A Randomized Controlled Trial of the Impact of Body-Worn Cameras in the Loudoun County, VA, Adult Detention Center

NIJ Grant/Award Number: 2018-75-CX-0019
Project Period: 01/01/2019 - 06/30/2023
Award Amount: $714,164.00

Final Research Report

Brittany C. Cunningham, Daniel S. Lawrence, Michael D. White, Bryce E. Peterson, James R. Coldren, Jr., Jennifer Lafferty, and Keri Richardson

Inquiries should be directed to:
Brittany C. Cunningham, PhD
Assistant Director
cunninghamb@cna.org
(703) 824-2756

CNA Corporation
Center for Justice Research and Innovation
3003 Washington Blvd., Arlington, VA 22201

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Suggested Citation:

Cunningham, B. C., Lawrence, D. S., White, M. D., Peterson, B. E., Coldren, J., Lafferty J., & Richardson, K. (2023). *A Randomized Controlled Trial of the Impact of Body-Worn Cameras in the Loudoun County, VA, Adult Detention Center*. Arlington, VA: CNA Corporation.

Study Team

James "Chip" Coldren, PhD	CNA Corporation
Brittany C. Cunningham, PhD	CNA Corporation
Carrie Hill, Esq.	National Sheriffs' Association
Jennifer Lafferty, JD	CNA Corporation
Daniel S. Lawrence, PhD	CNA Corporation
Bryce E. Peterson, PhD	CNA Corporation
Keri Richardson, MA	CNA Corporation
Danielle Rudes, PhD	Sam Houston State University
Michael White, PhD	Arizona State University

This project was supported by Award No. 2018-75-CX-0019, awarded by the National Institute of Justice, Office of Justice Programs, U.S. Department of Justice. The opinions, findings, and conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect those of the Department of Justice.

Distribution

CNA Document Number: IPD-2023-U-035803 **June 2023**

Abstract

This publication represents the final research report of the CNA Corporation's evaluation of body-worn cameras (BWCs) in the Loudoun County, Virginia, Adult Detention Center. The goal of this study was to conduct a rigorous process and impact evaluation of BWCs in a correctional setting to inform researchers and practitioners about the implementation and potential impacts of BWCs on critical correctional outcomes. To achieve this goal, the study team implemented a 12-month clustered randomized controlled trial and collected data using a mixed-method design. Primary data sources included (1) surveys of deputies; (2) interviews of jail leaders, deputies, and external jail stakeholders; (3) a focus group with deputies who serve on the Special Weapons and Tactics team; (4) observations of jail operations and BWC trainings; (5) review and analysis of jail administrative data, including response to resistance (RTR) events and resident injuries; and (6) review and analysis of data collected from stationary cameras and BWC footage.

Findings suggest that BWCs hold potential for improving the safety and security of correctional facilities by reducing RTR events and preventing injuries to incarcerated residents. However, findings from deputy surveys raised questions about the potential impact of BWCs on deputy-resident relations. The study also addresses one of the primary points of contention about implementing BWCs in correctional environments: that they are superfluous to the existing network of stationary cameras. This study found limitations with both types of cameras, as well as areas where they can complement one another to help overcome those limitations. The study team made several important recommendations for policy and disseminated the research through both academic and practitioner conferences and publications. This study thus offers significant contributions to the field, paving the way for future scholarship and practice.

Contents

1. Introduction

Background

Over the last decade, thousands of law enforcement agencies across the United States (U.S.) have adopted body-worn cameras (BWCs) as a tool to hold their officers accountable, enhance community trust, and optimize their potential evidentiary value (White & Malm, 2020). Data show that by 2020, 62% of U.S. law enforcement agencies had deployed at least some cameras to their officers, including 87% of large agencies (i.e., over 500 sworn), an increase from 47% and 80%, respectively, from 2016 (DOJ, 2023; Hyland, 2018). By April 2021, seven state legislatures had passed laws mandating the use of BWCs by all law enforcement officers statewide (National Conference of State Legislatures, 2022), and in May 2022, President Biden ordered their use by federal law enforcement agencies (White House, 2022). The rapid diffusion of BWCs has been driven by several factors, including numerous controversial uses of force by police against mostly community members of color (e.g., Michael Brown, Walter Scott, Freddie Gray, George Floyd, among others) and findings from early research studies suggesting that cameras can produce notable reductions in police use of force and complaints against police (Ariel et al., 2015; Jennings et al., 2015; Katz et al., 2015).

Interest in BWCs has now also spread to corrections. Agencies initially deployed these devices with their special operations and emergency-response teams to document cell extractions or other interactions between residents and correctional officers (COs; also referred to as deputies in jail settings) that had the potential to result in serious physical altercations (Brodie et al., 2020; Bui, 2016). More recently, officials have deployed BWCs throughout their facilities with the specific goal of increasing transparency and accountability, reducing staff misconduct, and enhancing the safety of the institution. For example, in March 2021, a California judge ordered the use of BWCs in five state prisons, concluding that "…body cameras are likely to improve investigations of misconduct by staff and to reduce the incidence of violations of [disabled incarcerated individuals' rights]" (*Armstrong v. Newsom*, 2021: 46). Following suit, several states have begun deploying BWCs, including New York (2,500 BWCs across eight prisons), Wisconsin (200 BWCs in all six maximum-security prisons and another 100 in a juvenile facility), and Florida (select staff in all 35 prisons across the state), with planning underway in Georgia and Virginia (Welsh-Huggins, 2021). Bogel-Burroughs (2022) also described the initiation of a statewide BWC program in Ohio that will deploy 5,100 BWCs across 28 prisons.

The adoption of BWCs by both state prisons and county jails represents an important development in use of the technology. Correctional settings are unique given the frequent interactions between correctional staff and incarcerated individuals, and the custodial nature of those interactions. Jails and prisons are also characterized by the presence of fixed surveillance cameras throughout facilities (Allard et al., 2008; Lawrence et al., 2022). While stationary video cameras serve many useful roles, such as monitoring and investigating events or allegations post-incident, they also have significant limitations (Washington State Department of Corrections, 2011). For example, stationary cameras typically do not record sound, they often are not capable of thoroughly capturing one-on-one resident-CO encounters, and there are "blind spots" in many facilities that stationary cameras cannot cover (Lawrence et al., 2022).

Unfortunately, there is virtually no research on BWCs in corrections, and as a result, it is unknown whether the positive findings from the policing context extends to jails and prisons. To date, there are only four published studies on BWCs in corrections, and all four examine attitudes among COs in New Zealand and Australia (Beales & Marsh, 2016; Dodd et al., 2020, 2023; Sydes et al., 2022). No studies to date have examined CO attitudes in the U.S., and more importantly, researchers have not yet tested the impact of BWCs on agency-level operations or behavioral outcomes in correctional settings, such as use of force, injuries, and complaints.

The following report outlines the setting, goals, analytical approaches, and findings from a randomized controlled trial on the impact of BWCs on correctional deputy perceptions, reduction in serious events (i.e., responses to resistance), resident injuries, and cost effectiveness within the Loudoun County, Virginia, Adult Detention Center (LCADC).

Major Goals, Objectives, and Research Questions

The purpose of this study was to contribute to the body of knowledge on the implementation and impact of BWCs in jail settings and to assess the degree to which BWCs affect deputy safety, serious events, resident injuries, and cost effectiveness. The study team successfully conducted a 12-month randomized controlled trial (RCT) of BWC placements on correctional deputies within the LCADC from November 2020 to October 2021. The study included interviews with jail staff and stakeholders, surveys with deputies, review of footages from BWCs and stationary cameras, and administrative data on costs, responses to resistance (RTRs), and resident injuries from RTRs. The study team examined and answered three research questions as part of this study, detailed in **Table 1**.

Table 1. Study research questions

Research Questions	
RQ1	How will the introduction of BWCs in an adult jail affect the number of RTRs by deputies, and the number of RTR-related resident injuries?
RQ2	How will the introduction of BWCs in an adult jail affect organizational processes and efficiencies as measured by the time and resources expended to investigate and resolve RTRs?
RQ3	How will correctional deputies feel about the introduction of BWCs and how will these devices affect their perceptions of staff-resident relationships?

Research Setting

Operated by the Loudoun County Sheriff's Office, the LCADC provides jail services to Loudoun County, Virginia. As the third most populous county in the state, Loudoun County was home to nearly 421,000 people in 2020, including 52% white residents, 21% Asian residents, 14% Hispanic residents, and 7% Black residents (U.S. Census Bureau, 2023). According to administrative data provided by the LCADC, the facility had an average daily population of 222 incarcerated residents across the study period (i.e., November 2020 to October 2021), of which 81% were male and 51% were white, 24% were Black, 21% were Hispanic, and 3% were Asian. During this time, more than 80% of residents had a length of stay under two weeks, while only 4% of residents had a length of stay over six months. Most LCADC residents were pre-trial detainees, while approximately 20% were serving sentences for misdemeanor or felony convictions.

The facility houses maximum-, medium-, and minimum-security residents and includes work release, workforce, drug treatment, and mental health programs. Staff supervise eight housing units, each with one to four housing pods (20 pods in the entire facility). There are also four general units in the LCADC, including the medical unit, hallways, intake unit, and transportation between the facility and the county courthouse. **Table 2** provides additional details on the characteristics of these units.

In total, the LCADC is staffed by 124 individuals, including 102 front-line deputies and 22 supervisors, the majority of whom are white and male. In 2019, prior to the study period, the LCADC conducted a small deployment of BWCs among six staff in its Special Weapons and Tactics (SWAT) unit. This deployment of cameras was well received by the deputies and the leadership aimed for a facility-wide release in 2020. This provided the study team with a unique opportunity to learn about the impact of such a program through a rigorous RCT design.

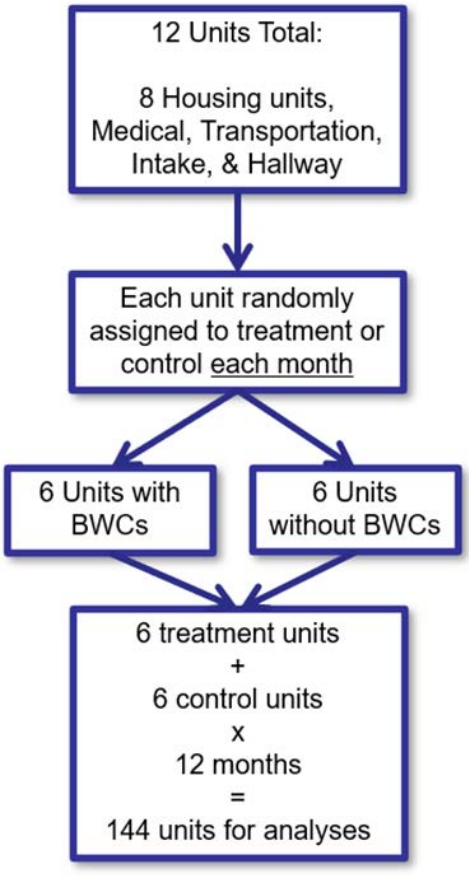
Table 2. LCADC units

Unit	Resident capacity	# Staff	Security level	Resident sex
Medical	n/a	3	Min.	Mixed: General
Hallway	n/a	3	Min.	Mixed: General
Intake	n/a	3	Min.	Mixed: General
Transport	n/a	3	Min.	Mixed: General
Unit A	96 (2 pods w/ 48)	6	Min.	Male
Unit B	96 (2 pods w/ 48)	6	Min.	Mixed: 1 Male, 1 Female
Unit C	96 (2 pods w/ 48)	6	Med.	Male
Unit D	48 (1 pod)	3	Med.	Male
Unit E	48 (1 pod)	3	Med.	Male
Unit F	32 (2 pods w/ 4, 2 pods w/ 12)	6	Med./Max.	Female
Unit G	56 (2 pods w/16, 2 pods w/ 12)	10	Max.	Male
Unit H	64 (4 pods w/16)	10	Max.	Mixed: (2 Female, 2 special housing)

2. Research Design, Methods, and Data Analysis Techniques

Randomized controlled trial

The study team worked with LCADC leadership to deploy BWCs among deputies in a clustered RCT from November 2, 2020, to October 31, 2021 (364 days). Before the start of each month, the study team randomly assigned the 12 units (8 housing units and 4 general units, as listed in **Table 2** and the **Figure**) so that deputies in 6 units would be required to wear a BWC during both the day and night shifts for the entire month, while deputies in the other 6 units would continue business-as-usual without BWCs. This random assignment was conducted 12 times, just prior to the start of the next month. Thus, at the conclusion of the 1-year RCT, there were a total of 72 treatment conditions and 72 control conditions.



This approach was necessary because it would have been impossible to identify two equivalent groups within the LCADC's 12 units. By re-randomizing group assignment at the start of every month, the study team was able to ensure

the treatment and control groups were comparable to one another at the conclusion of the RCT. This approach also helped avoid temporal contamination (i.e., it avoided a situation in which residents who learn that the morning shift will wear cameras put off any unruly or injurious behavior until the evening shift, when they may presume that deputies will not wear cameras, or a situation in which officers working overlapping shifts assigned to different study conditions respond to the same RTR event).

The study team achieved high fidelity with these protocols. To facilitate the randomization process and to check its fidelity, the LCADC provided the study team daily with data that detailed BWC assignments at the unit level. The study team regularly checked these files and informed the facility of errors if observed. Errors were noted in only 3% of all the unit-days of the study (i.e., BWCs were erroneously assigned or not assigned in 131 unit-days of the 4,368 of the study [12 units × 364 days]). In some instances, these errors occurred at the shift level, where the day or night shift incorrectly received BWCs when it should not have, or vice-versa. When examining error rates at the unit-day-shift level, the error rate is 2% (i.e., BWCs were erroneously assigned or not assigned in 164 unit-day-shifts of the 8,736 of the study [12 units × 364 days × 2 shifts]). These low error rates provide the study team with confidence that BWC intervention aligned with the study's theoretical design.

Sources of Data, Participants, and Collaborating Organizations

The primary data sources include: (1) surveys of deputies, (2) interviews of jail leaders, deputies, and external jail stakeholders, (3) a focus group with deputies who serve on the SWAT team (who were previously assigned BWCs), (4) observations of jail operations and BWC trainings, (5) review and analysis of jail administrative data (e.g., characteristics of RTR incidents and resident injuries), and (6) review and analysis of data collected from stationary cameras and BWC footage.

Surveys of Jail Deputies

The study team surveyed LCADC deputies at three distinct periods over the course of 14 months: (1) pre-implementation, which occurred approximately 2 months before the RCT of the BWC program in September 2020; (2) mid-implementation, which occurred a little over halfway through the RCT in June 2021, (3) and post-implementation 1 month after the RCT concluded in November 2021.

The pre-implementation survey instrument included 24 questions designed to measure

perceptions of BWCs across a variety of domains: (1) individual and general views; (2) familiarity, ease of use, and comfort; (3) use of BWCs; (4) resident-deputy interactions; (5) civilian reactions; (6) concerns; and (7) overall thoughts and conclusions. Questions were added to the mid- and post-implementation surveys regarding rate of BWC activation, training feedback, and advantages and disadvantages of using BWCs.

The team administered the survey online via Qualtrics to all LCADC deputies (including 102 front-line deputies and 22 supervisors) at all three periods, for a pool of approximately 124 eligible survey participants at each wave. Participation was voluntary, and the surveys took approximately 10 minutes to complete. Respondents were given roughly two weeks to complete each survey, during which time the study team provided regular reminders to improve response rates. Although there was some item-level variation in responses rates, there were 117 deputies overall who participated in the pre-implementation survey (94% response rate), 84 who participated in the mid-implementation survey (68% response rate), and 87 who participated in the post-implementation survey (70% response rate).

Interviews of jail leaders, deputies, and external jail stakeholders

During the study, research staff conducted a total of 27 interviews with jail staff and external community stakeholders about their perceptions of the BWCs, possible benefits from the technology, and challenges and obstacles around implementation. The interviews occurred one month prior to the BWC deployment (October 2020) as well as one to two months after the study period ended (November and December 2021). Agency interviews were conducted with supervisors and executive-level staff (i.e., sergeants, lieutenants, captains, majors, and commanders). External community stakeholder interviews were conducted with community leaders who either worked with the LCADC or Loudoun County Sheriff's Office, or had an interest in advocating for BWCs one way or another. These community members included staff from the Loudoun County Public Defender's Office, the County Attorney's Office, the Loudoun Coalition on Women and Girls, Legal Services of Northern Virginia, the American Civil Liberties Union, and the Opportunities, Alternatives, and Resources of Loudoun County. **Table 3** details the number of completed interviews, by period.

Table 3. Study interviews, by period

	Pre-Deployment	Post-Deployment	Total
Sergeants	5	1	6
Lieutenants	5	3	8
2nd Lieutenants/Captains/Majors/Commanders	3	3	6
External Community Stakeholders	5	2	7
Total	18	9	27

Focus group with jail SWAT deputies

The study team conducted a focus group with three of the six LCADC SWAT team deputies regarding their experiences with BWCs in the jail setting. As previously noted, this team was trained and received BWCs in 2019 to assess the usability, benefits, and challenges associated with the cameras in preparation for a larger agency-wide deployment. The focus group occurred in October 2020.

Observations of jail operations and BWC trainings

During the study, the team conducted two observations of jail operations to better understand the layout of the facility, the procedures staff follow, and the application of BWCs in practice. The study team virtually observed a total of four one hour-long BWC trainings to better understand the BWC policy and operation (e.g., activating, tagging, and docking). The training was developed by the LCADC, which all deputies, sergeants, and lieutenants attended in October 2020, one month before the RCT began. Training observations included review of trainee engagement, material covered, verbal and nonverbal communications, as well as questions or comments regarding BWCs from correctional deputies.

Administrative data

After the completion of the RCT, the LCADC shared administrative data with the study team that covered the study period (November 2020 to October 2021) and pertained to RTR events. The provided dataset included data for each responding deputy to a RTR and covered topics including: the location of the RTR, the shift, the level of resident resistance (Level 1 – Passive, Level 2 – Active, Level 3 – Aggressive), the service activity underway at the time of the RTR (cell extraction, escort, event within unit, intake, or other), resident injury, the reason for the use of force (resident assaultive/combative, resident noncompliant, other), and the type of force used (active countermeasures, arm-bar takedowns, close-quarter strikes, empty-hand controls, pressure

point controls, emergency restraint chair, handcuffs, hobble restraint, spit-hood, OC spray, personal weapon, or taser). Using the location of the event information, the study team was able to append additional data, such as the sex of the residents in the unit, the security level of the unit, and the unit's residential capacity.

The study team also created a data form for LCADC officials to complete pertaining to costs associated with the BWC program. Because the project supported the costs for the BWC hardware and staff time for trainings, this data form specifically focused on the staff time spent administering the BWC program and investigating RTR events.

Camera footage review

Finally, the study team developed a methodology for reviewing and assessing information gathered from the facility's BWCs and stationary close-circuit television (CCTV) cameras. The study team reviewed 13 randomly selected RTR events and pulled video footage from all cameras that captured these events, including both BWCs and stationary CCTV cameras. The study team was interested in learning how information differs across these two types of cameras and therefore developed a data collection form that they completed while reviewing this footage. In total, they reviewed footage from 46 BWCs and 48 CCTVs and entered this information into a database for analyses. The form covered topics such as the RTR event details, the audio and video quality of the footage, the actions of the residents and deputies, whether the resident acknowledged the presence of a camera in any way, injuries, and the disposition of the event.

3. CHANGES IN APPROACH FROM ORIGINAL DESIGN

Impact of COVID-19 Pandemic

Initially, onsite data collection was to start in April 2020. However, to follow OJP's COVID-19 guidance and the CDC's risk reduction recommendations, all onsite data collection was cancelled. The jail was also closed to outside consultants, researchers, and visitors due to the pandemic in April 2020. As a result, the study team worked with jail administration to develop alternative avenues for data collection during the pandemic. For example, the study team collected pre-implementation data virtually (e.g., phone interviews, online deputy surveys, online resident surveys) to keep the project moving forward.

Surveys and interviews with jail residents

The study team originally proposed pre- and post-surveys with approximately 200 jail residents to explore their perceptions of deputy behavior (as well as their own behavior) related to

procedural justice and legitimacy before and after the implementation of BWCs. In the original proposal, the study team planned to administer surveys onsite to all jail residents; however due to the COVID pandemic that was not possible. As a result, the team worked with the facility tablet vendor, GLT, to develop and administer an online survey. Flyers were created in both English and Spanish to introduce the study and survey. These flyers were strategically posted in common areas of each housing unit and near locations where residents accessed their tablets. The survey was open for four weeks, during which only 13 residents completed the survey. Additional efforts were made to increase the response rate but, unfortunately, the overall response rate remained low.

To address the limited participation of residents in the online survey, the study team devised a methodology after the experimental study period to conduct interviews with recently-released individuals from the facility. The study team worked with the LCADC to create a single-page flyer, in both English and Spanish, that would be included in resident release packages. This flyer provided information about the study and offered a small compensation to individuals who were able to participate in a 30 to 45-minute-long interview about their experiences within the facility. Unfortunately, none of the former LCADC residents contacted the study team to participate in an interview.

Changes to administrative data

The study team originally proposed examining the impact of BWCs on complaints by residents. Unfortunately, the LCADC did not systematically track these data and was therefore unable to provide them to CNA. Similarly, the study team had originally proposed collecting data on officer injuries, in addition to resident injuries. However, there were no officer injuries from RTR events during the RCT study period and this outcome was dropped from the final analyses.

The study team originally proposed collecting and examining use of force incidents for the impact evaluation. Beginning in October 2020, the LCADC transitioned from documenting instances where the deputies directly used force on the residents (i.e., a use of force) to documenting instances when residents resisted deputies in any way (i.e., a response to resistance). As a result, the number of documented events greatly increased after this change, from roughly 3.2 uses of force per month on average prior to the change to 8.6 RTRs per month on average after the change. As a result of this definitional change, the study team could only examine RTRs during the study period. This precluded, for example, the study team from conducting a facility-wide time-series analysis to assess the impact of BWCs on critical outcomes.

4. Outcomes

Activities/accomplishments

This study was successful in conducting the first RCT in a jail facility to examine the impact of BWCs on deputies and residents. **Table 4** provides an overview of study accomplishments.

Table 4. Study activities and accomplishments

Activity	Description
Purchase BWCs for LCADC	• Purchased 60 cameras for implementation in 12 units, including the cost for license, storage, hardware, and electronic transfer.
BWC training recommendations	• Based on the observations and review of best practices for BWC training, the study team recommended the LCADC add hands-on practice with the BWC and review of the policy during their initial training, which the jail intends to implement moving forward
Implement RCT in correctional setting	• Completed the first known RCT of BWCs in a correctional setting • Achieved high fidelity in the random assignment (errors noted in only 3% of all the unit-days and 2% at the unit-day-shift level)
Review camera footage	• Completed the first known comparative analysis of BWC and stationary camera footage of RTRs in a jail
Impact analyses	• Prevented 27 RTRs and 8 injuries to residents over the study period
Cost effectiveness	• Completed the first known cost effectiveness analysis of BWCs in a correctional setting, included startup costs, personnel costs for training, and costs associated with investigating RTR events

The RCT protocols were complex with significant potential for implementation failure, especially since the study occurred during the COVID-19 global pandemic. Nevertheless, as described above, the LCADC implemented the RCT protocols with high fidelity (3.0% of unit days improperly assigned), and their ability to maintain the integrity of the research design allows for a robust examination of BWC impact.

Impact on deputy perspectives

As previously detailed, the study team surveyed LCADC deputies at three distinct periods over the course of 14 months: (1) pre-implementation (2 months before the RCT), (2) mid-implementation (halfway through the RCT), (3) and post-implementation (1 month after the RCT). Findings from the study team's analyses of these data are detailed in **Peterson et al. (2023), which offers one of the first empirical examinations into end-users' perceptions of BWCs from a U.S. corrections facility**.

Overall, the study team found that LCADC deputies held neutral or slightly negative perceptions about whether BWCs could improve efficiency and accuracy, have a civilizing effect on incarcerated residents, or disrupt work-related activities. Moreover, these perceptions remained largely consistent across the pre-, mid-, and post-implementation periods. On the other hand, the study team found that deputies had more negative perceptions of their relationships with residents at both the mid- and post-implementation periods, compared to the pre-implementation period. **Table 5** details the mean differences between the survey domains at each period. For more detail on the results from the deputy surveys, see Peterson et al. (2023).

Table 5. Change in deputy perspectives

Domains	# Items	Scale Alpha	Means			Mean Differences		
			Pre	Mid	Post	Pre-Mid	Mid-Post	Pre-Post
Efficiency and Accuracy	8	.89	2.99	2.95	3.00	-0.04	0.05	0.01
Resident Civilizing Effect	3	.94	2.61	2.38	2.61	-0.23	0.23	0.00
Work disruptions	5	.69	2.77	2.85	2.70	0.08	-0.15	-0.07
Resident-deputy relationships	5	.81	3.69	3.31	3.44	-0.37 *	0.12	-0.25 *

Notes: All scales and items used a 5-point Likert response scale, where 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, and 5 = strongly agree. * $p < .01$

Impact on responses to resistance

The BWC intervention study period occurred across 364 days from November 2, 2020, to October 31, 2021. Because the randomization of units occurred at the start of each month, the unit of analysis in the dataset was the unit-month, where counts of each outcome were calculated within each unit within each month. As such, cases totaled 144, with 12 units × 12 months. There were 97 RTRs during the study period. **Lawrence et al. (2023a) tested the impact of BWCs on three outcomes – total RTRs, the specific control methods used by deputies during RTRs (physical controls, restraints, weapons), and the resident resistance level during RTRs (passive, active, aggressive).**

The analyses uncovered significant effects with each outcome, after controlling for the cumulative number of months the unit had BWCs, the security level of the unit, and the resident sex of the unit. First, the study team documented a statistically significant difference in RTRs among BWC and non-BWC unit-months, despite the seemingly low base rate across the study period (97 RTRs across 144 unit-months). More specifically, RTR events were approximately 40% lower in unit-months with BWCs ($p < .05$). Within the predicted margins, there were an average of 0.55 RTRs when BWCs were present, compared to 0.92 when BWCs were not present. This

finding suggests the presence of BWCs led to significantly lower rates of RTR events among correctional deputies in the LCADC during the study period.

The additional analyses of deputy control methods (i.e., force types) and resident resistance provide some insight into the specifics of that RTR reduction, as a significant decline occurred in the use of physical controls by deputies (average of 0.49 events in BWC months compared to .78 in non-BWC months) and active resistance by residents (average of 0.34 events in BWC months compared to .71 in non-BWC months). Passive resistance by residents and restraint controls by deputies both were lower in BWC unit-months, but the declines fell just short of statistical significance. Notably, both weapon force and aggressive resistance by residents were quite rare and did not differ between BWC and non-BWC conditions. **Table 6** details the impact BWCs had on the RTR outcomes estimated from the negative binomial regression models.

Table 6. Impact of BWCs on responses to resistance

Count Model	BWC IRR (SE)
Total RTR events	0.60 (0.13) *
Count of Level 1, Passive Resistance	0.44 (0.20) †
Count of Level 2, Active Resistance	0.48 (0.12) **
Count of Level 3, Aggressive Resistance	1.51 (0.53)
Count of Physical Controls	0.63 (0.12) *
Count of Restraint Controls	0.64 (0.15) †
Count of Weapon Controls	1.19 (0.44)

Notes: All models controlled for the cumulative number of months the unit was assigned BWCs, the security level of the unit, and the resident sex of the unit. Models on resistance levels and control methods include the number of staff as an exposure variable. IRR incidence rate ratio, SE robust standard error.
† $p < .10$, * $p < .05$, ** $p < .01$

Taken together, the findings on RTR, deputy control methods, and resident resistance levels suggest BWCs can positively alter the behavior of deputies and residents in a correctional setting. When BWCs were present, deputies used force less frequently, particularly physical force, and residents were less likely to actively resist against deputies. These findings are notable given the fundamental differences between police and correctional settings. For example, residents are incarcerated, their freedom of movement within the jail is strictly controlled, and the emphasis on institutional control is paramount. Moreover, the contact between deputies and residents is far more common than in policing, and the contacts are more frequently between the same individuals (though the average length of stay for 80% of residents is less than two weeks). Regardless of these differences, the potential for BWCs to reduce use of force in policing seems to be realized among

correctional deputies in the LCADC. For more detail on the results from the impact on RTRs, see Lawrence et al. (2023a).

Impact on resident injuries

Lawrence et al. (2023b) examined the impact BWCs had on the number of resident injuries. A resident was recorded as being injured in 18 of the 97 RTR events, corresponding to an injury rate of 18.56 percent. Of note, the LCADC recorded these injuries as "apparent minor injuries" but did not provide further detail. Events marked with no injury were reported as "no injuries noted or visible." Like the count models on the amount of RTRs, the study team examined injuries through a negative binomial regression model using robust standard errors and controlling for the cumulative number of months the unit was assigned BWCs, the average amount of responding deputies per RTR event, the security level of the unit, and the resident sex of the unit. Results indicated that fewer resident injuries were observed in unit-months where BWCs were randomly assigned by a factor of 0.42, or an approximately 58 percent reduction in injuries ($p < .05$). In practicable terms, this corresponded to an average count of resident injuries of 0.17 in unit-months without cameras compared to 0.07 in unit-months with the cameras.

The study team also used logistic regression to examine how RTR event characteristics affect the likelihood of an injury occurring. The logistic regression model included 13 event characteristics that were group together into three categories. Variables within *situational characteristics* included the presence of BWCs, the cumulative number of months the unit was assigned BWCs, whether the RTR occurred during the night shift or the day shift, the number of deputies who responded to the RTR event, whether the RTR occurred in a maximum housing unit compared to minimum or medium housing units, whether the RTR was in a unit that solely housed male residents compared to mixed-unit residents or solely female units, and finally, if the underlying reason for the resident contact was for a cell extraction event compared to other events, such as escorting, intake/processing, transports, or changing out a room. Variables focusing on *resident behaviors* included the reason the RTR occurred, specifically that the resident was being assaultive or combative compared to being non-compliant or they were indirectly involved in an event that needed to be secured, and the resident's resistance levels (Level 1 – Passive, Level 2 – Active, and Level 3 – Aggressive). The final grouping of variables included those that pertained to *deputy behaviors*, which specifically focused on the different control methods that deputies applied during the RTR (physical controls, restraint controls, and weapon controls).

Results from the final model indicated that only the presence of BWCs was associated with a reduction in the likelihood of resident injury (OR(SE) = 0.12(0.11), $p < .05$). In practical terms as estimated by predicted margins, injuries occurred in 28.4 percent of RTRs without BWCs compared to 8.8 percent of RTRs with BWCs. For more detail on the results from the impact on resident injuries, see Lawrence et al. (2023b).

Cost effectiveness

The study team paired the results of the RTR and resident injury analyses with information on the costs of the BWCs to conduct a cost-effectiveness analysis of the LCADC BWC program. Cost-effectiveness analysis allows researchers to relate the cost of a program to its key outcomes but is distinct from a full cost-benefit analysis in that it does not identify and attach monetary values to those outcomes (Cellini & Kee, 2015). This approach allows a straightforward yet practical description of the relative cost efficiency of the BWC program using the following equation:

$$\text{Cost-effectiveness ratio} = \frac{\text{Cost of LCADC's BWC program}}{\textit{Unit change in outcome}}$$

To calculate the cost of LCADC's BWC program, the study team gathered three primary types of data over the one-year study period: (1) equipment and startup costs; (2) initial training costs; and (3) personnel costs associated with RTR investigations. These breakdown of each of these costs is provided in **Tables 7A-7C**.

Table 7A. Equipment and startup costs

Item	Cost
Cameras (x 60)	$70,803
Electronic transfer module	$12,780
Licenses	$4,950
Storage	$14,744
Hardware (racks, cabling, etc.)	$2,878
Total	**$106,155**

Table 7B. Initial training costs

Position	# Staff	# Hours	Hourly wage	Cost
Deputy	165	2	$36.71	$12,113
Sergeant	20	3	$48.98	$2,939
1st Lt.	2	3	$65.13	$391
2nd Lt.	6	3	$54.52	$981
Captain	2	3	$78.16	$469
Major	1	3	$85.20	$256
			Total	**$17,149**

Table 7C. Personnel costs associated with RTR investigations

Staff information				Without BWCs			With BWCs		
Position	*# per RTR*	*Hourly wage*	*OT wage*	*# Hours*	*# OT hours*	*Total wages*	*# Hours*	*# OT hours*	*Total wages*
Deputy	6.5	$36.71	$55.06	0.66	0	$157.47	2	0	$477.18
Sergeant	1	$48.98	$73.48	2	0	$97.97	2	0	$97.97
1st Lt.	1	$65.13	$97.70	0.75	0	$48.85	2	0	$130.27
2nd Lt.	1	$54.52	$81.78	2	0	$109.05	2	10	$926.89
Captain	1	$78.16	$117.24	0.75	0	$58.62	2	0	$156.32
Major	1	$85.20	$127.79	0.75	0	$63.90	2	0	$170.39
		Cost per RTR				**$535.85**			**$1,959.02**
		Number of RTRs				**62**			**35**
		Total costs				**$33,222.70**			**$68,565.57**

Notes: OT=overtime; data obtained from grant expenditures and provided by LCADC officials.

As depicted in these tables, the costs of LCADC's BWC program over the course of the one-year RCT were estimated at $158,647, ($106,155 for equipment and start-up costs + $17,148.72 for training + $35,342.87 in increased personnel time investigating RTRs). It is noteworthy that, despite the reduction in RTR events in units with BWCs over the study period (35 RTRs in treatment units versus 62 RTRs in control units), the increased time required to review BWC footage of these events resulted in a more than 100% increase in personnel costs. Much of this was driven by the extra hours needed for second lieutenants, who were the primary supervisors responsible for investigating each RTR event in the LCADC. This finding contrasts with CNA's prior study of BWCs in the Las Vegas Metropolitan Police Department, which found that BWCs were cost-beneficial because of the reduction in time spent investigating and resolving community member complaints (Braga et al., 2017). However, that study focused on the reduction in time spent investigating complaints, not use of force incidents or RTR events. RTRs require more detailed investigations, including a careful review of all available video evidence.

It is also possible that there are savings associated with the reduction in injuries that could help offset the increased costs of RTR investigations. Though nearly all resident injuries were minor, and LCADC officials noted that none of them required offsite medical services, many of the injuries likely required medical care within the LCADC. There are, of course, costs associated with these services, but the LCADC was not able to break down these expenses. Moreover, because the study team opted to conduct a cost effectiveness analysis in lieu of a cost benefit analysis, they did not attempt to quantify the "social" cost savings associated with a reduction in injuries and RTRs or monetize the improvement in evidence collection, transparency, and accountability associated with BWCs (see Cellini & Kee, 2015). Instead, the cost-effectiveness ratio, combined with the estimate of RTRs (n=27) and injuries (n=8) prevented by the BWC program, indicates that each $5,875.80 spent on the program resulted in one prevented RTR, while each $19,830.82 resulted in one prevented injury.

BWC and Stationary Footage Review

Cunningham et al. (2023) details the review of a random sample of 13 response to resistance incidents conducted during the study, including 46 BWC videos and 48 stationary camera videos. The objective of this review was to monitor the quality of the audio and video features of the BWCs; examine whether BWCs added value to stationary videos; and understand the impact of BWCs on encounters between deputies and jail residents. The following summarizes the key takeaways from the video reviews.

Deputies did not noticeably announce the presence of the BWC during the incidents reviewed, nor did subjects clearly appear to take notice of the BWC on the officer. LCADC policy does not require deputies to announce activation of the BWC. Therefore, the subjects' knowledge of the presence of the BWC was not always clear from the BWC video and audio.

Footage of RTR events from both BWCs and stationary cameras was rated on a three-point scale (poor, fair, good) in terms of video quality and camera positioning. In almost all cases, both camera types were rated as either having fair or good video quality. In a few cases, interference (e.g., in one case a jail resident put a towel over the stationary camera) or the physical distance between the non-primary deputy and the jail resident lessened the visual quality of stationary videos (generally due to where the camera was positioned or lighting). For the most part, however, the BWC-wearing deputy, the jail resident, and others at the scene could be heard on the BWC, and the visual recording was generally clear in the direction that the BWC was pointing.

As for BWC positioning, for most cases in the sample, the BWC was pointed in the proper direction where the jail resident and event were clearly (or at least adequately) framed. However, the direction in which the non-primary BWC was pointing was occasionally problematic. At times deputies would be blocking BWCs or would not be in frame to see the event and the audio would be muffled due the distance between the non-primary officer and the resident. In these cases, the stationary video provided more complete pictures of the scene. Only once did it appear that the BWC mount had adjusted out of position, resulting in the BWC pointing at the ground. In these cases, the audio was clear, but the video did not capture the deputy's interaction, but the interaction could be seen from a distance on stationary cameras.

In sum, both the BWCs and stationary cameras provided valuable insight into RTRs despite some fundamental limitations with each. Importantly, the two camera types complemented one another to help overcome those limitations. For example, the stationary cameras did not capture audio but the BWCs did, and the audio provided important additional context to understand the situation, such as tone of voice and verbal exchanges. The BWCs sometimes were pointed in the wrong direction because they were attached to the deputies, but the stationary cameras captured an unobstructed view from overhead. Together, the stationary cameras and BWCs provide more complete evidence of what transpired than either camera type by itself. For more detail on the results from the review of BWC and stationary footage, see Cunningham et al. (2023).

Limitations

There were a few notable limitations. For example, this study relied on data that were unique in a single, relatively small jail: the LCADC. Thus, the findings cannot be generalized to prisons or other jail jurisdictions. Further, the study's sample size (12 housing units × 12 months = 144 observations) was small and produced a relatively low base rate of RTR incidents (n=97) and resident injuries (n=18). The protocol of re-randomizing units each month, though necessary, also made it impossible to use a difference-in-difference approach in the impact analyses. Similarly, because of the changes in LCADC policy to measure RTRs in lieu of use of force incidents, the study team was not able to use a time series or other analytic approach to examine facility-wide changes in relevant outcomes over time.

5. Artifacts

The study team implemented a comprehensive dissemination plan for the study findings that reached scholarly and wider audiences, including researchers, correctional practitioners, and other stakeholders. Artifacts included three briefs on the survey findings presented to LCADC personnel, a research brief summarizing the team's review of BWC versus stationary camera footage, three articles submitted to high-quality academic journals, an article for a jail practitioner magazine, three presentations at practitioner conferences and two at research conferences, a final report to NIJ, and archives of all relevant data collected under for the study. Descriptions of each of these artifacts are provided in **Table 8**.

Table 8. Study artifacts

Deliverable(s)	Description	Audience(s)
Briefs on survey findings	Created three memos highlighting the findings from pre-, mid-, and post-year surveys administered to correctional deputies	LCADC administers and staff, NIJ
Brief on footage	Published a research brief (Cunningham et al., 2023) detailing findings from the review of BWC footage versus footage from stationary cameras in the LCADC.	Correctional practitioners, researchers, NIJ
Academic journal articles	Prepared three manuscripts for peer-reviewed journals focusing on findings from the deputy survey analyses (Peterson et al., 2023), and the impact of BWCs on RTRs (Lawrence et al., 2023a) and resident injuries (Lawrence et al., 2023b)	NIJ, researchers
Practitioner magazine article	Published an article in the American Jail Association's *American Jails* magazine summarizing the study and its findings.	Jail practitioners, researchers
Academic and practitioner conferences	Presented findings at several conferences: • 2022 AJA's 41st Annual Conference & Jail Expos • 2022 American Society of Criminology • 2023 AJA's 42nd Annual Conference & Jail Expos • 2023 NSA Winter Annual Conference • 2023 NIJ Research Conference	Jail practitioners, researchers
Final research report	Final research report to NIJ summarizing the project's goals, research activities, and findings.	NIJ, researchers
Data archiving	Uploaded study data to the Inter-university Consortium for Political and Social Research National Archive of Criminal Justice Data (NACJD)	NIJ, researchers

6. Conclusion

This study represents the first known RCT of BWCs in a correctional setting. In partnership with the Loudoun County Sheriff's Office, the study team was able to (a) successfully execute the RCT with high fidelity, and (b) collect and analyze numerous critical outcomes related to the implementation and impact of the LCADC's BWC program. Findings from these analyses suggest that BWCs hold potential for improving the safety and security of correctional facilities by reducing RTRs and preventing injuries to incarcerated residents. However, findings from deputy surveys raised questions about the potential impact of BWCs on deputy-resident relations. The study also addresses one of the primary points of contention about implementing BWCs in correctional environments: that they are superfluous to the existing network of stationary cameras. This study found limitations with both types of cameras and identified where they can complement one another to help overcome those limitations. The study team made several important recommendations for policy and disseminated the research through both academic and practitioner conferences and publications. This study thus offers significant contributions to the field, paving the way for future scholarship and practice.

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