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How body-worn cameras affect the use of gunshots, stop-and searches and other forms of police behavior: A Randomized Control Trial in Rio de Janeiro

Stanford University

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Beatriz Magaloni
Professor of Political Science
Senior Fellow, Freeman Spogli Institute
Affiliated faculty at the Center on Global Poverty and Development
Director of the Poverty, Violence, and Governance Lab (PovGov)
Stanford University

Vanessa Melo
Researcher and Project Manager,
Poverty, Violence, and Governance Lab (PovGov)

Gustavo Robles
Research Scholar
Poverty, Violence, and Governance Lab (PovGov)

Gustavo Empinotti
Former Research Assistant,
Poverty, Violence, and Governance Lab (PovGov)

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Abstract*:*

In this paper we examine the effects of police body-worn cameras through a randomized control trial implemented in Rio de Janeiro. The paper explores the use of this technology by police officers in charge of tactical operations and officers performing "proximity" patrolling in the largest favela of Brazil, Rocinha. The study reveals that institutional and administrative limitations at Military Police of the State of Rio de Janeiro (PMERJ) were associated with limited use of the cameras –basically officers refusing to turn the cameras on. Despite low footage, results reveal that when a police officer was randomly assigned to a BWC, this technology had a significant effect reducing the number of gunshots fired by police officers. The reduction on police lethal force is particularly strong among GTTPs, which are tactical units assigned to operations that commonly involve armed confrontations. The use of BWC among these police officers reduced their use of ammunition by more than 45%. Moreover, we find that police officers assigned to a BWC had significantly lower number of activity reports or occurrences (BOPMs). The inactivity effect is mostly driven by GPP units, which have patrolling functions and more engagement with the community. These units reduce their reported activities almost by half.

1. Introduction

Police violence is a persistent social justice problem in many democratic societies. In the US police violence has sparked a recent wave of protests and a national controversy among policy-makers, practitioners and scholars in the wake of several recent police fatal shootings. Police violence is an even more serious problem in Brazil, where police killed 4,224 people in 2016.[2]

Given the complexity of the phenomena and the variety of factors that are correlated with police violence, designing and evaluating practical interventions aimed at controlling police excessive use of force is critical. One of the most prominent interventions is police body-worn cameras (BWC), which use in recent years has significantly expanded in many police departments in the US and other countries.

BWC are likely to curb police misbehavior and excessive use of force through two main mechanisms. First, BWC increase capacity to monitor the behavior of street police officers, allowing superiors within the corporation to detect and sanction lack of compliance with orders and existing protocols. Secondly, BWCs increase the probability of prosecution and conviction due to higher quality and more reliable evidence. Several strands of research, including the literature on criminal behavior and deterrence, have demonstrated that when the likelihood of apprehension rises, wrongdoing is less likely to occur. This deterrence channel may operate on both sides of the police–public interaction, both deterring the use of excessive force by police officers, and aggressive behavior toward the police when these interact with suspects.

Despite significant variation, the majority of current scholarship on BWC points out to promising results. BWC effects include fewer complaints against police officers (Ariel et al., 2013; Ariel et al. 2015; Hedberg et al. 2016; Braga et al., 2018; Peterson et al., 2018;). Other results suggests that officers become more proactive at their jobs (Justin et al, 2015; Wallace et al, 2018; Katz, 2014), and that BWC lead to improvements in prosecution outcomes (Morrow et al. 2016; Owens et al., 2014) and increasing of procedural justice's perceptions (White et al, 2017). Finally, enthusiastic supporters of the technology claim that BWCs is a critical tool to monitor police behavior (Stanley, 2015).

Other studies have heighted potential limitations of BWCs. Some studies are concerned that BWC can lead to de-policing strategies (Ariel et al, 2017: 12). A survey conducted at Phoenix PD shows that 65% of officers were concerned that the use of BWC will lead them to interact less with citizens (Katz et al., 2014). In a recent study in the Spokane Police Department, Wallace et al (2018) also examine if BWC might reduce pro-active work from the police, which they call "camera-induced passivity". Their results show, instead, no evidence that cameras induce passivity. Contrarily, according to the study officers wearing BWC increased self-initiative calls. Other studies demonstrate that officers wearing BWC we more likely to perform less stop-and-frisks and to make fewer arrests (Justin et al., 2015; Peterson et al., 2018).

[2] According to the 11th Annual Brazilian Yearbook of Public Security.
https://www.huffingtonpost.com/entry/brazil-police-violence-madonna-rio_us_59f9dc68e4b0d1cf6e91f1ef

Our study contributes to this emerging body of research by conducing the first RCTs in a high-violence developing world setting. This report presents results of a RCT of BWC conducted in Rocinha, a large favela located in the south zone of Rio de Janeiro. The study was conducted between December 2015 to November 2016 and included the random assignment of 9,752 camera-shifts to 470 police officers. The favela where the study was conducted had experienced a recent change of policing approach with the introduction of the Pacifying Police Units (UPPs), which were a form of problem-oriented policing with the explicit goal to build a more proximate relationship between police officers and favela residents. The UPPs represented an important initiative to abandon the militaristic strategy for policing the favelas and to reduce armed confrontations between police and drug trafficking groups. A critical question is if BWC can work in contexts such as Rocinha.

Overall our findings generate three main conclusions: 1) Protocol compliance is a critical problem. Despite the fact that random assignment of BWC worked in over 95% of the cases, most police officers refused to turn on their cameras. Lack of camera usage occurred less when officers were asked to turn their cameras all the time during their shifts, than when they were asked to turn their cameras only when they interacted with residents. 2) Despite limited footage, BWC had substantial effects in altering police behavior in two fundamental ways: they reduced police use of lethal force; and they induced police inactivity, suggesting a de-policing strategy to avoid conflicts that might be recorded.

2. Overview of Literature on BWC

With the Obama administration, there was a dramatic increase of funds to adopt this technology across the US. As a result, studies on BWCs have grown significantly during the last years. Mostly conducted in the U.S and the UK, the focus of the earlier studies has been use of force and citizens' complaints. More recently, studies have started to explore problems of compliance and officer "induced-passivity". Whether officers volunteer or are recruited to wear or participate in a BWC field experiment plays a substantial role in the outcomes of empirical evaluations.

A study for the US Department of Justice that reviewed five studies from the US and the UK, which represented "the entire body of evidence on body-worn cameras," cited a lack of "rigorous, independent studies using experimental methods" and concluded that "there is not enough evidence to offer a definitive recommendation regarding the adoption of body-worn cameras by police," and that "most of the claims made about the technology remain untested."[3]

The first Randomized Controlled Trial (RCT) was conducted in Rialto, California, with around 80 police officers. The study showed that the adoption of BWC reduced police use of force by 60% and citizens complains against the police by 90% (Ariel, 2013). Despite the promising results, it is difficult to generalize this study's findings because of the small number of events of use of force, giving the study limited statistical power.

[3] Michael D. White, Police officer body-worn cameras: Assessing the evidence. (Washington DC: U.S. Department of Justice, Office of Justice Programs Diagnostic Center and the COPS Office, 2014), 10,16,35.

The first large-scale RCT was conducted in the Las Vegas Metropolitan PD. The study shows limited effects on BWCs because of issues of compliance. The study highlights a series of political (both internal and external), infrastructure, and administrative challenges, including selection of locations due to infrastructure to host the cameras and officer selection/ recruitment due to constraints with the Police Union (Souza et al., 2015, 366).

A more recent large-scale RCT conducted with 2,224 officers of the Metropolitan Police Department in Washington, DC demonstrates that cameras did not meaningfully affect police behavior on a range of outcomes, including complaints and use of force. The authors conclude that "the effects of cameras are likely smaller than many have hoped" (Yokum et al, 2019: 1).

Cumulated research on the impact of BWC point out that findings significantly vary among police departments due to several reasons, including infrastructure, institutional cultural, and size of the corporation. Stought et al (2017) present three categories of potential benefits for the adoption of BWC (symbolic, behavioral, and information). According to them, each scenario of implementation has a large impact on whether any of these benefits can be achieved.

Further empirical research is necessary to understand how BWC impact police behavior. The adoption of BWC in violent vs. peaceful environments, large vs. small police departments, strong vs. weak protocol discretion will significantly impact the results.

Police department's protocols and the activation policy that rules the use of BWC also play a crucial role in the technology's impact. In 2015, a quasi-experimental research conducted with 100 line officers at Mesa PD (Arizona) showed that a mandatory vs. discretionary activation policy in the use of BWC significantly dictated final results. For example, the study shows that arrests were more likely to occur during the discretionary period of activation, which entails to turn on the cameras at their choice during encounters. When officers were in a mandatory protocol that required equipment activation at ANY interaction with citizens they tended to be more careful on their actions (Justin et al., 2015, 6).

Although mandatory activation policies appear to induce more compliance, a study conducted at Phoenix PD indicates that the adoption of a mandatory policy without management and accountability is inefficient. Phoenix PD adopted an objectively mandatory activation policy where officers were required to record all of their investigative or enforcement-related interactions with civilians. However, protocol compliance was very limited and officers failed to record most of the incidents. Throughout the study, officers complied only 42.2% of the time. By the end of the experiment, this number dropped to 13.2% (Katz et al., 2015:1416).

Hedberg et al., (2016) conducted a study in Maryvale that sheds light on the importance of activation compliance (recording) compared to the assignation of BWC to explain incident outcomes. Within the treatment group, the author's take two measures to determine the full potential of the adoption of BWC and provide an estimate of its efficiency. Firstly, they explore the effect of assigning cameras to officers, "which is similar to (but not equivalent to) "intent to treat" analyses". Then they estimate the effectiveness of BWCs on officers who really use BWC, "which is akin to (but also not equivalent to) the "treatment on the treated" estimator employed

in causal analysis". Although results show that overall BWCs have no effect on the rate of arrest or resistance, they can substantially reduce complaints. The authors argue that if cameras were used in full compliance, complaints towards officers would be eliminated. (Hedberg et al., 2016:10). Interestingly, the authors point out that understanding protocol compliance levels on cameras assignments and real usage shed light on critical aspects to generate knowledge on the extent of BWC effectiveness when employed in its full potential.

Even more limited scholarship is available to assess the effectiveness of BWC in developing world settings, where issues of compliance are likely to be even more pervasive. Our study in Rio de Janeiro is the first RCT of its kind to assign BWC in a very high-violence environment.

3. The Rio de Janeiro context

More than one-fifth of Brazil's 2016 police killings occurred in the Rio de Janeiro, where police killed close to 8,500 people in the past decade, including 925 in 2016. The exorbitant levels of officer-involved killings are associated with the militaristic approach of policing the favelas, irregular urban agglomerations that, since the 1980s, have been dominated by heavily armed drug gangs.[4] The state adopted a militaristic approach to confront drug trafficking organizations, increasingly relying on the Battalion of Special Operations (BOPE),[5] trained in urban warfare, as well as tactical teams operating inside the so-called territorial battalions, in charge of patrolling the streets.

In anticipation of the 2014 World Cup and the 2016 Olympics, the state of Rio de Janeiro instituted a far-reaching reform with the Pacifying Police Units (UPPs). The UPP's mission was to regain control of territory from drug trafficking groups by establishing a permanent police presence and changing the militaristic approach to policing the favelas.[6] The program began in 2008 in the small favela of Santa Marta, and gradually expanded to over 150 favelas with over 13,000 police officers deployed. [7]

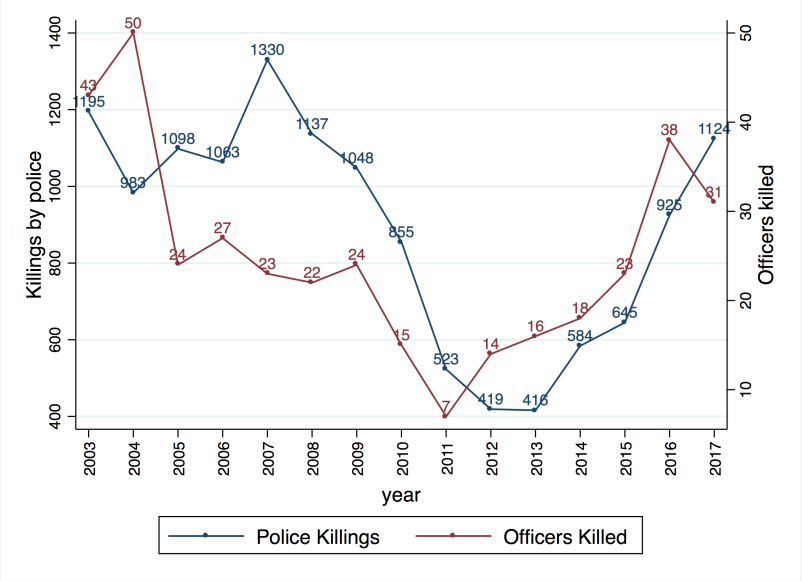
[4] Three main drug trafficking factions have constantly fought each other for control of the favelas: The Red Command (Comando Vermelho, CV), Friend of Friends (ADA), and Third Command (TC). In addition, vigilante groups or militias emerged across the city among well-organized armed men made up of former police officers, firemen, and prison guards.

[5] BOPE performs its operations with heavy armed weaponry, including a specially designed tank used to overpower barricades, as well as sniper rifles, ballistic shields, stunt grenades, and advanced night vision optics. BOPE cops seldom get injured –or die– and their operations are known for violence and "efficiency."

[6] The intervention entailed an initial "invasion" by special operation units, including BOPE and sometimes the armed forces were also involved. After some months of stabilization, UPP police officers were assigned to the intervened favelas.

[7] Another important reform was the enactment of a pay-for-performance reward introduced in 2009 through the Crime Reduction Performance Target Reward (Sistema de Metas). The government pays a bonus to those policemen who reduce basically three criminal indicators: homicide and other violent deaths; car theft; and street robberies. It is worth emphasizing that under the Sistema de Metas, police killings or previously called "Auto de Resistência" were added to the set of goals in January 2011. The new system of incentives offers a sharp contrast to the controversial "bravery bonus" reward policy, active from 1995 to 1998, which rewarded officers for being involved in lethal shootouts.

Mostly young officers with no prior experience in the Military Police were assigned. The new policing approach would require developing a more proximate relationship between police officers and favela residents. Between 2008 and 2013, killings by the police decreased by more than 60%. After 2013, officer-involved killings started to increase by 2017 reaching 1124, almost as high as pre-reform levels (see figure 1).



Source: Data from Institute of Public Security (ISP)

Figure 1: Number of Killings by the Police and police officers killed, 2003-2017

Most of the reduction on police lethal violence between 2008 and 2013 can be attributed to the UPPs (Magaloni et al, 2018). However, the mission of the UPP got increasingly compromised as instances of police violence and abuse began to accumulate. Moreover, the UPPs had the effect of dispersing crime to other areas of the city, largely increasing the challenged for the PMERJ to maintain order. The police reform effort would ultimately be reversed and in February 2018 Brazil's military took over security in Rio. The then Brazilian president explained the intervention as an "extreme measure" necessary to crack down on organized crime and drug trafficking. The military intervention will be in effect until December of 2019.

The "pacification" process confronted several challenges. Residents complain that police behavior is often arbitrary, and that the control of the favelas has shifted from brutal criminal gangs to overpowering police officers. The introduction of BWC to tape interactions between UPP officers and Rocinha residents could be a step in the right direction to constrain police misbehavior and build trust among the community.

4. The context of policing at the research site

Rocinha is the largest favela of Brazil with a population of over 100,000[8] inhabitants. The territory is located in the South Zone, one of wealthiest areas of Rio de Janeiro. Despite weak state presence and the rule of drug lords, Rocinha has substantial levels of development compared to other favelas. The favela has a lively and strong commerce, which accounts for around 5,000[9] diversified small business – from beauty salons to restaurants, to clothes stores. Additionally, the territory benefits from the presence of large businesses such as federal and private banks. Rocinha is also well-known for its strong social movements and local institutions.

Rocinha's drug business started to intensify in the 1980s under the leadership of a powerful drug lords. The drug faction, Comando Vermelho (CV) originally controlled Rocinha but after a violent turf war among factions within that criminal group, control switched to Amigos dos Amigos (ADA) in 2004. Rocinha received a UPP in 2010 with a large police operation that resulted in the arrest of the then local drug lord. Around 900 police officers were deployed to Rocinha's UPP.

In the summer of 2013, the commander in charge of the UPP, Major Edson dos Santos, and 13 soldiers were arrested for killing of the resident Amarildo de Souza. He was beaten and tortured by UPP police officers and eventually died. The *Amarildo* scandal not only disrupted the "pacification" in Rocinha, but also seriously damaged the legitimacy of the UPP among the wider public.

To better understand the challenges UPP police officers confront Rocinha, the study included three rounds of surveys with police, two focus groups and numerous interviews (narrative format) with commanders and local officers. 300 officers participated in the first round of survey that occurred before the experiment began (October 2015), followed by 190 in the second round (midway study), and 190 in the third upon completion of the project.

Table 1 shows the frequency of criminal events that police officers were involved in the last 12 months. 52% of respondents reported being involved in a domestic violence occurrence, 45% arrested someone, 32% apprehended drugs, and 30% participated in armed confrontations between 1 to 4 times. These results suggest that during the study, Rocinha was a hostile environment, where police officers were constantly involved in events that can result in the use of force.

Moreover, police officers were asked about the frequency of police reports that they were involved in their work routine. As shown in table 6, a large portion of respondents said that they were frequently or very frequently involved in police reports related to disturbance of peace (68%), followed by possession and use of drugs (61%), drug trafficking (60%), disrespect and disobedience (60%), and armed confrontations (45%).

[8] Censo 2010. http://censo2010.ibge.gov.br
[9] Source SEBRAE/RJ. http://www.bibliotecas.sebrae.com.br/chronus/ARQUIVOS_CHRONUS/bds/bds.nsf/1D783D6F8400E04E8325795700665AE2/$File/NT00047106.pdf

Table. 1 Police survey: frequency of events while in service

The frequency of events while in service in the last 12 months Event	Never	1 to 4	5 to 10	More than 10
	Respondents answers (%)			
Use your gun against someone	69%	21%	6%	4%
Wounded a civilian with a gun	95%	4%	0%	0%
Participated in an armed confrontation	54%	30%	8%	8%
Made use of less lethal weapons	86%	12%	1%	1%
Participated in operations that civilians died.	87%	12%	1%	1%
Fined someone for contempt of authority	70%	26%	3%	2%
Apprehended guns	75%	21%	2%	2%
Apprehended drugs	54%	32%	8%	6%
Got shot by a gun	95%	4%	1%	0%
Arrested someone	44%	45%	7%	4%
Participated in a domestic violence occurrence	35%	52%	10%	2%

These numbers highlight that the work routine in Rocinha for police officers were involved in many events that might result in the use of force.[10] Moreover, it is important to highlight that police officers in Rocinha are at significant personal risk. Almost 30% of police officers in the survey reported to have witnessed a co-worker get shot in Rocinha.

The frequency of the following police reports in your work routine	Never	Rarely	Frequently	Very frequently
	Respondents answers (%)			
Drug trafficking	17%	23%	30%	30%
Seizure of firearms	28%	56%	13%	4%
Disturbances of peace	13%	19%	33%	35%
Domestic violence	14%	27%	37%	23%
Disrespect/Disobedience	19%	31%	30%	30%
Bickering/Fights	17%	35%	31%	17%
Homicides	26%	53%	16%	4%
Robbery	21%	44%	24%	11%
Petty theft	21%	45%	24%	10%
Sexual violence	30%	55%	11%	4%
Transit related report	20%	42%	27%	11%
Possession and use of drugs	18%	21%	31%	30%
Armed conflict	24%	31%	28%	17%

The survey asked how police officers perceive residents' feelings towards the police with the following question: "In your opinion, what is the felling of residents towards the police? Officers were given a menu of options equally split between positive and negate words: fear, respect, distrust, admiration, sympathy, indifference, disrespect, indifference, and rage.

[10] During interviews and focus groups many officers said that they did not record because they did not have interactions with citizens.

The word cloud below summarizes the results, indicating that when police officers relate residents' feelings toward the police, they mostly used harsh language. The most frequently used words are "indifference" and "suspicion, followed by "anger". While positive words such as "sympathy," "respect" and "admiration" were also mentioned, they were used comparatively infrequently.

Officers perception about favela residents' feelings[11]

Officers were also asked how frequent they suffer from specific aggressions from residents on a daily basis. 56% reported that very frequently and frequently were cursed or shouted by a resident, 30% had water and 25% had urine thrown on them, 35% had a stone thrown on their direction, 53% heard a threat from a resident, and 37% suffered verbal or physical attacks upon effecting prisons.

4.1 Criminal indicators in Rocinha during the study

The study seeks to understand the effect of BWCs on police violence and behavior. Since the administered surveys throughout the experiment are subject to social desirability bias, in which some police officers might be underreporting or over-reporting the frequency of engaging in violent acts against civilians or excessive use of force, this section also employs the administrative records collected by the police of Rocinha.

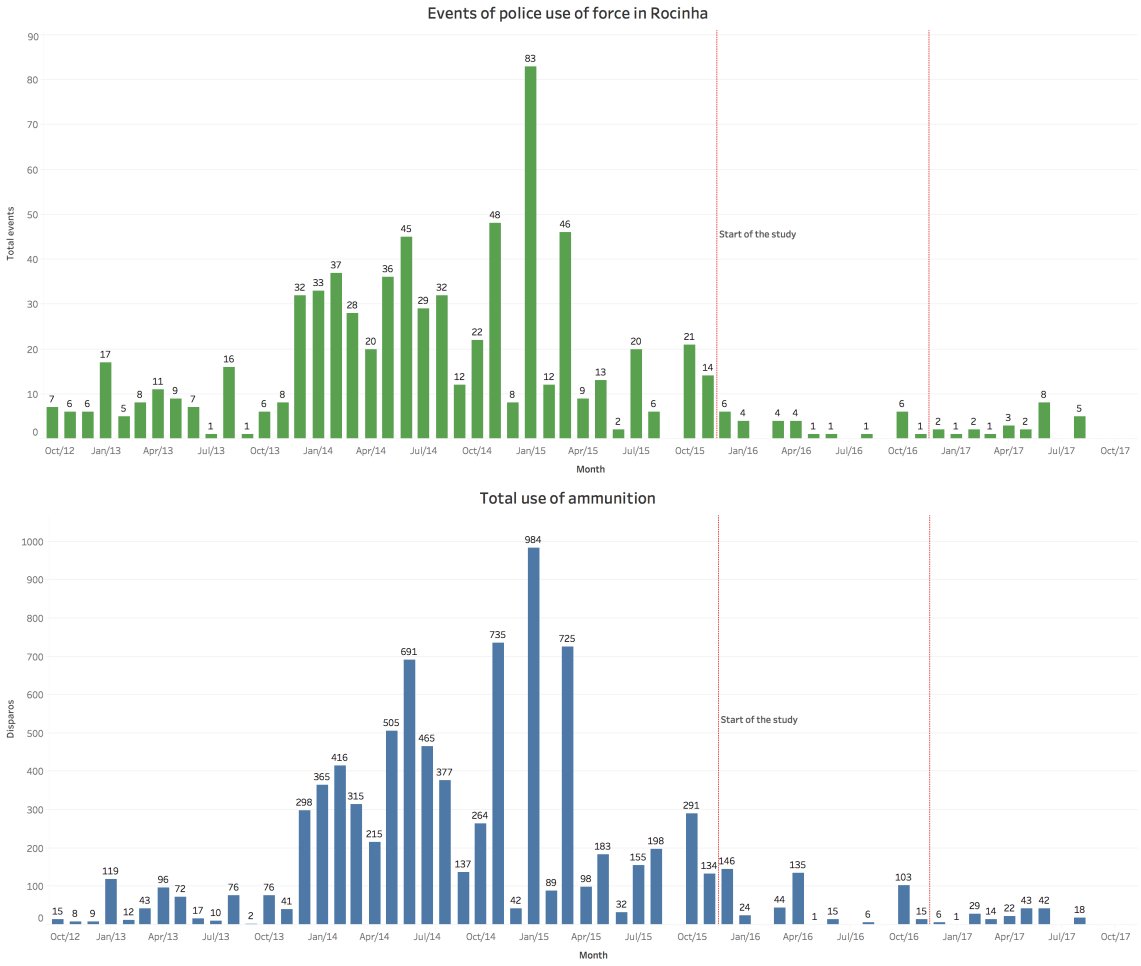
One of our main datasets comes from records on individual use of force (i.e. special operations involving drug seizures and shootings with firearms) on a daily basis. This database was provided by PMERJ and does not include personal information of police officers (name, sex, age) other than a unique identifier number.

Records on use of ammunition are available from September 2012 to August 2017. During this period, there were 774 individual incidents of use of lethal force for which 8,997 bullets were used. We were able to identify 28 events of use of force by the police in Rocinha during the 12 months of the study. A total of 489 bullets were used during these events.

[11] The word cloud displays every word selected by police officers to describe these feelings and adjusts the size of each word depending on the number of times it was mentioned.

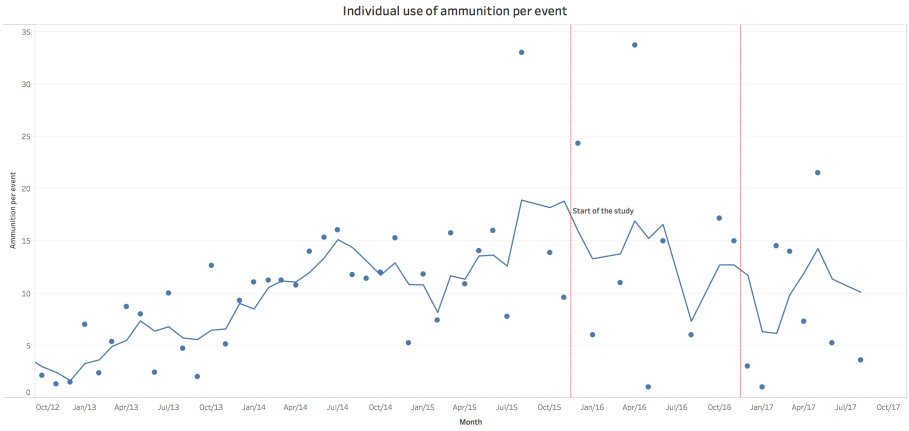
The following figures show the number of the events of use of force and ammunition spent in Rocinha since the creation of the UPP. A dramatic reduction in the police use of force is observed when our RTC was implemented (shade region) in comparison to the previous two years. As discussed in the second section of this paper, police violence was considered a serious public safety problem, consisting in "neutralizing" gangs, riots, and suspects. In fact, in 2014 and 2015 the police registered 350 and 232 events of use of force (green bars) accounting for 4,527 and 3,035 bullets (blue bars), respectively. After the intervention, events of use of force only increased by a small amount. From January to July 2017, there were 22 events of use of force involving 169 bullets.

Use of force in Rocinha
2012-2017



Although there is a dramatic reduction on the extensive margin of the use of force by the police during and after the experiment, there is no clear evidence that the police reduced the intensive margin of the use of force (bullets per event). The figure below summarizes the average individual use of ammunition per event from 2012 to 2016. According to these results, in 2016 a police in UPP Rocinha used an average of 14.5 bullets per event, and this rate is slightly higher than the ones for 2014 and 2015 (12.9 and 13.1, respectively). From January to July 2017, the police used only 7.7 bullets per event.

Individual use of ammunition per event in UPP Rocinha
January 2012 - July 2017



Although police use of force dramatically decreased after the introduction of BWC, our research design does not allow us to make causal claims on the impact of BWC between periods (before and after the intervention). There is evidence that trends on police enforcement efforts were decreasing before the introduction of BWC. Understanding the causes of these changes is important to understand the context during which the RCT was implemented. A decrease on police enforcement efforts can be explained by a change in commander's leadership style but also by a decreasing trend of crime activity in the favela.

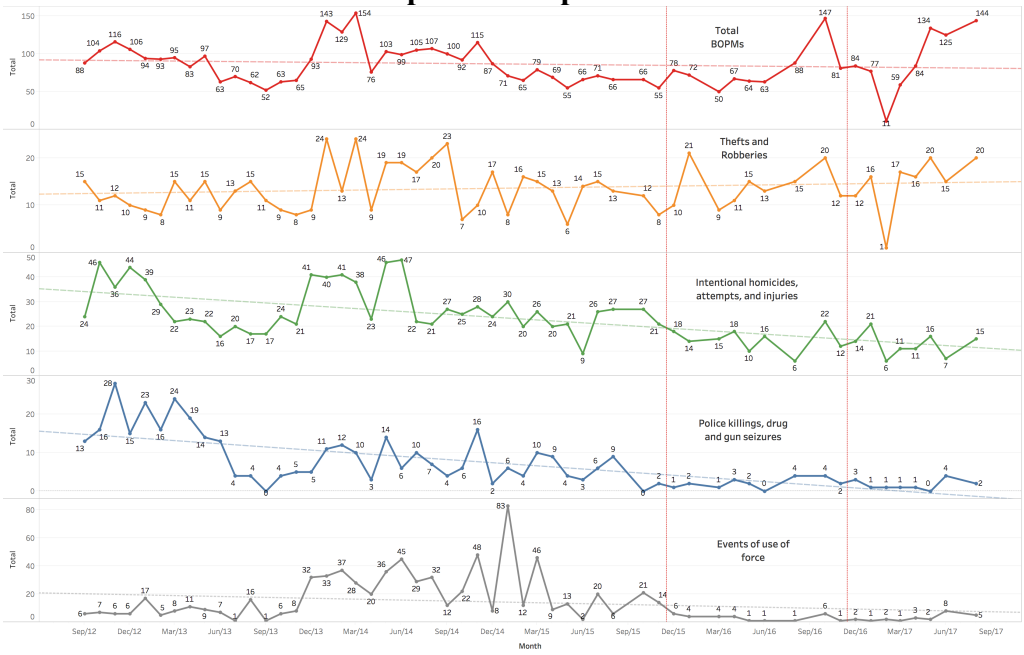
To better understand the context of Rocinha during the RCT, the following graph shows time trends on different indicators of crime activity and law enforcement in the favela since September 2012 using official public records. The data shows that crime activity in the favela during the intervention was similar to the crime activity in the year before (even slightly higher), but substantially lower to the one observed in 2014. A total of 975 occurrences were observed in 2016, compared to the 805 and 1310 occurrences observed in 2015 and 2014, respectively.

There were similar trends for the most common types of crimes in the favela. Between 2014 and 2015 the number of thefts and robberies went from 202 to 142 events. In 2016 there were 169 occurrences, which represents an increase of 19% with respect to the previous year and a decrease of 16% with respect to 2014.

Although common crime did not decrease significantlyduring the introduction of the BWC, law enforcement efforts such as drug and gun seizures, use of lethal force, and homicides by police intervention[12] show decreasing trends between the UPP's inauguration and the first half of 2017. Unfortunately, these trends reversed during the second half of 2017 and in 2018.

[12] Previously called "Autos de Resistencia" (resistance to arrest).

Figure. Trends on crime activity and law enforcement in Rocinha
Sep 2012 – Sep 2017



In order to show these results more formally, the next table presents regression models for selected monthly indicators of crime activity and law enforcement efforts with respect to different time periods before and after the experiment. The coefficients should be read as how many more or less events occurred in that period with respect to the number of events observed during the experiment in 2016 (shown in the last row of the table).

The results confirm there was no substantial difference in common crime activity (using as proxy the monthly number of total occurrences, thefts, and robberies) during the experiment with respect to one year before. In contrast, the number of monthly homicide attempts and intentional injuries was lower during the experiment than in the previous two years. Finally, as observed before, use of lethal force by the police and events of drug seizures were also lower during the experiment.

4.2 Changes in command at Rocinha during the RCT

Since the first stages of the study, PMERJ had several changes in command and leadership – From the general headquarters' commander to chiefs in strategic areas and positions, to local commanders. For example, the researchers negotiated the BWC project with two distinct general commanders and four different local commanders in less than two years. These changes also reflect on major modifications with critical PMERJ's areas, such as Coodenadoria de Assuntos Estratégicos (Area of Strategic Matters, "CAES"), a crucial partner to the implementation of the BWC project.

Locally, these changes affect patrolling approaches, "local" institutional goals such as proximity vs. repression, the configuration of units and critical daily tasks. The UPP of Rocinha was considerably delegitimized after the *Amarildo* scandal. Although the first commander of Rocinha

was a BOPE officer and had a violent policing approach, he had managed to gain substantial community support. Interviews suggested that Major Edson was effective confronting drug trafficking with traditional approaches while building a closer relationship with local residents and community leaders. After his arrest in 2013, police legitimacy quickly deteriorated. In attempts to rescue the UPP's legitimacy in Rocinha, a commander who became a strong symbol of the UPP project and who had successfully commanded the first UPP in Rio, Major Pricilla Azevedo, was appointed to be in charge of that UPP.

After been appointed to Rocinha, the Major and the general commander of the UPP were attacked while visiting a few areas of Rocinha. This was a clear message from the drug traffickers that they had regained strong presence in the community. During an interview about the BWC Major Priscila disagreed with the selection of Rocinha for the BWC study due to its hostile environment. Although Rocinha's new commander had a strong community policing experience, she rapidly comprehended that applying COP strategies in this favela would drastically differ from her first experiences as commander in the small favela of Santa Marta.

In August 2015, another highly experienced and trusted UPP commander, Major Nogueira, assumed control of Rocinha. During an interview, we learned that the new commander's main goal was to reestablish and strengthen COP strategies in the community. He enlarged the GPPs units, originally designated to COP strategies, and limited GTPPs, the tactical unit commonly involved in armed confrontations. During an interview to pre-set up the project and discuss RCT design, Nogueira explained that he could not use his local police officers, who were tasked to build a trustful relationship with the community, to conduct large and hostile operations in the territory. He also said that the specialized battalions such as BOPE and Choque were the correct units to conduct tactical operations and contacted them every time he felt in need of more aggressive policing strategies. Major Nogueira was also an enthusiastic supporter of the BWC study. In his perspective, the use of cameras would be a way to improve police work. He believed that this technology would increase his ability to monitor officers' performance and act more effectively to solve police misconduct. He left Rocinha's command during the final bureaucratic steps to implement the project.

The next two UPP's commanders shared the responsibilities of project implementation and execution. Major Pazzini was directly involved with the protocol's design and the first five months of project execution. The last commander was engaged with the establishment of the management area and the remaining period to conclude the study. As mentioned before, units' organization and size considerably changed with the last commander. Monthly reports about performance were periodically sent to both commanders. Both commanders made the sub-commanders available to supervise and attend project's needs. Additionally, they were fully aware of the low camera usage and protocol non-compliance.

Despite directly negotiating with commanders every measure to improve camera usage throughout the study, the actions ultimately failed. Our experience on the ground points out that local leadership strongly influenced the project's outcomes. Ultimately, the BWC study was a strategic decision made by PMERJ's leadership. Local commanders were never consulted about receiving the project at Rocinha.

Moreover, the incentives to improve compliance were very limited. Infrastructure at the UPPs are very limited and in many occasions, local units have no capacity to properly conduct standard procedures such as DRDs requests, investigations, and final report to proceed with punishment. For example, during an interview, a high-ranked general commander revealed that he did not even have human and infrastructure capacity to investigate or punish several police officers within the PMERJ who were absent from work during holidays, which is considered a serious fault within the institution.

Even though the study counted with the strong support of superiors within the PMERJ to reinforce the project with the local command, ultimately there is an internal understanding about these local limitations, which gives commanders freedom to act upon their priorities and establish more autonomous forms of command within the police. This certainly gives the commander high levels of freedom to act in their territories. We concluded the project understanding that for local commanders making available the BWC technology was never seen as a beneficial tool, although we had received their full support on administrative matters due to institutional pressure.[13]

5. Study Implementation and design

To implement the RCT, Axon partnered with researchers at the Poverty, Violence, and Governance Lab (PovGov) and lent 75 cameras. Additionally, Axon offered training, technical support, and footage management software, Axon Evidence, to conduct the study. The PovGov's team provided the import of AXON's equipment and delivery at PMERJ. The site of the study was selected by the PMERJ.

Rocinha's UPP armaments are held at the 23rd battalion located in the wealthy neighborhood of Leblon - around 20 minutes from the favela. The area designated to hold these items is called "Reserva de Armamento e Munição Bélica" (RUMB). Every day, police officers first stop at RUMB to get their daily equipment before heading to the favela. This process takes up around an hour until officers are able to reach their final patrolling destination. Similar routine happens after each shift, when officers drop off guns and report the use of ammunition, in case of any usage.

Thirteen dock stations to daily recharge BWC and download recordings were placed at RUMB to facilitate distribution. Every day, the officers in charge of distributing and registering equipment would add a camera to each of the officers assigned to the experiment.

[13] To process the randomization of the cameras, researchers needed to collect the schedule for officers' shifts. At the beginning of the study, police shifts were monthly collected and randomization sent monthly. After Abril, shifts were daily collected and randomization sent daily. Moreover, researchers monthly collected the number of cameras distributed by RUMB. Finally, data on police reports and use of ammunitions were monthly collected throughout the study.

At first, the researchers collected officers' monthly shifts[14] and randomly assigned the cameras. RUMB's officers received a monthly assignation spreadsheet and distributed the equipment accordingly. To improve assignment effectively, after a few months, officers' schedules were collected on a daily basis for camera assignment. On the previous night, RUMB's officers received Stanford assignments to use the next day. To ensure high control of the cameras and their assignment, RUMB follows PMERJ's institutional protocol to control the distribution of guns and bullets. They added the cameras to an official record, consisting of a bookkeeping track of entry and exit hours for each camera, which is attached to an officer ID who remained responsible for the safety of the equipment during his/her shift.

To receive the study at the 23rd Battalion, the researchers provided several adjustments to RUMB – which ranged from substantial construction work to receive appropriate electricity to support the dock stations and avoid shortages, to the physical organization, to the complex installation of a dedicated link to effectively and safely support the process of daily downloading the footages.

After completion of infrastructure requirements, AXON started training Rocinha's officers to use the equipment. Parallel, a 10-page baseline survey was applied to Rocinha's officers. Around 300 officers took part in the training and answered the questionnaire. Additionally, focus groups were conducted with police officers at the beginning of the study. All of these stages were directly coordinated by the researchers with PMERJ assistance.

Another critical aspect for this study was the storage and management of the recording. At first, the management team was allocated at the UPP headquarters, Coordenadoria de Policia Pacificadora (Pacified Police Unit Coordination, "CPP"), where a team of six officers under the supervision of a Major would work to store and process the videos according to the procedures established with PovGov, under AXON's guidance. Axon also provided technical training to the management team.

[14] The researchers worked closely with the area responsible for setting up officers' schedules to receive the shifts accordingly. At some point, it required daily communication to gather the schedules in time to run and send the randomization to RUMB.

Study Design

Unit of study

The study was aimed to units within the UPP that have patrolling functions or substantial amount of interaction with the residents. For the purpose of the study, we considered 3 types of units according to their functions, policing area, and length of the work shift:

- **GTPPs**: These are specially trained units within the UPPs that are significantly more likely to engage in armed confrontations. GTPPs are not deployed to fixed geographic areas but tend to be deployed to areas where armed confrontations happen. There were three GTPPs units during the length of the study, each with 5 to 7 officers each.

- **GPPs/Visibilidades**: These units are designated to fixed geographic areas and carry out regular patrolling and "proximity" policing. Most GPPs units in this group have 2 to 3 officers working shifts of 12 hours.[15] Later in the study, some of these units were called Visibilidades for administrative purposes.

- **GPPs/Bases/Patrulhamentos**: These GPPs or "Bases" are also designated to fixed geographic areas, and also carry out patrolling and "proximity" policing. Nevertheless, they have more police officers (4 to 5) than other GPPs and have shifts of 24 hours. Later in the study these units were called Patrulhamentos.

The map below shows the location of the GTPPs and GPPs in Rocinha at the beginning of the study.

Figure 1. Location of GTPPs and GPP

Source: UPP Rocinha. Map with the locations of GTPPs and GPPs units at in December 2015.

[15] Four GPP units in this group worked shifts of 24 hours, but they were smaller in size and assigned to smaller geographic areas. These units did not received cameras during the period of study.

Later in the study, we included and assigned cameras to Supervisors and Radio Patrulhas. There are two supervisors in the UPP at all time working shifts of 24 hours. They are in charge of monitoring the UPP's operations and have daily meetings where they provide feedback and operation orders to police officers. We assigned cameras to supervisors from February to July to increase the compliance on camera usage (see sections below). Radio Patrulhas are smaller units (2 officers) that attend contingencies reported to the police radio and work shifts of 12 hours. Although these units are not on the streets nor tend to use lethal force, we included them at a later stage of the study due to the substantial number of ocurrences or emergencies they respond to.

Number of shifts by unit type

	Treatment	Control	Total
BASE/PATRULHAMENTO	3,144 50.7%	3,056 49.3%	6,200 100.0%
GPP/VISIBILIDADE	8,156 42.2%	11,171 57.8%	19,327 100.0%
GTTP	4,160 67.9%	1,969 32.1%	6,129 100.0%
RADIO PATRULHA	550 21.2%	2,045 78.8%	2,595 100.0%
SUPERVISION	380 48.7%	401 51.3%	781 100.0%
Total	16,390 46.8%	18,642 53.2%	35,032 100.0%

The table above shows the number of shifts in the control and treatment group by type of unit. Bases (GPPs 24 hours) assignment was constant across the study (two units in the control group and two units in the treatment group). Two of the three GTTP units were assigned to the treatment group at all times. Nevertheless, we varied the months in which each unit was assigned to each of these groups. The higher percentage of shifts in the control group for GPPs 12 hours (Visibilidades) reflects the creation of new units after the start of the study and the existence of smaller GPP units that were assigned to the control group over the length of the study. All supervisors were assigned to the treatment group between February and June 2016. For each supervisor, we randomized the days (full weeks) he/she received a camera (see section below). Finally, as mentioned before, we included the two Radio Patrulha units in the study at later stages (July 2016).

5.2 Assignment to treatment

During the period of the study (Dec 2015 to Nov 2016), about 470 police officers were monthly assigned to UPP Rocinha on average, totaling more than 52 thousand individual shifts. From those, around two thirds were included in the study. The rest of the officers held administrative positions or were assigned to smaller or new units that were not included in the study.

Police officers in Rocinha
Dec 2015-Nov 2016

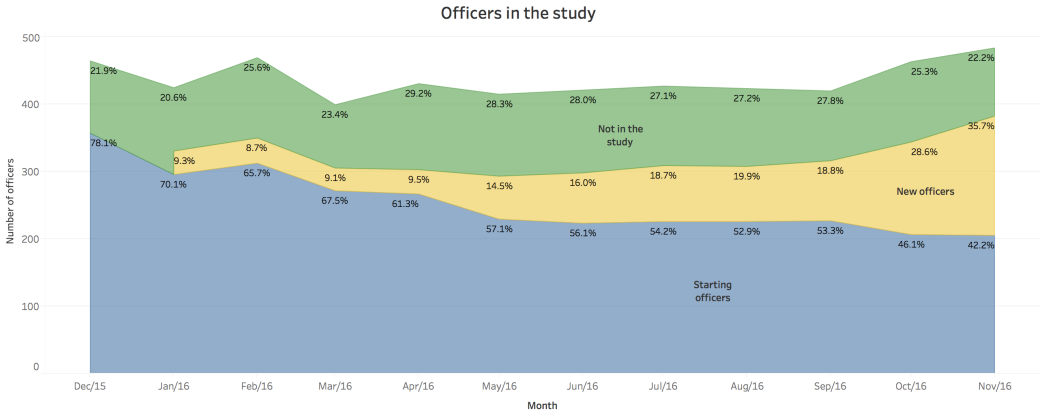
Number of police officers in the experiment

	Dec/15	Jan/16	Feb/16	Mar/16	Apr/16	May/16	Jun/16	Jul/16	Aug/16	Sep/16	Oct/16	Nov/16	Total
Control	177	152	208	171	171	180	191	205	177	176	220	246	540
Treatment	188	178	196	141	132	138	145	169	137	151	181	202	494
Not in the study	107	109	202	113	208	172	175	167	159	149	174	179	427
Total	464	439	552	418	511	454	456	465	449	458	490	497	857

Within each type of unit (GTTP, GPP-Visibilidades, and GPP Bases), we randomly assigned full units into treatment and control groups. Treated groups received body-worn cameras according to the protocol described on the next section. Control groups were not assigned cameras. In addition, in order to be able to make comparisons within units, we reassigned units to treatment and control groups at different stages of the study (see Appendix). This allowed us not only to compare camera usage and use of force between units, but also to compare officers within the same unit at different points of time with and without cameras.

There was a high turnover during the study with more than 850 different police officers being assigned to Rocinha at some point during the study. In fact, by November 2016, almost half of the officers in the study had been reassigned. The months with the highest turnover were May and October 2016 (see Figure below). Training and hard copy of the protocol on the use of cameras were provided to all newcomers. We estimate that, by November 2016, more than 50% of officers that were included in the study were replaced or reallocated to other units. The high turnover is not uncommon in Rio's PMERJ, although in this case was also associated with frequent shifts of commanders during the study (see below).

Number of officers in the study per month



5.3 Camera randomization

The main objective of the study was to assess the impact of BWC on police behavior using an experimental design that randomized camera assignment between units. The study was designed to provide empirical evidence to additional questions: Are there peer effects of BWCs? Do all officers in a unit have to wear BWC to observe a change in behavior? Do BWCs have to be turned on at all times or only when officers are interacting with residents?

In order to answer these questions, we initially varied the treatment (camera assignment) within treated units across three dimensions:

1. **Coverage:** we randomized the number of cameras that were assigned to each treated unit during a particular shift. The objective of this variation was to assess if there were peer effects of BWC and how many cameras were necessary to observe an impact on police behavior. In this variation, some treated units were given cameras for all police officers

working the shift ("Full team"), while the rest of the treated units were given cameras for half of the team ("Half team"). In this later scenario, cameras were randomly assigned between officers each shift.

2. **Intensity of use**: we randomized usage protocol across treated units. Officers in some units were asked to turn their cameras on during their entire shifts ("Always on mode"). Officers in the rest of the treated units were required to turn on their cameras only when interacting with citizens ("Interactive mode"), the prevalent practice in the US. The objective of this variation was to assess whether the intensity in the usage of BWC has a differential impact on police behavior.[16]

3. **Time**: within each treated unit, we randomized the shifts in which officers received a camera. Therefore, it was possible for an officer to be in a treated unit but do not receive a camera in a given shift. The objective of this treatment variation was to asses whether the expectation (or uncertainty) of receiving a camera had differential effects on police behavior. Officers in some of the treated units received a camera in *every* shift ("Always") the were assigned to. Officers in the rest of the treated units received a camera for only *some* ("Some shifts"). The randomization between shifts varied across units. For most units, the shift randomization was made at the unit level (e.g., all or none officers received camera in a given shift).[17]

Each police officer assigned to a camera received a copy of the protocol ("Always on" or "Interactive") that they were expected to follow besides the official publication of the document. Additionally, RUMB displayed a printed copy of both protocols outside of its glass window to assure that officers were aware of the procedures. A group of five supervisors was made available to supervise officers on the ground and ensure proper use of the equipment as directed in the protocol. Several procedures were stated in the protocol – from footage rights that belonged to PMERJ to administrative procedures such as equipment damage or loss to the types of unsafe interaction that might exclude officers from using the cameras. The protocol also explicitly conveyed the rules to follow the protocol and how and when to activate the camera.

The table below summarizes how camera assignment varied across treated units for different periods of the study.

Variation in treatment (camera assignment) across treated units

[16] There were some restrictions to enforce this treatment since BWC battery lasted on average 12 hours or less, especially during night shifts. To overcome this problem, we randomized for a few months the hours of the day that the camera was supposed to be used (first or second half of the shift). Nevertheless, we dropped this restriction since it was barely binding for actual usage.

[17] For fewer units, the shift randomization was made at the individual level and hence all, some, or none officers could receive a camera in a given shift. This last variation was implemented only for a few months.

	COVERAGE		INTENSITY OF USE		TIME	
Date	**GTPP**	**GPP**	**GTPP**	**GPP**	**GTPP**	**GPP**
1 Nov - 30 Ene	Random	Random	Random	Random	Random	Always
01 Feb - 15 Jul	Full team	Full team	Random	Random	Always	Always
16 Jul - Nov 30	Full team	Full team	Interactive	Interactive	Random	Random

Coverage randomization: Full or half team.
Intensity randomization: Always on or only on interactions.
Time randomization: Every shift or some shifts.

5.4 Changes in the experiment design

The original study design had three important changes. In February, we decided to drop the "Half team" (coverage) and the "Some shifts" (time) variations of the treatment. The reason to do this is because, from December 2015 to May 2016, the UPP of Rocinha sent us the scheduled shifts for the full month and we sent back the full randomization of cameras for the period. Nevertheless, there were constant changes and substitutions on a day to day basis that we were not aware of. Therefore, some of the cameras were not assigned due to new officers or changes in the daily shifts. To simplify the study and improve compliance, we asked PMERJ to assign cameras to all police officers in treated units ("Full team"), including substitute officers, for all shifts ("Always"). Moreover, to increase camera usage, we assigned cameras to all supervisors.[18]

The second change in the study came in May 2016 when there was a change of the UPP commander. The new commander implemented substantial changes in terms of size and range of territory of units. Almost all units slightly decrease in size (one less police officer on average) and some units previously allocated to the study were extinct and new units were added. These changes affected 5 of the 10 original GPPs-Visibilidad units, which merged into 3 new units that were assigned to the control group (see Appendix). The territoriality of the other GPP-Visibilidad, GPP-Base, and GTPP units remained unchanged. With the change of leadership, PMERJ started sending daily shifts to the team of researchers and randomization and camera assignment became considerably more effective (see sections below).

The last major change came in July 2016 after PMERJ setup group conversations to discuss the importance of the cameras and reinforce the protocol. It was clear from those conversations that police officers felt extremely uncomfortable with the fulltime ("Always-on") module, and efforts to improve compliance for this variation of the treatment were being unsuccessful.[19] Consequently, we adjusted accordingly and dropped this variation of the treatment. In exchange, we reincorporated the temporal dimension of the treatment and, for all treated units, we randomized shifts with cameras at the unit-shift level for the rest of the study.[20] Finally, we included the two Radio Patrulhas (RP) in the study and assigned one of them to the treatment group and the other one to the control group for the rest of the study. Although they don't use lethal force nor patrol, RPs attend a substantial number of minor incidents happening in the favela.

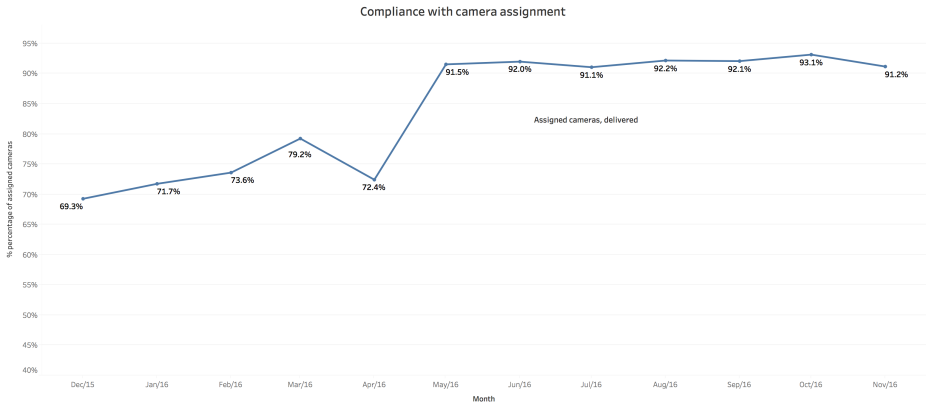
The new protocol published at Bol-PM in this last part of the study introduced a new rule for the interactive use, which reinforced that every police report generated by an officer using camera must be recorded. Although officers were instructed to turn on the cameras in every interaction with a civilian (i.e. assistance, information, etc.) even if the event had no potential to turn into a criminal report (BOPM), every criminal occurrence should generate footage to be stored and analyzed by the management team.

[18] We assigned cameras on the interactive mode ("Interactive") to supervisors for all shifts ("Always"), except on March and April when we randomize shifts on weekly basis.
[19] The first signs of protocol disobedience started to appear already at the end of January 2016.
[20] This was only possible after we increased compliance with camera assignment due to receiving daily, instead of monthly shifts.

For the researchers, the BOPMs would be the only mechanism to measure officers' performance from that point ahead. Additionality, the document provided procedures to penalize officers who did not comply with the protocol. Theoretically, lack of protocol compliance would lead to a DRD[21] – PMERJ's official administrative process to investigate and punish officers for mistakes. The process would be conducted by the CPP instead of Rocinha's commander.

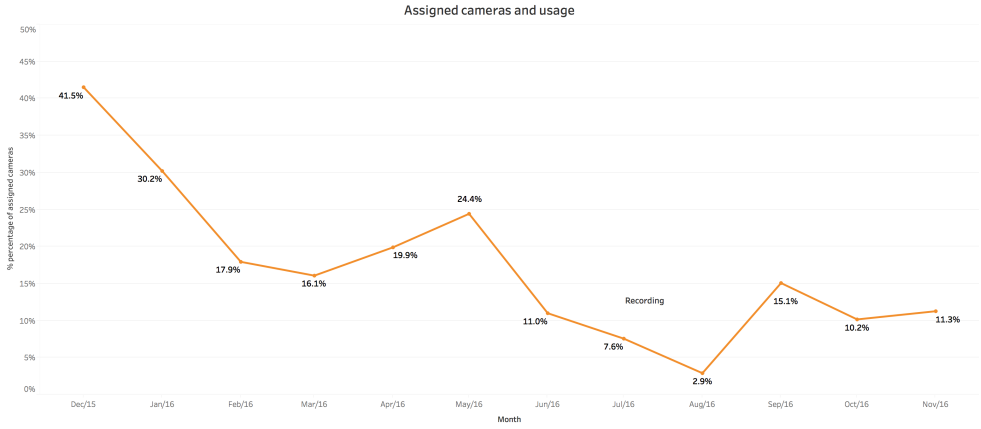
5.5.Compliance with camera assignment and usage

A RCT requires a strict design to achieve accurate results. One of the main concerns of researchers was the daily distribution of the cameras, a critical task delegated to police officers at RUMB. Daily, RUMB's staff received a document from researchers to distribute the equipment accordingly. Notably, the study had high compliance with cameras assignments, improving distribution to 90% for the second half the study. It is worth noting that compliance with camera assignment was particularly high after May 2016, when we started receiving scheduled shifts on a daily basis instead of on a monthly basis. This helped reduced significantly the number of cameras that were not assigned due to errors in the shifts, which were planned monthly but changed constantly every day. The 10% of cameras not assigned consists mostly on police officers that did not show up to their shifts.

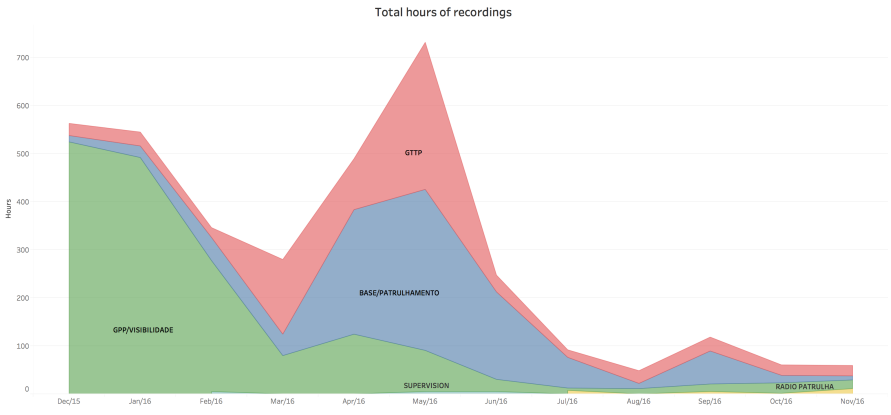


[21] A DRD (Direito de Razão de Defesa) is a formal document that PMERJ's superiors emit to police officers to give them the right to explain misconduct, such as absences, delays, behaviors, etc.

Approximately 18.5% of the 9,786 camera assignments in the treatment group were turned on at some point during the shift. There were different patterns of usage among units. Officers in GPPs/Visibilidades turned on 22.8% of their cameras at least once, followed by officers in Bases/Patrulhamentos (15.0%), and GTTPs (14.8%). Radio Patrulhas and supervisors turned their cameras on less frequently as well (10.8% and 15.3%, respectively).

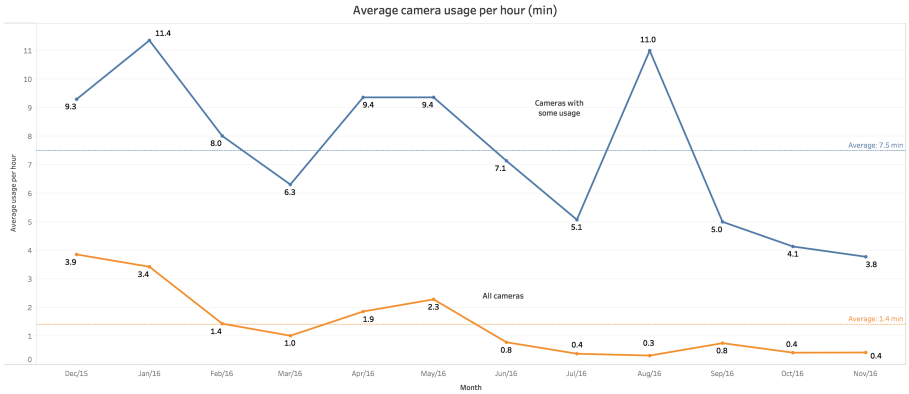


There were 3,582 hours of recordings during the experiment, with the highest volume in May and during the beginning of the experiment. It is worth noting that GPPs Visibilidades accounted for most of the recordings at the beginning of the study but GTTPs and Bases recorded a significant amount of hours in May.



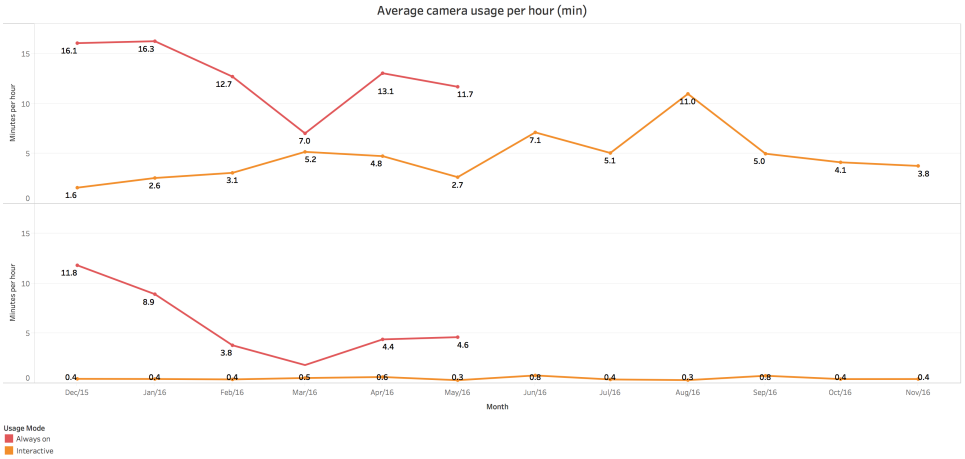
The average use of the cameras that were turned on during a shift was 7.5 minutes per hour.[22] The average usage including all cameras that were assigned was 1.4 minutes per hour. The usage for this group was higher at the beginning of the experiment and later in May.

There were some differences across unit types. The average usage of turned on cameras during a shift for GPPs Base/Patrulhamento was 9.9 minutes per hour, followed by GPPs Visibilidades (9.6 minutes) and GTTPs (5.4 minutes). Radio Patrulha and supervisors used cameras less intensively (5.3 and 1.0 minutes, respectively).



There were noticeable differences between modalities of camera usage. Cameras that were supposed to be always on ("Sempre Ligadas") recorded on average 13.3 minutes per hour for turned on cameras and 5.5 minutes for all assigned cameras. In contrast, cameras on interactive mode recorded and average of 4.0 minutes per hour for turned on cameras and 0.5 minutes for all assigned cameras.

Camera usage by modality of use



[22] We are subtracting two hours from the length each shift to account for the time in which officers rest and eat.

5.6.Actions to increase camera usage

Lack of camera usage remained an unresolved issue until the end of the study. However, several actions and interventions were implemented to improve camera usage throughout the study.

At the beginning of the experiment, there were strong indications that the study could be jeopardized due to compliance. To address the problem, the first measure entailed to periodically inform the headquarter, CPP, and Rocinha's commander about protocol disobedience per individual police officer. Moreover, we created a procedure to monthly track police officers with low usage. Individuals with less than 2 minutes of recording would be called upon to explain in person low usage. Due to the high level of non-compliance, we develop an audit system where officers with less than two minutes of recording would be randomly selected to meet with a superior and discuss usage performance.

Interviews with PMERJ high-ranked officers to understand the low usage of cameras revealed a broader institutional culture of disobedience and lack of effective procedures to increase compliance. Although interviews and focus groups with police officers showed that officers were willing to face charges for not conforming with the protocol, we strongly believe that three other main reasons led to protocol disobedience: 1) lack of penalty for not complying; 2) lack of leadership reinforcement; and finally 3) lack of resources to carry out compliance actions.

Focus groups conducted during the study with police officers revealed the following reasons for resistance to use the cameras. Officers expressed that the PMERJ wanted to use the cameras to harm them and not to help them. There was basically unanimity during the focus groups in the perception that the command would find a way to harm them if there were to be a situation of violence captured by the camera instead of trying to discuss the images and hear the officer's version of the story. Police often said that they are afraid that PMERJ would use the images against them, even though they are instructed and trained by the institution to work in "certain ways". Their comments highlight a deep distrust of the corporation.

Our interviews revealed that most officers perceive the cameras as a threat to the work and behavior they need to carry out on the ground. They are highly concerned that the cameras will constrain officers' actions, which according them differentiate from regular areas of Rio. The level of danger in the territory due to drug trafficking activities, distrust from the community, and lack of policy legitimacy are often the reasons provided by officers to justify the need of a rougher interaction with favelas' residents. Moreover, officers feel that they have no institutional and juridical support to carry out their work and actions in the favela. The following officers' comments on this matter highlight how the cameras might have provoked discomfort:

> "Here, we do not have regulations to embrace us… there isn't any support. We cannot act like we want… sometimes the guy [resident] wants to go head to head[fight] with us, and that is when we have an issue. Then, the media shows us using force but not what happened in the actual approach (abordagem). The law also doesn't support us…. the judge won't say: "the police officer acted correctly… let's just close the file." (Focus group, Rocinha, 2016, soldier 1)

> "I've been working at Rocinha for five years now, there is no way that we can work "correctly" at all times. We do not have the support for that. Sometimes we have to do something wrong to be able to do something right further down the road." (Focus group, Rocinha, 2016, soldier 2)

> "The officers feel intimidated to do his/her job." Sometimes we have to go into a place shooting… and what are we going to say when someone sees the images from the camera?" (Focus group, Rocinha, 2016, soldier 3)

According to the team at RUMB, where the equipment was daily distributed, officers often complained about the cameras being inconvenient to carry (i.e. because of the wires).[23] The PMERJ received a complete kit form AXON Inc., which gave police officer three options to display the camera: sunglasses, headbands, and a portable support to add to the uniform. At first, officers were giving the option to choose an accessory to wear the camera. While those who chose the sunglass often complained about it being foggy because of the hot weather in Rio de Janeiro, officers wearing the headbands frequently said that it was too tight to their heads and would give them headaches. After the first month, all the officers were using the portable support and wearing the equipment on the uniform.

Developing an efficient system to keep and manage footage was a second critical challenge. The research hoped to contribute to developing protocols for the processing of images, an enormous challenge for the police. Which videos should be audited and what strategies should commanders and supervisors follow to deliver feedback to police officers? As mentioned before, the first attempt to have a team of police officers working on the footages at CPP ultimately failed. Officers designated to this task hold other responsibilities at CPP and neglected the management of the footage. After three rounds of training by Axon and numerous personal discussions about the recording process, the researchers concluded that moving the infrastructure of footage management to Rocinha – with a room, supervisor, and team only dedicated to complete this task – might improve cameras' usage overall. By the end of Abril, the footage was physically allocated to Battalion 23rd, compromising a fulltime coordinator and 6 police officers working under the supervision of Rocinha's sub-commander. After this measure we see a considerable increase in usage in May (see section below).

Other aspects might have contributed to this improvement in usage such as changes in command. However, we strongly believe that allocating locally the footage management sent a powerful message about the importance of the project to officers. Moreover, having a local team to manage footages speeded up the system to identify police reports vs. recording. Daily, officers would check the footages and match with a BPOM, providing weekly feedback to superiors. Unfortunately, due to the lack of procedures to restrain disobedience, usage started to decline again. During a focus group conducted in June 2016, one of the officers explained that although they were willing to face punishment for disobeying protocol, they also understood that most officers in the experiment were not properly using the equipment, making unfeasible to their superiors to carry out even basic punishments procedures such as the DRD.

The trend of protocol non-compliance continued in the next months. Researchers implemented two more measures aimed at improving usage. On August 22nd, our team developed an

[23] According to Axon, the equipament has improved since it was employed at Rio's experiment. The company pointed out that Axon Body 2 was launched in 2016. It is a one piece camera (no wires) so it would solve complaints of police officers from several police departments, including in the Rocinha's experiment. Axon Body 2 were deployed in the London Metropolitan Police (22 thousands of units), Victoria Police in Australia (11 thousands of units) and LAPD (7 thousand units).

individual report of cameras' use to be distributed among officers. The goal was to show individuals that they were individually watched on a daily basis. Upon the collection of their cameras at RUMB, each officer participating in the experiment received a printed copy of an individual report showing his monthly performance. This strategy was also repeated on September 30th.

The Figures in the previous section show a slight increase in usage in September. Parallel to the delivery of the individual report, Rocinha's commander also issued the first round of DRDs. Ten officers received an official document to formally explain why they had not complied with the protocol. Although the researchers never received notifications whether the officers followed up with the document and if Rocinha's commander took any action to address them, we have reasons to believe that the DRD process led to usage increase.

Indisputably, PMERJ was highly involved in the project since its conception and strongly contributed to administratively carry out the intense work and commitment required for an RCT. However, a possible combination of varying local leadership styles, changes of unit commanders, lack of institutional procedures to sanction non-compliance, and the unit's high level of autonomy contributed to the lack of camera usage among police officers.

6. Evaluating the impact of BWC on police gunshots

As a first step to evaluate the effect of BWC on police use of lethal force, we compare ammunition usage between our treatment and control groups. Officers participating in the study were involved in 24 of the 28 events of use of force during the length of the study.[24] GTTP officers were involved in most of the events (17 of 24) followed by officers in GPP/Visibilidades (5 events), and in Radio Patrulhas (2 events). The comparison below only includes GTTP and GPP units since Radio Patrulhas were included in the later part of the study and are not directly comparable.

While the assignment to treatment was even throughout the experiment (see sections above), it is worth noting that 14 of the 22 (63.6%) events took place when officers were not wearing a camera. Also, the use of ammunition per event was higher in control units than in treated ones. There are no substantial differences in the intensive margin of the use of force between officers with and without cameras in treated units.

Use of ammunition by treatment group and camera assignment

	No camera		With camera		Total	
Control	Events	7			Events	7
	Total ammunition	202			Total ammunition	202
	Ammunition per event	28.9			Ammunition per event	28.9
Treatment	Events	5	Events	10	Events	15
	Total ammunition	61	Total ammunition	154	Total ammunition	215
	Ammunition per event	12.2	Ammunition per event	15.4	Ammunition per event	14.3
Total	Events	12	Events	10	Events	22
	Total ammunition	263	Total ammunition	154	Total ammunition	417
	Ammunition per event	21.9	Ammunition per event	15.4	Ammunition per event	19.0

We ran different models to evaluate the effect of BWC on police use of lethal force. We restricted the sample to the units that use force more regularly (GTTPs and GPP/Visibilidades). Our outcomes of interest are the probability of an event of use of lethal force, the total number of ammunition used, and the rate of ammunition used per event. We ran three different models for each outcome.

- The first model is a logit regression that includes an interaction with the treatment assignment with the actual assignment of a camera. This model assesses whether the physical presence of a BWC has an impact on police use of force.

- The second model includes a triple interaction of treatment assignment with camera assignment and a dummy variable that indicates whether the camera was turned on during the shift. Differences in the estimated coefficients of this model will show if turning the camera on has substantial effects on police behavior.

- The third model interacts camera assignment with unit type to assess whether the effects of the physical presence of a BWC on police use of force is different across different type of units.

[24] We excluded 3 events of use of force that occurred when officers were out of service and an additional one made by other unit within the UPP.

Estimated coefficients for these models are shown in the table below. The unit of analysis in each model is individual shifts of the police officers participating in the study (both in treated and control groups) between the first week of December 2015 and the last week of November 2016. The last three models, for which the outcome of interest is ammunition per event, restrict the sample to shifts where there was at least one incident of use of force (n=22).

In the first set of models, we do not find significant effects of camera assignment on the probability of an event of use of force and on the total use of ammunition (columns 1 to 6). Officers in the treated group seem to have slightly higher chance of being involved in an event of use of ammunition but at the same time they seem to use less ammunition (in total) than officers in the control group. Nevertheless, none of these coefficients are significant.

Table. Estimated effects of BWC on individual use of force

Variables	Probability of an event			Total ammunition			Ammunition per event		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Treated x No Camera	0.286	0.285		-0.012	-0.012		-16.4**	-16.4**	
	(0.558)	(0.558)		(0.012)	(0.012)		(7.1)	(7.2)	
Treated x Camera	0.143			-0.009			-18.2**		
	(0.489)			(0.014)			(7.1)		
Treated x Camera x No usage		0.069			-0.009			-16.8**	
		(0.518)			(0.015)			(7.6)	
Treated x Camera x Usage		0.447			-0.010			-23.1**	
		(0.800)			(0.015)			(10.8)	
GTTP									
x Treated x No Camera			0.022			-0.032			-16.2
			(0.754)			(0.045)			(10.0)
x Treated x Camera			0.481			-0.014			-18.1**
			(0.603)			(0.046)			(7.8)
GPP/VISIBILIDADE	-1.880***	-1.891***		-0.053***	-0.053***		-13.4*	-13.4*	
	(0.449)	(0.452)		(0.017)	(0.017)		(7.1)	(7.2)	
x Control			-1.600**			-0.062			-13.2
			(0.748)			(0.039)			(10.0)
x Treated x No Camera			-0.881			-0.066*			-29.8***
			(0.752)			(0.039)			(10.0)
x Treated x Camera			-			-0.070*			-
						(0.039)			
Constant	-6.082***	-6.078***	-6.192***	0.064***	0.064***	0.070*	34.6***	34.6***	34.5***
	(0.389)	(0.388)	(0.489)	(0.021)	(0.021)	(0.039)	(5.7)	(5.8)	(6.5)
Observations	21,472	21,472	16,937	21,472	21,472	21,472	22	22	22
R-squared				0.001	0.001	0.001	0.4	0.4	0.4
Log pseudolikelihood	-164.09	-163.99	-161.30						

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In the last set of models on events that involved use of ammunition, we find strong and significant effects (columns 7-9). The average use of ammunition per event during the study for the sample was 19 bullets per event, with a minimum of 3 and a maximum of 55 bullets.[25] We find that police officers assigned to the treatment group and used the camera consumed on average 18.2 less bullets than officers in the control group when involved in an event of use of force (column 7). Officers that were in the treated group but were not wearing a camera that day (because of the randomization of the cameras across shifts in treated units), used 16.4 less bullets than the control group. Both effects are statistically significant at the 5% level of significance. These results suggest that officers that knew they were not being monitored by a random

[25] The last event happened during the very first week of the experiment by GTTP officer wearing a camera.

assignment of BWC significantly used more ammunition than officers that were always (or intermittently) assigned a camera.

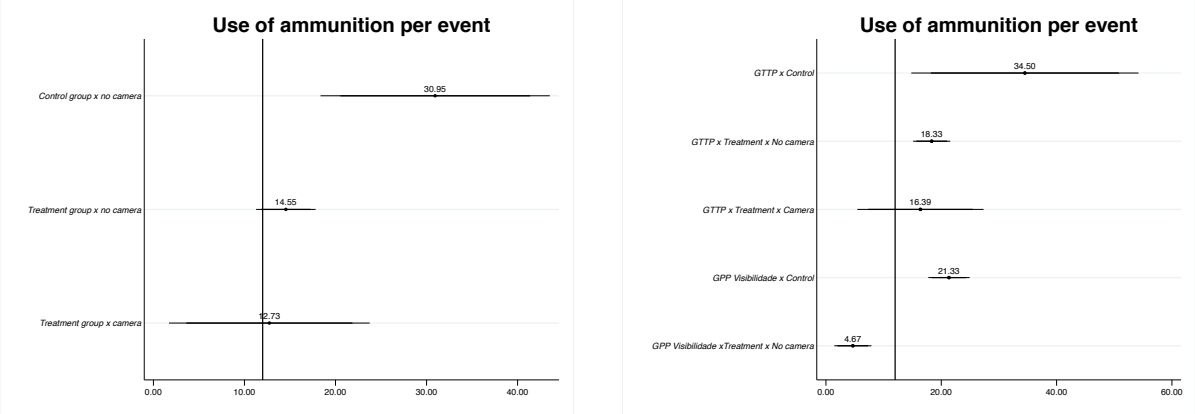
We do not find differences on police behavior with respect to actual camera usage, measured in this model with a binary variable that indicates whether the camera was turned on at least once during the shift. The results are not surprising since, as mentioned above, less than a fifth of the assigned cameras were turned on for a few minutes per hour on average.

Finally, we find strong and significant results for GTTP units across models. Officers in GTTP units, as expected, have almost twice chances of being involved in an event of use of force than officers in GPPs-Visibilidades and use more than twice ammunition per event.

The effects of treatment and BWC assignment were substantial within GTTP officers. We find that GTTP officers in the treated group not wearing a camera used 16.2 less bullets, on average, than GTPP officers in the control group. This difference was not statistically significant. In contrast, GTTP officers wearing a BWC used 18.1 less bullets per event than officers in the control group. This difference represents a 47.5% reduction in the use of force and is statistical significant at the 5% level.

We also observe significant differences in the use of ammunition between control and treatment groups for officers in GPP/Visibilidades even though there were only a few occurrences for this type of unit. Officers in the treated units use considerably less ammunition per event than those in control units. Notably, no officer in GPP/Visibilidades wearing a BWC used lethal force during the length of the study. The predicted use of ammunition per event of models in columns (7) and (9) are shown in the figure below.

Predicted use of individual ammunition per event of use of force (models 7 and 9)



This set of results indicates that BWC had substantial effects on police use of force in UPP Rocinha, especially in those units more prone to the use of violence.

Balance tests

A potential problem of these results is that officers assigned to control units might be more prone to use more lethal force than officers in treated units, even in the absence of the experiment or BWCs. This scenario could be true, for example, if control units were assigned to more dangerous or violent areas or if police officers in these units naturally tend to be more violent.

We can partially disregard the first explanation by noticing that all GTTPs units were assigned to the control and treatment groups at different parts of the study (see sections above and Appendix). Therefore, the comparison between treated and control groups above consists not only on a comparison between different units, but also a comparison *within the same police officers* under different scenarios across time (in the treatment or the control group, with and without camera).

In addition, the following table presents mean difference tests of use of ammunition between officers assigned to control and treated groups for the full sample, for all GTTP units, and for *each* individual unit. As shown before, we observe significant differences in the use of ammunition per event for the full sample and for GTTPs in general, with officers in the control group using more ammunition than those in the treated group.

Each of the three GTPP units was assigned to the control groups at some point during the study. For the first of these units (GTTP 1), the difference between the treatment and control scenarios in the use of ammunition is substantial (35 less bullets per event) and statistical significant. The second GTTP unit reported 8 events of use of force, all of them when it was assigned to the treatment group. Within these events, police officers wearing a camera used 5.33 less bullets on average than officers not wearing a camera during their shifts. This difference is statistically significant at the 1% significance. It is not possible to estimate a mean difference test for the third GTTP unit given the low number of events of use of force (3 events).

Table. Mean difference tests of use of ammunition

		By treatment group				By camera assignment			
		Control	Treatment	Diff	P (T > t)	No camera	Camera	Diff	P (T > t)
Full sample	Mean	28.86	14.43	19.02	0.01	20.85	16.39	4.46	0.25
	Obs	7	15			13	9		
Only GTTPs	Mean	34.50	16.88	17.63	0.03	27.57	16.39	11.18	0.09
	Obs	4	12			7	9		
GTTP 1	Mean	44.00	9.25	34.75	0.00	44.00	9.25	34.75	0.00
	Obs	3	2			3	2		
GTTP2	Mean	-	15	-	-	18.33	13.00	5.33	0.01
	Obs	0	8			3	5		
GTTP3	Mean	6	32	-26	-	6	32	-26	-
	Obs	1	2			1	2		

With respect to the second argument against the validity of our results (e.g., officers in the control group are more violent anyway), we present in the following table balance tests for individual characteristics of GTTP officers including sex, age, years experience in PMERJ, previous experience in elite units such as BOPE or CHOQUE, previous experience in regular

battalions, and use of ammunition in UPP Rocinha before the start of the study (2012-Nov 2015). Given that the same GTPP police officer could be assigned to control and treatment groups on different periods in the study, we provide balance tests between officers in the treatment and control groups for *each* month of the study.

In general, *we do not observe systematic differences between control and treated groups across time*. In particular, there are no significant differences in the use of individual ammunition in the pre-study period. If anything, for a few comparisons, GTPP officers in treated units used more ammunition in total before the start of the study than officers in the control group.

Table. Individual characteristics of GTTP officers by treatment group

	Initial groups		MONTHLY DIFFERENCES (1)-(2)											Final groups	
	Control	Treatment	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Control	Treatment
	(n=27)	(n=56)	2015	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	(n=23)	(n=41)
Variable	(1)	(2)	(1)-(2)	(1)-(2)	(1)-(2)	(1)-(2)	(1)-(2)	(1)-(2)	(1)-(2)	(1)-(2)	(1)-(2)	(1)-(2)	(1)-(2)	(1)-(2)	(1)	(2)
Age	31.296	30.018	1.278*	0.823	-0.042	-0.681	-0.655	1.347*	1.617**	1.182	1.361	1.214	0.537	0.439	31.000	30.561
Sex (1 Female 2 Male)	2.000	2.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.000	2.000
Years in PMERJ	3.556	2.982	0.573	0.845*	0.099	-0.543	-0.230	0.271	-0.063	-0.258	-0.033	-0.125	-0.393	-0.193	2.783	2.976
Worked in BOPE	0.000	0.036	-0.036	-0.020	0.000	0.000	-0.021	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Worked in CHOQUE	0.000	0.000	0.000	0.000	-0.018	-0.018	0.000	-0.020	-0.060	-0.041	-0.043	-0.042	-0.021	-0.049	0.000	0.049
Worked in regular battallion	0.148	0.161	-0.013	0.086	0.008	-0.005	0.082	-0.137**	-0.177*	-0.120	-0.125	-0.100	-0.019	-0.011	0.087	0.098
Events Jan 2012 - Nov 2015	1.333	2.107	-0.774	-1.202*	-0.731*	0.603	0.663	-0.368	-0.250	-0.450	-0.513	-0.290	-0.130	-0.204	0.870	1.073
Total ammo Jan 2012 - Nov 2015	17.333	25.250	-7.917	-17.182**	-12.126**	6.752	10.474*	-6.015	-3.109	-9.534	-10.463	-7.129	-5.194	-4.721	10.913	15.634
Ammo per event Jan 2012 - Nov 2015	7.961	7.918	0.043	-3.147	-2.136	1.828	2.885	-1.401	-0.061	-1.996	-2.612	-1.480	0.287	0.955	6.377	5.422

The value displayed for t-tests are the differences in the means across the groups.
***, **, and * indicate significance at the 1, 5, and 10 percent critical level.

Outliers

Our results of the use of BWC on the use of force rely on a relatively low number of events. Therefore, a source of concern is whether our results are affected by the presence of outliers or, in this case, events of extreme use of force. The sample of this study includes 22 events with an average use of 19 bullets per event and a range that goes from 3 to 55 bullets. While most of the events involved the use of 25 bullets or less, there were 4 events in which more than 40 bullets were shot. Notably, the most extreme case of use of force was made during the very first week of the study by a GTTP officer wearing a camera.

The following table replicates models (7) and (9) shown above excluding the three most extreme cases of use of force, one at a time. The columns show that our results are robust to the presence of these cases. In fact, the estimated effects of the use of BWC on the use of force are greater than the baseline effects and statistically significant once we exclude from the analysis the most extreme case (55 bullets in one event). With the exclusion of the second outlier, we observe similar effects than the ones estimated for the baseline models. It is only after the removal of the third outlier event that the estimated impacts are lower and not statistically significant. Nevertheless, the direction of the effect (negative) is maintained for all coefficients. These outcomes give certainty that our results on use of force are not being driven by a few extreme cases.

Table. Effects of BWC on use of force excluding outliers

	Use of ammunition per event					
	Without 1 outlier		Without 2 outliers		Without 3 outliers	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Treated x No Camera	-16.4***		-14.3**		-11.3*	
	(5.1)		(5.8)		(6.5)	
Treated x Camera	-23.0***		-19.9**		-15.4	
	(7.5)		(8.5)		(9.4)	
GTTP						
x Treated x No Camera		-16.2		-12.0		-4.7
		(9.7)		(11.7)		(14.1)
x Treated x Camera		-22.9**		-18.8		-11.4
		(9.6)		(11.6)		(14.0)
GPP/VISIBILIDADE	-13.4**		-11.3*		-8.3	
	(5.1)		(5.8)		(6.5)	
x Control		-13.2		-9.0		-1.7
		(9.7)		(11.7)		(14.1)
x Treated x No Camera		-29.8***		-25.7**		-18.3
		(9.7)		(11.7)		(14.1)
x Treated x Camera		-		-		-
Constant	34.6***	34.5***	31.5***	30.3**	27.0***	23.0
	(7.4)	(9.5)	(8.4)	(11.6)	(9.4)	(14.0)
Observations	21	21	20	20	19	19
R-squared	0.6	0.6	0.5	0.6	0.4	0.5

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

7. The impact of BWC on other forms of police activity

Our results on the impact of BWC on gunshots reveal how BWC affect use of police lethal force. Nevertheless, only a few police officers use the weapons on a day-to-day basis. An equally important objective of this study therefore is to assess whether BWC impact other components of police performance and behavior. In particular, it is of main interest to know whether the use BWC changed the ordinary interactions of police officers with the community. In order to approach this question, we use detailed data on individual events in Rocinha that were reported by the police during the period of study.

Our database comes from administrative records (also called BOPMs) of Rocinha in 2016 of all events or "ocurrences" that a police officer attended or was involved in. The records include calls and requests to the police, actions started by officers such as stops and searches, random or fortuitous encounters, and all events in which police officers were involved such as public disturbances and direct aggressions and confrontations with criminals.

According to public official records, about 710 occurrences or BOPMs were reported in Rocinha during the implementation of the study (December 2015-November 2016). The research team was able to access detailed data of each BOPM for almost all the cases between January to November 2016 (622 out of 626). The database includes day and time of the event, initial and final classification of the event (according to PMERJ's own classification), response time (for some cases), a brief description of the event and, in some cases, the location of the event. Each

occurrence is reported by the commander-in-charge of the unit that was involved in the BOPM. Although it was not possible to identify the officers involved in each occurrence, it was possible to identify the unit and particular shift that was involved/attended each event in the database.

BOPMs are classified by the military police according to their source and crime code. There are four types of BOPMs according to their source: more than half of the occurrences (57% in 2016) are started at the *operations center* and include all calls to 911 and other request made to the police. Most of the triggered alarms (potential thefts), robberies, domestic violence incidents, loud noise complaints, street fights, gunshot reports, drug seizures, and police operations are included in this category. *Stop and searches* ("Abordagens") are BOPMs originated by the police and mostly involve suspicious individuals or vehicles and administrative measures. *Encounters* consist on all the "unexpected" events encountered by police officers on their regular patrolling functions including traffic accidents and transport of injured individuals to the hospital. Suspicious individuals and vehicles are also registered in this category. *Requests* are all BOPMs originated in response to a petition made directly to an officer by a citizen, a colleague officer, or other security agent. This category includes mostly traffic accidents, hospital transports, medical emergencies and other street incidents.

The following table shows the number of BOPMs by source and unit type. It can be observed that almost half of the BOPMs (48%) are attended by officers in GPPs/Visibilidades. Officers in Patrol Cars ("Radio Patrulhas") are also involved in a considerable amount of BOPMs (28%), most of which are started at the operations center. These units attend proportionally more events of potential thefts and robberies (triggered alarms) than other units. GTTPs officers are involved in fewer BOPMs (13% of the total), nevertheless, they conduct more stops and searches of suspicious individuals and vehicles and are involved in more crackdowns of guns and drugs. Officers in GPPs / Bases are only involved in a few occurrences.

Table. BOPMs in Rocinha by unit type

	BASE/ PATRULHAMENTO	GPP/ VISIBILIDADE	GTTP	RADIO PATRULHA	OTHER UNITS	**TOTAL**
Total BOPMs	**17**	**298**	**82**	**172**	**53**	**622**
BOPMs by source						
Stop and search	5	15	21	2	15	**58**
Encounter	3	59	20	20	17	**119**
Operations center	5	165	33	134	17	**354**
Request	4	59	8	16	3	**90**
Selected BOPMs						
Suspicious person or vehicle	4	19	24	2	4	**53**
Public disturbance	2	39	0	23	0	**64**
Transport to hospital	0	46	0	20	0	**66**
Alarm trigger	0	35	1	36	7	**79**
Crimes against women	1	27	0	7	2	**37**
Drug trafficking	0	5	7	3	3	**18**

In the following section, we assess the effect of the use BWC on the probability of attending/being involved in a BOPM. Given that it was not possible to identify the individual officers involved in BOPMs, our units of analysis are GPPs and GTTPs shifts.

On average, GPP Bases/Patrulhamentos and GTTP units had 4 shifts working 24 hours for each 72 hours of rest. Shifts were composed of 5 to 7 police officers for GTTPs units and of 3 to 5 police officers for GPP Bases. In contrast, GPP Visibilidades had shorter work hours during the study. A regular unit had 4 shifts of 2 to 4 police officers working 12 hours for each 24 or 48 hours of rest.[26]

Our database consists then of more than 7,700 unit shifts from January to November 2016. For each shift, we identified the treatment group of the corresponding unit and whether at least one police officer of the shift was assigned a BWC. We also estimated the total number of BOPMs that were reported during the shift.

The next table shows the coefficients of logit models on the probability of a BOPM during a particular unit shift. We estimate the effects of BWCs for all BOPMs and with respect to their source. Given that BOPMs related to suspicious individuals are vehicles (one of the most common BOPMs) can be recorded both as *stops and searches* or *encounters*, we combined these two sources into a single category to better capture the effects of BWC on occurrences started by police officers.[27]

For each type of BOPM we ran two models. The first model estimates the overall effect of the treatment and camera assignment on the probability of a BOPM controlling for each unit type. In the second model we interact the three variables to assess whether the effects of BWC on police behavior are more pronounced for a particular type of unit. In this second model we excluded GPP Bases due to the low number of BOPMs they respond to.

The results for the first model show that shifts for which there was at least one camera were involved in significantly fewr BOPMs than shifts in the control group. In particular, the average probability of a BOPM during a shift goes from 0.035 for the control group to 0.023 for the shifts where there was at least one camera. This difference represents a decrease in the probability of reporting a BOPM of 34%.

We ran a similar linear regression (not shown here) using the total number of BOPMs per shift as a dependent variable. We find that the average number of BOPMs goes from 0.038 to 0.024 between the control and treatment group (with camera), that is, a reduction of 0.014 BOPMs per shift. There were on average 703 shifts per month during the length of the study, we estimate then an effect of 9.8 less BOPMs (from 26.7 to 16.9 BOPMs per month, on average).

The effect of BWC is of similar magnitude for BOPMs initiated by police officers (stops and searches and encounter). The effects on BOPMs originated by direct request to police officers are stronger and statistically significant (we find an average decrease in the probability of

[26] It was only until the very last 15 days of the study (Nov 16th-30th, 2016) that all GPPs worked shifts of 24 hours, with the exception of one unit that changed to the 24 hour schedule during the second week of September.
[27] Individual models for each source show similar effects and are available upon request.

occurrence of 58.6%). Finally, we also find negative effects of BWC on the occurrence of BOPMs initiated at the operations center. Nevertheless, these effects are weaker (a decrease of 24%) and not statistically significant.

Overall, these results suggests that officers wearing BWC reduce their regular policing activities and engaged in less interactions with the community, especially in those activities or interactions that are under their control such as stops and searches and direct requests by citizens.

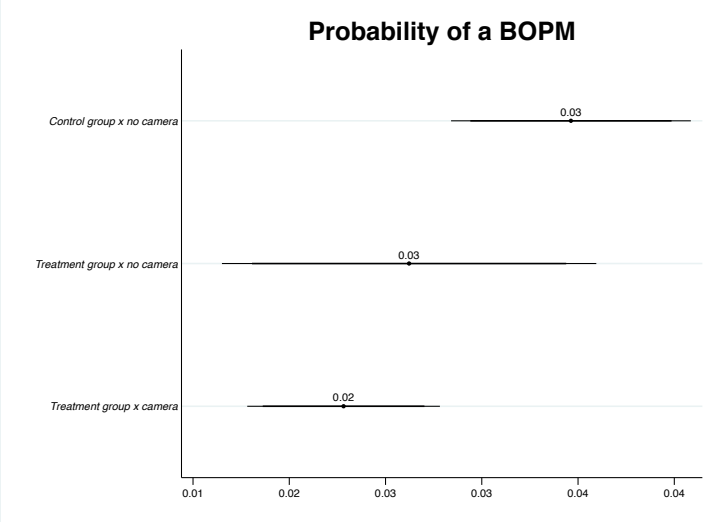
Table. Effects of BWC on the probability of a BOPM

	Probability of an event							
			BOPM source					
	Total BOPMs		Stop and search & encounters		Operations center		Request	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treated x No Camera	-0.291		0.010		-0.405		-0.791	
	(0.220)		(0.318)		(0.335)		(0.617)	
Treated x Camera	-0.436***		-0.435*		-0.293		-0.886**	
	(0.152)		(0.248)		(0.211)		(0.397)	
GPP/VISIBILIDADE								
x Treated x No Camera		-0.274		0.089		-0.435		-0.243
		(0.284)		(0.461)		(0.409)		(0.631)
x Treated x Camera		-0.842***		-1.134**		-0.655**		-0.951*
		(0.218)		(0.459)		(0.275)		(0.513)
GTTP	1.334***		1.960***		0.956***		0.632	
	(0.152)		(0.237)		(0.221)		(0.436)	
x Control		0.819***		1.523***		0.424		0.472
		(0.252)		(0.361)		(0.388)		(0.632)
x Treated x No Camera		0.879***		1.694***		0.434		-
		(0.332)		(0.440)		(0.528)		
x Treated x Camera		1.071***		1.627***		0.794***		0.252
		(0.193)		(0.302)		(0.278)		(0.561)
BASE/PATRULHAMENTO	-0.606**		-0.075		-1.252***		-0.376	
	(0.260)		(0.393)		(0.464)		(0.541)	
Constant	-3.552***	-3.444***	-4.887***	-4.738***	-4.172***	-4.059***	-5.064***	-5.104***
	(0.107)	(0.112)	(0.196)	(0.209)	(0.147)	(0.150)	(0.233)	(0.251)
Observations	7,732	6,400	7,732	6,400	7,732	6,400	7,732	6,246
Log-likelihood	-952.6	-857.1	-428.7	-377.5	-547.5	-512.3	-219.8	-192.4

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

It is worth noting we only find significant negative effects of BWC on BOPMs for shifts that were assigned to at least one camera. We find mostly negative but not significant effects for unit shifts that were assigned to the treatment group but did not received a camera due the time randomization component of our treatment. *This suggests that the physical presence of a camera was the most important determinant of the change in police behavior that we observe*. The predicted probabilities of a BOPM for each group and type of united are shown in the figure below.

Figure. Predicted probabilities of model 1



The coefficients of the second model (column 2) show that the effects of BWC on the probability of a BOPM are mostly driven by GPP (Visibilidades) units. For these units, the average probability of an occurrence during a shift was 0.0309 for the control group and 0.0136 for the shifts where there was at least one camera. This difference represents a decrease in the probability of a BOPM of 49%.

Using a linear regression on the number of BOPMs per shift (not shown here), we find that the average number of BOPMs for GPPs (Visibilidades) goes from 0.031 to 0.014 between the control and the treatment group (with camera), that is, a reduction of 0.017 BOPMs per shift. There were on average 493 GPP Visibilidades shifts per month during the length of the study, we therefor estimate an effect of 8.4 less BOPMs per month (from 15.3 to 6.9 BOPMs, on average).

Moreover, for GPP (Visibilidades) units, we find significant negative effects for any type of BOPMs including those originated at the operation center (although of lesser magnitude). For BOPMs originated by requests and by police officers (stops and searches and encounters) we find decreases in the probability of 61% and 68%, respectively. Once again, we find weaker and non significant effects for shifts in the treatment group that were not assigned cameras.

For all models, we find that GTTP units have much higher chances than GPP Visibilidades of engaging in a BOPM during a particular shift (0.082 vs 0.023, on average). Nevertheless, we do not find substantial differences for these units between treatment and control groups nor with respect to camera assignment. This is partly explained by wide confidence intervals generated by the relatively low number of occurrences GTTPs respond to.

8. Assigning BWCs to supervisors and Radio Patrulhas

As mentioned in previous sections, we decided to give cameras to supervisors from February to mid-July in order to increase camera usage among police officers. Rocinha commanders also request to include supervisors in the study in order to improve overall monitoring of police performance.

The RCT intervention was originally intended to asses the effects of BWC on the use of lethal force. Nevertheless, once the research team had access to detailed data on individual BOPMs, the scope of the study was widened in order to understand the effects of cameras on regular police interactions with the community. Consequently with this new objective, we decide to include Radio Patrulhas on the last third of the study due to the high number of BOPMs they attend.

In order to make fair comparisons of the effects on BWC on police behavior for these two additional units, we ran models (1) and (2) from the previous section over three different sub periods of the study. The first period goes from January[28] to February of 2016, month in which we reassigned GTTPs and GPPs units between treatment and control groups.

The second period goes from March to the mid July of 2016. During this period, we randomly assigned cameras to the supervisors at the shift level (e.g., cameras were assigned to all or none supervisors of a shift). There was also a major redesign of GPP Visibilidades with the creation of 3 new units replacing 5 existing ones. We are still able to provide valid comparisons in this second period because (fortunately) all the GPP units that disappeared were assigned to the control group (see Appendix). The newly formed units were then undoubtedly assigned to the control group as well.

The third period goes form the third week of July 2016 to the end of the study. At the start of this later period, we reassigned GPP units between treatment and control groups. This treatment reassignment was constant until the end of the study and there were no major changes in the number or structure of GPP and GTTP units. The two Radio Patrulhas units were included in the study in this period, one of them was randomly assigned to the treatment group.

The following table shows the estimated coefficients of our baseline models for each of the three sub periods. The models for the second period estimate effects of BWC on BOPMs for supervisors while models for the third period include estimated coefficients for Radio Patrulhas.

[28] Detailed data on individual BOPMs was available only for 2016. We therefore do not include December 2015 in this analysis.

Table. Effects of BWC on the probability of a BOPM by period

	Probability of an event					
	Total BOPMs					
	Jan 1st - Feb 29th		Mar 1st - Jul 15th		Jul 16th - Nov 30th	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Treated x No Camera	0.398		-		-0.299	
	(0.479)				(0.207)	
Treated x Camera	-0.592*		-0.175		-0.604***	
	(0.343)		(0.238)		(0.217)	
GPP/VISIBILIDADE						
x Treated x No Camera		-0.579		-		-0.446
		(1.056)				(0.310)
x Treated x Camera		-0.711		-0.324		-1.323***
		(0.497)		(0.335)		(0.386)
GTTP	2.248***		1.817***		0.307	
	(0.329)		(0.250)		(0.272)	
x Control		1.791***		1.740***		-1.203*
		(0.514)		(0.368)		(0.728)
x Treated x No Camera		2.835***		-		-0.098
		(0.576)				(0.480)
x Treated x Camera		1.641***		1.598***		0.246
		(0.462)		(0.298)		(0.345)
RADIO PATRULHA					1.255***	
					(0.183)	
x Control						1.048***
						(0.229)
x Treated x No Camera						0.877***
						(0.319)
x Treated x Camera						0.645*
						(0.362)
BASE/PATRULHAMENTO	-0.169		-0.380		-0.942**	
	(0.631)		(0.442)		(0.377)	
SUPERVISOR						
x Treated x Camera			1.317***	1.242***		
			(0.467)	(0.469)		
Constant	-3.947***	-3.816***	-4.924***	-4.798***	-3.268***	-3.121***
	(0.289)	(0.320)	(0.474)	(0.478)	(0.142)	(0.151)
Observations	1,620	1,380	2,614	2,200	4,070	3,392
Log likelihood	-175.74	-159.19	-328.46	-297.68	-623.32	-573.47

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

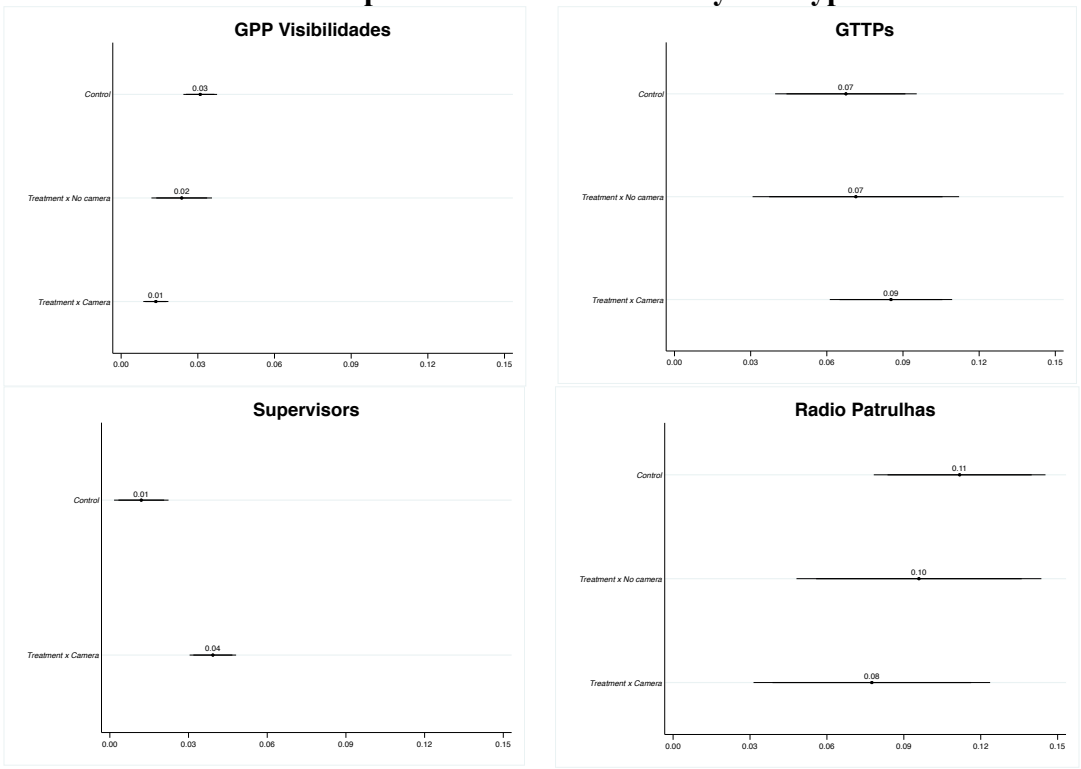
The coefficients show that the overall effects of BWC on the probability of a BOPMs are negative for each of the three phases of the study and statistically significant for the first and third. These outcomes provide compelling evidence that the results of our study are not driven by the particular selection of units into treatment and control groups.

Once again, the effects of BWC on BOPMs are stronger for GPPs Visibilidades than for other units (model 2), especially during the last period of the study (the longest and most stable) for which we estimate a 73% decrease in the probability of a BOPM, on average. In contrast, the estimated impact on BOPM incidence for these units is of lesser magnitude and non significant for the other two periods. This can be partially explained by the fact that compliance of camera assignment was considerably lower during the first months of the study (see sections above).

The models for the second period show that there were more BOPMs in Rocinha on the days were supervisors were assigned BWC. According to these coefficients, the probability for a given shift of observing at least one BOPM increased by 0.025 on average on days that supervisors were wearing a camera. This result is insightful and supports the intuition behind assigning cameras to the supervisors. The idea of assigning BWC to supervisors came originally from the UPP commander because, according to him, supervisors would be compelled to do a better job and will monitor police officers more closely. While we find that BWCs inhibited police performance and engagement with the community, our results suggest the opposite effect on supervisors, who seem to feel pressured to increase their performance and productivity.

The following graphs show the predicted probabilities of observing a BOPM during a shift for each type of unit. Predictions for GTTP and GPP units come from the models using the full sample, estimates for supervisors and Radio Patrulhas come from the models that restrict the sample to shifts in the second and third phase of the study, respectively.

Predicted probabilities of BOPMs by unit type



9. Effects of BWC on BOPM incidence by type of treatment

We showed in the previous section that the use of BWCs body-worn cameras reduce police performance and engagement with the community, as measured by the probability of reporting a BOPM during a particular shift.

In this section we assess whether there were differentiated effects of BWC according to the variation of the treatment designed for the study. For each shift in treated units, we varied the assignment of the cameras in three different dimensions or components: 1) **coverage**: whether all officers in the shift were assigned a camera or only a few of them (randomly selected); 2) **intensity**: whether assigned cameras should be turned on all at all times or only on interactions with members of the community ("Always on" versus "Interactive"); and 3) **time**: whether a shift of a treated unit will receive cameras every time (shift) or only on randomly selected occasions.

The variation of these three dimensions of the camera assignment was done at the unit level, which implies that all shifts within a unit receive the same variation of the treatment. This also allowed for the possibility that a police officer in a treated unit did not necessarily received a camera in every shift, and that there were full shifts of treated units in which no officer received a BWC. The objective of these variations of the treatment was to provide insights on the efficient allocation of cameras across shifts, the optimal number of cameras for a particular shift, and the most efficient mode of usage of an individual camera.

To provide empirical evidence con the effects of each treatment on police behavior, the following table presents logit models on the probability of reporting a BOPM during a given shift with respect to the variation of the treatment received. We ran three models for our three different dimensions of the treatment.[29] For each dimension (coverage, intensity, and time), we identify two variations: full treatment (all officers with camera, camera always on, and cameras assigned on all shifts, respectively) and partial treatment (some officers with camera, camera on interactions, cameras assigned on some shifts, respectively).

[29] We also ran a triple interaction model and observed similar results (not shown here). Coefficients are available upon request.

Table. Probability of a BOPM by variation of the treatment

	Probability of an event					
	T1: Coverage (Some officers or full team)		T2: Intensity (On interactions or always on)		T3: Time (Some or all shifts)	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Partial treatment	-0.154		-0.471***		-0.319*	
	(0.354)		(0.152)		(0.180)	
Full treatment	-0.422***		-0.147		-0.461***	
	(0.144)		(0.227)		(0.166)	
Partial treatment x No Camera		0.274		-0.287		-0.211
		(0.603)		(0.224)		(0.225)
Partial treatment x Camera		-0.315		-0.548***		-0.432*
		(0.427)		(0.171)		(0.242)
Full treatment x No Camera		-0.346		-0.434		-1.354
		(0.231)		(1.015)		(1.010)
Full treatment x Camera		-0.447***		-0.132		-0.434***
		(0.156)		(0.231)		(0.167)
GTTP	1.340***	1.342***	1.346***	1.343***	1.322***	1.315***
	(0.152)	(0.153)	(0.152)	(0.153)	(0.153)	(0.153)
BASE/PATRULHAMENTO	-0.598**	-0.595**	-0.592**	-0.599**	-0.609**	-0.623**
	(0.260)	(0.261)	(0.260)	(0.261)	(0.260)	(0.261)
Constant	-3.554***	-3.555***	-3.556***	-3.555***	-3.549***	-3.546***
	(0.108)	(0.108)	(0.108)	(0.108)	(0.107)	(0.107)
Observations	7,732	7,732	7,732	7,732	7,732	7,732
Log-likelihood	-952.53	-952.13	-951.88	-951.28	-952.54	-951.71

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Columns (1), (3), and (5) show the estimated coefficients for each variation of the treatment (partial vs full). Coefficients are negative for all cases. We observe the greatest effects of BWC on the probability of reporting a BOPM for unit shifts in which all police officers were wearing a camera and for those shifts assigned to treatment that would always receive at least one camera.

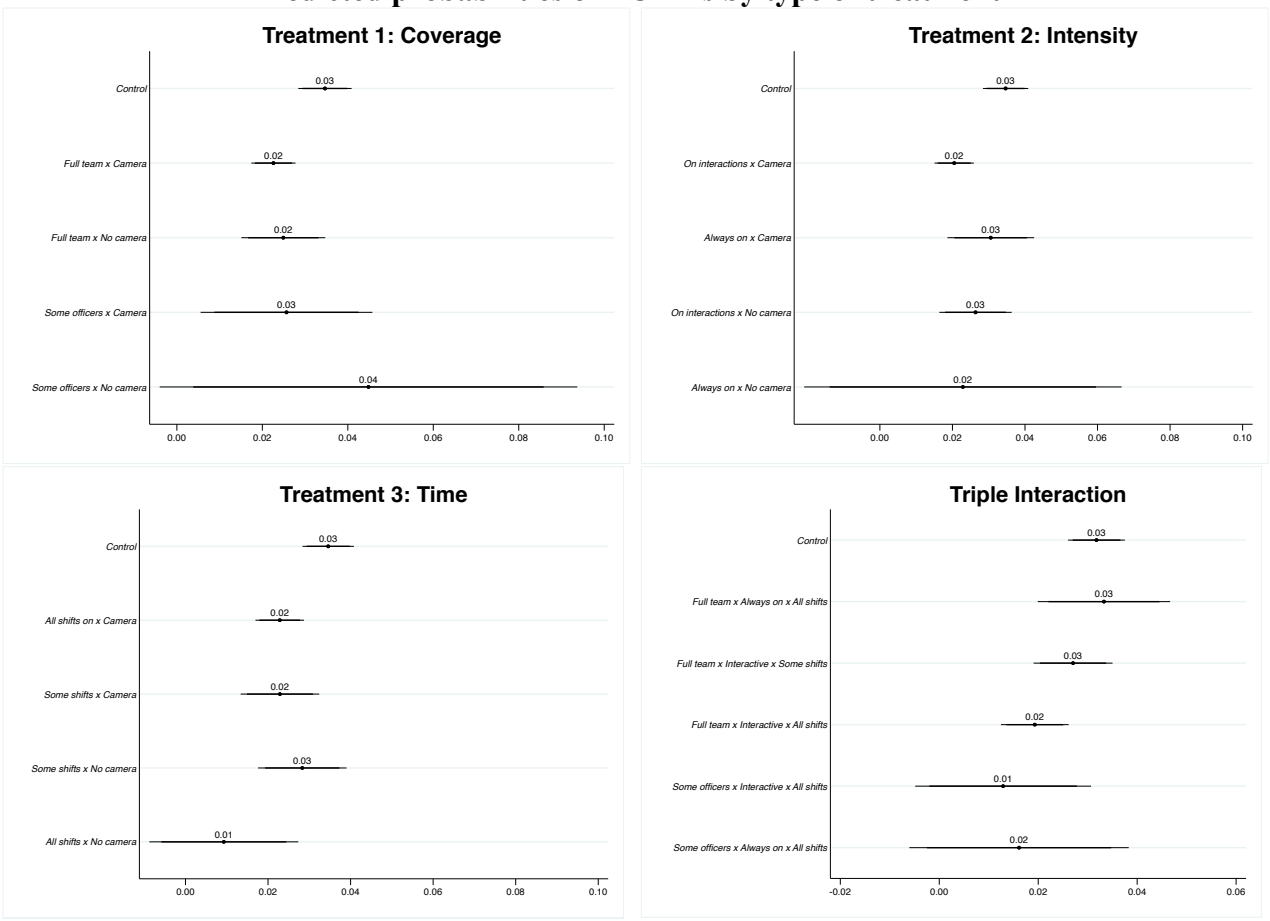
With respect to the second dimension of the treatment (intensity), we observe similar significant effects on those shifts where police officers were asked to use their camera on interaction. This result is partly explained because most of the treated shifts were asked to turn their cameras only on interactions (78% of the time). Only a few shifts at the first half of the study were asked to wear their cameras at all time. In addition, compliance with this type of camera usage was extremely low since most officers refused to turn their camera on at all times.

Columns with even numbers show coefficients for the interaction between treatment and camera assignment. Once again all coefficients (except one) are negative and of substantial magnitude. Nevertheless, the effects are only statistically significant for those shifts were there was a least one camera. These results reinforces our previous findings that the actual camera assignment during a shift had more impact on police behavior than former experiences wearing a BWC on previous shifts or than the expectation of receiving one BWC in the future (that is, being assigned to the treatment group but not receiving a camera during a particular shift).

To show the magnitude of the estimated effects, the following figure shows the predicted probabilities for each type of variation for each dimension of the treatment. The fourth and last figure shows the predicted probabilities of a model that includes a triple interaction of the

different dimensions of the treatment.[30] Overall, we observe the greater impacts of BWC on the predicted probability of reporting at least one BOPM for those unit shifts for which all police officers of the unit were assigned a camera every time they were in service. We also find effects on those shifts that were required to turn cameras on only on interactions with the community. We did not find significant differences with respect to those shifts who were asked to turn their cameras on at all times. As mentioned above, this result is partly explained for the low number of shifts with this type of treatment but also because of the impossibility to enforce this type of treatment among police officers.

Predicted probabilities of BOPMs by type of treatment



10. Balance tests on BOPMs

A potential threat to the validity of the study with respect to BOPMs might arise if the particular realization of our randomization into treatment created groups that are not comparable between them. This could be the case, for example, if units in our control group tend to observe more BOPMs than units in the treated group even in the absence of BWC. This could also happen if there is one particular unit that attends an extraordinary high or low number of BOPMs and therefore is not directly comparable to the rest of the units.

[30] Table of coefficients is available upon request.

Once again we partially disregard this concern by noticing that almost all units (with the exception of two) were assigned to treatment and control groups at different stages of the study (see sections above and Appendix). This implies that our estimated effects of BWC capture differences on police behavior not only between different units, but also within units across time.

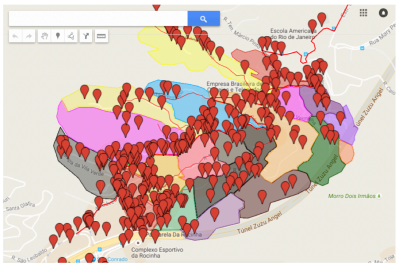
To show that police units are comparable, we follow a similar strategy to the one used in previous sections to show that there were not substantial differences between treated and control units. To do so, we show difference in means tests of the number of BOPMs per month on the months before the implementation of the study in November 2015.

The research team had access to detailed BOPM data on from January to July of 2015. This dataset includes day and time of the event, type of occurrence, response time (for some cases), a brief description and, for some cases, the location of the event. Unfortunately, this dataset (in comparison to the one for 2016) does not identify the unit nor commander in chief that reported or attended the event.

The team manually geo-located several BOPMs of the dataset using information of the location of the event (when available), geographical references mentioned in the event description (when available), and information on the police sector where the BOPM occurred (when available).[31] Less than half of the BOPMs in the dataset had accurate (or any) geographic information. We were able to geo-located 36.8% of the 492 events in the database (see Figure below).

Figure. Examples of geographical references and geo-coding of BOPMs

referencia	referenciaUniform	referenciaLat	referenciaLon
		NA	NA
BANCO DO BRASIL	banco do brasil	-22.99088	-43.25118
VILA VERDE	vila verde	NA	NA
RJ RUA QUATRO ESTRADA DA GAVEA	rua 4	NA	NA
ROLINHA	rolinha	-22.99126	-43.25022
ACESSO AO PARQUE DA CIDADE	parque da cidade	NA	NA
		NA	NA
EM FRENTE COLEGIO AMERICANO	colegio americano	-22.98437	-43.24520



After this, we matched the geo-coded events to their corresponding police sector. Police sectors are designated geographic areas drawn by the police for patrolling and administrative functions (see map in Section 3). Each GPP unit is primarily assigned to one or more police sectors. Nevertheless, the geographic boundaries between them are not strict in the sense that one or more GPP units might be assigned to the same sector on a given day or a GPP unit might attend a BOPM in sector different than the one that it was assigned to. To impute police sectors to units, we use as reference the closest GPP unit to each sector without replacement.

[31] Finding the exact locations of BOPMs in a favela as big and complex as Rochina turned out to be extremely challenging to the researchers, especially since most of the events have a loose description of their location (e.g., "next to a pizza place on Rua II"). Therefore, we established a collaboration with "Cartero Amigo", a local company that provides mailing services to Rocinha's residents, some of which do not have a formal mailing address. Cartero Amigo helped us finding the geo-coordinates of most BOPMs that had vague or imprecise information on their location.

With these caveats, we present in the following table balance tests of the number of BOPMs for the first half of 2015 for GPP Visibilidades. The balance tests are shown for the control and treatment groups as they were formed at each month of the study. In general, we do not observe systematic differences between control and treated units with respect to BOPM incidence in the months before the implementation of the study. We also show balance tests for BOPMs in the pre-study period by source and also for the most common incidents. Although there are some imbalances for a small subset of BOPMs[32], the differences are of minor magnitude and not persistent thorough the study.

Balance tests for GPPs

		Initial groups		MONTHLY DIFFERENCES (1)-(2)													Final groups	
Variable	Period	Control (n=108) (1)	Treatment (n=144) (2)	Dec 2015 (1)-(2)	Jan 2016 (1)-(2)	Feb 1-15 2016 (1)-(2)	Feb 16-29 2016 (1)-(2)	Mar 2016 (1)-(2)	Apr 2016 (1)-(2)	May 2016 (1)-(2)	Jun 2016 (1)-(2)	Jul 1-15 2016 (1)-(2)	Jul 16-31 2016 (1)-(2)	Aug 2016 (1)-(2)	Sep 2016 (1)-(2)	Oct 2016 (1)-(2)	Nov 2016 (1)-(2)	Control (n=108) (1)	Treatment (n=108) (2)
Total BOPMs per month	Jan-Jun 2015	1.458	1.694	-0.236	-0.063	-0.097	0.236	-0.181	-0.181	0.292	0.958	0.958	0.375	0.375	0.375	0.375	0.375	2.375	2.000
By Source																			
Stop and search and encounters	Jan-Jun 2015	0.542	0.528	0.014	0.190	0.153	0.333*	-0.014	-0.014	-0.069	0.125	0.125	-0.208	-0.208	-0.208	-0.208	-0.208	0.500	0.708
Operations Center	Jan-Jun 2015	0.875	0.889	-0.014	-0.071	-0.153	0.083	-0.125	-0.125	0.264	0.583	0.583	0.333	0.333	0.333	0.333	0.333	1.417	1.083
Request	Jan-Jun 2015	0.042	0.278	-0.236**	-0.183	-0.097	-0.181	-0.042	-0.042	0.097	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.458	0.208
Common BOPMs																			
Thefts and triggered alarms	Jan-Jun 2015	0.333	0.083	0.250*	0.373**	0.250*	0.236*	-0.250*	-0.250*	-0.056	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.417	0.333
Injuries	Jan-Jun 2015	0.083	0.083	0.000	-0.119	-0.069	-0.069	0.069	0.069	0.153	0.167	0.167	0.083	0.083	0.083	0.083	0.083	0.167	0.083
Suspicious person or vehicle	Jan-Jun 2015	0.125	0.167	-0.042	0.024	-0.042	0.111	0.042	0.042	-0.069	-0.042	-0.042	-0.042	-0.042	-0.042	-0.042	-0.042	0.083	0.125
Public disturbance	Jan-Jun 2015	0.000	0.083	-0.083	-0.071	-0.083	-0.056	0.083	0.083	0.194**	0.292***	0.292***	0.125	0.125	0.125	0.125	0.125	0.208	0.083
Drug seizures	Jan-Jun 2015	0.125	0.056	0.069	0.040	0.000	0.000	0.139*	0.139*	0.111*	0.125*	0.125*	0.042	0.042	0.042	0.042	0.042	0.083	0.042
Gunshots	Jan-Jun 2015	0.125	0.111	0.014	0.071	0.014	0.125	0.056	0.056	0.056	0.125	0.125	-0.208*	-0.208*	-0.208*	-0.208*	-0.208*	0.042	0.250

The value displayed for t-tests are the differences in the means across the groups.
***, **, and * indicate significance at the 1, 5, and 10 percent critical level.

11. Additional robustness checks

A second strategy to attend the concern that units in the treatment and control groups might not be directly comparable - although we do not find substantial differences between groups - is to present difference of means tests for different groups of GPPs and for each individual unit.

As explained in previous sections, with the change of leadership in May 2016, some GPP units were modified and/or merged into new ones. Consequently, the research team adjusted the research design and randomization strategy to incorporate these new units into the study. We present then t-tests for three groups of GPP Visibilidades: GPPs that left the study in May (5 units), new GPPs that were included in the study (3 units), and GPPs in the study that did not observe changes (5 units). Units in each group were randomly assigned (and reassigned in most cases) to treatment. The tests presented below show the differences in BOPM incidence in 2016 between unit shifts in treatment and control groups and between shifts that were assigned at least one BCW and those shifts for which there was no camera.

The results of the t-tests confirm our previous results for the whole sample and for all GPP Visibilidades: unit shifts in the control group observed significantly more BOPMs than shifts in the treatment group. The effects are also significant and of similar magnitude for GPP units that were not adjusted during the length of the study and for the GPPs that were created during the second half of the study. We do not find significant nor substantial effects of BWC on those GPPs that disappeared or merged into new ones. One partial explanation for this result is that

[32] Banks and formal businesses in Rocinha are highly concentrated in a few areas of the favela. Therefore, we find some differences between groups with respect to the monthly number thefts and cases of triggered alarms attended in the pre-study period. These differences are not significant for the randomizations done at the last half of the study.

compliance on camera assignment was relatively low during the first months of the study. Similarly, enforcement efforts on camera usage were implement only after these units were adjusted under the new leadership.

The table also shows difference in means tests for each individual GPP unit that was assigned to both treatment and control groups at different points of the study. The objective of this exercise is to make comparisons within units before and after the assignment to treatment. It is observed that most of the coefficients are substantial, in the expected direction (difference greater than cero), and significant for a couple of cases. In contrast, none of the differences that were negative are statistically significant. Further qualitative analysis are required to explain differential effects on BWC on BOPM incidence across GPP units.

Table. T-tests for GPP Visibilidades of BOPM incidence, Jan-Nov 2016

		By treatment group				By camera assignment			
		Control	Treatment	Diff	P (T > t)	No camera	Camera	Diff	P (T > t)
Full Sample	Mean	0.035	0.029	0.006	0.09	0.034	0.028	0.007	0.06
	Obs	2,961	3,439			3,748	2,652		
All GPPs	Mean	0.031	0.016	0.015	0.00	0.030	0.014	0.016	0.00
	Obs	2,650	2,769			3,283	2,136		
GPPs with no adjustments	Mean	0.027	0.016	0.011	0.02	0.026	0.015	0.012	0.01
	Obs	1,115	2,016			1,482	1,649		
GPP VIS 1	Mean	0.008	0.006	0.002	0.36	0.008	0.006	0.001	0.43
	Obs	239	340			265	314		
GPP VIS 2	Mean	0.012	0.013	-0.001	0.54	0.011	0.014	-0.002	0.61
	Obs	252	390			272	370		
GPP VIS 3	Mean	0.017	0.017	0.017	0.49	0.022	0.013	0.009	0.18
	Obs	118	545			272	391		
GPP VIS 4	Mean	0.046	0.000	0.046	0.01	0.045	0.000	0.045	0.01
	Obs	482	120			484	118		
New GPP units	Mean	0.073	0.016	0.057	0.00	0.059	0.009	0.050	0.00
	Obs	578	441			800	219		
GPP VIS 5	Mean	0.083	0.016	0.067	0.00	0.062	0.000	0.062	0.01
	Obs	108	187			195	100		
GPP VIS 6	Mean	0.009	0.016	-0.006	0.69	0.012	0.017	-0.004	0.63
	Obs	108	254			119	243		
Old GPP units	Mean	0.010	0.013	-0.002	0.64	0.011	0.011	0.000	0.51
	Obs	957	312			1,001	268		
GPP VIS 7	Mean	0.000	0.010	0.004	0.89	0.000	0.013	-0.013	0.93
	Obs	146	96			165	77		
GPP VIS 8	Mean	0.007	0.017	-0.009	0.75	0.013	0.009	0.004	0.39
	Obs	135	120			149	106		
GPP VIS 9	Mean	0.000	0.010	-0.010	0.92	0.000	0.012	-0.012	0.94
	Obs	192	96			203	85		

12. Conclusion

The use of BWC has become a widespread tool among law enforcement agencies. Their goal is to improve institutional performance by enhancing capacity of superiors to monitor police behavior and provide hard evidence that, in case of misconduct, can be used to prosecute and sanction police officers. Several studies suggest that BWCs can reduce police misconduct and increase community trust. Other studies are more skeptical, highlighting problems of compliance and the potential BWCs have to make police officers less active. Few studies have been conducted on developing world settings characterized by extreme levels of violence and police-citizen distrust.

To our knowledge, this is the first empirical analysis to assess the effects of BWC on police violence and behavior in a Latin American context. The favela da Rocinha in Rio de Janeiro was a remarkable setting to test the efficiency and limitations of BWC in places with strong presence of drug trafficking and an extensive history of violence and police use of lethal force.

The study involved 470 police officers from several units at UPP Rocinha, which account for 52 thousand individual shifts. Our results provide a complex picture that highlight important challenges the use of BWCs can confront in settings like these. Only in 18.5% of 9,752 camera assignments in the treatment group police officers turned on the camera at some point during the shift. Most officers neglected the instructions to activate the equipment when explicitly required by the protocol.

Surveys and focus groups reveal that high levels of distrust in the adoption and use of BWC among police officers are one of the main reasons for the lack of protocol compliance. Although officers mostly agree that the equipment can be somehow important and useful to a few situations, they fear that their superiors will use the footage against them. Other aspects that potently explain failure in protocol compliance include, but are not limited to, lack of appropriate supervision on the ground, lack of strategic engagement by the local commanders and also high turnover among these. A lack of sanctions to non-compliant officers was a mayor challenge in the study.

In terms of the effects of BWCs on police behavior, our results provide two solid and significant conclusions. First, assignment to cameras (even without footage) can have a powerful effect reducing police lethal force. We find that the police officers assigned to the treatment group and had a camera used on average 18.2 less bullets than officers in the control group when involved in an event of use of force. Officers that were in the treated group but were not wearing a camera that day (because of the randomization of the cameras across shifts in treated units) used 16.4 less bullets than the control group. Both effects are statistically significant at the 5% level of significance. These results suggest that officers that knew they were not being monitored by a random assignment of BWC significantly used more ammunition than officers that were always (or intermittently) assigned a camera.

Officers in GTTP units have almost twice chances of being involved in an event of use of force than officers in GPPs-Visibilidades and use more than twice ammunition per event. We find that GTTP officers in the treated group not wearing a camera used 16.2 less bullets, on average than

GTPP officers in the control group. This difference was not statistically significant. In contrast, GTTP officers wearing a BWC used 18.1 less bullets per event than officers in the control group. This difference represents a 47.5% reduction in the use of force and is statistically significant at the 5% level.

This study also assesses the effect of BWC on police performance and interaction with the community. To understand the impact on these interactions, we considered the probability of attending/being involved in a formal police occurrence called BOPM. The results show that shifts for which there was at least one camera were involved in significantly fewer BOPMs than shifts in the control group. In particular, the average probability of a BOPM during a shift goes from 0.035 for the control group to 0.023 for the shifts where there was at least one camera. This difference represents a decrease in the probability of reporting a BOPM of 34%. Overall, our results suggest that officers wearing BWC reduce their regular policing activities and engaged in fewer interactions with the community, including stops-and-searches.

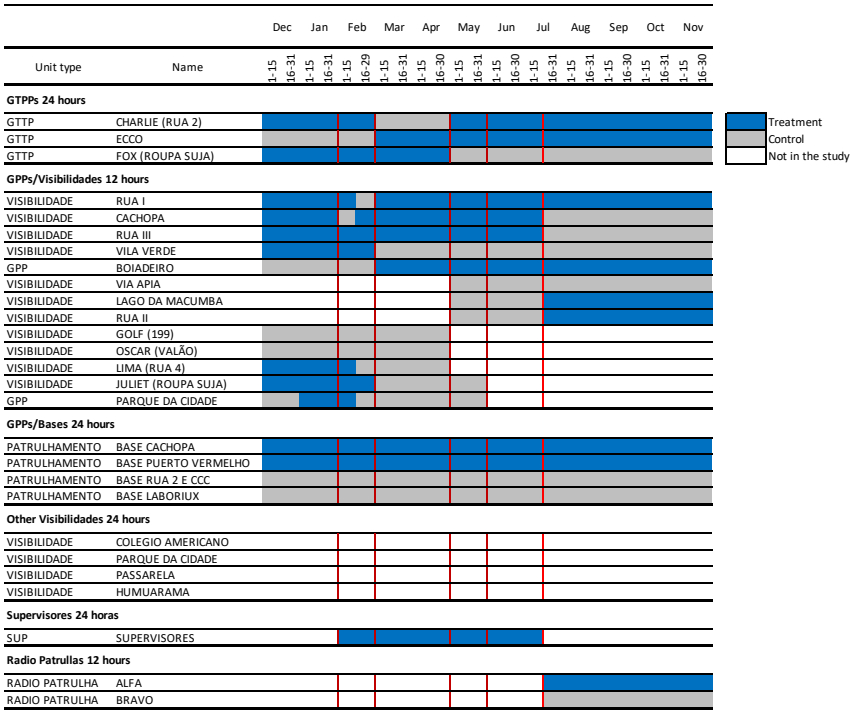
The study generates an intriguing conclusion: BWC can reduce police use of lethal force despite limited footage. For police officers being assigned to a BWC probably signaled that their superiors were more inclined to monitoring their behavior. Carrying a camera not only reduced the number of gunshots fired, but also inhibited police activity in general. The consequences of police inactivity remain ambiguous. On the one hand, in over-policed communities less police activity –including through stop-and-searches -- might contribute to improve relationships with the community. But it is also possible that a less active police might be counter-productive by diminishing capacity to deter criminal activity. We leave this question for further research.

Appendix:

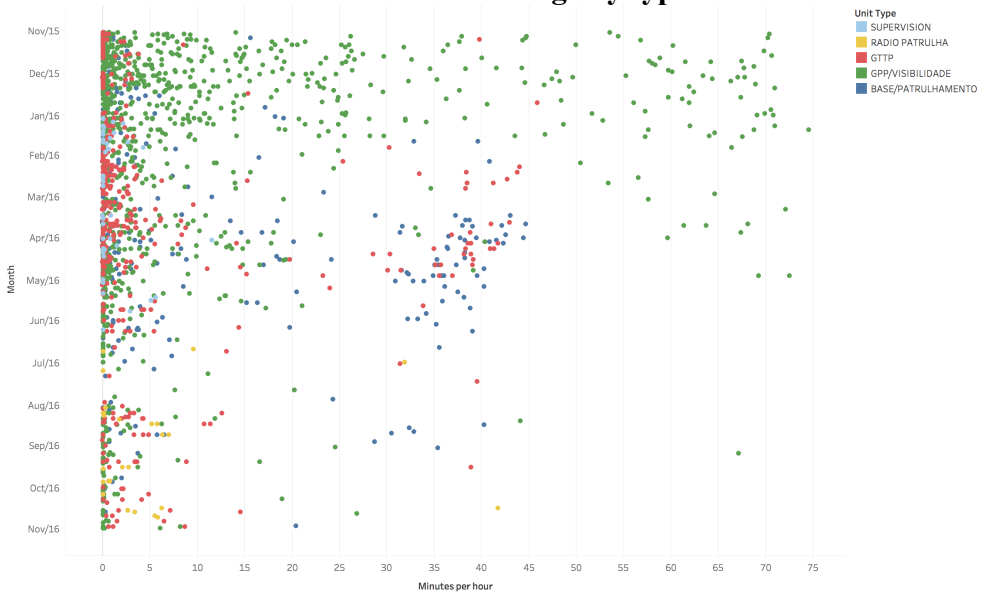
Treatment assignment by type of unit and month

		Dec/15	Jan/16	Feb/16	Mar/16	Apr/16	May/16	Jun/16	Jul/16	Aug/16	Sep/16	Oct/16	Nov/16	Total
BASE/PATRULHAMENTO	Control	372	372	297	256	240	185	160	184	243	257	251	239	3,056
		50.0%	51.5%	54.5%	51.4%	50.0%	42.0%	42.6%	45.8%	52.7%	51.3%	51.5%	43.9%	49.3%
	Treatment	372	350	248	242	240	255	216	218	218	244	236	305	3,144
		50.0%	48.5%	45.5%	48.6%	50.0%	58.0%	57.4%	54.2%	47.3%	48.7%	48.5%	56.1%	50.7%
GPP/VISIBILIDADE	Control	1,113	915	1,152	1,309	1,138	798	690	648	845	749	977	837	11,171
		46.6%	41.3%	53.0%	67.7%	64.9%	64.5%	60.6%	58.1%	65.4%	64.5%	63.0%	61.3%	57.8%
	Treatment	1,274	1,302	1,022	624	615	439	448	468	448	413	574	529	8,156
		53.4%	58.7%	47.0%	32.3%	35.1%	35.5%	39.4%	41.9%	34.6%	35.5%	37.0%	38.7%	42.2%
GTTP	Control	209	186	188	187	225	151	131	125	148	137	140	142	1,969
		32.5%	32.8%	32.1%	33.2%	39.1%	31.3%	28.5%	26.4%	30.8%	31.1%	31.5%	34.5%	32.1%
	Treatment	434	381	397	377	351	332	329	348	332	304	305	270	4,160
		67.5%	67.2%	67.9%	66.8%	60.9%	68.7%	71.5%	73.6%	69.2%	68.9%	68.5%	65.5%	67.9%
RADIO PATRULHA	Control	248	186	232	172	226	195	191	119	119	108	119	130	2,045
		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	65.4%	49.4%	47.2%	48.8%	52.2%	78.8%
	Treatment								63	122	121	125	119	550
									34.6%	50.6%	52.8%	51.2%	47.8%	21.2%
SUPERVISION	Control	62	70						31	60	59	62	57	401
		100.0%	100.0%						50.0%	100.0%	100.0%	100.0%	100.0%	51.3%
	Treatment			72	69	90	61	57	31					380
				100.0%	100.0%	100.0%	100.0%	100.0%	50.0%					48.7%
Total		4,084	3,762	3,608	3,236	3,125	2,416	2,222	2,235	2,535	2,392	2,789	2,628	35,032
		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Figure. Assignment to treatment by unit



Individual distribution of camera usage by type of unit and month



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