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LETTER

Estimating the Impact of Drone Strikes on Civilians Using Call Detail Records

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Abstract

Drone strikes are a fixture of U.S. counterterrorism policy, often advertised as a "surgical" alternative to ground operations. The effects of drone strikes, however, are somewhat less precise than proponents suggest. Using a dataset of over 12 billion call detail records from Yemen between 2010 and 2012, we show that the U.S. drone campaign significantly disrupted civilian lives in ways that previous studies do not capture. Strikes cause large increases in civilian mobility away from affected areas and create immediate and durable displacement: Mobility among nearby individuals increases 24% on strike days, and average distance from the strike region increases steadily for over a month afterward, signifying prolonged displacement for thousands of individuals. Strikes disrupt civilian life regardless of whether they kill civilians, though the effects are larger after civilian casualties. Our findings suggest that even carefully-targeted drone campaigns generate collateral disruption that has not been weighed in public debate or policy decisions about the costs and benefits of drone warfare.

Keywords: drone strikes, call detail records, conflict, Yemen

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1. Introduction

Between 2001 and 2020, the United States conducted over 14,000 confirmed airstrikes using unmanned aerial vehicles (drones) in countries like Yemen, Pakistan, Afghanistan, and Somalia (Bureau of Investigative Journalism 2020), establishing drones as an enduring pillar of U.S. counterterrorism (Tecott 2017).[1] Drone adoption is rising globally—22 countries have conducted drone strikes and 22 more field armed, re-usable drones (DroneWars.net 2025)—largely because proponents argue that drones are cost effective, reduce risk to military personnel, provide intelligence collection advantages, and deliver precise violence with little collateral damage (Brennan 2012; Sales 2022).

Existing research shows that drones can disrupt militant operations (Byman 2013; Loidolt 2022, but see Jordan 2014), but may not be cheaper (Calcara et al 2022), and may cause "blowback" if collateral damage from strikes fuels resentment and increases support for the targeted groups (Boyle 2013; Cronin 2013; Silverman 2024). Quantitative tests yield mixed results: Some studies (primarily in Pakistan) find that drone strikes cause insignificant support for militants or "blowback" violence (Jaeger and Siddique 2018; Johnston and Sarbahi 2016; Mir 2018; Mir and D Moore 2019; Schwartz

[1]ACLED data from 2021 to mid-2025 record 700 more air and drone strikes in Yemen alone (Raleigh et al 2010).

et al 2022; Shah 2018), while others identify short-term violence spikes (Mahmood and Jetter 2023) or violence diffusion due to degraded militant command structure (Gartzke and Walsh 2022; Rigterink 2020).

Empirical debates about the costs of drone warfare have overlooked non-lethal disruptions to civilian life, which complicate claims about the "surgical" nature of drone strikes.[2] First, drone strikes cause some nearby civilians to flee their homes, either temporarily or permanently, undermining physical and mental health (Atrooz et al 2024; Bürgin et al 2022; Yip and Sharp 1993) and economic security (Fiala 2015; Kondylis 2010; Ruiz and Vargas-Silva 2013), as well as the economies of destination communities (Cazabat 2018; Depetris-Chauvin and Santos 2018). Second, evidence suggests that information about strikes spreads widely, potentially altering political behavior and attitudes of civilians (García-Ponce et al 2023; Pearlman 2013; Young 2018). Most existing studies have analyzed data that would not have captured either of these effects. The major exception is work by Christia et al 2021, which finds spikes in overall call volume around drone strikes in Yemen, but does not document civilians' physical displacement, or calling cascades originating in strike regions.

Using over 12 billion cellphone call detail records (CDRs) from Yemen, we show that 74 U.S.-conducted drone strikes between 2010 and 2012 significantly disrupted civilians' ordinary patterns of movement—whether or not the attack caused recorded civilian casualties. The high spatial and temporal resolution of CDRs make it possible to capture civilian reactions without relying on self-reported data (Ansari 2022; Fair et al 2014; Shah 2018).

We find that mobility for all exposed individuals increases by an average of 24% (6.47km) above baseline on days with drone strikes, with effects lasting over a month. Across 74 strikes, 4,500 individuals (5.4% of exposed individuals) flee their homes immediately, with over 1,000 (1.2%) remaining displaced after a month. We also show that drones are *more* disruptive to civilian life than other types of political violence at the same magnitude.[3] Where previous research finds that forced migration (migration due to violence) primarily increases with violence intensity (Davenport et al 2003; Fearon and A Shaver 2020), our analyses show that drone strikes cause more long-term displacement than similar non-drone events in Yemen. Finally, in Supplementary Information we document communication cascades started by exposed individuals, signifying the spread of strike-related information, opinions, and emotions through the population, and suggesting negative consequences for civilian well-being beyond displacement.

Accurately characterizing drone strikes' non-lethal disruption—including displacement—is important for academic and policy conversations around the costs and benefits of drone campaigns. First, the higher-order effects of forced migration on civilian well-being (cited above) and political stability (e.g. Salehyan and Gleditsch 2006, but see Zhou and AC Shaver 2021) are potentially large, even if displacement is modest. Therefore, showing that drones cause displacement suggests they likely cause more sociopolitical disruption than previously understood. Second, disruption without long-term displacement can still cause negative psychological and social impacts (Coll 2014; Edney-Browne 2019; Gusterson 2019) that are counterproductive for counterterrorism policy. Finally, the targeting and approval process (in the United States, at least) has historically weighed "anticipated military advantage" (Lushenko 2022) against "expected collateral damage" (Cartwright 2013).[4] Even if the comparison still favors conducting drone strikes, identifying new forms of non-lethal collateral damage should weigh on future targeting decisions at the margin.

Ultimately, this paper contributes to three themes in the broader study of counterterrorism and civilian behavior. First, we demonstrate the potential of digital communications data for studying behavior—especially displacement—during conflict (Buckee et al 2022; Milliff and Christia 2025;

[2]Non-monetary economic costs have been documented elsewhere (for example Hall and and Coyne 2014; Sterman 2022/2023; Wood 2025).

[3]The high-intensity conventional conflict between Yemen and AQAP in 2011-2012, for example, displaced Yemenis at roughly the same rate as drone strikes (545,000 out of 28.4 million population).

[4]The standard was later updated to "near certainty" of no civilian casualties (Raman et al 2021).

Salah et al 2019; Tai et al 2022). Communication and location data from conflict zones are now available on a massive scale and can be fruitfully used to measure (and minimize) the disruptive effects of conflict on civilians. Second, our analysis sheds light on the U.S. drone campaign in Yemen, which is an understudied theater compared to Afghanistan and Pakistan. With U.S. strikes in Yemen on the rise in 2025, understanding the effects of the early stages of the drone campaign has renewed importance for foreign policy. Finally, our analysis complicates the characterization of drone strikes as "surgical" violence. We show that strikes have non-lethal but highly disruptive consequences for civilians that have not previously been documented in quantitative analysis.

2. The U.S. Drone Campaign in Yemen

The second-ever drone strike occurred in Marib Governorate, Yemen in November 2002, when a CIA-operated MQ-1 Predator killed an alleged plotter of the 2000 U.S.S. Cole attack and five others. Regular strikes in Yemen began in 2009; as of 2023, Bergen et al 2020 reports at least 375 strikes in Yemen—killing an estimated 91 high-value targets and 1,300-1,700 other people.[5]

Between 2010 and 2012, al-Qaeda in the Arabian Peninsula (AQAP) launched conventional offensives, capturing territory across Yemen. U.S. strikes increased in response, peaking in 2012 during Yemen government counteroffensives. Data from the Bureau of Investigative Journalism 2020 and Bergen et al 2020 count 108 strikes between 1 January 2010 and 31 October 2012 (our data's end-date). We analyze 74, dropping 34 strikes in rural areas without cellphone coverage. Most strikes we analyze did not cause reported civilian casualties, but our results suggest they still caused other types of harm.

The Obama administration heralded the campaign as a success, promoting a "Yemen model" of targeted killing *via* drones with support for local proxies (Hennessey 2014; Taub 2015). Now rebranded as "counterterrorism plus" (Council on Foreign Relations 2020), the approach promises reduced costs to the United States *without imposing major costs on civilians* (Plaw and Fricker 2012).

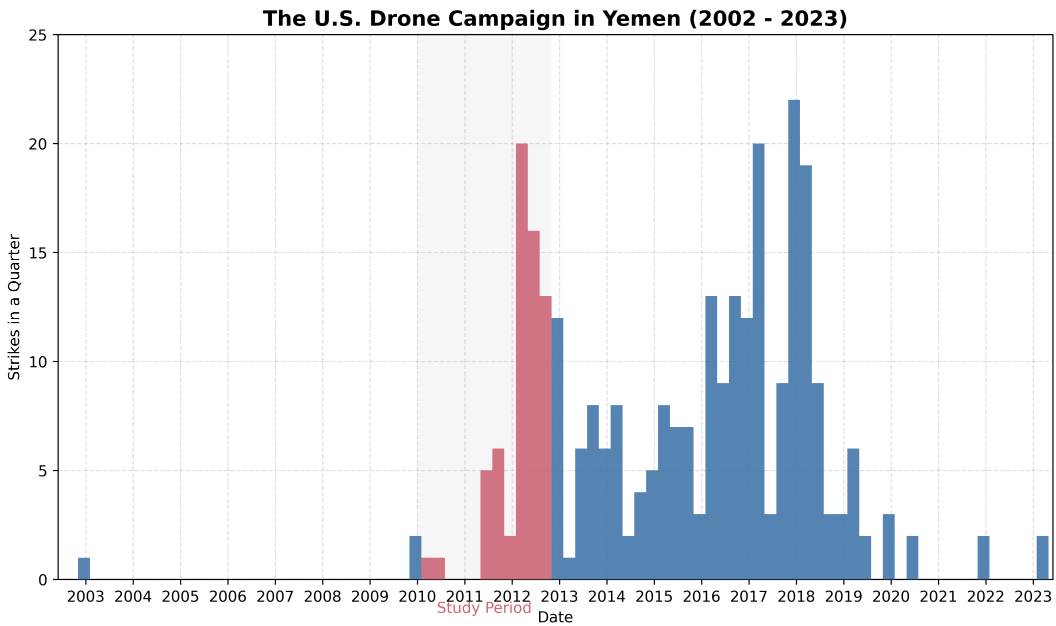


Figure 1. U.S. drone strikes in Yemen, 2002–2023 (Bergen et al 2020). Time period analyzed in this paper in red.

[5]Casualty estimates exclude 82 strikes during the first Trump administration, which stopped releasing figures.

Early results looked promising. Government reporting claims that four early strikes (2009–2010) killed three high-value AQAP targets. Strike frequency then increased, averaging monthly 2011, and more than weekly in 2012. Our analysis covers the first "spike" in a decade-plus campaign which continued from 2013-2022 averaging one strike every twelve days. The strikes delivered some benefits over alternative strategies: the median strike caused no civilian casualties per Bureau of Investigative Journalism 2020 data, and the campaign was responsible for an estimated 72 civilian deaths over a decade. However, as we show, casualties only tell part of the story. Exposure to a drone strike is about as disruptive as other major violence events in Yemen (like suicide bombings), whether or not civilian casualties are reported.

3. Measuring Mobility and Drone Strikes

We use cellphone metadata (CDRs) to measure civilian responses to drone strikes. We analyze records of over 12 billion calls and texts from roughly 6 million subscribers to a major Yemeni telecom provider between January 1, 2010 and October 31, 2012. Each record includes a timestamp, duration, anonymized caller and recipient IDs, and the towers that handled the call, which approximate caller/callee locations when merged with tower coordinates.

Our data covers nearly 50% of Yemen's adult population—including subscribers in all populated districts—during the first "peak" in the U.S. drone campaign.[6] Cellphones were Yemen's most important communication technology in the 2010s. Cell penetration rose during the period we cover, from 49% of *total* population in 2010 to 58% in 2012 (Statista 2019), while internet (12%, World Bank 2019) and landline penetration (5%, International Telecommunications Union 2023) remained low. Though CDRs lack detailed subscriber demographics, widespread phone ownership across regions, income ranges, and genders suggests our data capture a broad cross-section of the population, rather than "early adopters" who would be overwhelmingly male, urban, and wealthy (Aker and Mbiti 2010).

We derive two measures of mobility from CDRs of subscribers exposed to drone strikes. We estimate mobility by calculating the distance (summed daily) between towers used in consecutive records. We also measure each record's distance from strike coordinates to estimate cumulative distance traveled. We also measure communication patterns from the same CDR data, tracking both the behavior of individuals exposed to a strike, and individuals who are not physically proximate to a strike, but are called by a strike-exposed subscriber. In the supplementary information we show that the post-strike spike in call volumes observed in Christia et al 2021 persist across multiple degrees of social distance, indicating that some of the disruptive potential of strikes expands beyond the targeted areas.

We focus on civilian mobility/displacement because there are reasons to expect that drone strikes change civilians' patterns of movement: Since physical violence/threats often cause displacement (among others Davenport et al 2003), it is plausible that people would flee from drone strikes. The magnitude of the effect (if any) is less theoretically clear. On one hand, drones are lower intensity and/or shorter duration violence relative to alternatives like ground operations or airstrikes with larger munitions. On the other, drones have unique technical capabilities (persistent target surveillance, high precision strikes with little warning) and are clearly attributable to a very powerful foreign military, creating an unusual level of uncertainty and "anticipatory fear" about the risk of future strikes (Mir 2018). Since uncertainty or unpredictability can, in some circumstances, encourage migration (Milliff 2024), drone strikes' displacement effects may be larger than the small explosive payload would suggest. These competing hypotheses have not been empirically adjudicated, perhaps due to the assumption that drone strikes are small, high precision interventions.

[6] In 2010, 14 million Yemenis were over 15 years old (United Nations Population Division 2019). Cellphones in Yemen functioned more like a household public good than an individual posession (Lee and Bellemare 2013, but see Barnes et al 2025), so 6 million subscribers could cover up to 6 million households.

Drone strike data come from the Bureau of Investigative Journalism 2020 and Bergen et al 2020. While news-based event data is often incomplete compared to data from governments (A Shaver et al 2023), the opposite is true here; researchers use local reporting to identify and confirm strikes and casualty estimates that are not disclosed by the U.S. government.[7] Data include strike coordinates, timestamps, and civilian and militant casualty estimates (with uncertainty bounds). We merge strike records with CDR data to identify subscribers exposed to each strike and track prior and subsequent mobility.

4. Design

We estimate the causal effect of drone strikes on civilian mobility using a panel-data event study design, which regresses outcomes on temporal lag and lead indicators relative to drone strikes in order to estimate dynamic treatment effects, controlling for strike-specific heterogeneity *via* fixed effects. We use the protocol from Schmidheiny and Siegloch 2023, which bins endpoints to estimate dynamic treatment effects without un-treated units. Our parameters of interest are lag and lead coefficients, indexed $-j$ to j, which compare mobility in period j relative to baseline period $j = -2$. We describe notation and setup more fully in Supplementary Information. We define individuals as *exposed* to a strike event if they make a call within 15 miles (24.1 km) of the strike locations during the strike period. This threshold is based on existing literature (Christia et al 2021; Gao et al 2014), and is robust to alternative radii from 5 miles to 30 miles (8km–48.3km, see Supplementary Information).

Causal interpretation of the event study relies on two assumptions. First, drone strikes are assumed to be exogenous shocks with respect to civilian movement. This requires: 1) no simultaneity—e.g. mobility changes do not drive strike occurrence—and 2) no joint response—i.e. no confounding events cause both strikes and mobility (Greene 2018). We evaluate simultaneity by examining pre-treatment trends, finding no evidence of anticipatory changes in mobility (see Figure 2). We also note that U.S. drone strike planning does not rely on aggregate mobility data.[8] We evaluate the joint response assumption with data from the Critical Threats Project 2019 and Bergen et al 2020. We find that strikes do not overlap with potentially-confounding events like AQAP attacks or known U.S. ground operations.

Beyond these formal assumptions, our design also satisfies the conditions enumerated by Dunning 2012, 237–239 for "as-good-as random" assignment. Individual cellphone subscribers lack sufficient information to predict strike exposure, so they cannot self-select out of treatment. Furthermore, U.S. strike planners lack incentives to manipulate strike timing or treatment assignment for particular non-targeted civilians. Planners' focus on civilians is limited to efforts to keep them out of the strike's blast radius (65 feet / 20 meters (Anderson 2014)), well within our 15 mile exposure threshold. Consequently, civilians' treatment status is not plausibly self-selected or U.S.-selected based on mobility.

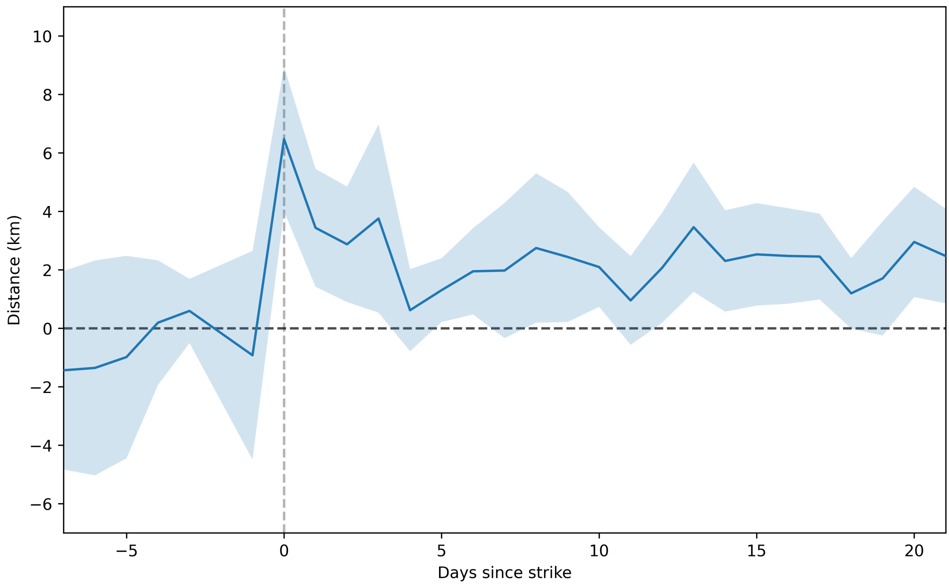
5. Results

We use CDRs to construct a time series of exposed individuals' locations and compute daily distance traveled. Using the event study design, we estimate the effect of 74 strikes on daily mobility over a 7 day pre- and 21 day post-strike window (Figure 2a). The average subscriber's mobility increases by 6.47km (24% over pre-strike mean, SE 1.26) on strike days and remains elevated over the baseline by 2.47km (SE 0.83) 21 days afterward. Pre-strike trends are negligible, supporting our identifying assumptions.

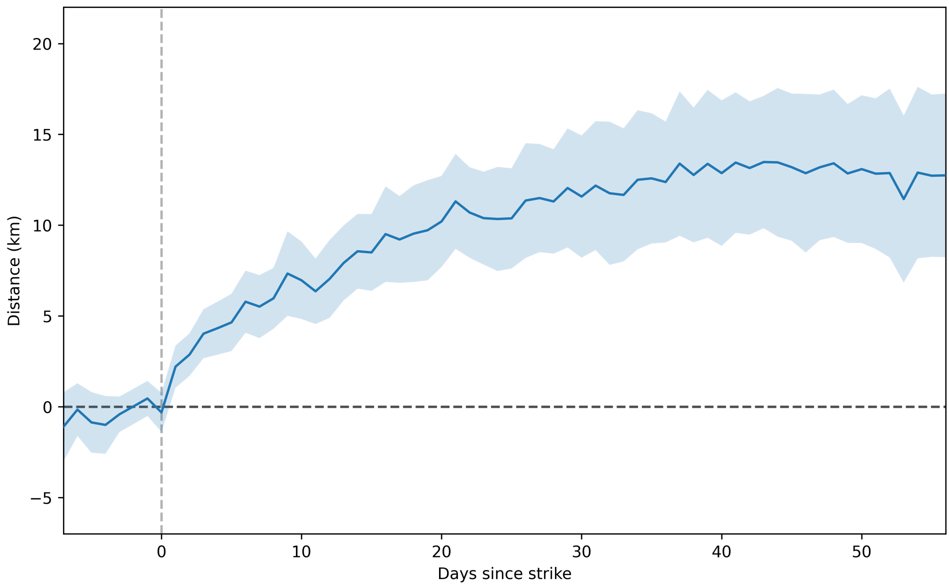
Average distance from strike locations also increases over time—from 5.52km (SE 0.89) at one week, to 11.31km (SE 1.33) at 21 days, peaking at 13.48km (SE 1.86) at 43 days (Figure 2b). This

[7]For details on reporting methodology, see: https://www.thebureauinvestigates.com/explainers/our-methodology.

[8]Cell data can verify a particular targeted individual's location (Scahill and Greenwald 2014), butaggregate mobility in a potential strike area is not used in strike planning/approval (Center for Civilians in Conflict 2012).



(a)

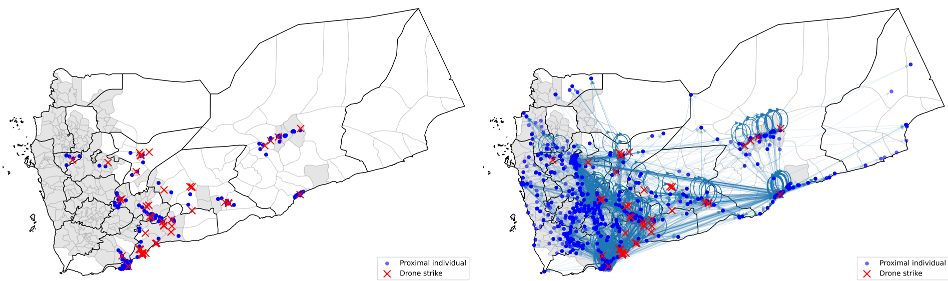


(b)

Figure 2. Effect of drone strikes on mobility. Figures show parameter estimates from an event study (full model in Supplementary Information) for exposed individuals' (a) change in daily distance traveled and (b) distance from the strike region. Shading indicates 95% confidence intervals from strike-clustered standard errors (Abadie et al 2017).

suggests that a large number of people leave the strike region quickly, dispersing around the country within 24 hours (Figure 3). Across the 74 strikes, 4519 subscribers (5.3% of exposed subscribers) leave the area and remain away for at least 24 hours. Almost all displaced individuals are likely civilians not militants.[9] Some displacement is long term: 51% of displaced subscribers return home within five days, but roughly 25% remain displaced for over a month. Average distance away from strike areas among the displaced is nearly double the full-sample average (see SI), suggesting that people displaced by strikes travel long distances before stopping. The long-term displacement we measure eclipses the number of militants targeted ($\sim$ 390) by 2.7x. Our estimate of displacement is almost certainly conservative. First, poverty and poor infrastructure in Yemen likely inhibit some displacement that would otherwise occur in response to strikes. Second, some of the ~50% of Yemeni adults *not* in our data—subscribers to other telecoms and/or non-phone owners including family members of subscribers—were likely displaced by drone strikes as well.

Even a modest number of conflict-related displacements indicates broader social disruption. Exposed subscribers who do not migrate still experience substantially increased mobility after strikes—behavior which computational social scientists have linked to increased stress and anxiety (Müller et al 2020). Displacement also negatively impacts destination communities including the relatives that displaced people likely stayed with. In 2011-2012, IDP flows in Yemen created severe housing shortages in major destination cities like Aden (IRIN News 2013). In one of the world's poorest countries, crowding plus migration-induced income loss could create long-term hardship.



(a) (b)

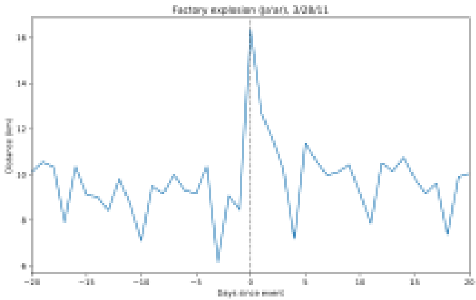
Figure 3. Displacement after drone strikes. **(a)** Subscriber locations at strike time, in blue (strikes as red X's). Grey shading indicates districts with > 30 people/km^2. **(b)** Subscriber locations 24 hours post-strike. Light blue arrows show displacement trajectories.

5.1 Drone strikes displace more than other violence

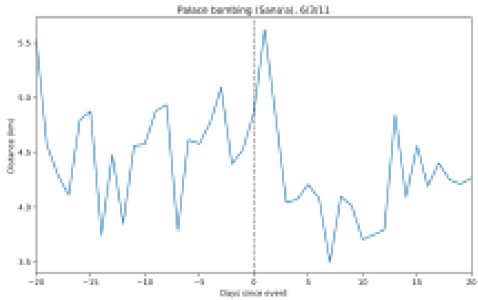
Displacement from drone strikes (5.3%) is similar in magnitude to displacement after qualitatively larger disasters, like the catastrophic 2010 Haiti Earthquake that killed at least 100,000 Haitians (6% Lu et al 2012), or early COVID-19 lockdowns in New York City in March 2020 (5.5% Bakker et al 2020). Drone strikes also cause more displacement than similar violent events in Yemen, like suicide bombings. We select five non-drone comparison events that are unexpected, localized (i.e. not coordinated with attacks elsewhere), and unusually high-casualty compared to previous local events and to average drone strikes (See Supplementary Information for selection details).

Mobility of exposed subscribers (daily distance traveled) spikes on the event day for most comparison events (Figure 4). Event day average mobility increased 7.5 km (84%, SE 0.40), 0.4 km (8%, SE 0.06), 3.9 km (52%, SE 0.37), 1.4 km (23%, SE 0.06), and 3.0 km (38%, SE 0.14) respectively, but events produced smaller magnitude and less durable displacement. After the events, an average of 1.7% exposed subscribers were displaced, but *no* individuals remained away for more than 30 days across all five events.

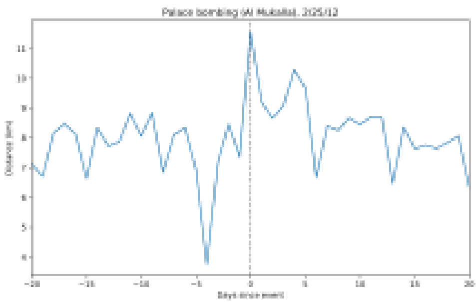
[9]97% of displaced subscribers travel to government-held territory, while contemporaneous reporting suggests that AQAP fighters typically fled toward AQAP strongholds after defeats (Horton 2017, see SI for more detail).



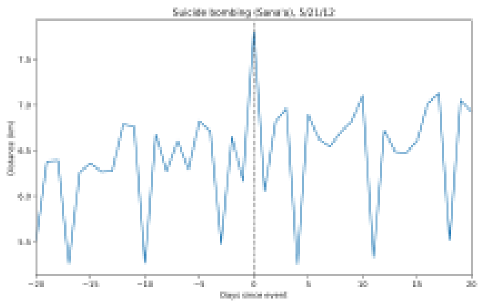
(a) Factory Explosion, Ja'ar, 28/3/2011



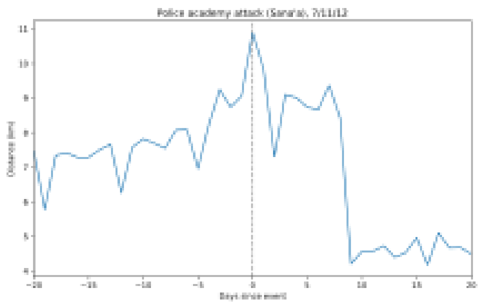
(b) Presidential Palace Bombing, Sana'a, 3/6/2011



(c) Palace Bombing, Al Mukalla, 25/2/2012



(d) Suicide Bombing, Sana'a, 21/5/2012



(e) Police Academy Attack, Sana'a, 11/7/2012

Figure 4. Mobility after five comparison events. The figures display average daily distance traveled by exposed subscribers.

5.2 *Civilian casualties matter at the margin*

Drone strikes have different consequences depending on the reported numbers of militants and civilians killed. All strikes are disruptive, but strikes causing more civilian casualties are, on balance *more disruptive*, causing more displacement. We regress the number of individuals who remain displaced 30 days post-strike on predictors including the number of civilian and militant casualties, the time of day, the district population, and the number of strikes in the district in the preceding month (all data from Bureau of Investigative Journalism 2020 and Bergen et al 2020).

Table 1 shows that reported civilian casualties are strongly associated with higher long-term displacement: A strike killing 10 civilians results in 40.8 more long-term displacements, compared to a strike causing no civilian casualties.[10]

This suggests that precision targeting matters at the margins: Strikes causing more collateral damage are associated with more civilian displacement. At the same time, the event study results are not solely driven by civilian casualties– 90% of strikes we analyze report no civilian casualties but still cause displacement and increased mobility for non-displaced subscribers. These results have clear implications for operational planning and broader counterterrorism policy: while drone campaigns negatively affect civilian well-being in any circumstance, minimizing civilian casualties reduces their disruptive impacts.

Table 1. Effects of civilian casualties on displacement

	Dependent variable:
	Displacement
Civilians killed	4.08**
	(1.61)
Militants killed	0.38*
	(0.23)
High-ranking militant	9.45
	(5.83)
Morning	–2.41
	(–0.52)
Evening	3.48
	(4.30)
Strikes in past month	1.93
	(2.64)
Population (10k)	1.50***
	(0.53)
Constant	–9.29
	(7.26)
Observations	74
R^2	0.553
Note:	*p<0.1; **p<0.05; ***p<0.01

[10]Only 5% of strikes caused more than ten civilian casualties. Nearly 90% of strikes 2010–2012 cause no reported civilian casualties.

6. Why are drones so disruptive?

Despite the U.S. drone campaign's "precision" reputation, disruptive effects on civilians' mobility are substantial and surprisingly durable even for civilians *who are not physically harmed by the strikes*. Why are drone strikes, hardly Yemen's highest-intensity violence between 2010 and 2012, so disruptive? Our results are consistent with various mechanisms, which may operate in parallel.[11]

First, evidence from Pakistan suggests that drone strikes cause *anticipatory fear*, which reduces targeted militants' movement and communication (Mir 2018). We posit that anticipatory fear causes different behaviors for civilians vs. militants that Mir 2018 studies: Fearing possible future strikes and aware of ongoing drone activity, civilians might migrate away from areas they expect to be targeted again (WH Moore and Shellman 2004). High uncertainty about future strikes (compared to uncertainty around conventional front lines elsewhere in Yemen, for example) might further drive displacement (Milliff 2024). Higher civilian casualties could amplify fear and uncertainty. Anticipatory fear might blunt the effects of increasing familiarity or habituation to drone strikes over time, which *ceteris paribus* might decrease response to later strikes (though not in Yemen; see SI).

Second, drone strikes may have a platform-specific reputation in Yemen.[12] Reporting suggests that civilians in Yemen were aware of drones as a separate technology of conflict—and one particular to the United States—in the early 2010s (Terrill 2013), likely thanks to militant groups' use of drone strikes in recruiting propaganda. Civilians' particular associations with drone strikes may explain different responses compared to other types of violence. Analyses of calling cascades (See SI) are consistent with this "reputation" effect: Information about strikes spreads rapidly across Yemen, reaching many people who aren't directly exposed and potentially conditioning their future behavior.

7. Conclusion

In this article, we study the effects of drone strikes on civilians, and show that a purportedly high-precision counterterrorism strategy causes previously un-measured disruption. Using an event study framework and a dataset on the location and communication of nearly 6 million Yemeni cellphone users over 34 months, we provide causally identified evidence that drone strikes trigger rapid, substantial, and durable changes in civilian mobility.

Across 74 strikes between 2010 and 2012 in Yemen, we find that thousands of people quickly flee the area around the strike, with over 1,000 remaining displaced for at least a month. Our estimates might represent a lower-bound estimate of civilian responses to drones in other contexts, given Yemen-specific impediments like poor transport infrastructure (Yemen has <10,000 km of paved roads) and widespread poverty.

Our findings raise new questions about the costs of drone campaigns. Even when drone strikes do not cause civilian casualties, they create substantial collateral damage because displacement during conflict has severe consequences for physical and mental health (Owoaje et al 2016; Toole and Waldman 1993), household finances (Fiala 2015), and long-term economic wellbeing and human capital (Kondylis 2010; Ruiz and Vargas-Silva 2013). Prior research finds that U.S. drone strikes can acquire a negative "reputation" that spreads beyond the battlefield (Silverman 2019), which is especially concerning given a large body of research emphasizing the importance of civilian attitudes in asymmetric conflicts (Berman et al 2018, among many). In 2019 (Arab Barometer has since been unable to survey Yemen), 84% of Yemenis said attacks against the United States were a "logical consequence" of American intervention in the region, and 93% said America's foreign policy was bad

[11] In the Supplementary Information, we report additional analyses and *do not* find that the effect of strikes depends majorly on 1) timing (day vs. night), 2) target value (whether a high-ranking militant is killed), or 3) familiarity (whether the strike takes place early or late in the 2010-2012 campaign period). Strikes in rural areas are associated with greater total distance from the strike area.

[12] In Pakistan, for instance, some civilians express preferences about drones vs. the alternative of ground operations by the Pakistan Army (Fair et al 2014; Shah 2018).

for Yemen (Arab Barometer 2019). More research is needed to understand how drone strikes shaped these opinions but our results suggest some ways they may have contributed to negative attitudes.

Finally, new evidence of the disruption caused by the U.S. drone campaign in Yemen ought to change the ethical calculus for using the platform in the future. Despite touted benefits like reducing civilian casualties compared to non-drone interventions, lowering costs, and minimizing U.S. casualties, we show that drones create less of a "win-win" than advertised. Decision-makers should account for these costs when evaluating the strategic utility of drones.

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Competing Interests None declared.

Data Availability Statement Material to replicate the results in this paper can be found in the Harvard Dataverse at: https://doi.org/10.7910/DVN/HH1YUN.

Ethical Standards The research meets ethical guidelines, including adherence to the legal requirements of the study country. Respondent privacy, specifically, is discussed in greater detail in the supplementary information.

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