary quarantine. Sweden had enacted no physical distancing or isolation and quarantine policies prior to March 1.
In the period from March to May, Sweden mandated four physical distancing policies and no isolation and quarantine policies, which are detailed in *Table 2* below.

COVID-19 Physical Distancing and Isolation and Quarantine Policy - Sweden (Bergkvist, Jehrlander, Gunnarsson, Kancans, & Janlöv, 2021)		
Date	**(D) Physical Distancing**	**(Q) Isolation and Quarantine**
03-17-20	**D1** High schools, Folk High Schools and universities are urged to teach at a distance, but elementary schools are kept open.	
03-19-20	**D2 A**t the request of the European Council and the Commission, the Government decides to prohibit unnecessary trips to Sweden.	
03-25-20	**D3** Only table service is allowed in restaurants and bars (no drinking or ordering at the bar).	
03-30-20	**D4** Visitors are banned in residential care homes for older people.	

Table 2: COVID-19 Physical Distancing and Isolation and Quarantine Policy - Sweden (Bergkvist, Jehrlander, Gunnarsson, Kancans, & Janlöv, 2021)

By March 17, which was 18 days after Sweden's first case of COVID-19, the jurisdiction shut down upper-level schools, but not elementary schools, making it the only jurisdiction in this analysis to keep schools open during this time period in at least some physical, in-person form. Due to external pressure from the European Council and the Commission, Sweden prohibited unnecessary visitors. They also reduced restaurant operations to table service and prohibited visitors to elderly homes by the end of March. Outside of these few, narrow restrictions, there were no physical distancing or isolation and quarantine policies enacted in Sweden during the first few months of the pandemic.

March 26 and April 9 will be used as the change points for Pre- and Post-Policy periods for Sweden, respectively, as these are the dates congruent with Norway's quarantine policy implementation. Sweden's Pre- and Post-Policy periods will mirror Norway's so as to compare them more accurately. Therefore, in terms of COVID-19 cases, Sweden's Pre-Policy period runs from the date of its first recorded case on

February 28 until March 26, when the effects of Norway's first isolation and quarantine policy might begin to be reflected in case data. Sweden's Post-Policy period runs from March 27 until May 31. In terms of COVID-19 deaths, Sweden's Pre-Policy period runs from its first recorded death on March 12 until April 9, when the effects of Norway's isolation and quarantine policy might begin to be reflected in Norway's death data. Sweden's Post-Policy period runs from April 10 until May 31.

4.2.2 Cases

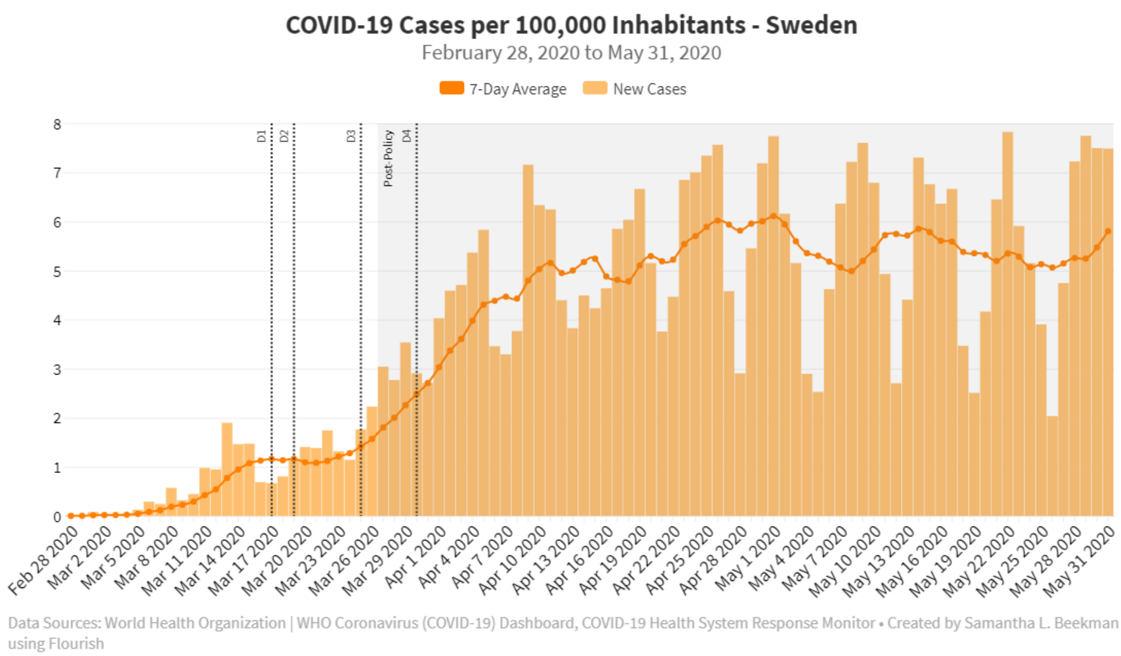

Figure 7: COVID-19 Cases per 100,000 Inhabitants - Sweden (World Health Organization, 2021)

In *Figure 7* above, the timeline of Sweden's physical distancing and isolation and quarantine policies is overlayed atop the timeline of new cases of COVID-19 per 100,000 inhabitants. The Pre-Policy period is in white, and the Post-Policy period is in light gray. Here, you can begin to observe case trends and how they may have been shaped by policy as it was enacted.

4.2.2.1 Pre-Policy Period

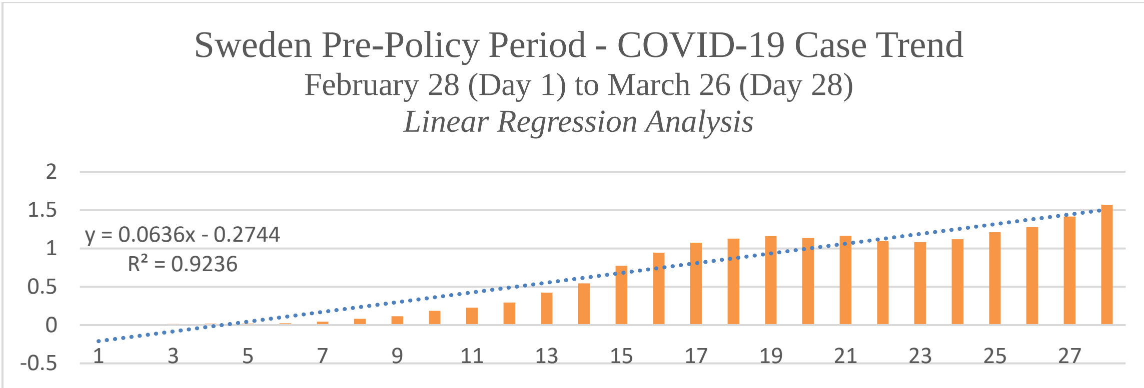

Figure 8: Sweden Pre-Policy Period - COVID-19 Case Trend
(World Health Organization, 2021)

During the Pre-Policy period as shown in *Figure 8****Error! Reference source not found.*** above, the linear regression is defined by the equation $y = 0.0636x - 0.2744$. The slope of this line is 0.0636, meaning that each day, the model predicts an additional 0.0636 new cases per 100,000 inhabitants. The R Squared value is 0.92, indicating that the data is a good fit for the regression line and that 92% of the variation in new COVID-19 cases might be explained by the passage of time after Sweden's first case of COVID-19. The P-value is 4.84×10^{-16}. Because this number is less than the significance level of .01, the variable is considered statistically significant, and the results are unlikely due to random chance.

4.2.2.2 Post-Policy Period

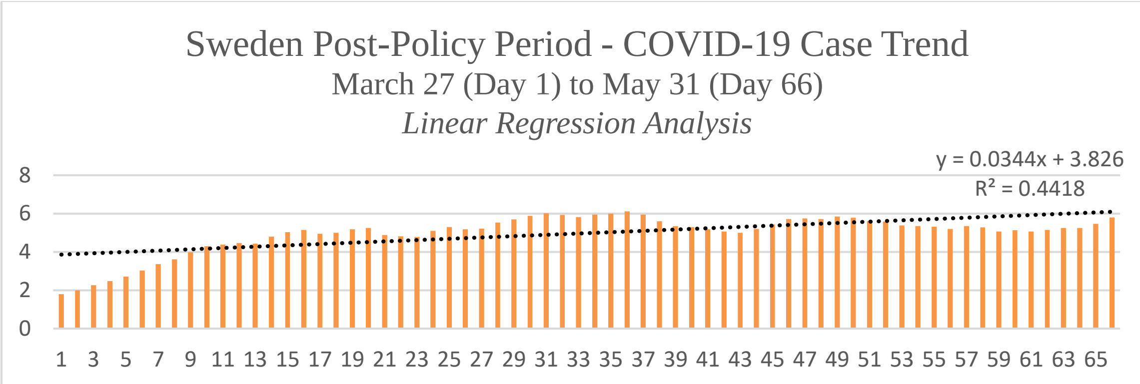

Figure 9: Sweden Post-Policy Period - COVID-19 Case Trend
(World Health Organization, 2021)

During the Post-Policy period as shown in *Figure 9* above, the linear regression is defined by the equation $y = 0.0344x + 3.826$. The slope of this line is 0.0344, meaning that each day, the model predicts an additional 0.0344 new cases per 100,000 inhabitants. The R Squared value is 0.44, indicating that the data is not a great fit for the regression line, and only 44% of the variation in new COVID-19 cases can be explained by the passage of time after the change point. The P-value is 1.16×10^{-9}, indicating that the model is well within statistical significance.

4.2.3 Deaths

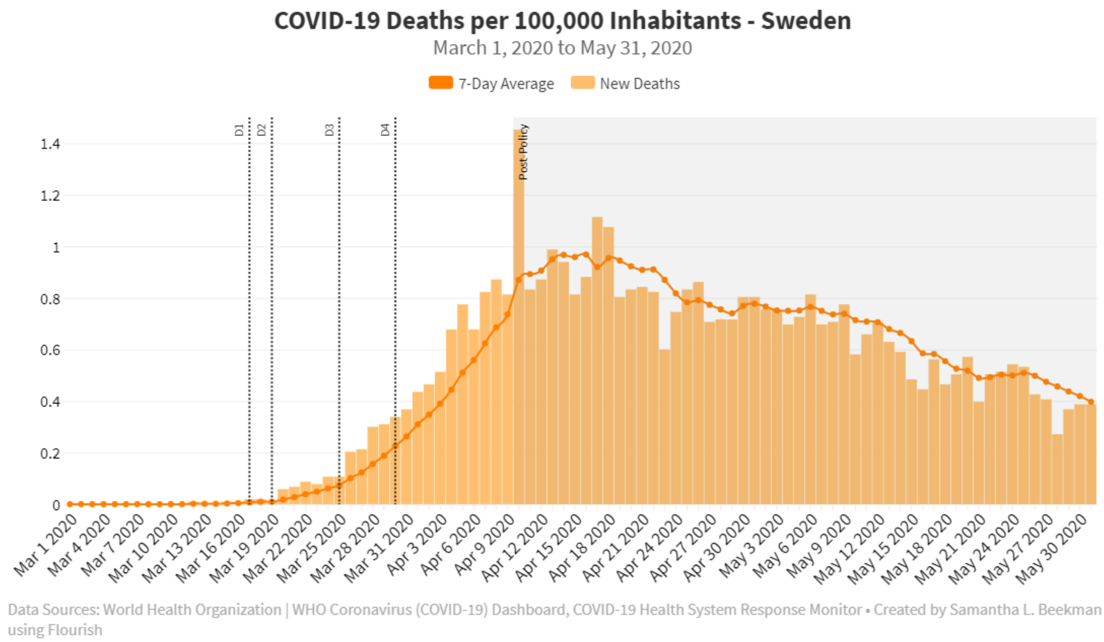

Figure 10: COVID-19 Deaths per 100,000 Inhabitants – Sweden
(World Health Organization, 2021)

In *Figure 10* above, the timeline of Sweden's physical distancing and isolation and quarantine policies is overlayed atop the timeline of new COVID-19 deaths per 100,000 inhabitants. The Pre-Policy period is in white, and the Post-Policy period is highlighted in a light gray. Here, you can begin to observe death trends and how they may have been shaped by policy as it was enacted, keeping in mind that COVID-19 deaths lag behind case trends by about two weeks.

4.2.3.1 Pre-Policy Period

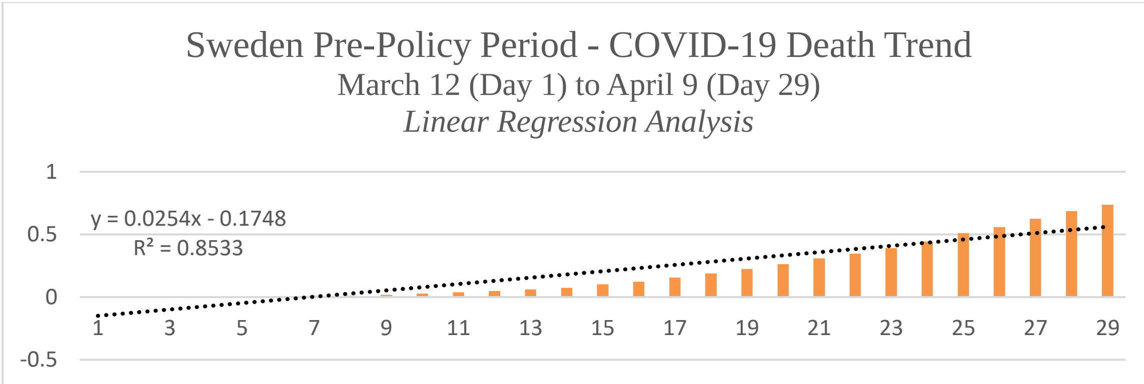

Figure 11: Sweden Pre-Policy Period - COVID-19 Death Trend
(World Health Organization, 2021)

During the Pre-Policy period as shown in *Figure 11* above, the linear regression is defined by the equation y = 0.0254x - 0.1748. The slope of this line is 0.0254, meaning that each day, the model predicts an additional 0.0254 new deaths per 100,000 inhabitants. The R Squared value is 0.85, indicating that the data is a good fit for the regression line and that 85% of the variation in new COVID-19 deaths might be explained by the passage of time after Sweden's first COVID-19 death. The P-value is $9.16x10^{-13}$. Because this number is less than the significance level of .01, the variable is considered statistically significant, and the results are unlikely due to random chance.

4.2.3.2 Post-Policy Period

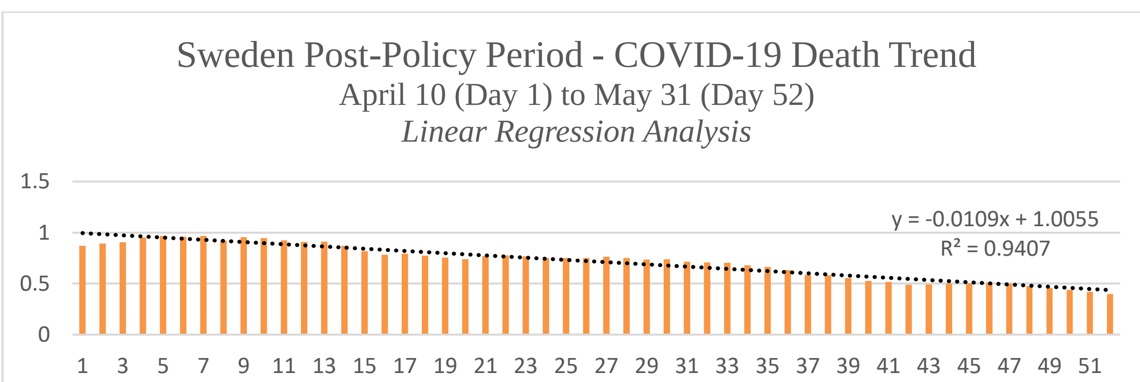

Figure 12: Sweden Post-Policy Period - COVID-19 Death Trend
(World Health Organization, 2021)

During the Post-Policy period as shown in *Figure 12* above, the linear regression is defined by the equation $y = -0.0109x + 1.0055$. The slope of this line is -0.0109, meaning that each day, the model predicts 0.0109 fewer new deaths per 100,000 inhabitants. The R Squared value is 0.94, indicating that the data is a good fit for the regression line and that 94% of the variation in new COVID-19 deaths can be explained by the passage of time after the change point. The P-value is 2.41×10^{-32}, indicating that the model is well within statistical significance.

4.3 Scandinavia

4.3.1 Policy

The physical distancing and isolation and quarantine policies that Norway enacted during the first few months of COVID-19, from before the first recorded case in the country until May 31, were more numerous and wider-encompassing than those of Sweden. Norway implemented three isolation and quarantine policies regarding mandated isolation and quarantine procedures for those who tested positive for or came into close contact with COVID-19 and implemented three strict physical distancing policies which required most non-essential businesses to close for in-person conduct including schools at all levels, long-term care facilities, and most workplaces. Meanwhile, Sweden enacted no isolation and quarantine policies, kept elementary schools open for in-person learning, and required almost no other physical distancing policies outside of table service-only at restaurants and banning visitors from residential care homes. Norway's more physically restrictive policy strategy which focused policy on physical distancing and particularly isolation and quarantine strategies presented a stark policy divide between the two countries.

4.3.2 Cases

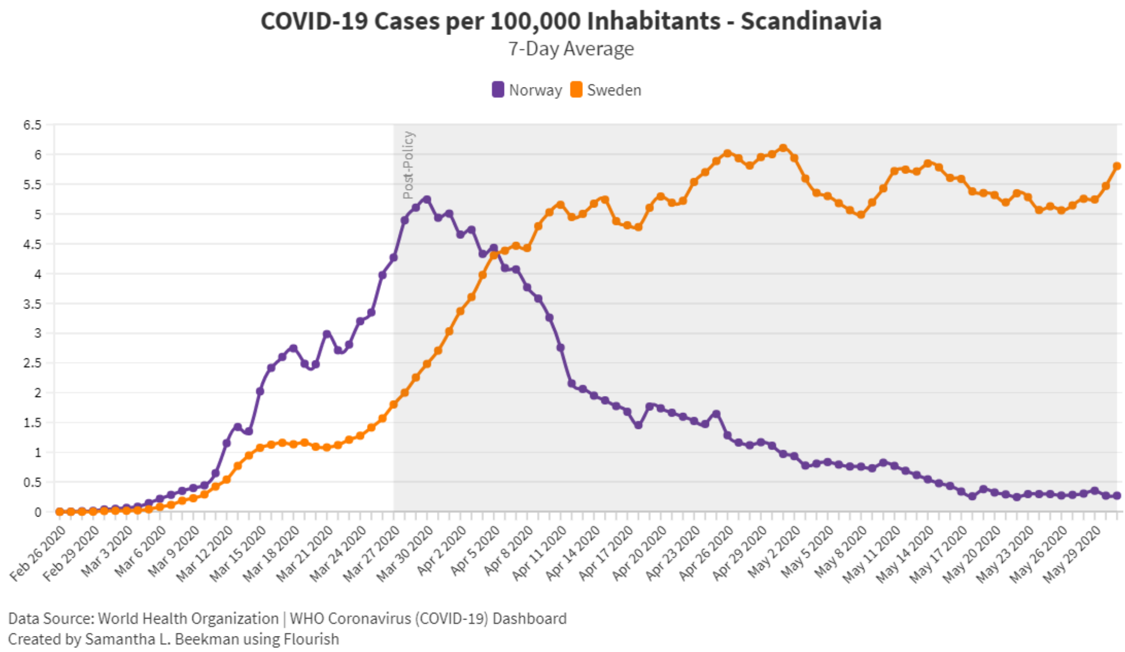

Figure 13: COVID-19 Cases per 100,000 Inhabitants - Scandinavia
(World Health Organization, 2021)

4.3.2.1 Pre-Policy Period

During the Pre-Policy period, Norway and Sweden's linear regression analyses both yielded high R Squared values, indicating that both sets of data were good fits for their respective regression lines and the date did well to predict the number of cases. Both slopes were positive, which meant that the two variables moved in tandem with each other in the same direction, and as time passed, there were more new COVID-19 cases.

However, the slope of Norway's linear regression line was more than twice as large as Sweden's, at 0.1418 and 0.0636, respectively. This means that Norway's new COVID-19 cases grew at almost twice the rate of Sweden's. Also during this period, Norway's 7-day average of new COVID-19 cases per 100,000 inhabitants peaked at 4.27, representing a head start over Sweden's peak of 1.8, again more than twice the number. The significance levels of both of these linear regression analyses were well less than

0.01, so the models are both statistically significant. These factors might suggest that COVID-19 was transmitted much wider much faster per capita in Norway than in Sweden.

4.3.2.2 Post-Policy Period

During the Post-Policy period, Norway's linear regression analysis yielded a high R Squared value, indicating that the data is a good fit for the regression line and that 83% of the variation in new COVID-19 cases could be explained by the passage of time after the implementation of Norway's isolation and quarantine policy. Norway's slope is negative, indicating that as time passed, there were fewer new COVID-19 cases reported.

However, the slope of Sweden's regression line, 0.0344, is positive, indicating that new COVID-19 cases actually grew by some amount as time went on. This is in contrast to Norway's negative slope and decreasing number of COVID-19 cases. This outcome would be especially surprising since, based off data from the Pre-Policy period, one would have expected Norway's COVID-19 cases to subside slower than Sweden's, as there were more per capita. In fact, the data presents the opposite. During the Post-Policy period, the majority of the increase in cases in Sweden occurred during the first few weeks of the period and then leveled off, as shown in *Figure 13*. However, case levels remained elevated through May 31.

At 0.44, Sweden's R Squared value is low compared to Norway's. This is because the slope of the linear regression line is so shallow that it might be better characterized as a plateau. Practically, this means there was not much of a relationship between the variables. This measure could suggest that the progression of time after Norway's implementation of physical distancing and isolation and quarantine policies had no significant effect on Sweden's COVID-19 case levels, as one might expect, as Norway's policies were not in effect in Sweden.

These models could suggest that Norway's implementation of stricter isolation and quarantine-oriented COVID-19 policies made a significant difference in the health outcomes of affected populations in that COVID-19 case levels subsided more quickly and to a greater extent in Norway than in Sweden, where there was no isolation and quarantine policy intervention.

4.3.3 Deaths

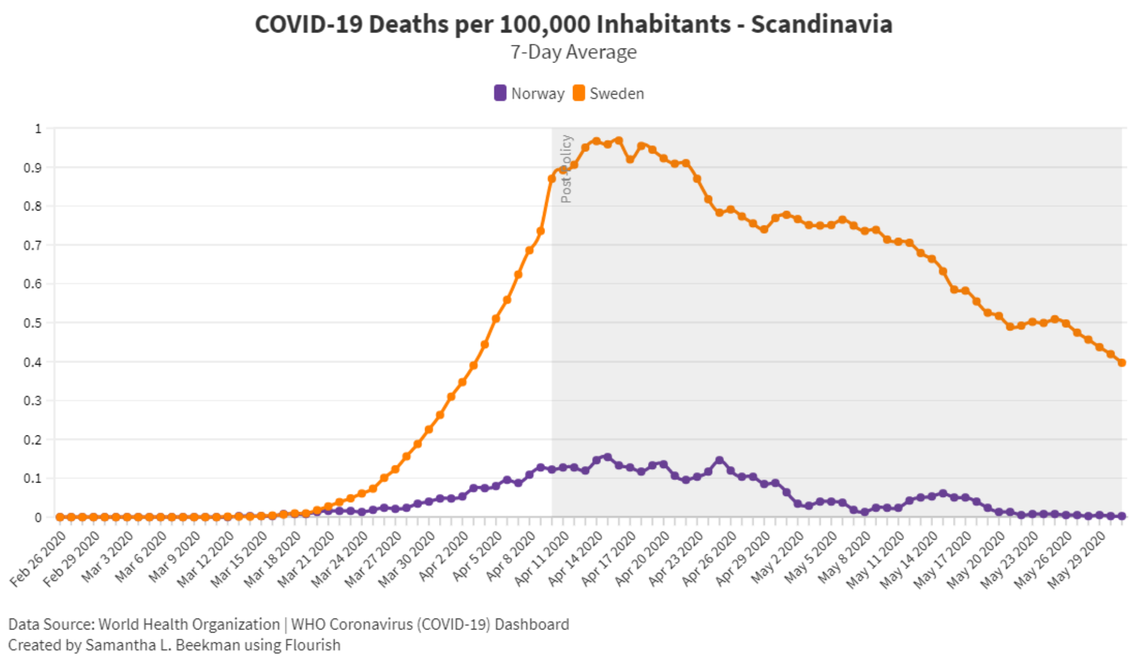

Figure 14: COVID-19 Deaths per 100,000 Inhabitants - Scandinavia
(World Health Organization, 2021)

4.3.3.1 Pre-Policy Period

During the Pre-Policy period, Norway and Sweden's linear regression analyses both yielded high R Squared values, indicating that both sets of data were good fits for their respective regression lines. Both slopes were positive, which meant that the two variables moved in tandem with each other in the same direction, so as time passed, there were more new COVID-19 deaths.

However, the slope of Sweden's linear regression line was more than six times larger than Norway's, at 0.0254 and 0.0041, respectively. Sweden's new COVID-19 deaths grew almost exponentially faster than Norway's, as demonstrated in *Figure 14*. During this period, Sweden's 7-day average of new COVID-19 deaths per 100,000 inhabitants peaked at 0.87, way ahead of Norway's peak of 0.13. The significance levels of both of these linear regression analyses were well less than 0.01, so the models are both statistically significant.

4.3.3.2 Post-Policy Period

During the Post-Policy period, Norway and Sweden's linear regression analyses both yielded high R Squared values, indicating that both sets of data were good fits for their respective regression lines, though the progression of time did slightly better to predict the number of deaths in Sweden than in Norway during this timeframe. Both slopes were negative, which meant that the two variables moved in tandem with each other in opposite directions, so as time passed, there were less new COVID-19 deaths.

The slope of Sweden's linear regression line is -0.0109. Because the smaller negative number is further from zero than the bigger negative number on a number line, the smaller negative slope is actually steeper than the bigger slope and indicates a faster rate of change. Sweden's slope is almost four times smaller than Norway's during the same period. However, this difference is not as stark as the six-time difference in slopes during the Pre-Policy period. This indicates that Sweden's deaths decreased faster than Norway's in the Post-Policy period, but not by as much as they had increased during the

Pre-Policy period. During the entire timeframe, Sweden's deaths peaked at 0.97 per 100,000 inhabitants and Norway's peaked at 0.15. In conjunction, these measures mean that Sweden's COVID-19 deaths rose very quickly and much higher than Norway's, and though its rate of change was decreasing faster than Norway's after each jurisdiction's peak, its death levels were still very elevated compared to Norway's.

This outcome is especially surprising since Sweden's COVID-19 cases during the Post-Policy period did not decrease but instead increased and then maintained a plateau. One would have expected Sweden's COVID-19 deaths to follow a similar shape, but instead, the data presents a relatively steep decrease in Sweden's deaths.

Both jurisdictions' P-values were well within the significance level of 0.01, so both models are considered statistically significant.

While Norway did see a significant decrease in COVID-19 deaths following its implementation of isolation and quarantine policies, Sweden saw the same despite enacting none. These models could suggest that some outside factor influenced the subsidence of Sweden's COVID-19 deaths, and this factor could have also played a role in the progression of Norway's COVID-19 deaths as well. This indicates that the implementation of stricter isolation and quarantine-oriented COVID-19 policies might not necessarily be the principal factor impacting the health outcomes of affected populations for this metric. However, Norway's COVID-19 deaths were significantly lower than Sweden's, and despite Sweden's rate of change decreasing faster than Norway's after each jurisdiction's peak, Sweden's death levels were still very elevated compared to Norway's. This indicates that severity of COVID-19 deaths may have been lessened due to Norway's isolation and quarantine policies.

4.4 Louisiana

4.4.1 Policy

As demonstrated in the table below, though perhaps not as sweeping and thorough as Norway, Louisiana enacted more physical distancing and isolation and quarantine policies than Sweden. Prior to March 1, the United States had already implemented 2-week home-based quarantines for some entering the United States.

In the period from March to May, Louisiana mandated three physical distancing policies and two isolation and quarantine policies, which are detailed in *Table 3* below.

COVID-19 Physical Distancing and Isolation and Quarantine Policy – Louisiana (Johns Hopkins University & Medicine, 2021)		
Date	**(D) Physical Distancing**	**(Q) Isolation and Quarantine**
Prior to March 2020		**02-02-20 Q1(N) NATIONAL** By 5 PM on Sunday, those en route to the United States have to have left China or they can face a 2-week home-based quarantine if they had been in Hubei province. Mainland visitors, however, will need to undergo health screenings upon their return, and foreign nationals can even be denied admittance.
03-13-20	**D1(N) NATIONAL** The Trump administration issues a travel ban on non-Americans who visited 26 European countries within 14 days of coming to the United States. People traveling from the United Kingdom and the Republic of Ireland are exempt. **D2** The Governor signed a proclamation that immediately halts any gathering of more than 250 people until April 13 and closes all K-12 public schools statewide effective March 16.	
03-17-20	**D3** The Governor ordered bars, gyms and movie theaters to close and limited restaurants to delivery	

	and takeout. The Governor announced measures to reduce the spread of COVID-19, including further limiting the size of gatherings to fewer than 50 people, closing casinos, bars and movie theaters and limiting restaurants to delivery, take out and drive-through orders only.	
03-22-20		**Q2** The Governor issued a statewide Stay at Home Order.

Table 3: COVID-19 Physical Distancing and Isolation and Quarantine Policy – Louisiana
(Johns Hopkins University & Medicine, 2021)

On March 13, the Trump administration also issued a travel band on non-Americans originating in 26 European countries. That same day, the governor of Louisiana enacted the first statewide physical distancing policy by limiting the size of gatherings and closing K-12 schools statewide. By March 22, the governor had closed several nonessential businesses and ordered a statewide Stay at Home Order, requiring residents to stay in their homes whenever possible. This date serves as my enactment date for quarantine policy in the country. Two weeks from March 22 was April 5, which serves as the change point between Pre- and Post-Policy periods for case data. Two weeks later, April 19, serves as the change point between Pre- and Post-Policy periods for death data. Therefore, in terms of COVID-19 cases, Louisiana's Pre-Policy period runs from the date of its first recorded case on March 9 until April 5, and its Post-Policy period runs from April 6 until May 31. In terms of COVID-19 deaths, Louisiana's Pre-Policy period runs from its first recorded death on March 15 until April 19, and its Post-Policy period runs from April 20 until May 31.

4.4.2 Cases

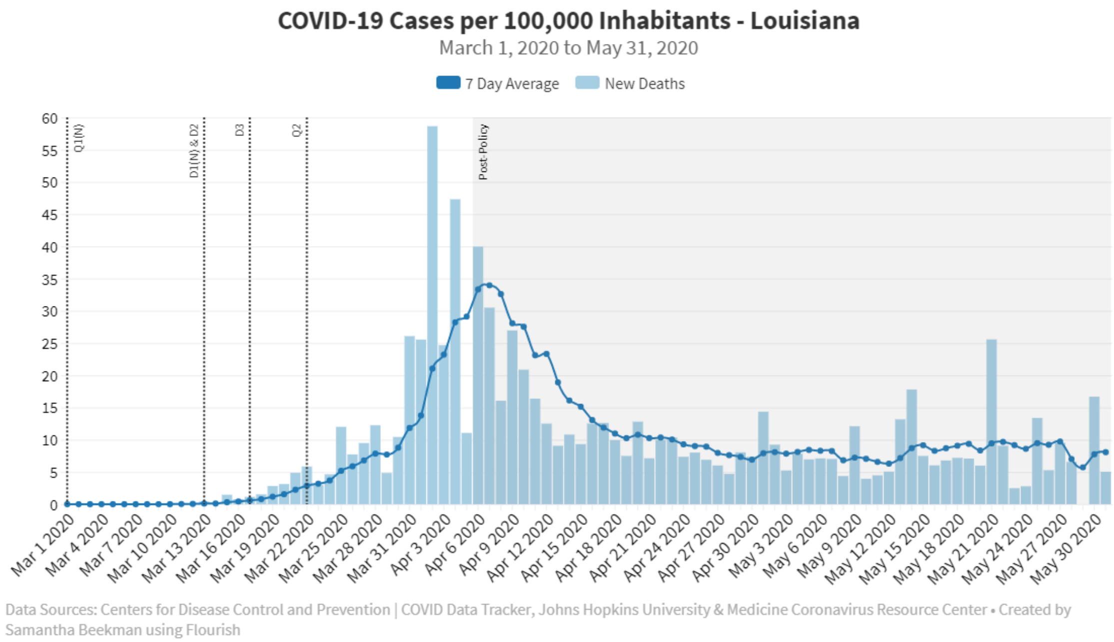

Figure 15: COVID-19 Cases per 100,000 Inhabitants – Louisiana
(Centers for Disease Control and Prevention, 2021)

In Figure 15: COVID-19 Cases per 100,000 Inhabitants – LouisianaFigure 15 above, the timeline of Louisiana's physical distancing and isolation and quarantine policies is overlayed atop the timeline of new cases of COVID-19 per 100,000 inhabitants. The Pre-Policy period is in white, and the Post-Policy period is demarcated by a light gray highlight. Here, you can begin to observe case trends and how they may have been shaped by policy as it was enacted.

4.1.2.1 Pre-Policy Period

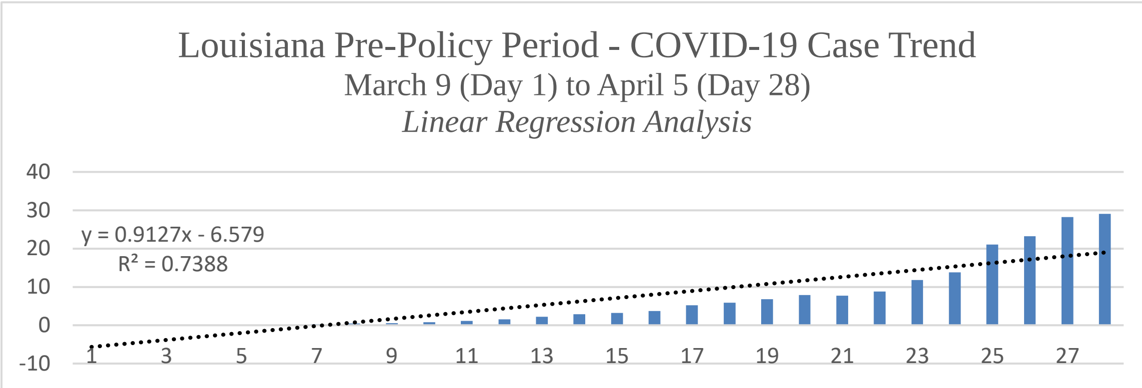

Figure 16: Louisiana Pre-Policy Period - COVID-19 Case Trend
(Centers for Disease Control and Prevention, 2021)

During the Pre-Policy period as shown in *Figure 16* above, the linear regression is defined by the equation $y = 0.9127x - 6.579$. The slope of this line is 0.9127, meaning that each day, the model predicts an additional 0.9127 new cases per 100,000 inhabitants. The R Squared value is 0.74, indicating that the data is a good fit for the regression line and that 74% of the variation in new COVID-19 cases might be explained by the passage of time after Louisiana's first case of COVID-19. The P-value is $4.68\text{x}10^{-9}$. Because this number is less than the significance level of .01, the variable is considered statistically significant, and the results are unlikely due to random chance.

4.1.2.2 Post-Policy Period

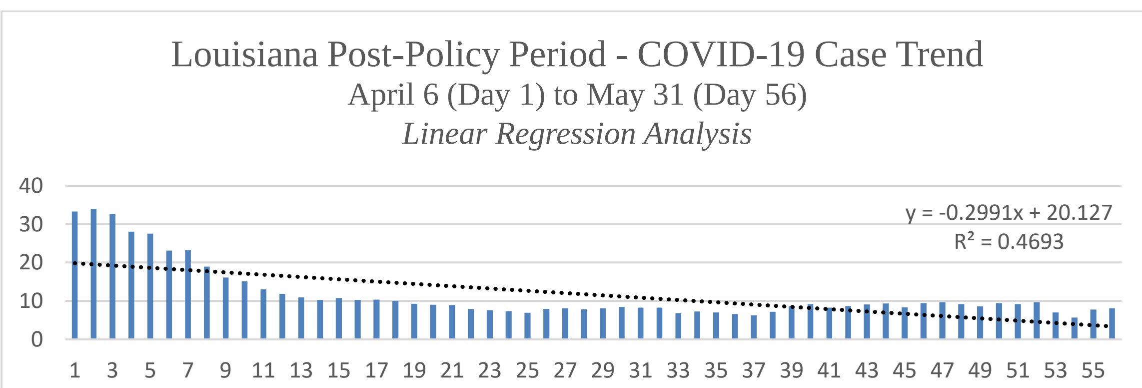

Figure 17: Louisiana Post-Policy Period - COVID-19 Case Trend
(Centers for Disease Control and Prevention, 2021)

During the Post-Policy period as shown in *Figure 17* above, the linear regression is defined by the equation $y = -0.2991x + 20.127$. The slope of this line is -0.2991, meaning that each day, the model predicts 0.2991 fewer cases per 100,000 inhabitants. The R Squared value is 0.47, indicating that the data is not as good of a fit for the regression line and that only 47% of the variation in new COVID-19 cases might be explained by the passage of time after Louisiana’s first case of COVID-19. The P-value is 5.77×10^{-9}. Because this number is less than the significance level of .01, the variable is considered statistically significant, and the results are unlikely due to random chance.

4.4.3 Deaths

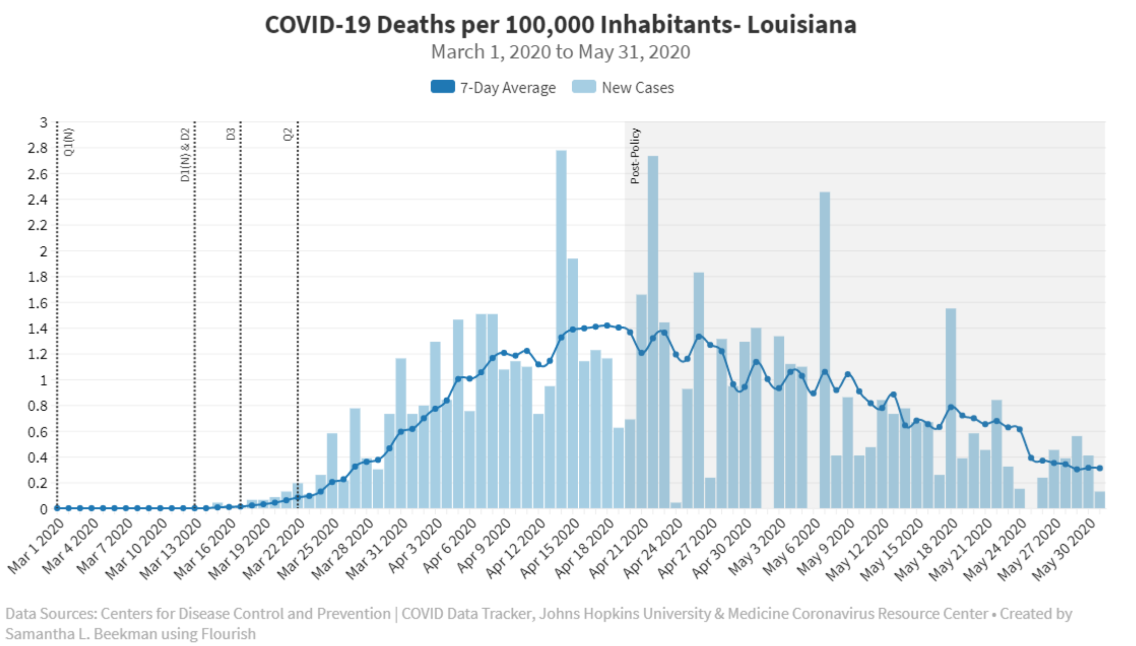

Figure 18: COVID-19 Deaths per 100,000 Inhabitants - Louisiana
(Centers for Disease Control and Prevention, 2021)

In Figure 18 above, the timeline of Louisiana’s physical distancing and isolation and quarantine policies is overlayed atop the timeline of new COVID-19 deaths per 100,000 inhabitants. The Pre-Policy period is in white, and the Post-Policy period is highlighted in a light gray. Here, you can begin to observe death trends and how they may have been shaped by policy as it was enacted, keeping in mind that COVID-19 deaths lag behind case trends by about two weeks.

4.4.3.1 Pre-Policy Period

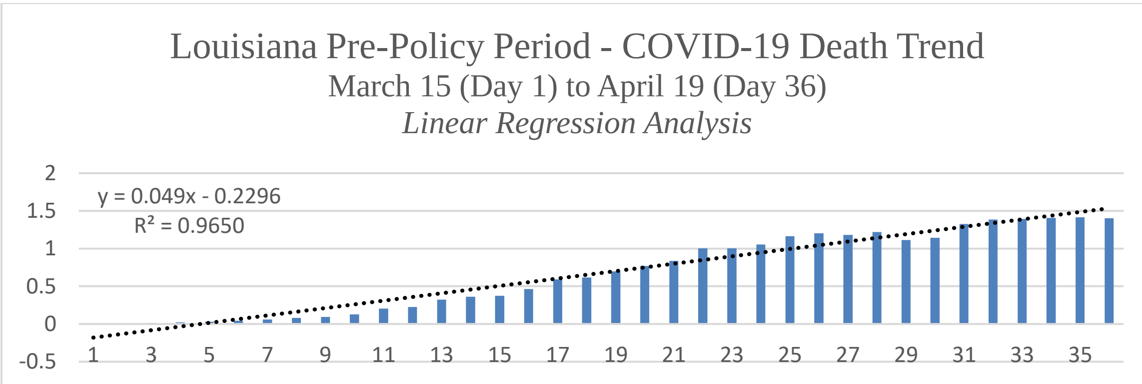

Figure 19: Louisiana Pre-Policy Period - COVID-19 Death Trend
(Centers for Disease Control and Prevention, 2021)

During the Pre-Policy period as shown in Figure 19 above, the linear regression is defined by the equation $y = 0.049x - 0.2296$. The slope of this line is 0.049, meaning that each day, the model predicts an additional 0.049 new deaths per 100,000 inhabitants. The R Squared value is 0.96, indicating that the data is a good fit for the regression line and that 96% of the variation in new COVID-19 deaths might be explained by the passage of time after Louisiana's first COVID-19 death. The P-value is 2.48×10^{-26}. Because this number is less than the significance level of .01, the variable is considered statistically significant, and the results are unlikely due to random chance.

4.4.3.2 Post-Policy Period

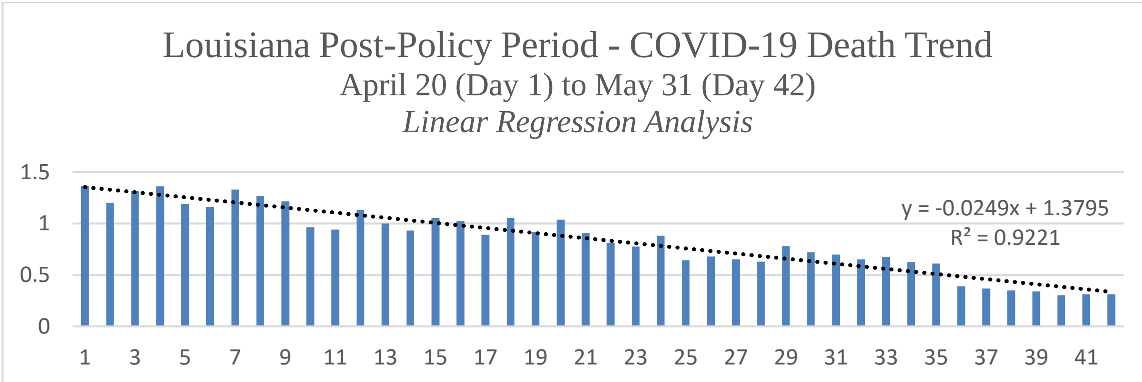

Figure 20: Louisiana Post-Policy Period - COVID-19 Death Trend
(Centers for Disease Control and Prevention, 2021)

During the Post-Policy period as shown in Figure 20 above, the linear regression is defined by the equation $y = -0.0249x + 1.3795$. The slope of this line is -0.0249, meaning that each day, the model predicts 0.0249 fewer new deaths per 100,000 inhabitants. The R Squared value is 0.92, indicating that the data is a good fit for the regression line and that 92% of the variation in new COVID-19 deaths can be explained by the passage of time after the change point. The P-value is 8.81×10^{-24}, indicating that the model is well within statistical significance.

4.5 Arkansas

4.5.1 Policy

Arkansas' policy strategy was closer to Sweden than to the other two states. Prior to March 1, had already enacted one policy on February 12 which fell into the physical distancing category and restricted health care professionals from traveling abroad. By March 1, the United States had already implemented 2-week home-based quarantines for some entering the United States.

In the period from March to May, Arkansas mandated five physical distancing policies and no isolation and quarantine policies outside of the national mandate on February 2. These policies are detailed in the table below.

COVID-19 Physical Distancing and Isolation and Quarantine Policy - Arkansas (Johns Hopkins University & Medicine, 2021)		
Date	**(D) Physical Distancing**	**(Q) Isolation and Quarantine**
Prior to March 2020		**02-02-20 Q1(1) NATIONAL** By 5 PM on Sunday, those en route to the United States have to have left China or they can face a 2-week home-based quarantine if they had been in Hubei province. Mainland visitors, however, will need to undergo health screenings upon their return, and foreign nationals can even be denied admittance.
03-13-20	**D1(N) NATIONAL** The Trump administration issues a travel ban on non-Americans who visited 26 European countries within 14 days of coming to the United States. People traveling from the United Kingdom and the Republic of Ireland are exempt.	
03-15-20	**D2** The Governor closed all public schools starting March 17 for on-site instruction.	
03-17-20	**D3** The Governor ordered the states' three casinos to close for two weeks.	
03-19-20	**D4** The Governor banned sit-down service at all restaurants and bars. The Governor announced the state will move to telecommuting, with on-site work limited to employees needed for the proper function of government.	

03-24-20	**D5** The Governor issued a directive closing in-person operations of all barbers, body art establishments and schools, cosmetology establishments, massage therapy clinics/spas, and medical spas.	

Table 4: COVID-19 Physical Distancing and Isolation and Quarantine Policy – Arkansas
(Johns Hopkins University & Medicine, 2021)

On March 13, the Trump administration also issued a travel band on non-Americans originating in 26 European countries. On March 15, the governor closed all public schools for on-site instruction. By the end of the month, most nonessential businesses had been closed as well. April 5 and April 19 will be used as the change points dividing Pre- and Post-Policy periods for Arkansas, respectively, as these are the dates congruent with Louisiana's quarantine policy implementation. Therefore, in terms of COVID-19 cases, Arkansas' Pre-Policy period runs from the date of its first recorded case on March 11 until April 5, when Louisiana's first isolation and quarantine policy was implemented, and the Post-Policy period runs from April 6 until May 31. In terms of COVID-19 deaths, Arkansas' Pre-Policy period runs from its first recorded death on March 24 until April 19, when the effects of Louisiana's isolation and quarantine policy would begin to be reflected in Louisiana's death data. Arkansas' Post-Policy period runs from April 20 until May 31.

4.5.2 Cases

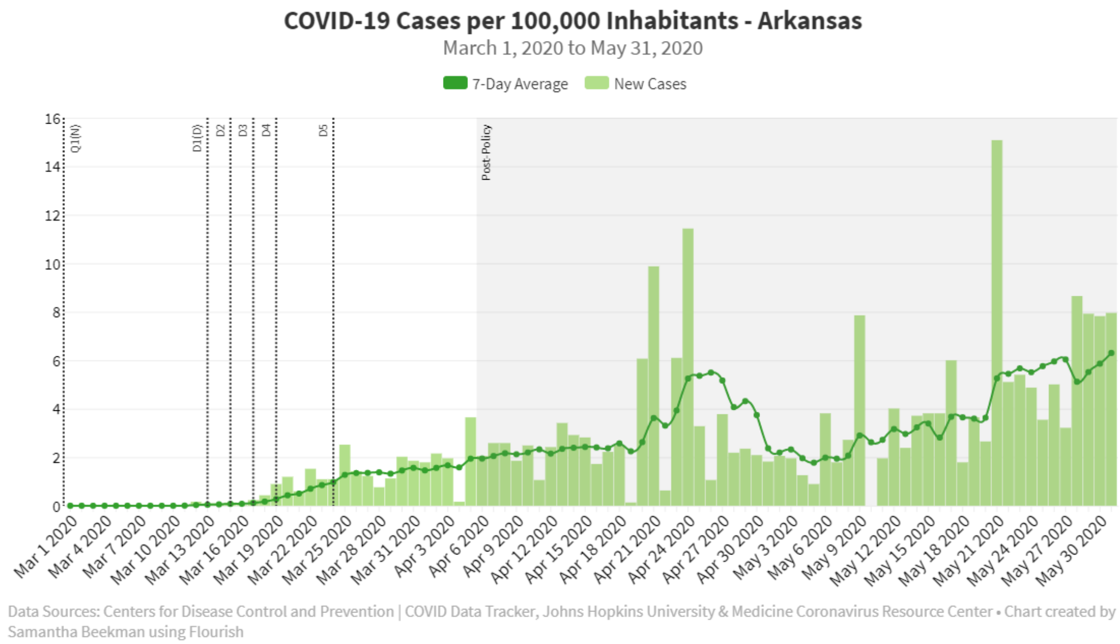

Figure 21: COVID-19 Cases per 100,000 Inhabitants – Arkansas
(Centers for Disease Control and Prevention, 2021)

In Figure 21 above, the timeline of Arkansas' physical distancing and isolation and quarantine policies is overlayed atop the timeline of new cases of COVID-19 per 100,000 inhabitants. The Pre-Policy period is in white, and the Post-Policy period is demarcated by a light gray highlight. Here, you can begin to observe case trends and how they may have been shaped by policy as it was enacted.

4.5.2.1 Pre-Policy

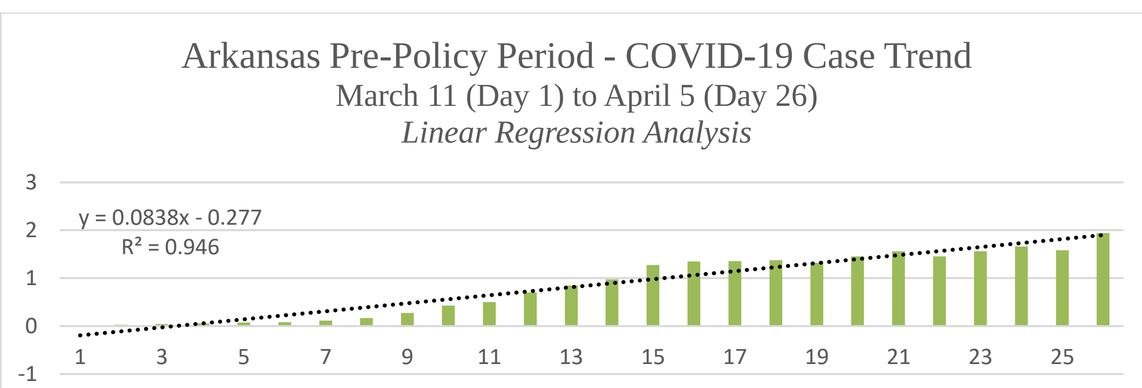

Figure 22: Arkansas Pre-Policy Period - COVID-19 Case Trend

(Centers for Disease Control and Prevention, 2021)

During the Pre-Policy period as shown in *Figure 22* above, the linear regression is defined by the equation $y = 0.0838x - 0.277$. The slope of this line is 0.0838, meaning that each day, the model predicts an additional 0.0838 new cases per 100,000 inhabitants. The R Squared value is 0.94, indicating that the data is a good fit for the regression line and that 94% of the variation in new COVID-19 cases might be explained by the passage of time after Arkansas' first case of COVID-19. The P-value is 1.02×10^{-16}. Because this number is less than the significance level of .01, the variable is considered statistically significant, and the results are unlikely due to random chance.

4.5.2.2 Post-Policy

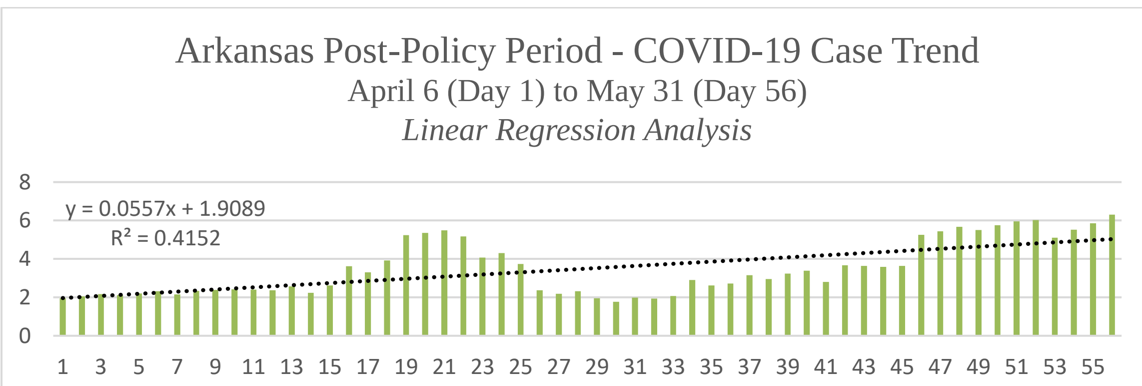

Figure 23: Arkansas Post-Policy Period - COVID-19 Case Trend
(Centers for Disease Control and Prevention, 2021)

During the Post-Policy period as shown in Figure 23 above, the linear regression is defined by the equation $y = 0.0557x + 1.9089$. The slope of this line is 0.0557, meaning that each day, the model predicts and additional 0.0557 cases per 100,000 inhabitants. The R Squared value is 0.42, indicating that the data is not as good of a fit for the regression line and that only 42% of the variation in new COVID-19 cases might be explained by the passage of time after the change point. The P-value is 8.37×10^{-8}.

Because this number is less than the significance level of .01, the variable is considered statistically significant, and the results are unlikely due to random chance.

4.5.3 Deaths

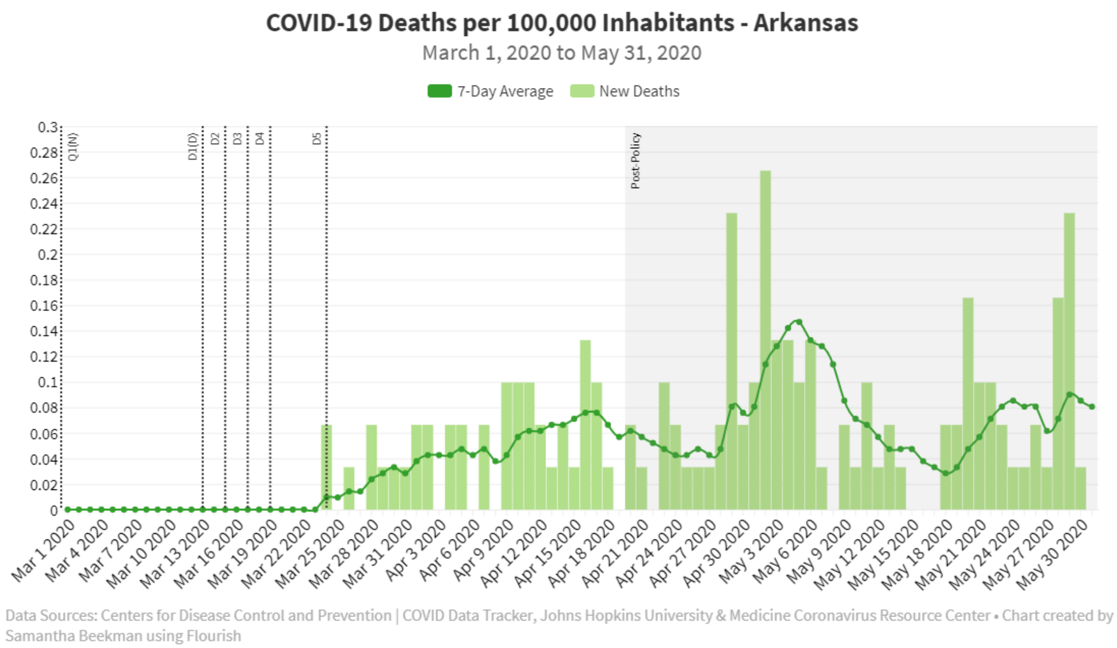

Figure 24: COVID-19 Deaths per 100,000 Inhabitants – Arkansas
(Centers for Disease Control and Prevention, 2021)

In *Figure 24* above, the timeline of Arkansas' physical distancing and isolation and quarantine policies is overlayed atop the timeline of new COVID-19 deaths per 100,000 inhabitants. The Pre-Policy period is in white, and the Post-Policy period is highlighted in a light gray. Here, you can begin to observe death trends and how they may have been shaped by policy as it was enacted, keeping in mind that COVID-19 deaths lag behind case trends by about two weeks.

4.5.3.1 Pre-Policy

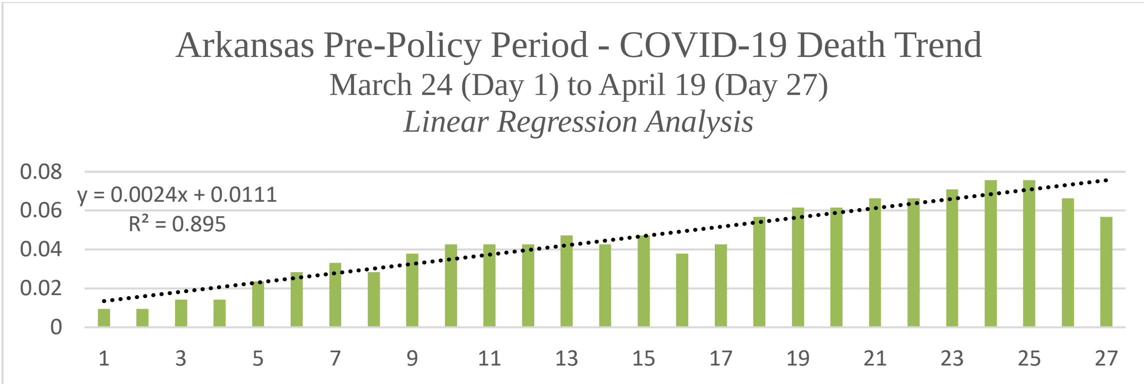

Figure 25: Arkansas Pre-Policy Period - COVID-19 Death Trend
(Centers for Disease Control and Prevention, 2021)

During the Pre-Policy period as shown in Figure 25 above, the linear regression is defined by the equation $y = 0.0024x + 0.0111$. The slope of this line is 0.0024, meaning that each day, the model predicts an additional 0.0024 new deaths per 100,000 inhabitants. The R Squared value is 0.90, indicating that the data is a good fit for the regression line and that 90% of the variation in new COVID-19 deaths might be explained by the passage of time after Arkansas' first COVID-19 death. The P-value is 9.66×10^{-14}. Because this number is less than the significance level of .01, the variable is considered statistically significant, and the results are unlikely due to random chance.

4.5.3.2 Post-Policy Period

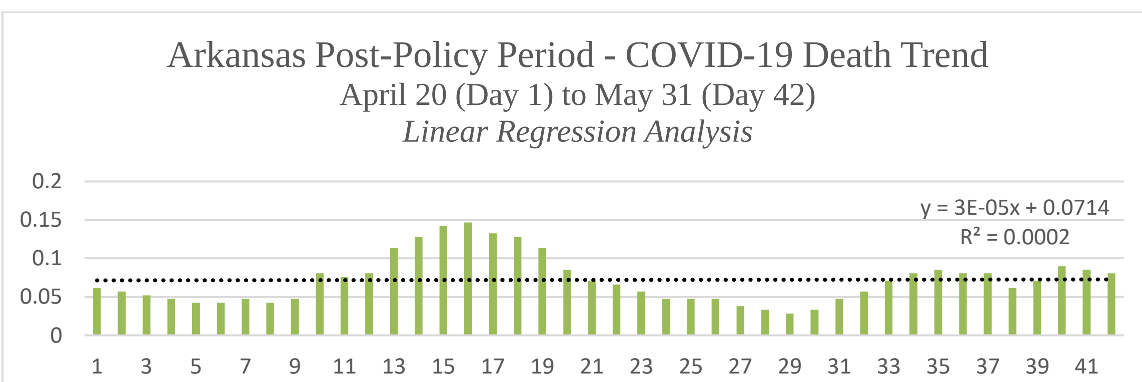

Figure 26: Arkansas Post-Policy Period - COVID-19 Death Trend
(Centers for Disease Control and Prevention, 2021)

During the Post-Policy period as shown in Figure 26 above, the linear regression is defined by the equation $y = .00003x + 0.0714$. The slope of this line is .00003, meaning that each day, the model predicts an additional 0.00003 new deaths per 100,000 inhabitants. The R Squared value is 0.0002, indicating that the data does not fit the regression line and that only 0.02% of the variation in new COVID-19 deaths can be explained by the passage of time after the change point. The P-value is 0.94, which is greater than the significance level of 0.01 and is therefore not statistically significant and suggests that the data could have been due to random chance.

4.6 American South

4.6.1 Policy

Prior to March 2020, the United States had enacted an isolation and quarantine policy which mandated isolation and quarantine procedures for those who entered the country from China, and by March 13 had enacted a travel ban for all foreign nationals visiting from high-risk countries including 26 European countries. Afterward, Louisiana enacted physical distancing and isolation and quarantine policies of its own requiring most non-essential businesses to close for in-person conduct including schools at all levels and many workplaces. Comparatively, Arkansas issued no isolation and quarantine policy of its own and implemented fewer physical distancing policies. Arkansas banned sit-down service at all restaurants and bars and closed some non-essential businesses, but not as many as Louisiana. Louisiana’s more physically restrictive policy strategy which focused policy on physical distancing and particularly isolation and quarantine strategies presented a stark policy divide between the two jurisdictions.

4.6.2 Cases

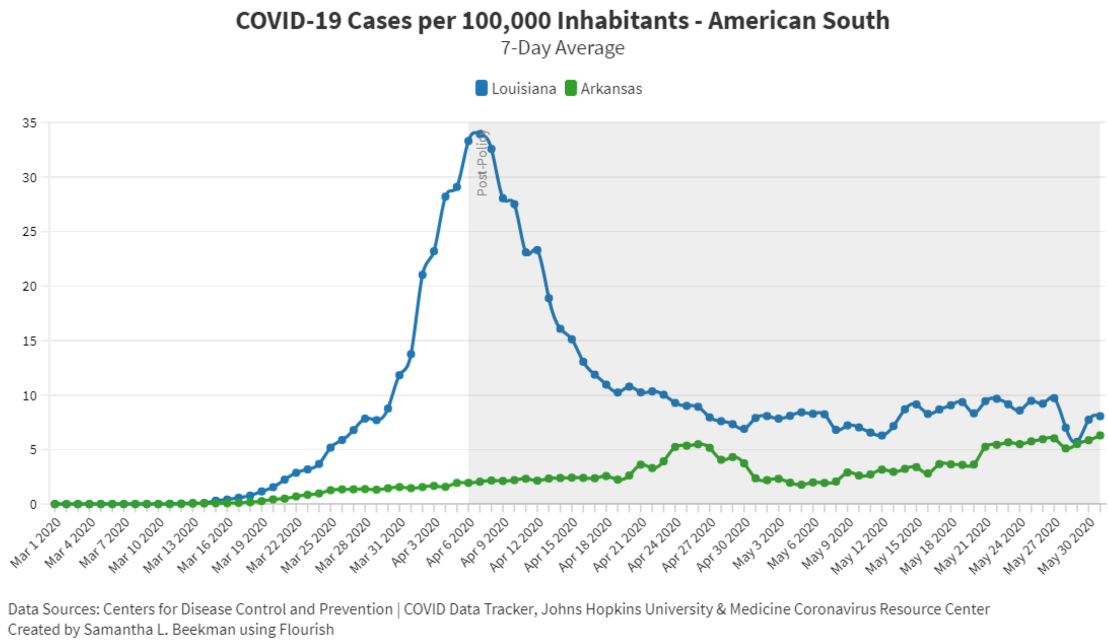

Figure 27: COVID-19 Cases per 100,000 Inhabitants - American South
(Centers for Disease Control and Prevention, 2021)

4.6.2.1 Pre-Policy Period

During the Pre-Policy period, Louisiana and Arkansas' linear regression analyses both yielded high R Squared values, indicating that both sets of data were good fits for their respective regression lines. Both slopes were positive, which meant that the two variables moved in tandem with each other in the same direction, and as time passed, there were more new COVID-19 cases.

However, the slope of Louisiana's linear regression line was more than ten times as large as Arkansas', at 0.9127 and 0.0838, respectively. This means that Louisiana's new COVID-19 cases grew at ten times the rate of Arkansas'. Also during this period, Louisiana's 7-day average of new COVID-19 cases per 100,000 inhabitants peaked at 33.95, representing a huge lead over Arkansas' peak of 1.95 during this time period, and again more than ten times the number. The significance levels of both of these linear regression analyses were well less than 0.01, so the models are both statistically significant. These factors demonstrate that COVID-19 was transmitted drastically wider much faster per capita in Louisiana than in Arkansas during this time period. Still, COVID-19 was present in Arkansas and had begun to spread.

4.6.2.2 Post-Policy Period

During the Post-Policy period, both Louisiana and Arkansas' linear regression analyses yielded a low R Squared value, indicating that the data is not a great fit for the regression line. In Louisiana, only 47% of the variation in new COVID-19 cases could be explained by the passage of time after the change point, and in Arkansas that number was 42%. Practically, this means there was not much of a relationship between the variables. In Louisiana, this is due to a steeper decrease in cases after the first several days of the change point followed by a plateau of a lower but steady number of cases as demonstrated in Figure 27. In Arkansas, this is due to the uneven increase in cases following the change point, with a small blip in cases a few weeks in and then an increase over the proceeding days through May 31 as demonstrated in Figure 27. Louisiana's slope is negative, indicating that as time passed, there were fewer new COVID-19 cases reported. However, the slope of Arkansas' regression line is positive, indicating that new COVID-19 cases grew as time went on. This is in contrast to Louisiana's negative slope and decreasing number of COVID-19 cases.

These models might suggest that the progression of time after Louisiana's implementation of physical distancing and isolation and quarantine policies had no significant effect on Arkansas' COVID-19 case levels, as one might expect, as Louisiana's policies were not in effect in Arkansas. They could also suggest that the policies may have improved health outcomes in the first days by sharply bringing down case levels, but transmission of COVID-19 was still present in Louisiana to some extent.

4.6.3 Deaths

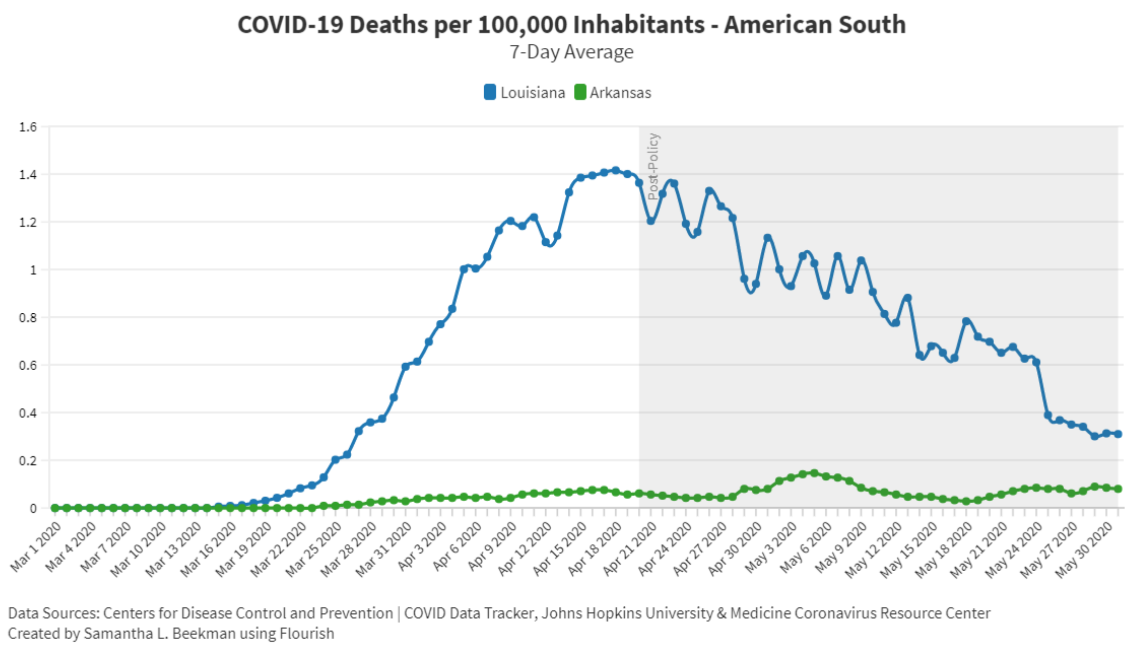

Figure 28: COVID-19 Deaths per 100,000 Inhabitants - American South
(Centers for Disease Control and Prevention, 2021)

4.6.3.1 Pre-Policy Period

During the Pre-Policy period, Louisiana and Arkansas' linear regression analyses both yielded high R Squared values, indicating that both sets of data were good fits for their respective regression lines. Both slopes were positive, which meant that the two variables moved in tandem with each other in the same direction, so as time passed, there were more new COVID-19 deaths.

However, the slope of Louisiana's linear regression line was more than 20 times larger than Arkansas', at 0.049 and 0.0024, respectively. Louisiana's new COVID-19 deaths grew almost exponentially faster than Arkansas', as demonstrated in *Figure 28*. During this period, Louisiana's 7-day average of new COVID-19 deaths per 100,000 inhabitants peaked at 29.1, more than 10 times higher than Arkansas' peak of 1.94. The significance levels of both of these linear regression analyses were well less than 0.01, so the models are both statistically significant.

4.6.3.2 Post-Policy Period

During the Post-Policy period, Louisiana's linear regression analysis yielded a high R Squared value, indicating that the data was a good fit for its regression line. The slope was negative, which meant that the two variables moved in tandem with each other in opposite directions, so as time passed, there were less new COVID-19 deaths. Louisiana's P-value indicates that the model is statistically significant.

During the entire timeframe, Louisiana's deaths peaked at 1.42 per 100,000 inhabitants and Arkansas' peaked at 0.15. In conjunction, these measures mean that Louisiana's COVID-19 deaths rose very quickly and much higher than Arkansas', and though its rate of change was decreasing faster than Arkansas' after each jurisdiction's peak, Louisiana's death levels were still very elevated compared to Arkansas' during the Post-Policy period.

Arkansas' linear regression analysis yielded an almost nonexistent R Squared value of 0.0002, indicating that the data does not fit the regression line and that only 0.02% of the variation in new COVID-19 deaths can be explained by the passage of time after the change point. The slope of Arkansas' linear regression line is likewise close to zero, at 0.00003. Practically, this means there was not much of a relationship between the variables. This measure could suggest that the progression of time after Louisiana's implementation of physical distancing and isolation and quarantine policies had no significant effect on Arkansas' COVID-19 death levels, as one might expect, as Louisiana's policies were not in effect in Arkansas.

Arkansas' P-value was 0.94, which is much greater than the significance level of 0.01. The model is therefore not statistically significant and could have been due to random chance rather than Louisiana's implementation of isolation and quarantine policies. It's clear that Louisiana's policies had no significant effect on Arkansas' COVID-19 deaths during the Post-Policy period. However, until and beyond May 31, Arkansas' COVID-19 deaths continue to increase.

These models could suggest that Louisiana's implementation of stricter isolation and quarantine-oriented COVID-19 policies made a significant difference in the health outcomes of affected populations in that COVID-19 deaths peaked and then subsided in Louisiana compared to Arkansas, where there was no isolation and quarantine policy intervention and death levels slightly grew during this period.

5. Conclusion

Both Norway and Louisiana implemented stricter physical distancing policies than their regional neighbors Sweden and Arkansas, and they also implemented isolation and quarantine policy, joined by neither Sweden nor Arkansas. The goal of these policies was to prevent the transmission of COVID-19 and improve the health outcomes of affected populations. The effects of these policies are demonstrated in the COVID-19 cases and deaths in each jurisdiction, and their relationship was calculated utilizing segmented regression analyses of interrupted time series data. These linear regression analyses indicated a statistical significance and a strong relationship between the effects of isolation and quarantine policy in the jurisdictions which enacted them and a positive result in the health outcomes of affected populations. In each case, cases and deaths subsided after the implementation of this policy.

However, not all external factors can be controlled, and several surfaced during this study which leave further questions for other researchers to analyze.

In the Scandinavian group, the linear analyses demonstrated that COVID-19 was transmitted much wider much faster per capita in Norway than in Sweden during this time period. However, while Norway did see a significant decrease in COVID-19 deaths following its implementation of isolation and quarantine policies, Sweden saw the same despite enacting none. These models could suggest that some outside factor influenced the subsidence of Sweden's COVID-19 deaths, and this factor could have also played a role in the progression of Norway's COVID-19 deaths as well. This indicates that the implementation of stricter isolation and quarantine-oriented COVID-19 policies might not necessarily be the principal factor impacting the health outcomes of affected populations for this metric. Because the shape of case trends do not mirror the shape of death trends, this factor could have to do with the nature of the virus itself. Alternatively, it could pertain to the spread of the virus; if COVID-19 was more widely spread to vulnerable or high-risk populations, we might see a higher number of deaths even if the overall case trend did not increase. This discussion illuminates one limitation of this study: COVID-19 is not egalitarian in its impact on a population. Those who are more vulnerable to the virus and to complications from the ensuing disease have worse health outcomes which are not necessarily one-to-one with infection rates.

Still, Norway's COVID-19 deaths were significantly lower than Sweden's, and despite Sweden's rate of change decreasing faster than Norway's after each jurisdiction's peak, Sweden’s death levels were still very elevated compared to Norway’s. This indicates that severity of COVID-19 deaths may have been lessened due to Norway’s isolation and quarantine policies.

In the American South group, the sheer number of COVID-19 cases and ensuing deaths was many times higher in Louisiana than in Arkansas. The peak of Louisiana’s COVID-19 cases per 100,000 inhabitants was more than ten times that of Arkansas. However, Louisiana’s case and death trends both shifted to a decrease after the implementation of isolation and quarantine policy. Overall, Arkansas’ case and death numbers increased throughout the time period. These models suggest that Louisiana’s implementation of stricter isolation and quarantine-oriented COVID-19 policies made a significant difference in the health outcomes of affected populations in that COVID-19 deaths peaked and then subsided in Louisiana compared to Arkansas, where there was no isolation and quarantine policy intervention and death levels slightly grew during this period.

Louisiana’s outsized number of cases compared to Arkansas in during this period may have impacted the results of the statistical analyses. In a more in-depth study, a researcher might extend the time period examined to analyze each jurisdiction’s cases and deaths over a longer period of time. Arkansas’ COVID-19 cases and deaths continued to increase until January 2021, while Louisiana experienced three different waves of COVID-19 during that time period where cases and deaths increased, peaked, and then subsided. One would be able to extend the regression analyses through this period for a more full picture of case and death trends and how policies work on a longer term.

Another major limitation of this study and any study utilizing COVID-19 case data in any jurisdiction is that reported case counts are an inherently imperfect measurement of the spread of the virus. The number of reported COVID-19 cases depends on many other external factors such as a jurisdiction's supply of tests and an individual's access to receive a test, as well as an individual's desire to take the test. One way to try and control for this factor is by including the analysis of a jurisdiction's positivity rate, or the share of tests with a positive result in any batch of reported tests. A high positivity rate likely indicates much external, untested spread of the virus in the community, and it would help to temper the unreliability of testing and test reporting.

This study also did not include COVID-19 hospitalizations in each jurisdiction, is another important measure of COVID-19's impact on a population's health outcomes. It is also a more reliable metric than case numbers, as it doesn't rely on testing.

These other considerations which go beyond the scope of this study could all be explored utilizing a similar method to that established herein.

Ultimately, this study concludes that isolation and quarantine policy strategies with the goal of preventing the transmission of COVID-19 improved the public health outcomes of the populations within the jurisdictions where this policy was enacted.

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