PIONEER
ACADEMIC PUBLISHING LIMITED

Journal of Research in Social Science and Humanities
ISSN 2709-1910
www.pioneerpublisher.com/jrssh
Volume 3 Number 10 October 2024

Wall, Wall in the Mirror: Which Is the Sturdiest of Them All?

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doi:10.56397/JRSSH.2024.10.12

Abstract

This research examines the comparative effectiveness of physical versus virtual border walls in managing illegal border crossings along the U.S.-Mexico border, focusing on Yuma, Arizona, and Laredo, Texas. It addresses the question of which type of infrastructure is more efficient in reducing migration and how these approaches influence crossing patterns. Previous studies have largely concentrated on other factors of migration such as economic conditions, overlooking the role of evolving border security systems. This gap in the literature calls for a deeper analysis of these evolving strategies. Utilizing U.S. Customs and Border Protection data from 2020 to 2024, the study analyzes border encounters in these regions, employing time series analysis to investigate shifts in crossing rates and demographic trends. Our findings reveal that physical barriers are effective when properly maintained but lose deterrence power when consistent maintenance and construction is absent. Conversely, virtual walls provide consistent monitoring but are less effective in significantly deterring crossings. Both methods present significant ethical concerns, as physical walls drive migrants to more dangerous routes, while virtual walls amplify surveillance and privacy issues. We conclude that a hybrid approach, integrating physical and technological solutions, could better balance migration management with ethical border enforcement.

Keywords: physical border wall, virtual border wall, migration patterns, border security, U.S.-Mexico border

1. Introduction

In an era marked by rapid technological advancements, the integration of automated systems into various sectors of society is transforming how the government addresses longstanding challenges. Among these is the issue of border security, which has gained increasing prominence in political debates within the United States. As technology continues to push the boundaries of what is possible, the development of sophisticated surveillance and artificial intelligence (AI) systems is reshaping the methods by which borders are managed and secured. This paper examines the intersection of these technological innovations with border security, focusing on the comparative effectiveness of physical barriers versus automated surveillance systems along the U.S.-Mexico border, known as the "virtual border wall." By analyzing recent trends and data, this study seeks to provide a comprehensive understanding of how these

technologies impact border deterrence and the broader implications for national security and human rights.

Automated surveillance systems are expected to become an increasingly important part of U.S.-Mexico border security. Initially installed in 2018, they later became a program of record in 2020, called the Integrated Surveillance Towers (IST) ("CBP's Autonomous Surveillance Towers"). The "virtual border wall" has been shown to be a bipartisan effort, initially begun by the Trump administration which, according to the Washington Post, brokered a five-year agreement with Anduril Industries to deploy hundreds of towers (Biesecker). This initiative has since been expanded by the Biden administration, in the creation of a network of hundreds of towers. The Department of Homeland Security's (DHS) budget request for the 2025 fiscal year includes $101 million to upgrade and maintain existing towers. According to Defense Daily, U.S. Customs and Border Protection (CBP) plans on acquiring 277 new IST towers supplied by Advanced Technology Systems Company, General Dynamics, and Elbit America. According to the Electric Frontier Foundation, as of July, there were 479 towers along the border, and CBP has plans for 336 future deployments ("CBP Is Expanding Surveillance Tower Program").

Thus, as the "virtual wall" continues to extend alongside the U.S.-Mexico border, the following question is posed in this study: *How does the implementation of the virtual US-Mexico border wall affect border deterrence and human rights conditions compared to the physical border wall?*

In this paper, the physical border wall refers to tangible, constructed barriers, such as fences or walls, that are erected along the border to prevent or deter unauthorized crossings. These physical structures are typically reinforced by on-ground enforcement measures like border patrol agents and checkpoints. On the other hand, the virtual wall will refer to series of Autonomous Surveillance Towers (AST), specifically the "Sentry" towers developed by Anduril Industries which have been deployed at the border (Electronic Frontier Foundation). For the purposes of this research and to make a geographic comparison possible, the virtual wall will not include Remote Video Surveillance Towers (RVSS), because there is no segment of the border where RVSS is absent, but a physical wall is present. Additionally, ASTs, with autonomous detection and decision-making, represent a shift toward technology-driven solutions, unlike RVSS, which still relies on human monitoring to check footage. Although RVSS could be considered part of a virtual wall, excluding it in this analysis allows a clearer comparison between autonomous systems and human-dependent methods. This approach is particularly crucial given the growing role of automation in shaping border control, as ASTs comprise the majority of future deployments.

Scientifically, this research advances theories of migration — in particular, it pays specific attention to the role of borders in systems of international migration, thus filling theoretical gaps in both the initiation and perpetuation of international migration. Existing migration theories, while some implicitly create room for the role of borders, do not address how borders affect international movement. For instance, world systems theory, dual labor market theory, and the macroeconomic theory of migration, do not leave room for borders to affect migration. The neoclassical microeconomic theory of migration assumes that decisions for migration are made based on a rational calculation of costs versus benefits, and while a part of that calculation assumes "the probabilities of avoiding deportation," it does not explain how border controls affect that probability as opposed to interior enforcement and other variables. Institutional theory, similarly, posits that private institutions and voluntary organizations help sustain international movement, such as services that smuggle migrants in. Thus, the theory assumes the role of barriers as something which prompts institutional response, thus helping to sustain international movement. However, again, it fails to explain how the barriers themselves affect institutions as opposed to other sources of social capital for institutions and organizations, such as social services, shelter, counterfeiting documents, and so on. This research aims to fill these gaps by explaining how different borders influence institutional responses, deportation, and ultimately the flow of migration.

Practically, the findings of this research are important to informing future policy decisions regarding the US-Mexico border, especially now as immigration is a larger issue than ever with the upcoming 2024 election. Thus, these insights can inform campaign platforms, future policies, and voter decisions regarding a key topic on the

legislative agenda.

Additionally, the implications of this research extend beyond the US-Mexico border, offering valuable lessons for other global migration contexts. Around the world, countries are experimenting with technology to modernize their borders, from the smart borders of Europe, to Israel's separation barrier. These regions, like the US-Mexico border, are experimenting with a combination of physical barriers and advanced surveillance technologies in an attempt to manage migration and security threats. Thus, this research can help identify where types of borders excel and how they can be effectively combined depending on specific environments.

2. Literature Review

2.1 Review of Literature on Effectiveness of Virtual Versus Physical Walls

Very few studies exist concerning the most recent developments in border surveillance technology, especially statistical analysis of their effectiveness. This gap highlights the need for a thorough examination of how modern border technologies perform in practice, especially given their frequent deployment.

According to Dr. Josiah Heyman, a Professor of Anthropology currently focusing on migration and human rights at the U.S.-Mexico border, virtual walls face several limitations. Besides border enforcement failing to deter unauthorized migrants as a whole due to entries simply shifting elsewhere, Dr. Heyman suggests that current technologies employed in virtual border walls remain largely untested and unreliable, raising significant concerns about their effectiveness (Heyman, 316-317). However, Heyman's article was written in 2008, and since then, much has changed in the creation and use of border technology, with surveillance towers and advanced systems being deployed very frequently now. Additionally, Heyman does caution against prematurely concluding that virtual walls are ineffective, emphasizing the need for a longer-term assessment to accurately gauge their impact (317). Despite the article's age, concerns about the general failure of border enforcement to fully deter crossings remain relevant today. Heyman's data on early virtual wall efforts and their failures is valuable as a foundation, but it underscores why more recent, updated research is crucial. Thus, this research is significant, serving as a longer-term evaluation of the virtual border wall to identify whether current virtual wall systems are now fulfilling the operational promises made by both governmental and corporate stakeholders, or if they continue to fall short of expectations.

Additionally, Tamara Vukov and Mimi Sheller, both scholars focused on mobility research, there are notable shortcomings to virtual walls. Weather, for instance, is capable of triggering radars and ground sensors (Vukov & Sheller, 237). SBInet, a U.S. government program initiated in 2005 aimed at creating a "virtual fence" through advanced surveillance technologies, also failed to deliver promised success rates despite massive expenditures (237). Similar to Heyman, Vukov and Sheller's article was written in 2013, and does not assume new surveillance technology that the Trump and Biden administrations employed. However, this source is still applicable in its discussion of consistent issues like weather interference and past program failures, which continue to inform concerns over modern virtual wall efforts. Additionally, the failure of previous virtual wall attempts indicates the need for cautious optimism in hypothesizing the success of current surveillance technologies, as past failures suggest the potential for similar outcomes today.

Kevin Hernandez, from Texas A&M University School of Law, agrees with Heyman that physical border walls fail to deter unauthorized migrants, and identifies several other limitations such as the environmental tradeoffs (Hernandez, 81) and economic harm to Latinx border communities (76). However, he posits the virtual wall as an alternative solution, which he argues is less environmentally harmful and more effective. Namely, it allows for more consistent technology-based patrols in places that are difficult to monitor, and more resource-efficient responses to illegal crossings (82). However, Hernandez's work has its limitations. As a student piece, it is largely theoretical and lacks the data-driven analysis necessary for making definitive conclusions. While the ideas presented offer useful suggestions for potential benefits of virtual walls, they remain speculative without supporting empirical evidence.

Based on existing literature, it is hypothesized that the implementation of the virtual US-Mexico border wall will have a mixed effect on border deterrence compared to the physical border wall. While virtual surveillance technologies may lead to more efficient

monitoring and reduced environmental impact, they are unlikely to significantly improve overall deterrence of unauthorized crossings, as migrants will continue to adapt to enforcement measures by shifting their entry points. Furthermore, the increased reliance on technology-based enforcement may exacerbate human rights violations, such as privacy infringements and the risk of more frequent encounters between migrants and law enforcement, without addressing the root causes of migration or ensuring adequate humanitarian protections.

This hypothesis anticipates that while the virtual wall may offer technological advantages, it will struggle with the same fundamental issues as the physical wall, including the failure to fully deter migration and potential negative implications for human rights.

2.2 Review of Literature of Human Rights Implications of Virtual Versus Physical Wall

There is significantly more? literature on the human rights implications of the border wall, particularly the surveillance technologies involved in the construction of a virtual wall. Notably, there is a consensus in the literature base on the negative human rights implications of both types of walls, with researchers largely agreeing on concerns with increased surveillance and the lethal effects of deterrence.

According to Christopher J. Coyne and Nathan P. Goodman, economists at George Mason University specializing in the intersection of economics and civil liberties, the use of virtual walls for border enforcement significantly amplifies surveillance and intrudes upon privacy rights. They argue that the surveillance technologies inherent to the virtual wall lead to violations of the Fourth Amendment, eroding civil liberties not only for migrants but also for U.S. citizens (Coyne and Goodman, 9). Their study is valuable in understanding the surveillance implications of virtual walls, especially regarding privacy concerns, but its limitation is the heavy focus on economic perspectives rather than broader human rights impacts.

In a 2023 report from the nonprofit No More Deaths, humanitarian advocates emphasize that physical border enforcement exacerbates human rights violations, by "funneling" migrants crossing the border into the most remote and deadly regions of the U.S. In particular, Pima County accounts for 50% of known immigration-related deaths (No More Deaths, 5). Even as distress calls are received, they are often deferred to Border Patrol which frequently delays or denies timely medical access, mainly based on one's migrant status. This report highlights the lethal consequences of physical border enforcement, but its limitation lies in the narrow geographic focus, which may not reflect the full scale of the issue across the U.S.-Mexico border (13).

Similarly, geographers Samuel Norton Chambers et al. agree that border enforcement pushes migrants into more dangerous and remote terrain but apply the "funnel effect" to the virtual wall. They argue that surveillance infrastructure along the U.S.-Mexico border, particularly through the virtual wall's expansion, leads to increased migrant mortality by pushing migrants into more dangerous and remote terrain (Chambers et. al, 18). Using geospatial modeling, their study shows a strong correlation between surveillance and human remains locations, indicating that virtual walls escalate the physiological toll on migrants. The study is highly reliable due to its rigorous methodology, but it focuses heavily on the specific corridor of southern Arizona, limiting its generalizability.

Thus, it is hypothesized that the implementation of virtual and physical walls along the U.S.-Mexico border leads to distinct human rights violations, each manifesting in different ways. Virtual walls, with their extensive surveillance infrastructure, are likely to exacerbate privacy violations, intrude on civil liberties, and create a pervasive sense of constant monitoring. These effects extend beyond migrants, impacting residents in border areas. On the other hand, physical walls are more likely to directly lead to life-threatening situations by obstructing emergency services, funneling migrants into dangerous terrain, and causing preventable deaths. While both forms of enforcement create significant human rights concerns, the virtual wall's focus on surveillance may lead to broader, more insidious civil liberties violations, whereas the physical wall's impact is more immediate and life-threatening for migrants crossing the border.

3. Methodology

3.1 Data Collection

Data on border encounters was sourced from the

U.S. Customs and Border Protection (CBP) Nationwide Encounters database, covering October 2020 (FY 2021) to June 2024. This dataset includes U.S. Border Patrol (USBP) Title 8 Apprehensions, Office of Field Operations (OFO) Title 8 Inadmissibles, and Title 42 Expulsions. This data is authored by Customs and Border Protection, the agency responsible for regulating and enforcing the border in an accountable and transparent manner, and it is published on official U.S. government websites. As such, it can be expected to be reliable.

3.2 Methods of Analysis

To determine the relative effectiveness of a physical border wall versus a "virtual" border wall, a geographic comparison was made between two locations along the US-Mexico border: Yuma, Arizona, and Laredo, Texas. Yuma has no Autonomous Surveillance Towers, while Laredo has no physical barriers. Thus, Yuma is illustrative of physical walls, while Laredo is illustrative of virtual walls. By analyzing data on border encounters for Yuma and Laredo, a comparative analysis of physical walls versus virtual walls' effectiveness can be made.

Maps of the physical wall and virtual wall were utilized to determine that Yuma and Laredo would be the locations of comparison, by identifying Yuma as a sector with only physical fences, and Laredo as a sector with only Autonomous Surveillance Towers. A map of the physical wall was obtained from "The Wall" project by the USA Today Network, which maps every known piece of border fence via flying and driving the entire border and cross-referencing findings with public records, satellite imagery, on-the-ground reporting, and digital property maps. USA Today is namely a news organization, limiting their authority in mapping skills such as geospatial analytics. However, USA Today's map comes with easily accessible aerial footage of every part of the border, which provides more reliability.

For the virtual wall map, the Electronic Frontier Foundation (EFF)'s map was used, which tracks over 290 autonomous surveillance towers installed by CBP along the border, via public records, satellite imagery, and road trips. EFF is a digital rights non-profit organization that mainly deals with litigation, lobbying, and activism, limiting their authority in mapping. Additionally, as an organization that campaigns against legislation perceived to infringe on personal freedoms, the EFF has a vested interest in scrutinizing surveillance measures. Thus, while the map is a necessary tool, its data should be considered with caution.

Upon collecting data on border encounters for both Yuma and Laredo, time-series graphs over the course of four fiscal years were created. These graphs were further segmented by demographic groups, including unaccompanied children, single adults, and family units (FMUA). They were also segmented by citizenship of the migrants. Additional graphs included a graph of the sum of encounters for Laredo and Yuma over time, and the difference in encounters between the two regions over time.

3.3 Key Limitations

The data has two key limitations, namely a relatively short timeframe of only 4 years. A longer time horizon would provide more robust insights, capturing trends that may emerge over extended periods. Additionally, data on border encounters may not entirely measure the effectiveness of the type of border itself, as it does not consider those who crossed the border without detection. However, it can sufficiently measure the deterrence capabilities of a virtual versus physical border wall.

Additionally, a limitation of the analysis is that there are only two locations under consideration, whereas a more robust analysis would include multiple sites with similar configurations, allowing for broader comparisons and stronger conclusions.

4. Findings and Discussion

4.1 Total Border Encounters of Laredo Versus Yuma

4.1.1 Border Encounters over Time

This section analyzes the fluctuations in border encounters over time at Yuma and Laredo and considers how the implementation of physical and virtual border barriers influences migrant deterrence.

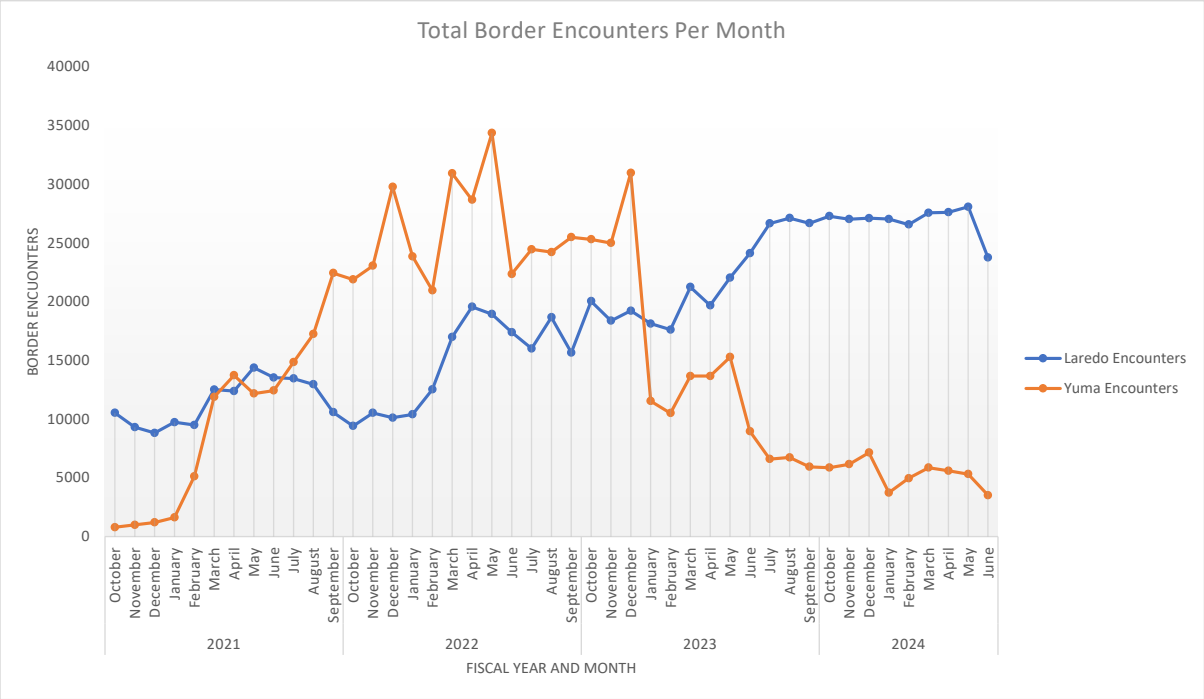

Figure 1. Total Border Encounters Per Month of Laredo and Yuma

Historically, border encounters tend to peak during December, with fluctuations depending on the type and state of border infrastructure. According to the data in Figure 1, this seasonal pattern is apparent in Yuma, where spikes in encounters are observed in December 2021 and December 2022. However, this pattern does not hold in Laredo, suggesting a distinct dynamic between the two regions. The discrepancy in the trends could be attributed to differences in border enforcement strategies, specifically the impact of a physical wall in Yuma versus virtual surveillance in Laredo.

Until January 2021, border encounters at Yuma were relatively low, while Laredo experienced consistently higher numbers. This difference correlates with the extensive construction of physical barriers in Yuma up until early 2021, during which 107 miles of new border wall were completed (Associated Press). The deterrent effect of the physical border wall appears effective during this period, as encounters remained minimal. However, in February 2021, following the Biden administration's halt to construction on physical walls, Yuma began experiencing a surge in encounters. By July 2021, Yuma overtook Laredo as the more popular crossing point. This shift suggests that the cessation of construction and the resultant gaps in the wall weakened the deterrent effect of Yuma's physical barrier (Rivera).

The spike in encounters continued throughout 2021 and 2022, with the largest peak occurring in December 2022. This may be explained by the exacerbation of seasonal migration flows, as physical gaps created by the halted construction allowed for increased crossings. Attempts by Arizona Governor Doug Ducey to close these gaps with shipping containers in August 2022 proved only temporarily effective, as Yuma's border crossings continued to rise during this period. The ineffectiveness of these temporary barriers became evident when border encounters drastically dropped in January 2023, following the U.S. government's deconstruction of the container walls and the Biden administration's resumption of border wall construction, this time with more advanced bollard gates and temporary fencing (Perez).

In contrast, Laredo's border encounters show a relatively stable trend throughout this period, even in the absence of a physical barrier. As noted in Figure 1, Laredo encounters remained lower than Yuma's after July 2021, despite the lack of a constructed wall. This suggests that the virtual surveillance infrastructure implemented in Laredo may have provided a more consistent and stable form of deterrence compared to the physical wall in Yuma. Virtual surveillance, which includes the use of drones, sensors, and automated monitoring systems, potentially deters irregular migration in a more continuous

manner than the physical barriers whose effectiveness fluctuated depending on their maintenance and stage of construction.

Additionally, the stability in Laredo could be attributed to broader environmental and geopolitical factors. The Binational River Conservation Project, proposed in 2021, prevented the construction of a physical wall in Laredo ("Instead of a Wall, Park To Be Built"). The ongoing diplomatic efforts associated with this conservation initiative may have fostered a different dynamic in border management, leading to a more regulated and predictable flow of migrants, compared to the construction-stalled regions like Yuma. The steady increase in encounters in Laredo, however, remains in line with nationwide trends, as total U.S. encounters have been steadily increasing during this period.

When comparing the virtual surveillance in Laredo to the physical wall in Yuma, the data shows several key differences in terms of border deterrence. Yuma's physical wall, while initially effective, suffered from gaps and construction delays that led to unpredictable surges in migration. The temporary use of shipping containers in 2022 as a makeshift wall was ineffective in maintaining deterrence, raising concerns about both the practical and humanitarian implications of such infrastructure. The need to constantly adjust or repair physical barriers suggests that they may contribute to chaotic and dangerous crossing conditions, increasing risks for migrants and complicating border management efforts.

On the other hand, the virtual border wall in Laredo has not experienced the same variability in deterrence. The more stable and predictable environment suggests that technological surveillance may create fewer instances of mass crossings, reducing the risks of dangerous overcrowding and humanitarian crises at the border. However, it is important to consider the potential human rights implications of increased surveillance. While virtual monitoring may be more humane by limiting the physical dangers of crossings, it also raises concerns about privacy and the use of high-tech systems to track and apprehend individuals in vulnerable situations. The balance between deterrence and human rights remains a critical issue in this analysis.

The findings from this analysis indicate that while physical walls can provide strong deterrence when fully constructed and maintained, their gaps and delays often lead to unpredictable surges in migration, with negative consequences for both border security and human rights. In contrast, virtual surveillance systems, as implemented in Laredo, offer a more stable form of deterrence, though they come with their own set of ethical concerns. Future policy should consider integrating both physical and virtual strategies in a balanced manner, ensuring both security and the protection of human rights at the U.S.-Mexico border.

4.1.2 Sum of Total Encounters for Laredo and Yuma over Time

This section analyzes the sum of border encounters in both Laredo and Yuma per month.

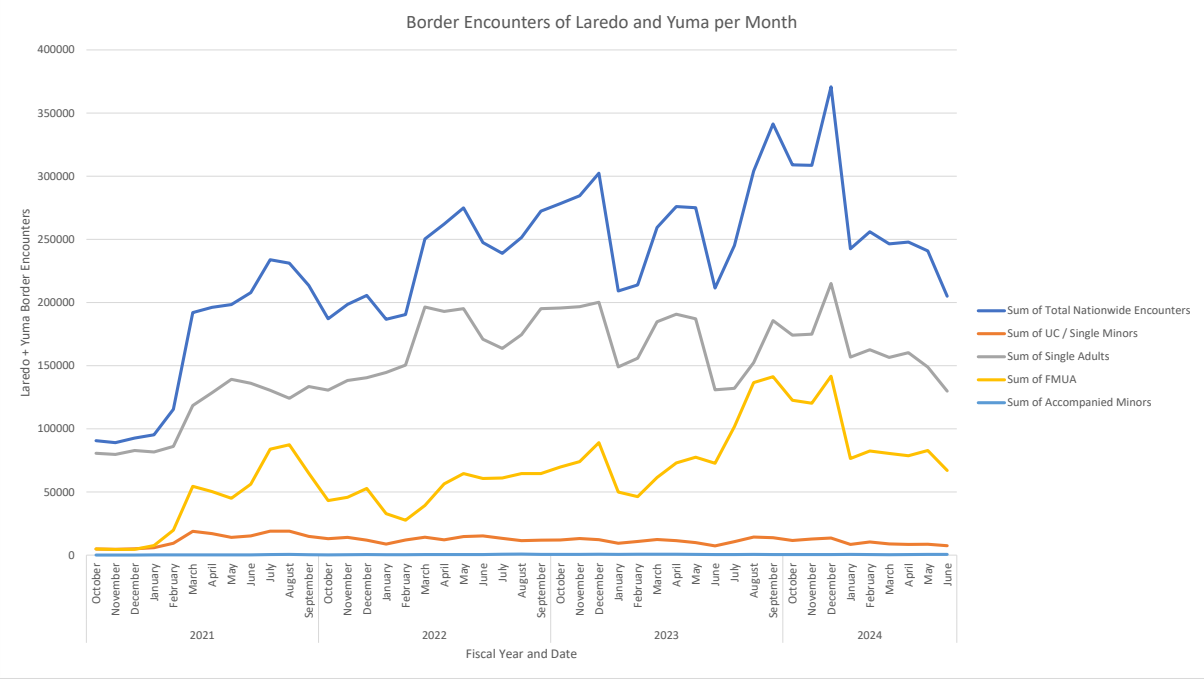

Figure 2. Sum of Total Border Encounters Across Laredo and Yuma per Month

The migration trend shown in Figure 2 aligns with broader migration trends seen nationwide. The blue line, representing the sum of total encounters, reflects a clear upward trend over time, signaling consistent migration pressures across the U.S.-Mexico border. This trend is likely driven by persistent push factors such as economic instability, political unrest, and climate-related issues in countries of origin, as well as pandemic recovery impacts that intensified migration flows throughout 2021 and 2022.

One of the most notable features of the data is the seasonal pattern in border encounters. Peaks are consistently observed between August and October each year, which aligns with the timing of milder weather conditions that make crossing the border more feasible. This period may also coincide with increased demand for agricultural labor in the U.S., further driving migration during these months. In contrast, the data shows a decline in border encounters during the winter months, particularly around December and January, which likely reflects harsher weather conditions that deter migrants from attempting the journey. The December-January period also tends to coincide with holidays, further contributing to reduced migration activity.

There are also clear indications of policy-driven shifts within the data. Notably, the sharp declines in encounters in October-November 2022 and again in December 2023-January 2024 suggest that increased border enforcement or administrative actions had a temporary effect on reducing crossings. For instance, the October 2022 decline may be tied to stricter enforcement measures under the Biden administration, while the 2023 dip may be influenced by a combination of seasonal factors and targeted policy changes, such as deportation operations or temporary border restrictions.

Despite these periodic declines, the broader trend in total encounters continues to rise, underscoring the persistent upward pressure of migration. Unless significant geopolitical or economic changes occur, migration flows will likely remain high.

4.1.3 Difference in Total Encounters Between Laredo and Yuma

This section analyzes the difference in border encounters between Laredo and Yuma per month.

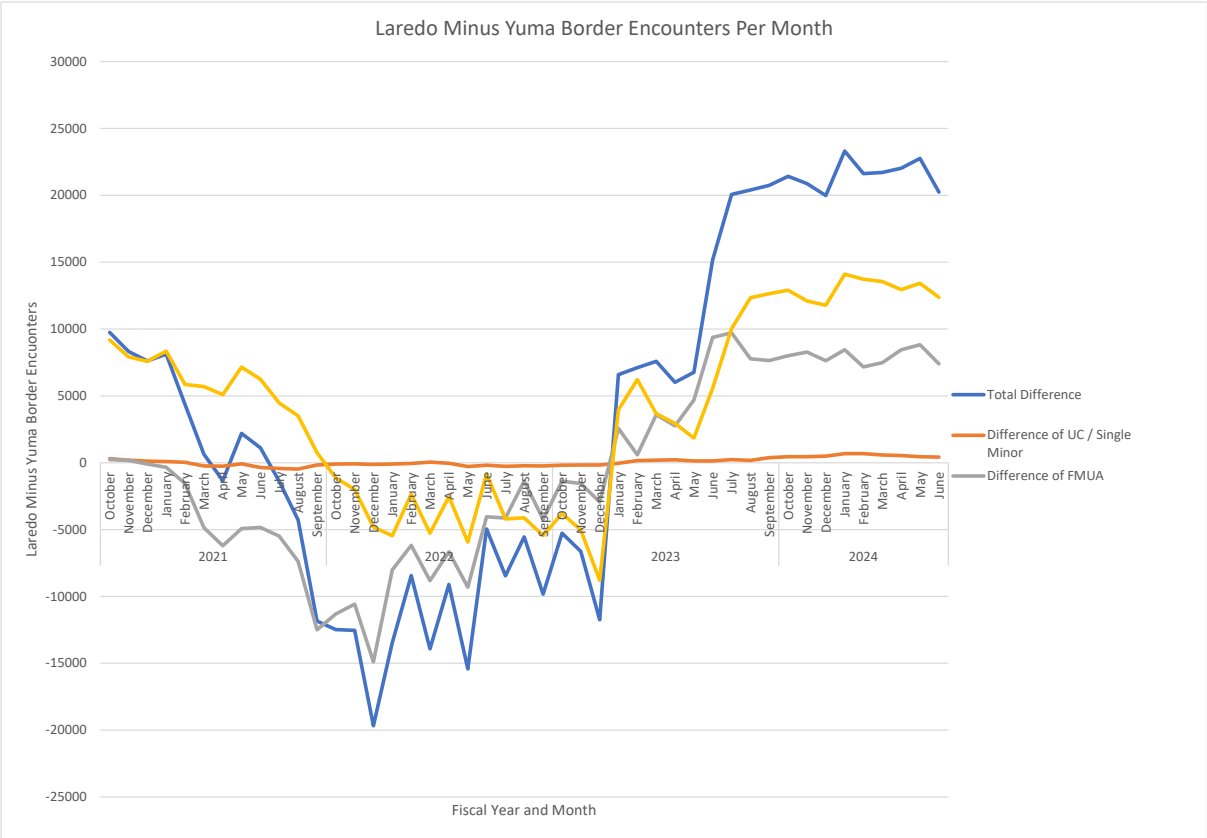

Figure 3. Difference in Border Encounters for Laredo and Yuma per Month (Laredo minus Yuma)

The difference in border encounters between Laredo and Yuma over time reveals several key patterns that align with the analysis of border encounters across both regions. Yuma's rise in encounters since January 2021 is especially notable, following the halt in physical wall construction. This surge, reflected in the Figure 1 analysis, is a significant shift where Yuma overtook Laredo in terms of total crossings, particularly after July 2021. This aligns with the upward trend seen in the difference graph, which shows a strong increase in encounters at Yuma relative to Laredo starting in mid-2021.

The December 2021 and December 2022 spikes in encounters at Yuma, discussed in the encounter analysis, are also evident in the difference graph. This reflects Yuma's seasonal peaks, especially during times when physical barriers had gaps or were under maintenance, allowing for increased crossings. The temporary use of shipping containers as a barrier in Yuma, which proved ineffective as mentioned in the encounter analysis, also appears in the difference graph, where Yuma encounters remained significantly higher than Laredo's during the latter half of 2022.

On the other hand, Laredo's stable encounter rates throughout the period align with the difference graph's findings that Laredo experienced less fluctuation. The virtual surveillance system in Laredo, mentioned in the analysis, appears to have provided a steadier form of deterrence compared to Yuma's physical wall, where encounters surged when gaps emerged. The difference graph supports this observation by showing that Laredo maintained a relatively consistent rate of encounters, especially when compared to Yuma's more volatile trends.

The sharp decline in encounters at Yuma in early 2023, following the resumption of border wall construction, is also captured by the difference graph. This decline mirrors the encounter analysis, which points out how the construction of advanced bollard gates and fencing led to fewer crossings at Yuma, reinforcing its deterrent effect once more.

Overall, the difference graph confirms many aspects of Figure 1. Yuma's encounter trends are characterized by greater variability, largely driven by physical infrastructure issues and seasonal migration flows. In contrast, Laredo's

encounter rates reflect the stability brought by virtual surveillance, with fewer fluctuations over time.

4.2 Demographic Composition of Border Crossings for Laredo Versus Yuma

Figures 4 and 5 show the shifting demographic composition of border encounters at Yuma and Laredo over time, focusing on three primary migrant groups: Single Adults, Individuals in a Family Unit (FMUA), and Unaccompanied Children (UC) / Single Minors. By analyzing these trends, insight can be gained regarding the evolving nature of migration patterns at these points of entry.

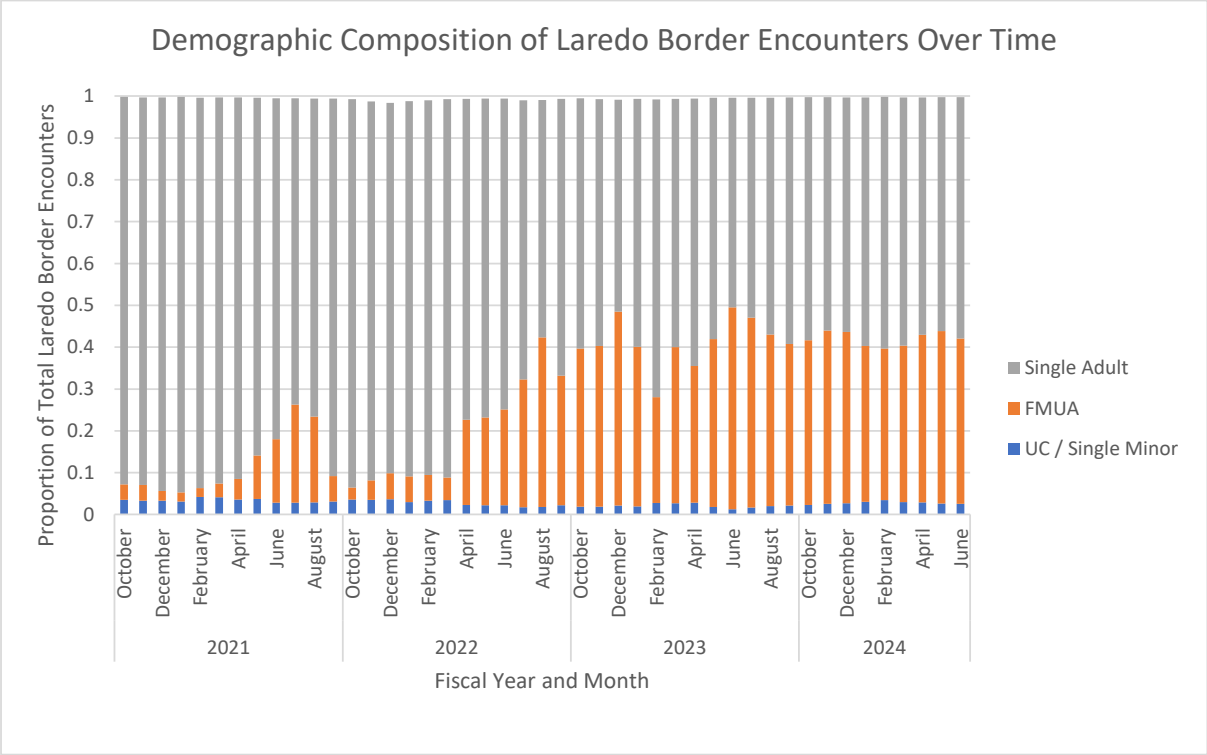

Figure 4. Demographic Composition of Laredo Border Encounters Over Time

As shown in Figure 4, Single Adults represent the dominant demographic in border encounters at Laredo, maintaining a consistently high proportion over the years. This group accounts for nearly all border crossings in late 2021, with little variance over time. In contrast, the proportion of Family Unit Aliens (FMUA) began to increase notably around mid-2022, reaching its peak in early 2023, before slightly declining in mid-2024. The proportion of Unaccompanied Children (UC) has remained relatively stable and consistently low throughout the period, rarely surpassing 5% of total encounters.

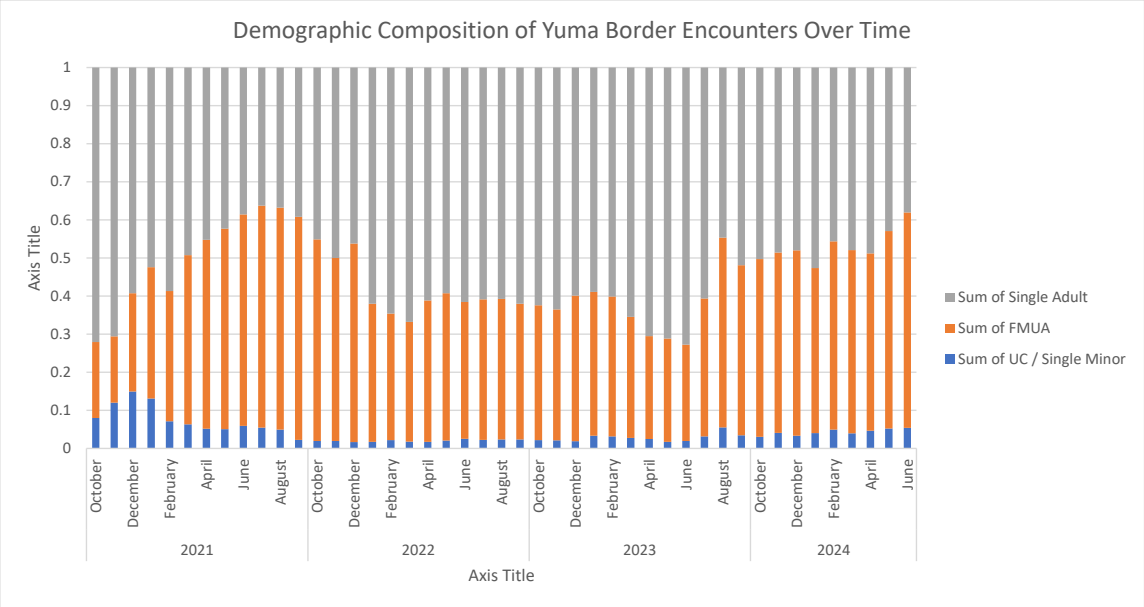

Figure 5. Demographic Composition of Yuma Border Encounters over Time

In contrast to Laredo, the Yuma sector shows a significantly higher proportion of encounters involving Family Unit Aliens (FMUA). Beginning in early 2021, FMUA makes up almost half of all border encounters and remains a major component through 2024. The peak of FMUA encounters occurs in mid-2021, when FMUA makes up over half of all crossings, before stabilizing to around 30-40% in subsequent months. It then reaches this peak again in June, 2024. Single Adults, while still the largest group overall, have a much smaller share of encounters compared to Laredo, consistently fluctuating between 50-60%. The proportion of Unaccompanied Children, though somewhat higher in Yuma than Laredo, still remains minor, rarely exceeding 10% of the total encounters.

4.2.1 Border Encounters with Single Adults for Laredo Versus Yuma

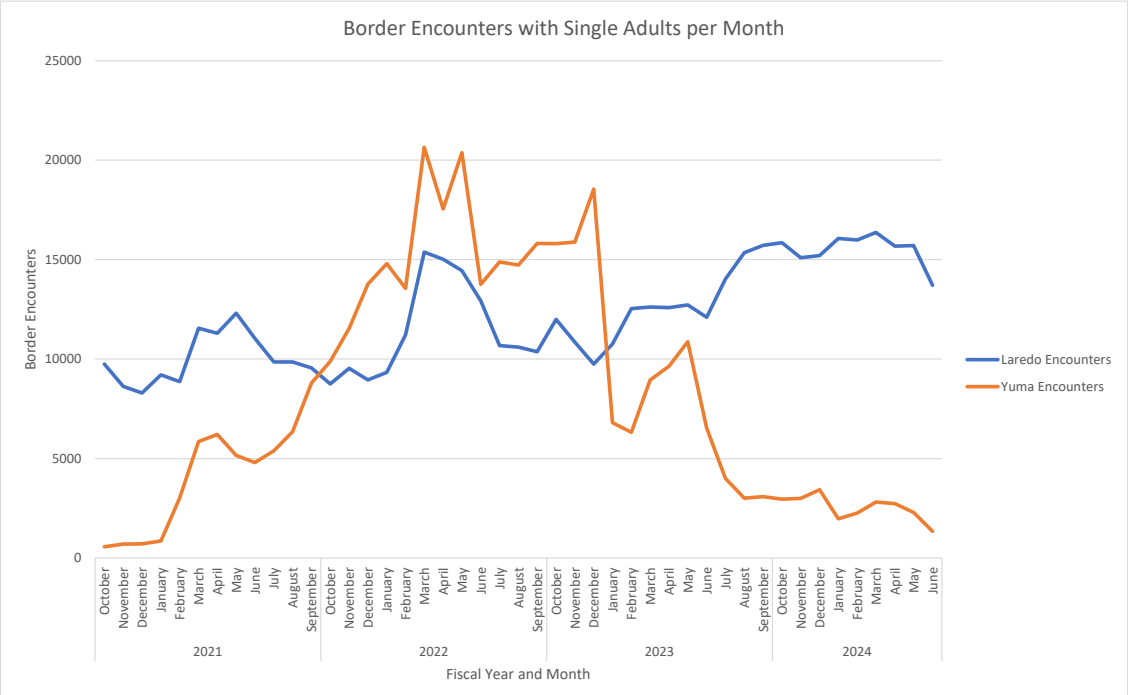

Figure 6. Encounters with Single Adults for Laredo and Yuma Per Month

The graphs depicting the migration flow of single adults in the Laredo and Yuma sectors highlight distinct regional patterns of migration that reflect broader geopolitical and economic dynamics. In Laredo, the encounter rates of single adults appear relatively stable, indicating a more consistent flow of migrants. This stability could suggest that the single adults crossing into Laredo represent established migratory patterns, where economic migrants, particularly men, make repeat attempts to enter the U.S. for work or family reunification. The consistency in numbers may also point to the effectiveness of enforcement measures in deterring large surges.

In contrast, Yuma has seen fluctuating and, in some instances, increasing numbers of single adult encounters. This could be attributed to the reparation of the physical walls in Yuma, which led to a strong decrease in border encounters broadly.

4.2.2 Border Encounters with Unaccompanied Children for Laredo Versus Yuma

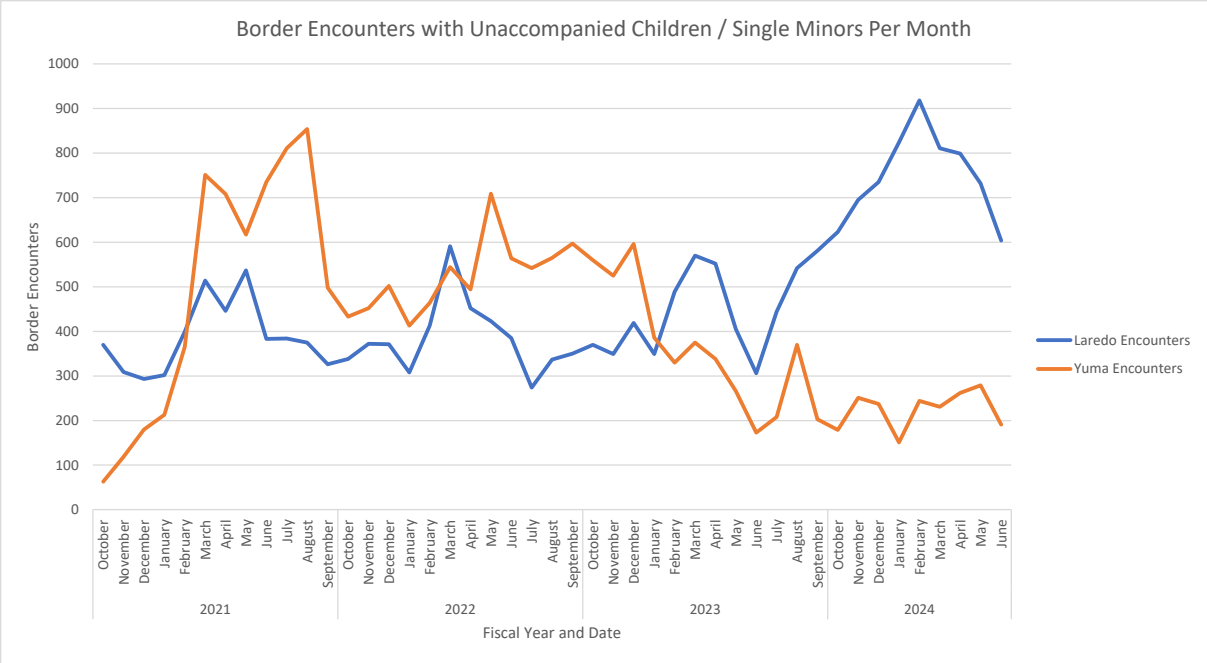

Figure 7. Encounters with Unaccompanied Children for Laredo and Yuma Per Month

In Laredo, the number of encounters with unaccompanied children remains relatively gradual until early 2023, where it begins to increase before peaking in February, 2024. At the same time that encounters in Laredo began to increase, encounters in Yuma decrease, which can be attributed to the reparation of the border gaps in Yuma during early 2023. Thus, this may imply that the reinforcement of border security measures in Yuma shifted migration patterns, redirecting unaccompanied children toward less fortified areas like Laredo. This suggests a correlation between enhanced physical barriers in one region and increased migration activity in adjacent areas, as migrants seek alternative entry points along the border where security measures are less stringent.

4.2.3 Border Encounters with FMUA for Laredo Versus Yuma

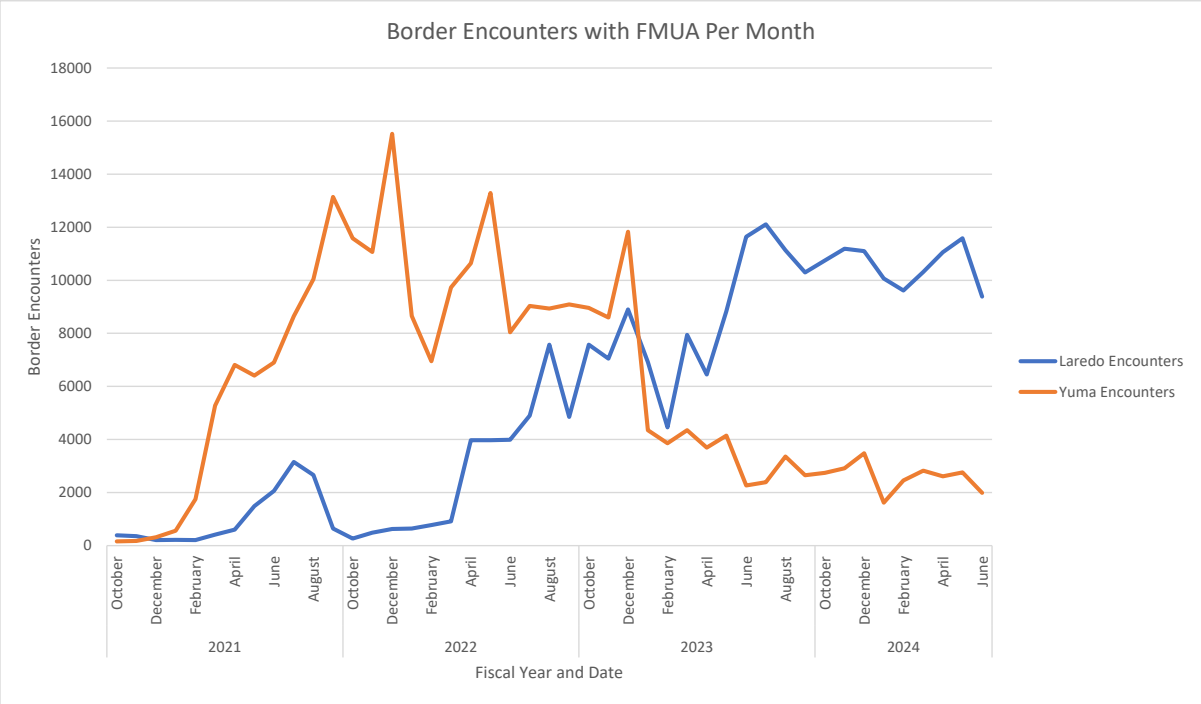

Figure 8. Encounters with FMUA for Laredo and Yuma Per Month

This section presents a comparative analysis of Family Unit Aliens (FMUA) encounters at two U.S. border sectors—Laredo, which utilizes a digital or virtual border wall, and Yuma, which employs a physical border wall. The data, spanning from 2021 to mid-2024, reveals significant contrasts in migration patterns and the effectiveness of these two types of border security infrastructures.

The Laredo sector, which relies heavily on virtual surveillance methods such as drones, sensors, and cameras, experienced a gradual but consistent rise in FMUA encounters over the period analyzed. Initially, encounters were minimal in early 2021, but by late 2021, there was a marked increase. FMUA encounters fluctuated between 2,000 and 6,000 throughout 2022, with noticeable peaks in early 2023. By the middle of 2023, the numbers climbed to over 8,000, with occasional spikes exceeding 10,000. The overall trend in Laredo indicates a persistent increase in FMUA encounters, suggesting that while virtual surveillance might enable rapid detection and monitoring, it may not effectively deter crossings over the long term.

In contrast, the Yuma sector, characterized by its reliance on a physical border wall, experienced an initial surge in FMUA encounters in mid-2021, peaking at nearly 16,000 in June. However, this sharp increase was followed by a dramatic decline beginning in late 2021 and continuing through 2022. By the end of 2022, encounters had dropped to below 4,000, with numbers stabilizing at lower levels into 2023 and 2024. This pattern suggests that the physical barrier initially resulted in higher apprehension numbers, potentially due to bottlenecking or a concentration of migrant crossings, but over time, the deterrent effect seemed to take hold as encounters dropped significantly.

The comparison between these two sectors reveals insights into the effectiveness of physical versus virtual border walls in mitigating FMUA encounters. While Yuma's physical wall produced an early spike followed by a sustained decrease in encounters, Laredo's virtual wall has seen a steady increase over time. This divergence may reflect the limitations of virtual deterrence methods, which, despite being cost-effective and technologically advanced, may not sufficiently reduce crossings in high-traffic areas. Conversely, the early success in Yuma could be attributed to the physical barrier's capacity to redirect migration flows or dissuade crossings entirely.

The data suggests that the virtual wall in Laredo has been less effective in curbing FMUA encounters over time, with numbers steadily rising. In contrast, Yuma's physical wall led to an initial surge but has since facilitated a decrease in FMUA activity, implying a stronger long-term

deterrent effect. These findings highlight the need for a nuanced understanding of border enforcement strategies, where physical and virtual walls may serve different functions based on geographic, logistical, and migratory factors. Further research could examine how these patterns align with broader migration trends and the socio-political factors influencing border security policies.

4.3 Citizenship of Migrants for Laredo Versus Yuma

The migration trends along the U.S.-Mexico border, specifically in the Yuma and Laredo sectors, reflect the broader geopolitical, economic, and social conditions within the home countries of migrants. By examining the top five nationalities encountered in each sector, one can better understand the factors driving these patterns and the regional differences that shape border dynamics.

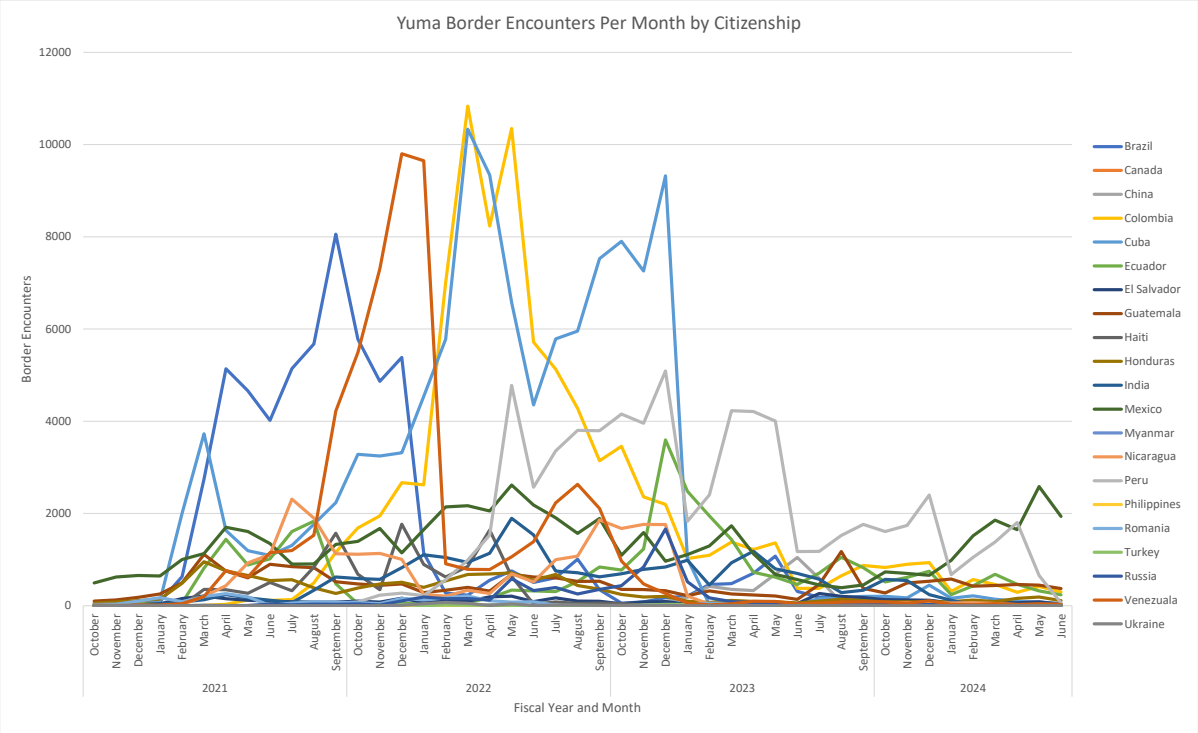

Figure 9. Encounters for Yuma Per Month by Citizenship

In the Yuma sector, the top nationalities of migrants include Brazil, Venezuela, Colombia, Cuba, and Nicaragua, all of which experienced significant peaks and declines in migration numbers from 2021 through 2023.

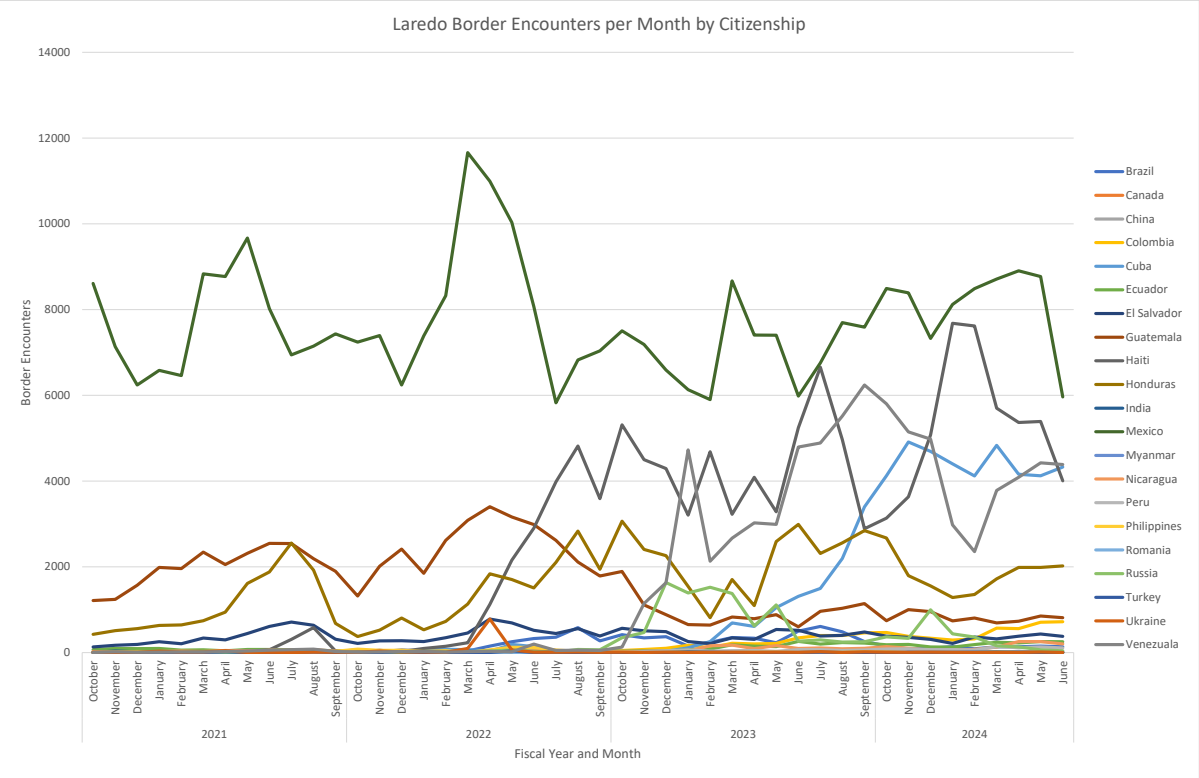

Figure 10. Encounters for Laredo Per Month by Citizenship

In contrast, Figure 8 shows the Laredo sector exhibiting a different set of migration patterns, shaped largely by the proximity of Mexico and long-standing migration routes. The top five nationalities encountered at the Laredo border include Mexico, China, India, Venezuela, and Honduras. Mexican migration has remained relatively stable compared to other nationalities. Mexico's geographic closeness to Laredo, combined with the longstanding economic ties between the U.S. and Mexico, contributes to a consistent level of migration from the country.

One potential explanation for migration trends is the economic conditions in migrant-sending countries, often measured by Gross Domestic Product (GDP) per capita. Figure 9 shows the GDP per capita data from Mexico, Brazil, Venezuela, Nicaragua, and India between 2019 and 2023 to determine whether economic performance correlates with the volume of migration from these countries.

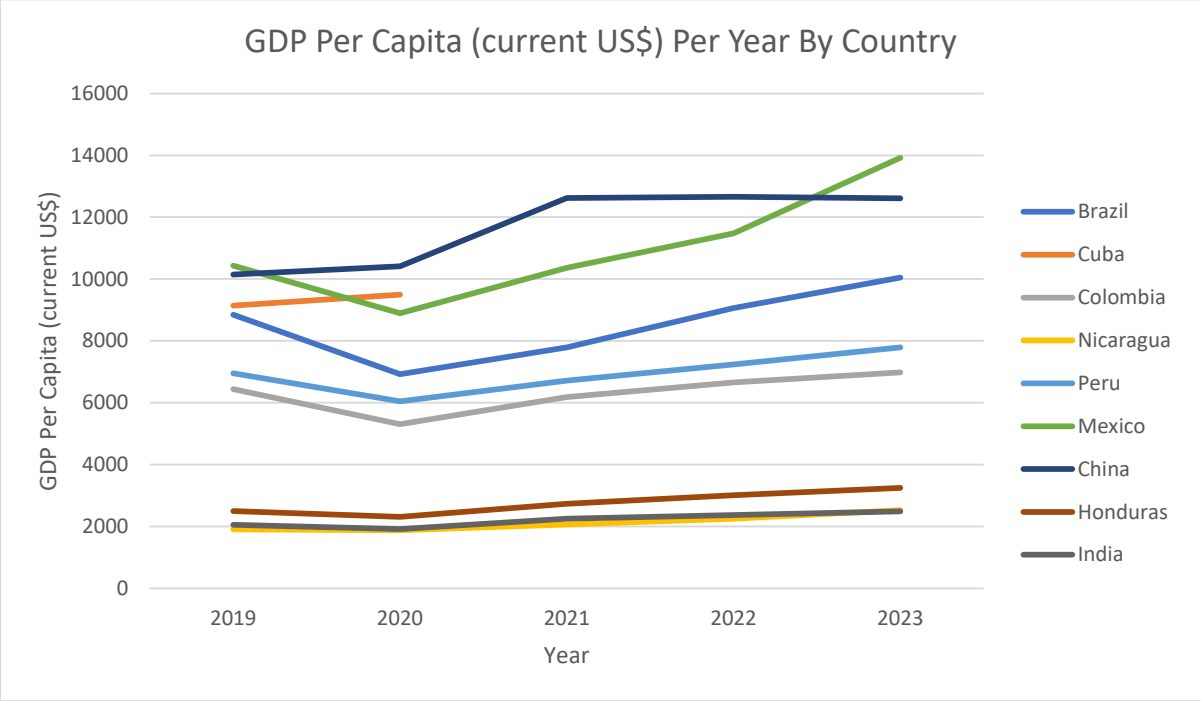

Figure 11. GDP Per Capita Per Year by Country

The GDP per capita of Mexico, Brazil, Venezuela, Nicaragua, and India varies significantly, reflecting the diverse economic conditions across these countries. Mexico experienced a steady increase in GDP per capita after a brief decline in 2020, likely due to the global economic slowdown during the COVID-19 pandemic. By 2023, Mexico's GDP per capita had nearly returned to pre-pandemic levels. Brazil, similarly, saw a decline in 2020, followed by a gradual recovery, maintaining a higher GDP per capita than most countries in this analysis. Venezuela, on the other hand, has faced a consistent and dramatic decline in GDP per capita, reflecting the country's well-documented economic collapse. Nicaragua shows a gradual decline in economic output, while India, though starting with the lowest GDP per capita of the five countries, exhibits steady economic growth over the five-year period.

Despite these variations, the data suggests that GDP per capita alone does not fully explain migration trends. For instance, while Venezuela's severe economic deterioration correlates strongly with the outflow of migrants, countries like Mexico and Brazil continue to experience significant migration despite their more stable or even improving economic performance. This indicates that other factors—such as political instability, security concerns, and labor market opportunities—likely play a role in driving migration decisions. Nicaragua, with its declining GDP per capita, and India, with steady economic growth, similarly demonstrate that migration is influenced by a more complex set of factors beyond just economic decline.

In the case of Mexico, despite economic recovery, factors such as organized crime, violence, and demand for labor in the United States may help explain continued migration patterns. Similarly, Brazil's political instability and social inequality may contribute to emigration, despite the country's relatively high GDP per capita. In contrast, Venezuela's collapsing economy, driven by hyperinflation, sanctions, and political crisis, directly aligns with high levels of migration, illustrating the stark effects of extreme economic deterioration on population outflows.

This analysis suggests that while GDP per capita offers some insights into migration trends, it is not sufficient on its own to account for the complex dynamics of migration. Other qualitative factors, such as governance, political stability, security, and labor market conditions, must be considered to fully understand the reasons behind migration from these countries. Further investigation into these factors is necessary to provide a more comprehensive explanation of the migration flows observed in

recent years.

5. Conclusion

In conclusion, this research highlights the following key findings about broader migration trends along the U.S.-Mexico border.

First, single adults consistently constitute the largest proportion of migrants, particularly in regions like Laredo, which relies on virtual surveillance. However, in areas like Yuma with physical barriers, there has been a notable rise in encounters with Family Unit Aliens (FMUA). The data shows a growing trend of FMUA, particularly after gaps emerged in the physical wall due to stalled construction, indicating a shift in migration dynamics as more families seek entry into the U.S.

Second, when analyzing the drivers behind these migration patterns, GDP per capita proves not to be a significant factor. For instance, despite Brazil and Mexico having relatively stable or improving GDP per capita, both countries continue to see high levels of migration. In contrast, countries like Venezuela, facing severe economic collapse, exhibit clear correlations with out-migration. This suggests that economic conditions alone do not fully explain migration trends, and factors like political instability, violence, and social inequality are likely more influential in driving people to cross the border.

Third, a comparison of physical versus virtual walls seems to indicate that physical barriers, while effective in certain conditions, are susceptible to disruptions when gaps or delays occur in construction. This was especially evident in Yuma, where border encounters surged when physical barriers were incomplete. On the other hand, the virtual wall in Laredo provided a more stable form of deterrence, particularly for single adults, but has been less effective in reducing FMUA over time.

In conclusion, while virtual surveillance offers consistent monitoring and avoids some environmental and construction challenges associated with physical walls, it does not significantly reduce overall migration, especially among families. Moreover, the ethical concerns related to heightened surveillance raise additional human rights implications. To enhance border deterrence, US border authorities are best served by a hybrid approach that combines both physical and virtual barriers, alongside policies targeting the root causes of migration.

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