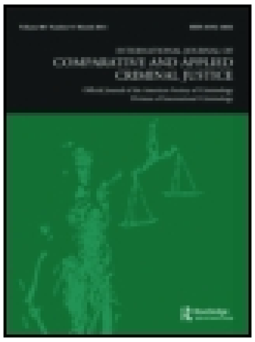

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ARTICLE

The internationalisation of cctv surveillance: Effects on crime and implications for emerging technologies

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ABSTRACT
In the last two decades, closed-circuit television (CCTV) surveillance cameras have come to occupy a central role in contemporary crime prevention across the world. Widely viewed as the "internationalization" of CCTV surveillance, there has been a corresponding growth in the evidence base about its effect on crime. The cumulative evidence demonstrates that CCTV surveillance is associated with significant yet modest reductions in crime and the effects vary across a range of contextual factors, including country of origin. This paper reports on the global expansion of CCTV schemes and examines – using systematic review methods with meta-analytic techniques – effects of CCTV schemes on crime in different countries. It draws upon a recently updated database of CCTV evaluations (N = 162) covering nearly five decades of research and spanning the globe, which now includes many industrialised countries. Implications for policy and research are discussed, with a special emphasis on emerging surveillance technologies.

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CCTV; surveillance; crime prevention; international; systematic review; meta-analysis

Introduction

In the last two decades, closed-circuit television (CCTV) surveillance cameras have come to play a central role in contemporary crime prevention across the world (Goold, 2004; Welsh & Farrington, 2009; Weisburd & Majmundar, 2018). This growth in CCTV is taking place both within and across countries. It is no longer the case that a high prevalence of CCTV cameras is associated with one or two industrialised countries, such as it once was in the United Kingdom (Norris & McCahill, 2006). Camera systems are now being widely used in cities in industrialised and developing countries across all of the populated continents, with the largest growth being experienced in Asia, Europe, North America, and South America. In many of the large cities – for example, Beijing, Chicago, London, and Rio de Janeiro – the camera systems are highly sophisticated, incorporating emerging technologies, such as networked camera systems, facial recognition applications, and licence plate reader technology. This phenomenon has come to be recognised as the "internationalization" of CCTV surveillance (Hier, 2010).

One of the pressing questions in this "internationalization" of CCTV is whether it is having a desirable effect on crime rates within the wide range of public and private settings it operates. These settings include, but are not limited to, city and town centres, public housing, residential areas, public transportation facilities, car parks, hospitals, and retail shops. Based on a new systematic review and meta-analysis of the effects of CCTV on crime, the best available evidence demonstrates that CCTV is associated with a significant yet modest reduction in crime (Piza et al.,

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2019). But this aggregate or pooled-effects finding hardly tells the full story. Effects of CCTV cameras on crime vary across a wide range of contextual factors, including geographical setting, crime type, camera monitoring strategy, who is doing the monitoring, use of other interventions, and even country of origin (Piza et al., 2019).

This article has two chief aims: (1) to report on the expansion of CCTV surveillance cameras in public and private settings across the world, and (2) to examine the effects of CCTV schemes on crime in different countries. Using systematic review methods and meta-analytic techniques, the paper draws upon a recently updated database of CCTV evaluations (N = 162) covering nearly five decades of research and spanning the globe. We begin with some background on CCTV, focusing on theoretical perspectives and programmatic features that have come to shape how CCTV is understood and implemented in public and private settings across the world. We conclude the paper with a discussion of the findings in the context of emerging surveillance technologies, in recognition of public and private entities relying more heavily on emerging technologies in an attempt to enhance the effectiveness of CCTV (Skogan, 2019).

Background

The main purpose of utilising CCTV surveillance technology, in both public places and private settings, is to prevent the occurrence of personal and property crimes (Welsh & Farrington, 2009). In the taxonomy of crime prevention approaches, CCTV is categorised as a form of situational crime prevention (Clarke, 1997). The potential crime prevention effect of CCTV lies in the technology's ability to reduce the types of situational cues that rational choice (Cornish & Clarke, 1986) and routine activities (Cohen & Felson, 1979) models assert are necessary for crime commission. From a rational choice perspective, CCTV operates with a fundamental purpose to "trigger a perceptual mechanism in a potential offender" (Ratcliffe, 2006, p. 8). From a routine activities perspective, CCTV can provide the necessary guardianship to prevent motivated offenders from taking advantage of criminal opportunities. The crime prevention mechanisms suggested by both rational choice and routine activities might be generated via increased "formal surveillance" within specific, designated areas targeted by CCTV cameras (Cornish & Clarke, 2003). Another view holds that the presence of CCTV can convince citizens to better safeguard their property and promote increased usage of public places, which can increase "natural surveillance" in target areas (Gill & Spriggs, 2005).

The perceived crime prevention benefits of CCTV have led to widespread adoption of the technology over recent decades. Armitage (2002) traced the early growth of CCTV in the United Kingdom, noting that in 1990 there were only 100 cameras dispersed throughout three separate town centres. By 1997, there were an estimated 5,238 cameras in 167 different schemes across the country (Armitage, 2002). CCTV use has continued to spread rapidly throughout the UK, with estimates ranging from 4 to 5.9 million (Barrett, 2013). Subsequent to the rapid expansion in the UK, CCTV emerged as a popular crime prevention tool in the US. A survey of US police agencies conducted in 2013 found 49% of local US police departments report using CCTV, according to the most recent figures collected by the Bureau of Justice Statistics (Reaves, 2015). Reported use rises to 87% for agencies serving jurisdictions with populations of at least 250,000 persons. Given the increased reliance on technology in day-to-day policing over the last decade (Ariel, 2019), the proportion of US police agencies using CCTV today is likely even higher than what was reflected in the Bureau of Justice Statistics report.

An increase in evaluation research has occurred amidst this expanded use of CCTV. This increase in CCTV evaluations over time is perhaps best reflected in the US. While only four evaluations of CCTV schemes in the US met the inclusion criteria in the prior systematic review (Welsh & Farrington, 2009), the latest review included 24 US evaluations, accounting for 30% of the overall sample (Piza et al., 2019). Evaluations have increasingly been conducted in other countries as well, including South Korea, the Netherlands, Colombia, Poland, Uruguay, Sweden, Canada, Spain, Norway, and Australia.

As argued by Skogan (2019), the spread of CCTV should be contextualised in terms of technological innovations that will shape the future of video surveillance. Technological developments have resulted in contemporary CCTV systems bearing little resemblance to their predecessors. The earliest evaluation identified in Piza et al.'s (2019) review (Musheno, Levine, Palumbo et al., 1978) reported on a system in which cameras installed in the lobby and elevators of a housing complex were hard-wired to a central receiver that transmitted footage to television monitors throughout the property. Today, CCTV systems are commonly integrated with complementary technologies such as licence plate readers and linked traffic cameras (Skogan, 2019). Technological developments have been so drastic that La Vigne & Lowry, 2011) argued "closed-circuit television" no longer accurately describes modern video surveillance, given the sophisticated digital infrastructure underlying the cameras and ability to stream video of footage to any device granted access to the computer network.

This rapid expansion of technologies meant to bolster the impact of CCTV stands to increase in the near future (Skogan, 2019). Improvements in machine learning may make video surveillance more autonomous (Idress et al., 2018; Chen et al., 2020). At the same time, Skogan (2019) notes improvements in facial recognition software may make CCTV more of a central component of criminal investigations while aerial drones may be widely used to provide overhead surveillance for in-progress events (see Kanno-Youngs, 2018). Given differences in relevant policies, oversight, and legal restrictions, countries may begin to adopt such emerging technologies at differing rates. As an example, while legislators in the state of California recently introduced a ban to limit the use of facial recognition software in police surveillance cameras (Rosenhall, 2019), this technology has been heavily promoted and deployed in China (Mollman, 2019) and is beginning to grow in India (Zaugg, 2019). Better understanding of how CCTV effects differ across countries may allow for the identification of countries that could benefit from closer integration of emerging technologies or, conversely, whether certain countries have little to gain from introducing additional technologies into their surveillance infrastructures.

Methods

The primary list of studies used in this review was compiled by Piza et al. (2019) as part of their updated systematic review and meta-analysis of the effects of CCTV on crime. Studies were included in the systematic review if they met the following criteria: (a) CCTV was the main focus of the intervention; (b) the evaluation used an outcome measure of crime; (c) the research design involved, at minimum, before-and-after measures of crime in treatment and comparable control areas; and (d) both the treatment and control areas experienced at least 20 crimes during the pre-intervention period. Studies were located through a rigorous approach incorporating five comprehensive search strategies: (1) searches of electronic bibliographic databases; (2) manual searches of CCTV evaluation study bibliographies; (3) manual searches of other (non-evaluation) CCTV study bibliographies; (4) forward citation searches of CCTV evaluations; and (5) contacts with leading researchers.

To investigate the global expansion of CCTV, we expanded upon Piza et al.'s (2019) inclusion criteria to include all evaluations where CCTV was deployed for crime prevention purposes, irrespective of whether CCTV was unequivocally the primary intervention. This allowed for the inclusion of four evaluations that were excluded by Piza et al. (2019). Two evaluations focused on the use of CCTV as part of police-directed motor vehicle patrol (Piza, Caplan, Kennedy, Gilchrist et al., 2015) or foot patrol interventions (Hennen, 2017). We also included two additional evaluation studies conducted in retail settings, which were reported in Hayes and Downs (2011).

Piza et al. (2019) amassed a database of 162 CCTV studies. Eighty-four of the studies met the inclusion criteria (see Appendix A) with 80 providing the necessary data for inclusion in the meta-analysis. Seventy-seven studies were excluded from the review (see Appendix B).[1] A vast majority of the excluded studies (88.3% or 68) did not include a comparable control area. An additional nine studies (or 11.7%) were excluded owing to issues related to crime data (i.e. four studies reported fewer than 20 crimes during the pre-intervention period; three studies did not report any crime data; one study did not include a measure of crime prior to the installation of the intervention; and one study did not report reliable crime data). One study (Pointing et al., 2010) could not be obtained and assessed against the inclusion criteria. This study is included in the sample but is not classified as either meeting the inclusion criteria or being excluded from the review.

Analytical Approach

We begin our analysis by presenting descriptive statistics to demonstrate how the evaluation of CCTV has expanded over time and throughout the world. Two sets of descriptive statistics are presented: one for all 162 studies included in the database and the other for the 84 studies fitting the criteria for inclusion in the review. We feel that this provides insight into the global expansion of CCTV evaluation research generally, as well as how the use of rigorous evaluation methodologies varies across countries.

We next use meta-analytic techniques to assess the impact of CCTV on crime across countries. The odds ratio (OR) is used as the measure of effect size, indicating the proportional change in crime in the control area compared with the treatment area. Meta-analyses were conducted using BioStat's Comprehensive Meta-Analysis software (version 3.0).

To further explore country-specific effects of CCTV, we conduct a meta-analysis to determine whether effects on specific crime types were consistent across countries. When considering individual crime types explored across the cumulative studies, 99 individual tests were conducted. However, due to low frequencies, we were unable to include all 99 tests in a meta-analysis using country as a moderator variable. Over 80% (n = 81) of these tests focused on property crime, vehicle crime, or violent crime. Outside of the UK and US, no country underwent tests of each of these three crime types. Therefore, we restrict the crime-across-country analysis to property crime, vehicle crime, and violent crime in the UK and US.

Lastly, in recognition of the potential influence of evaluation strength, we analysed how effect size differed across different research designs. Following the approach of Braga and colleagues (2018), each study was classified as a quasi-experiment with a non-equivalent comparison group, a quasi-experiment with a near-equivalent control groups created through matching techniques, or a randomised controlled trial. Meta-analyses then report whether CCTV effect varied across research designs. We conducted meta-analyses as random effects models under the assumption that effect sizes are heterogeneous across individual evaluations as well as sub-populations of evaluations (Lipsey & Wilson, 2001). In all but one case, observed Q statistics and associated p values supported this assumption, demonstrating significantly heterogeneous effect sizes across countries. For the outlier model (reported in Table 5), we conducted a fixed-effects meta-analysis.[2]

Following the analytical approach of recent systematic reviews (Braga et al., 2018, 2019; Piza et al., 2019), we conduct our meta-analyses using three approaches. First, all reported outcomes are summed in order to present an overall average effect size statistic. This is a conservative measure of the effect of CCTV. Second, the largest reported effect size for each study is used, which presents a "best-case" estimate. Third, we used the smallest reported effect size for each study to provide a highly conservative measure, representing the lower bound estimate of the effect of CCTV.

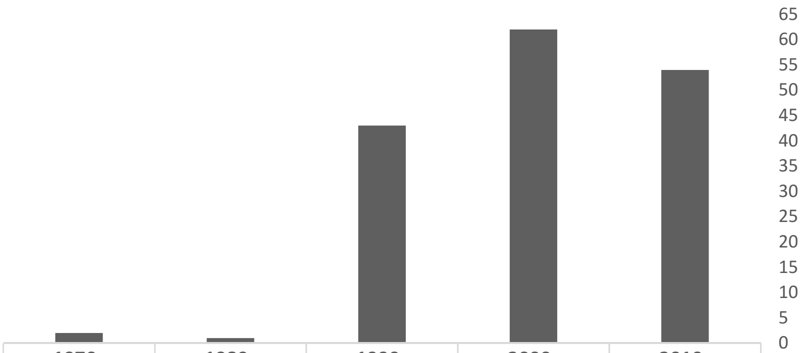
We conclude our analysis by exploring whether CCTV characteristics associated with effectiveness differed across countries. For each country, we generated cross tabulations between countries and categories of these CCTV characteristics: study setting (car park, city centre, public housing, residential, public transport, and other); monitoring type (active, passive, or unknown); the use of other interventions (multiple, single, or none); and evaluation design (quasi-experiment, matched quasi-experiment, or randomised controlled trial). Fisher's exact test measured whether these characteristics significantly differed across countries. Fisher's exact test was used in lieu of Chi-Square due to the number of cells with expected frequencies in the cross-tabulations with expected values less than five (Piza & Sytsma, 2016). For each test, Cramer's V was reported as a measure of effect size.

Results

Frequency of CCTV evaluations across decades and countries

Figure 1 displays the marked and sustained growth of CCTV evaluations over the past nearly five decades. By the end of the 1980s, only three CCTV evaluations had appeared in the literature. A rather drastic increase in the number of evaluations occurred in the 1990s, with 43 CCTV evaluations reported during this decade. These 43 evaluations were carried out in four different countries. The number of CCTV evaluations continued to increase in the 2000s, with 62 evaluation studies reported during this decade. Nine countries are represented in the 2000s, more than double the total in the 1990s. Furthermore, even more countries were represented in the 2010s, with 54 evaluations carried out in 11 countries.

Table 1 identifies each of the countries in which CCTV evaluation studies have been conducted. Some noteworthy patterns are apparent in terms of the frequency across the nearly five decades. Sixty-two of the 63 UK evaluations were reported in the 1990s or 2000s, with the other evaluation reported in the 1970s. US evaluations have appeared more recently, with 38 of 40 evaluations reported in the 2000s or 2010s. Thirteen of 17 evaluations of CCTV in Australia were reported in the 2000s. Beginning in the 2000s, CCTV evaluations appear for a number of countries not previously represented, including Colombia, Germany, Japan, the Netherlands, Norway, Poland, South Korea, Spain, Sweden, Turkey,



	1970s	1980s	1990s	2000s	2010s
Countries	2	1	4	9	11
Total Evaluations	2	1	43	62	54

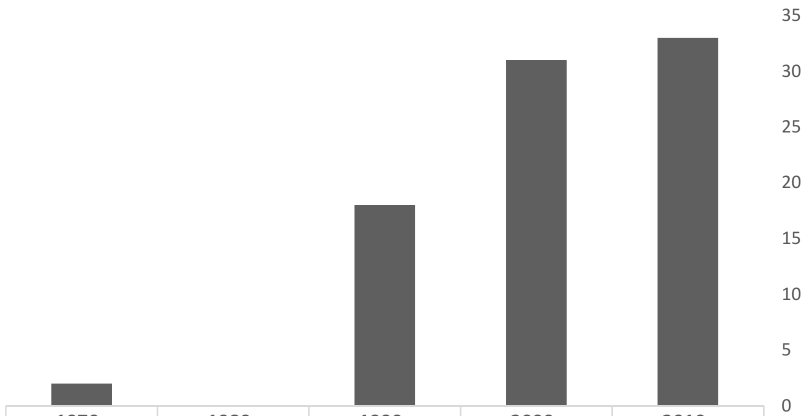
Figure 1. Frequency of CCTV evaluation studies, by decade and country (N = 162).

Table 1. Frequency of CCTV evaluation studies, by decade and country (N = 162).

Country	1970s	1980s	1990s	2000s	2010s	Total
Australia	0	1	1	13	2	17
Canada	0	0	1	4	4	9
Colombia	0	0	0	0	2	2
Germany	0	0	0	1	0	1
Japan	0	0	0	1	0	1
Netherlands	0	0	0	0	1	1
Norway	0	0	0	1	0	1
Poland	0	0	0	0	3	3
South Korea	0	0	0	5	6	11
Spain	0	0	0	0	1	1
Sweden	0	0	0	4	6	10
Turkey	0	0	0	0	1	1
UK	1	0	40	22	0	63
US	1	0	1	11	27	40
Uruguay	0	0	0	0	1	1
Total	2	1	43	62	54	162

and Uruguay. In sum, the frequencies in Table 1 indicate temporal clustering in the reporting of CCTV evaluations across countries and throughout the decades.

Although CCTV evaluations began in the 1970s, span the globe, and now encompass 162 different studies, the level of scientific rigour varies across studies. Eighty-four of the 162 studies (or 51.9%) used a high-quality design. Figure 2 and Table 2 focus on these studies. As shown, fewer countries are represented as compared to the overall sample. No more than eight countries are represented in the literature during any of the decades. For some countries, studies meeting the inclusion criteria represent a small proportion of the total number of evaluations. For example, of the 17 evaluations in Australia, only one (reported in the 2010s) used a high-quality design. Five countries are excluded from the systematic review due to evaluations using less than a quasi-experimental design (i.e. Colombia, Germany, Japan, the Netherlands, and Uruguay). Also, when considering only high quality evaluations, the increase in the number of CCTV evaluations over time is more pronounced. These CCTV evaluations nearly doubled (from 18 to 33) from the 1990s to 2010s (see Figure 2).



	1970s	1980s	1990s	2000s	2010s
Countries	2	0	2	6	8
Total Evaluations	2	0	18	31	33

Figure 2. CCTV evaluation studies meeting systematic review inclusion criteria, by decade and country (N = 84).

Table 2. CCTV evaluation studies meeting systematic review inclusion criteria, by decade and country (N = 84).

Country	1970s	1980s	1990s	2000s	2010s	Total
Australia	0	0	0	0	1	1
Canada	0	0	1	2	3	6
Norway	0	0	0	1	0	1
Poland	0	0	0	0	2	2
South Korea	0	0	0	1	2	3
Spain	0	0	0	0	1	1
Sweden	0	0	0	1	4	5
Turkey	0	0	0	0	1	1
UK	1	0	17	18	0	36
US	1	0	0	8	19	28
Total	2	0	18	31	33	84

CCTV effects: Pooled, across countries, and by evaluation design

Figure 3 presents a forest plot of the ORs for the 80 studies included in the meta-analysis, with studies grouped by country of origin. Overall, the pooled OR for these studies was 1.105 ($p < 0.001$), which indicates that CCTV schemes exhibited a significant but modest crime prevention effect. Here, crime decreased by approximately 10% in CCTV target areas compared to control areas. Furthermore, there was a desirable effect found in both the largest (OR = 1.149, p = 0.028) and smallest (OR = 1.008, p = 0.028) effect-size analyses.

As stated earlier, the 80 evaluations included in this meta-analysis were carried out in nine different countries: UK (n = 34), US (n = 27), Canada (n = 6), South Korea (n = 3), Sweden (n = 5), Spain (n = 1), Australia (n = 1), Norway (n = 1), and Poland (n = 2). For the purposes of this meta-analysis, the latter four countries are grouped together to form the "other country" category.

In the meta-analysis, there were three countries where CCTV was associated with a statistically significant reduction in crime: UK (OR = 1.259, $p < 0.001$), South Korea (OR = 1.506, $p < 0.001$), and the US (OR = 1.076, $p = 0.028$).[3] However, we are somewhat cautious in interpreting the findings from South Korea, as it had only three studies. In addition, although findings from the largest effect-size analysis revealed support for crime reductions in the UK, the US, and South Korea ($p < 0.001$), the smallest effect-size analysis did not reveal a significant effect of CCTV in any of these three countries. In fact, the only country that approached significance for the smallest effect-size analysis was Canada (OR = 0.908, p = 0.056; see Table 3c).

Table 4 reports findings of the meta-analysis measuring CCTV effect on property crime, vehicle crime, and violent crime (the most common crime categories) for the UK and the US. CCTV effects were larger in the UK across all three crime types. CCTV was associated with statistically significant reductions of approximately 34% for property crime (OR = 1.517), 32% for vehicle crime (OR = 1.481), and 15% for violent crime (OR = 1.177). For the US, effect sizes did not reach statistical significance for any of the crime types. This stands in contrast to the main country analysis (see Table 3) that found significant positive effects in the US in both the average- and largest-effects models. These disparate findings indicate that, while CCTV in the US exhibits positive effects when outcome measures are summed or the largest effect is isolated, effects are much less pronounced for the most common crime types.

Table 3. Effects on crime, by country (N = 80).

			95% Confidence Interval		
Country	N	Odds Ratio	Lower	Upper	p
(a) Average Effects					
Canada	6	1.041	0.812	1.333	0.753
Other	5	0.996	0.779	1.273	0.973
South Korea	3	1.506	1.212	1.871	<0.001
Sweden	5	0.952	0.826	1.097	0.498
United Kingdom	34	1.259	1.122	1.414	<0.001
United States	27	1.076	1.008	1.149	0.028
Q = 85.817, df = 5, p = 0.002					
(b) Largest Effects					
Canada	6	1.048	0.841	1.306	0.676
Other	5	1.078	0.937	1.240	0.293
South Korea	3	1.627	1.426	1.856	<0.001
Sweden	5	1.522	0.751	3.083	0.244
United Kingdom	34	1.400	1.256	1.560	<0.001
United States	27	1.367	1.251	1.494	<0.001
Q = 76.286, df = 5, p < 0.001					
(c) Smallest Effects					
Canada	6	0.908	0.823	1.002	0.056
Other	5	0.907	0.629	1.306	0.599
South Korea	3	1.354	0.932	1.967	0.112
Sweden	5	0.943	0.813	1.095	0.443
United Kingdom	34	1.003	0.931	1.081	0.933
United States	27	0.960	0.880	1.047	0.357
Q = 63.754, df = 5, p < 0.001					

Table 4. Effects on property, vehicle, and violent crime, by country.

Country	N	Odds Ratio	95% Confidence Interval		p
			Lower	Upper	
(a) Property Crime					
United Kingdom	5	1.517	1.278	1.800	<0.001
United States	14	1.104	0.963	1.266	0.155
Q = 103.050, df = 1, p < 0.001					
(b) Vehicle Crime					
United Kingdom	10	1.481	1.309	1.675	<0.001
United States	12	0.989	0.836	1.171	0.902
Q = 59.868, df = 1, p < 0.001					
(c) Violent Crime					
United Kingdom	8	1.177	1.005	1.378	0.043
United States	15	1.034	0.898	1.191	0.640
Q = 9.586, df = 1, p = 0.002					

Table 5 reports findings of the meta-analysis measuring CCTV effect across evaluation designs. The findings show that effect sizes differed across designs, but not always in the expected direction. In consideration of prior research, we would expect evaluations with more rigorous designs to generate smaller effects sizes (Weisburd et al., 2001; Welsh et al., 2011). However, randomised controlled trails exhibited the largest effect sizes in both the average- (OR = 1.701, p = 0.044) and largest-effects (OR = 1.359, p= 0.001)[4] analyses. Traditional quasi-experiments had a larger effect size (OR = 1.166, p < 0.001) than matched quasi-experiments (OR = 1.064, p = 0.113). Conversely, matched quasi-experiments (OR = 1.313, p < 0.001) exhibited a larger effect than traditional quasi-experiments (OR = 1.299, p < 0.001) in the largest effects meta-analysis.

Table 5. Effects on crime, by evaluation design.

Design	N	Odds Ratio	95% Confidence Interval		p
			Lower	Upper	
(a) Average Effects					
QE	60	1.166	1.078	1.263	<0.001
QE-M	16	1.064	0.986	1.149	0.113
RCT	4	1.701	1.013	2.857	0.044
Q = 11.313, df = 2, p = 0.003					
(b) Largest Effects					
QE	60	1.299	1.264	1.334	<0.001
QE-M	16	1.313	1.252	1.378	<0.001
RCT	4	1.359	1.127	1.638	0.001
Q = 0.345, df = 2, p = 0.842 [F]					
(c) Smallest Effects					
QE	60	0.986	0.926	1.050	0.663
QE-M	16	0.949	0.869	1.036	0.241
RCT	4	1.482	0.761	2.883	0.247
Q = 7.666, df = 2, p = 0.022					

Notes: QE = quasi-experiment, QE-M = matched quasi-experiment, RCT = randomised controlled trial. [F] = fixed-effects meta-analysis conducted in lieu of random effects.

The unexpected relationship between research design and effect size may be explained by the characteristics of the four RCTs included in the review. Piza et al. (2019) found that CCTV effect was significantly related to geographic setting, monitoring type (i.e. active or passive), and the use of

Group by COUNTRY	Study name	Odds ratio	Lower limit	Upper limit	Z-Value	p-Value
Canada	Montreal (R)	1.712	1.462	2.006	6.663	0.000
Canada	Montreal Metro	1.021	0.856	1.218	0.231	0.817
Canada	Toronto (D52)	1.011	0.807	1.265	0.092	0.927
Canada	Montreal (C)	0.946	0.767	1.167	-0.515	0.606
Canada	Toronto (D51)	0.856	0.636	1.151	-1.030	0.303
Canada	Surrey, BC	0.817	0.595	1.123	-1.245	0.213
Canada		1.041	0.812	1.333	0.315	0.753
Other	Footscray	1.183	0.929	1.506	1.360	0.174
Other	Malaga	1.133	0.933	1.374	1.262	0.207
Other	Warsaw (M)	0.884	0.142	5.497	-0.132	0.895
Other	Oslo	0.760	0.618	0.935	-2.593	0.010
Other	Warsaw (CR)	0.684	0.082	5.694	-0.351	0.726
Other		0.996	0.779	1.273	-0.033	0.973
South Korea	Seoul	1.675	1.471	1.907	7.788	0.000
South Korea	Chuncheon	1.328	0.934	1.889	1.578	0.114
South Korea	Gwand Myeong	1.080	0.579	2.017	0.243	0.808
South Korea		1.506	1.212	1.871	3.692	0.000
Sweden	Malmo (Blixit)	2.316	1.036	5.175	2.046	0.041
Sweden	Malmo (Hennen)	1.030	0.775	1.371	0.206	0.837
Sweden	Stockholm (M)	0.931	0.801	1.082	-0.931	0.352
Sweden	Stockholm (S)	0.888	0.765	1.031	-1.557	0.119
Sweden	Malmo (Gerell)	0.781	0.342	1.785	-0.585	0.558
Sweden		0.952	0.826	1.097	-0.678	0.498
UK	Hawkeye	3.340	2.732	4.084	11.759	0.000
UK	Bradford	2.671	1.431	4.986	3.086	0.002
UK	Ung (S)	2.576	1.840	3.608	5.508	0.000
UK	Coventry	1.952	1.406	2.710	3.997	0.000
UK	Birmingham	1.913	1.236	2.961	2.909	0.004
UK	Westcap Estate	1.850	1.442	2.375	4.832	0.000
UK	Airdire	1.787	1.557	2.051	8.255	0.000
UK	Hartlepool	1.779	1.255	2.521	3.235	0.001
UK	Sutton	1.488	1.162	1.907	3.144	0.002
UK	Gillingham	1.475	1.276	1.705	5.261	0.000
UK	Glasgow	1.434	1.194	1.724	3.849	0.000
UK	Doncaster	1.422	1.239	1.631	5.006	0.000
UK	City Hospital	1.384	0.797	2.404	1.153	0.249
UK	Burnley	1.375	1.194	1.583	4.424	0.000
UK	City Outskirts	1.337	1.160	1.541	4.018	0.000
UK	Northern Estate	1.337	0.841	2.124	1.228	0.219
UK	Ung (N)	1.320	0.865	2.014	1.289	0.197
UK	Shire Town	1.216	0.978	1.512	1.763	0.078
UK	Borough Town (C)	1.124	0.888	1.423	0.972	0.331
UK	Mutiple	1.106	0.951	1.285	1.308	0.191
UK	Southwark (C)	1.104	0.950	1.282	1.291	0.197
UK	Southwark (EC)	1.054	0.907	1.224	0.685	0.494
UK	Eastcap Estate	1.031	0.749	1.418	0.187	0.851
UK	South City	0.989	0.877	1.116	-0.181	0.856
UK	Southwark (E)	0.947	0.812	1.104	-0.698	0.485
UK	Newcastle	0.896	0.793	1.012	-1.766	0.077
UK	Ung (C)	0.891	0.396	2.005	-0.279	0.781
UK	Deploy Estate	0.851	0.696	1.040	-1.578	0.115
UK	Cambridge	0.848	0.725	0.991	-2.072	0.038
UK	Borough Town (R)	0.802	0.628	1.023	-1.778	0.075
UK	Market Town	0.786	0.611	1.010	-1.879	0.060
UK	Dual Estate	0.780	0.630	0.967	-2.272	0.023
UK	Southcap Estate	0.761	0.568	1.019	-1.833	0.067
UK	Guildford	0.234	0.023	2.379	-1.227	0.220
UK		1.259	1.122	1.414	3.917	0.000
US	Retail (Domes)	3.618	2.017	6.491	4.313	0.000
US	Newark (RCT)	1.720	1.088	2.720	2.321	0.020
US	Retail (PVMs)	1.502	0.848	2.660	1.394	0.163
US	Baltimore (TD)	1.444	1.203	1.734	3.942	0.000
US	Denver (D6)	1.359	1.110	1.665	2.965	0.003
US	Cincinnati (R)	1.305	1.069	1.594	2.617	0.009
US	Newark (C)	1.191	0.978	1.449	1.741	0.082
US	Chicago (HP)	1.168	1.038	1.315	2.577	0.010
US	Philadelphia	1.128	0.992	1.283	1.844	0.065
US	D.C. (MVS)	1.124	0.951	1.328	1.368	0.171
US	Newark (R)	1.116	0.898	1.388	0.988	0.323
US	Baltimore (G)	1.104	0.944	1.292	1.235	0.217
US	Cincinnati (S)	1.090	0.889	1.338	0.828	0.407
US	Las Vegas (FS)	1.056	0.893	1.249	0.641	0.522
US	D.C. (Parking)	1.054	0.867	1.281	0.525	0.600
US	Las Vegas (FS-E)	1.042	0.922	1.178	0.664	0.507
US	D.C. (City-Wide)	1.007	0.869	1.166	0.088	0.930
US	Cincinnati (FM)	1.002	0.885	1.134	0.028	0.978
US	L.A. (HB)	0.993	0.849	1.160	-0.095	0.925
US	Cincinnati (N)	0.983	0.857	1.127	-0.251	0.802
US	Chicago (WGP)	0.932	0.825	1.052	-1.139	0.255
US	Cincinnati (HP)	0.911	0.773	1.073	-1.119	0.263
US	NYC (PCV)	0.893	0.548	1.457	-0.452	0.651
US	NYC (Musheno)	0.891	0.383	2.072	-0.267	0.789
US	Baltimore (NA)	0.875	0.744	1.029	-1.611	0.107
US	L.A. (JD)	0.819	0.602	1.113	-1.278	0.201
US	Cincinnati (C)	0.794	0.701	0.899	-3.632	0.000
US		1.076	1.008	1.149	2.197	0.028
Overall		1.105	1.052	1.161	3.983	0.000

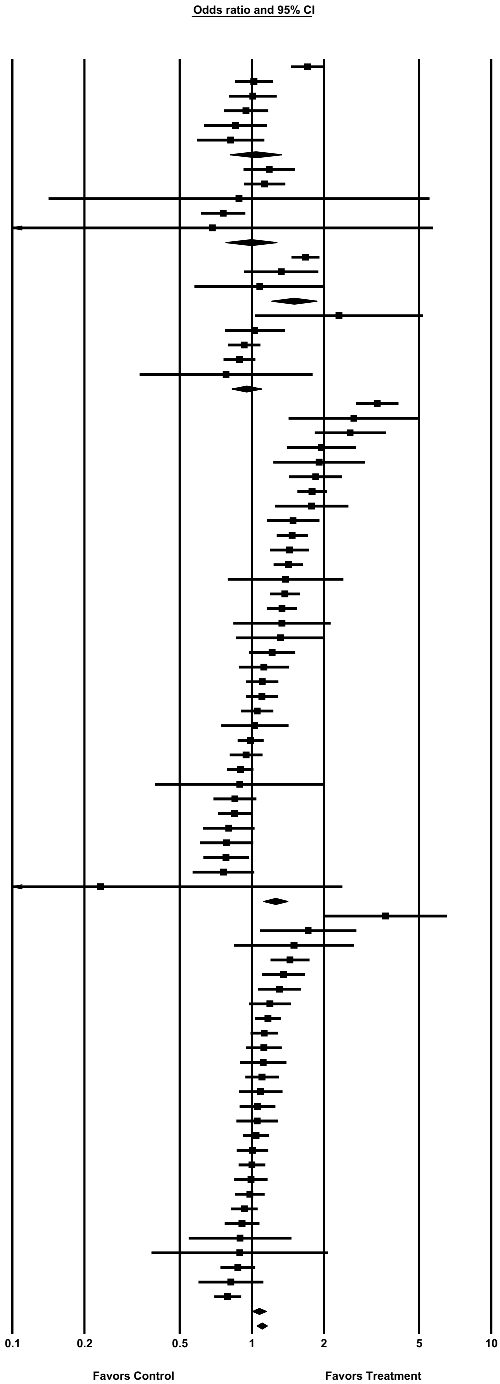


Figure 3. Forest plot of CCTV studies across countries (average effects).

other interventions alongside CCTV. In sum, Piza et al.'s (2019) meta-analysis found CCTV effects are largest in car parks, followed by residential areas; CCTV schemes incorporating active camera monitoring have larger effects than passive systems, and; schemes deploying complementary interventions alongside CCTV had larger effects than stand-alone CCTV systems. In regards to effective settings, La Vigne & Lowry, (2011) tested CCTV effect in a car park and Piza, Caplan,

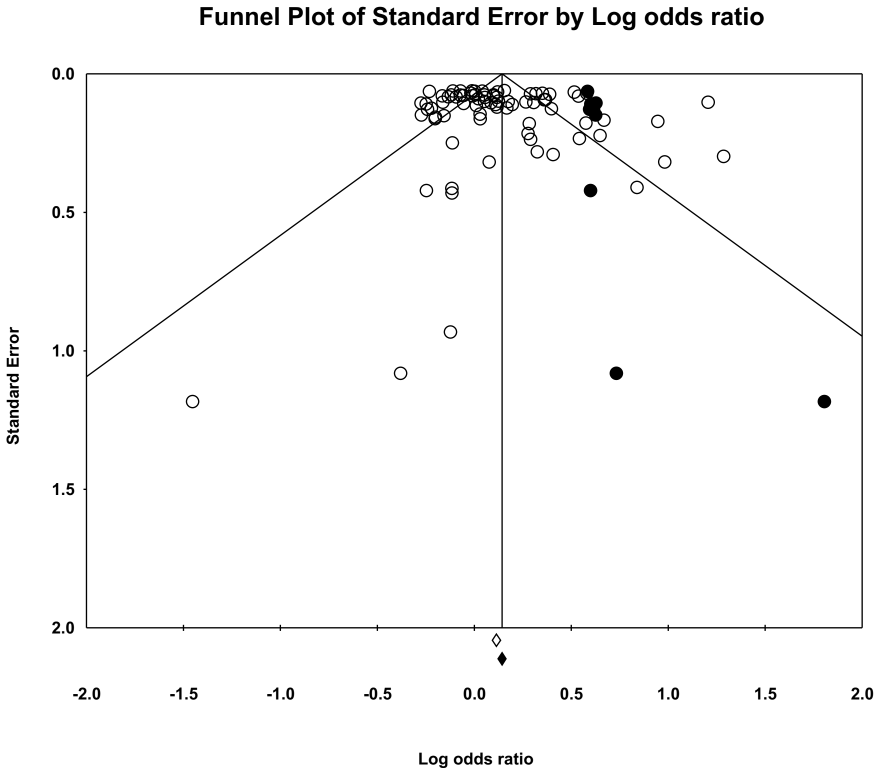


Figure 4. Publication bias test Notes: Empty circles indicate the original studies. Filled-in circles indicate imputed studies from the trim-and-fill analysis. Observed values (random effects) = 1.155 (95% CI 1.086, 1.230). Adjusted values (random effects, 8 studies trimmed): 1.196 (95% CI 1.122, 1.275).

Kennedy, Gilchrist et al., (2015) analysed groups of camera clusters, many of which were in residential areas. While the effect size of the La Vigne & Lowry, (2011) study did not achieve statistical significance (OR = 1.054; p = 0.600), the positive value favourably contributed to the cumulative effect of the RCTs. Regarding monitoring type, Hayes and Downs (2011) reported the use of active monitoring techniques and Piza, Caplan, Kennedy, Gilchrist et al., 2015) reported both active monitoring and the use of a complementary intervention (directed vehicle patrol) alongside CCTV. In considering the RCT study characteristics, such contextual factors may have been more influential than research design in the current study.

To confirm the robustness of our meta-analyses, we test for the presence of publication bias in our results. We used BioStat's trim-and-fill procedure to estimate how reported effects would change if bias was discovered and addressed (Duval, 2005). This assumes that effect sizes should show symmetry around the mean when a representative collection of studies has been obtained. When there is asymmetry, the trim-and-fill procedure inputs the hypothesised missing studies and re-computes a mean effect size. Publication bias test results are presented in Figure 4. The analysis shows that asymmetry is present, with symmetry being achieved by adding eight studies to the right of the mean. When the effect size is re-computed to include these additional studies, the mean effect size increased from OR = 1.155 to OR = 1.196. However, the 95% confidence intervals of the observed and adjusted ORs overlap, suggesting that the effect sizes are not significantly different. The smallest- and largest-effect versions of the trim-and-fill procedure similarly produced estimates with overlapping confidence intervals (results not shown). From the results of these tests, we can conclude that publication bias did not influence the meta-analysis results.

Comparison of CCTV scheme characteristics across countries

Table 6 presents cross tabulations of characteristics of CCTV interventions associated with effectiveness across countries. Here, we examine the setting, monitoring type, the use of other interventions, and type of evaluation design. In terms of setting, Piza et al. (2019) found that CCTV was effective in car parks and residential areas. Six of the eight car park evaluations were conducted in the UK, and 11 of the 13 residential area evaluations were conducted in the US. Fisher's exact test shows that these differences in frequencies are statistically significant (p = 0.004), with Cramer's V (0.345) indicative of a moderate effect size.

Piza et al. (2019) found that CCTV schemes that were actively monitored generated larger effect sizes than passive systems. All but three (31 of 34) UK schemes included in the meta-analysis reported active monitoring. While the proportion was not as high in the US, 16 of 27 (59.3%) schemes included active monitoring. Patterns were not as evident in the other countries. For example, in Canada, schemes were evenly split in their use of active and passive monitoring. In South Korea, all three did not report the monitoring type. Fisher's exact test shows that these differences in frequencies are statistically significant ($p < 0.001$) and moderately strong ($V = 0.418$).

Regarding the use of other interventions alongside CCTV, Piza et al. (2019) found that schemes incorporating multiple interventions had the largest effects. Compared to other countries, a higher proportion of UK schemes reported the use of multiple interventions (35.3%). While only one CCTV scheme in the US used multiple interventions, almost half (13 of 27) did incorporate a single intervention alongside CCTV. Including no interventions alongside CCTV was the most common approach in all of the other countries. Fisher's exact test shows that these differences in frequencies are statistically significant (p = 0.047) and moderately strong (V = 0.335).

Interestingly, all 12 of the 16 matched quasi-experiments and each of the four randomised controlled trials were conducted in the US. Four of the 35 UK studies used matched-quasi

Table 6. Fisher's exact test findings: Comparison of CCTV scheme characteristics across countries.

	Canada	Other	South Korea	Sweden	UK	US
Setting						
Car park	1	0	0	0	6	1
City centre	3	4	0	5	15	7
Housing	0	0	0	0	7	3
Other	0	0	2	0	1	5
Residential	1	1	1	0	2	11
Transport	1	0	0	0	3	0
p	*0.004*					
V	*0.345*					
Monitoring Type						
Active	3	4	0	4	31	16
Passive	3	0	0	1	0	7
Unknown	0	1	3	0	3	4
p	*<0.001*					
V	*0.418*					
Use of Other Interventions						
Multiple	1	0	0	1	12	1
None	4	4	3	2	12	13
Single	1	1	0	2	10	13
p	*0.047*					
V	*0.335*					
Evaluation Design						
QE	6	4	3	5	31	11
QE-M	0	0	0	0	4	12
RCT	0	0	0	0	0	4
p	*0.007*					
V	*0.414*					

Notes: QE = quasi-experiment, QE-M = matched quasi-experiment, RCT = randomised controlled trial.

experiments. Evaluations conducted in all other countries used traditional quasi-experimental methods exclusively. Fisher's exact test shows that these differences in frequencies are statistically significant ($p = 0.007$) and moderately strong ($V = 0.414$).

Discussion and conclusions

In considering the current study's findings, one of the most notable aspects is just how much the CCTV evaluation landscape has evolved since the first systematic review almost 20 years ago (Welsh & Farrington, 2002). In this review, 46 studies were identified with 22 meeting the inclusion criteria. This updated review identified 162 studies, with 84 meeting the inclusion criteria and 80 providing the necessary data to be included in the meta-analysis. Within the last few decades, the number of countries that have conducted evaluations of their CCTV schemes has increased dramatically. While the UK accounted for over 70% of studies in the first review, UK studies accounted for 38.8% of our overall sample and 42.5% of studies meeting the inclusion criteria. Furthermore, no new UK studies were reported from the time period between 2010 and 2016, suggesting CCTV may not be as much of a research priority in the UK today as compared to previous decades. So, while the UK has contributed more CCTV evaluation research than any other individual country, many more countries are now contributing to this field of research.

For this meta-analysis, the US contributed 27 studies, almost all of which occurred in the last two decades. When considering evaluation studies irrespective of research design (i.e. both studies included and excluded from the meta-analysis), 43 US studies appear in the literature. Taken alongside the increase in other countries, this provides further support for the "internationalization" of CCTV, as observed previously by other researchers (Hier, 2010).

The strength of the evaluation research conducted in the US is particularly noteworthy, as all of the RCTs and three-quarters of quasi-experiments with near equivalent matching between treatment and control groups were conducted in the US from 2000 onwards. These findings are indicative of the rapidly developing nature of CCTV research in the US. The quality of CCTV research in the US is remarkable in light of the limited number of US evaluations included in the first review (Welsh & Farrington, 2002). Conversely, it is noteworthy that no CCTV evaluations in the UK have been published since the 2000s. The rapid installation of many CCTV systems in the UK that would later be subjected to empirical evaluation resulted from aggressive funding efforts of the Home Office, most notably the CCTV Challenge (Painter & Tilley, 1999). Shifting funding priorities may have reduced opportunities for CCTV evaluations in the UK. However, given that the UK accounts for the majority of studies in the review, another view may be that the UK reached somewhat of a tipping point in which CCTV no longer occupies a central place in the national research agenda. Whatever the reason, there has been limited opportunity to readily apply advanced research techniques (i.e. matched quasi-experiments and randomised controlled trials) that have become more commonplace in recent decades in the UK. In this context, it is also possible that some countries adopted CCTV with too high of expectations based upon research in the UK using less rigorous methods.

Similar to prior reviews (Welsh & Farrington, 2002, 2009; Piza et al., 2019), CCTV schemes evaluated in the UK demonstrate statistically significant reductions in crime. In these cases, such reductions may be due to the contextual factors in which CCTV schemes are operated. Results of Fisher's exact tests indicate that a higher proportion of UK studies focused on CCTV schemes with characteristics associated with effectiveness, as compared to the other countries included in our studies. For example, 91.2% (31 out of 34) of UK studies involved active monitoring and 35.3% (12 out of 34) involved the use of multiple other interventions alongside CCTV; over a quarter collectively occurred in car parks ($n = 6$) and residential settings ($n = 2$). Interestingly, this review found that the CCTV schemes evaluated in the US also displayed statistically significant reductions in crime. This finding may similarly reflect the importance of contextual factors. In particular, the US had the highest proportion of studies conducted in residential areas ($n = 11$, or 40.7%), which

Piza et al. (2019) found had the second strongest effect of CCTV on crime, and almost 60% ($n = 16$) of the studies conducted in the US reported the use of active monitoring practices. Furthermore, it is important to reiterate the findings in this analysis differ slightly from what was reported in Piza et al. (2019), which did not find any statistically significant effects for the studies conducted in the US. This difference is most likely attributed to the fact that this paper was able to include three additional US evaluations by broadening the inclusion criteria of the studies selected for review, thus increasing the number of RCTs conducted in the US from just one to four. As previously stated, contrary to the patterns observed in prior research (see Weisburd et al., 2001; Welsh et al., 2011), these RCTs were associated with significantly larger effect sizes in both the average- and largest-effects analyses than either of the quasi-experimental design groups. Taking these factors into consideration, it is important to reiterate that effects in the US fail to reach significance when restricted to the most commonly-reported crime categories: vehicle crime, property crime, and violent crime (see Table 4).

CCTV schemes in South Korea were also associated with statistically significant reductions in crime. However, unlike the UK and US, CCTV schemes in South Korea were largely not associated with effective CCTV characteristics. For example, not one of the three South Korea studies reported other interventions alongside CCTV and two of the studies were conducted in "other" settings, a setting type not associated with significant CCTV effects. However, given the small number of studies in South Korea, more research is necessary to investigate effects of CCTV in this country.

The findings of the current study are seemingly important in the context of the present digital age and in an era of "big data" policing (Ferguson, 2017; Kennedy et al., 2018). Moreover, it is imperative to continue to assess the effectiveness of CCTV schemes as public and private agencies begin to rely more heavily on emerging technologies in an attempt to enhance the effectiveness of video surveillance. The use of emerging technologies has grown rapidly across the globe, with most of the growth occurring in China, India, and the US (Bishoff, 2019). As the most recent evidence continues to support the use of multiple interventions alongside CCTV schemes for optimum crime control benefits (Piza et al., 2019), it is important to consider the types of emerging technologies that can be effectively integrated. As argued by Skogan (2019, p. 161), "CCTV's close association with other digital technologies, the explosion in Internet-connected devices with complementary roles to play in crime prevention, and the rapidly changing tech world … indicates the future of CCTV may be about now." Skogan (2019) identified gunshot detection technology (GDT), computer vision technology (CVT), and facial recognition as emerging technologies likely to become greatly integrated with CCTV in the coming years.

GDT requires the installation of acoustic audio sensors to recognise different types of gunshots or the system may use equipment that is geared towards possessing gunshot-flash recognition (e.g. where it would have the capability to recognise gunshot-flashes) (La Vigne, Lowry, Markman, Dwyer et al., 2011). This type of technology may afford camera operators the ability to focus their attention on a specific camera monitor when they are required to watch numerous display screens simultaneously (La Vigne & Lowry, 2011). However, integrating GDT in CCTV schemes may not increase proactive monitoring practices to the level that policymakers anticipate (see Piza et al., 2014).

While GDT may be the most widely known technology that is used in conjunction with CCTV, it is not the only one. Police agencies are now widely considering CVT as a supplement to existing video surveillance operations. In addition to being a new, affordable technology, CVT presents law enforcement agencies the option of substituting some of their human monitors with computer vision technology (Idres et al., 2018). This is accomplished by applying "mathematical algorithms to each frame of CCTV footage for the purpose of automating the detection of crime-relating events. Upon detection of an image of concern … CVT alerts the CCTV operator (who may have been monitoring a different camera at the time)" (Piza et al., 2019, p. 151).

Facial recognition technology (FRT) and licence plate readers (LPR) are currently the most common examples of computer vision technologies (Idress et al., 2018), with FRT being the newer, and more controversial, method. Despite the fact that these two different types of technologies are comparable in nature, the American public and civil rights organisations are less comfortable with police agencies using FRT in public places (Carter, 2018). Proponents of FRT argue that FRT and LPR are similar in that "they both scan the image of an unknown variable and attempt to match it against a known variable contained in a database, collecting all information–without bias–on license plates or persons" (Carter, 2018, p. XVI). And if there is an apparent match, the information is sent for human verification (Carter, 2018). Outside of the US, the use of FRT faces less stark opposition, as international police agencies routinely rely on real-time FRT as a crime reduction tool (Carter, 2018).

Such rapidly developing technology presents challenges for the legal community. As mentioned earlier, California is currently attempting to determine the proper legal protections for citizens when FRT is utilised by police using body worn cameras (Rosenhall, 2019). This search for balance in legal protections and crime control is even less clear in other countries. For example, in India, where authorities are seeking to create the world's largest facial recognition system, there are currently no laws to protect how an individual's data is used (Zaugg, 2019). In addition, there are also questions as to how this newly acquired data is being used in China. For example, Mollman (2019) reports the wide-spread use of facial recognition and artificial intelligence combined with a social credit score by the government to reward or punish citizens for their social behaviour, even jaywalking. With such diverging ways in which this type of data can be used, it is even more pressing to continue exploring how video surveillance performs across different countries and contexts.

The findings of this systematic review provide policymakers with the beginning of an evidence base that can be used to develop and deploy CCTV schemes as a way to prevent crime. As CCTV continues to expand internationally and becomes more integrated with other technologies, it is imperative that the research community continues to contribute evaluations of the highest quality. Also, understanding CCTV as a global phenomenon allows researchers to discern which geographic setting and mechanisms of CCTV schemes are associated with crime reduction.

Notes

1. Appendix A and Appendix B appear after the references section.
2. It should be noted that a random-effects model generated similar results for this meta-analysis.
3. The US findings differ from what was reported in Piza et al. (2019), which did not find any significant effects in the US. That is due to the increased number of US studies, and their positive effects, in the current study.
4. The smaller OR in the largest effects model is a result of the fixed-effects meta-analysis. When a random-effects model is run, the OR increases to 1.895 (p = 0.034).

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Appendix A: Studies meeting the criteria for inclusion in the systematic review

Armitage, R., Smyth, G., & Pease, K. (1999). Burnley CCTV evaluation. In K. A. Painter & N. Tilley (Eds.), *Surveillance of public space* (pp. 225–250). Criminal Justice Press.

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Cameron, A., Kolodinski, E., May, H., & Williams, N. (2008). *Measuring the effects of video surveillance on crime in Los Angeles*. University of Southern California.

Cerezo, A. (2013). CCTV and crime displacement: A quasi-experimental evaluation. *European Journal of Criminology*, *10*, 222–236. 2 https://doi.org/10.1177/1477370812468379

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Ditton, J., & Short, E. (1999a). Yes, it works, no it doesn't: Comparing the effects of open-street CCTV in two adjacent Scottish town centres. In K. A. Painter & N. Tilley (Eds.), *Surveillance of public space: Vol.* 10, (pp. 201–224). Criminal Justice Press.

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Mazerolle, L., Hurley, D. C., & Chamlin, M. (2002). Social behavior in public space: An analysis of behavioral adaptations to CCTV. *Security Journal*, *15*, 59–75. 3 https://doi.org/10.1057/palgrave.sj.8340118

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Park, H. H., Oh, G. S., & Paek, S. Y. (2012). Measuring the crime displacement and diffusion of benefits of open-street CCTV in South Korea. *International Journal of Law, Crime and Justice*, *40*, 179–191. 3 https://doi.org/10.1016/j.ijlcj.2012.03.003
Piza, E. L. (2018). The crime prevention effect of CCTV in public places: A propensity score analysis. *Journal of Crime and Justice*, *41*, 14–30. 1 https://doi.org/10.1080/0735648X.2016.1226931
Piza, E. L., Caplan, J. M., Kennedy, L. W., & Gilchrist, A. M. (2015a). The effects of merging proactive CCTV monitoring with directed police patrol: A randomized controlled trial. *Journal of Experimental Criminology*, *11*, 43–69. 1.
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Reid, A. A., & Andresen, M. A. (2014). An evaluation of CCTV in a car park using police and insurance data. *Security Journal*, *27*, 55–79. 1 https://doi.org/10.1057/sj.2012.14
Sarno, C. (1996). The impact of closed circuit television on crime in sutton town centre. In M. Bulos & D. Grant (Eds.), *Towards a safer sutton?* (pp. 13–49). London Borough of Sutton.
^ Sarno, C., Hough, M., & Bulos, M. (1999). *Developing a picture of CCTV in Southwark town centres*. South Bank University.
Scott, N., Higgs, P., Caulkins, J. P., Aitken, C., Cogger, S., & Dietze, P. (2016). The introduction of CCTV and associated changes in heroin purchase and injection settings in footscray, Victoria, Australia. *Journal of Experimental Criminology*, *12*, 265–275. 2 https://doi.org/10.1007/s11292-016-9259-x
Sivarajasingam, V., Shepherd, J. P., & Matthews, K. (2003). Effect of urban closed circuit television on assault injury and violence detection. *Injury Prevention*, *9*, 312–316. 4 https://doi.org/10.1136/ip.9.4.312
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Winge, S., & Johannes, K. (2003). An evaluation of the CCTV scheme at oslo central railway station. *Crime Prevention and Community Safety*, *5*, 49–59. 3 https://doi.org/10.1057/palgrave.cpcs.8140155

* Evaluation study is missing the necessary data for inclusion in the meta-analysis.
^ 2 separate evaluation studies were reported. One was missing the necessary data for inclusion in the meta-analysis.

Appendix B. CCTV Evaluations Not Meeting Inclusion Criteria (N = 77)

Alvarado, C., Burton, C., Chen, V., Cutler, J., Debenedetti, L., Derkacheva, A., Lopez, V., & von Numers, S. (2011). *Crime in College Park: Understanding crime levels, perceptions, and environmental design in an off-campus student-occupied neighborhood*. Master's thesis.
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Blixt, M. (2003b). *The use of surveillance cameras for the purpose of crime prevention (English summary)*. National Council for Crime Prevention.

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Brown, B. (1995b). *CCTV in town centres: Three case studies (no. 68)*. Home Office, Crime Detection Prevention Series.

Burrows, J. N. (1991). *Making crime prevention pay: Initiatives from business (No. 27)*. Home Office.

Carr, K., & Spring, G. (1993). Public transport safety: A community right and a communal responsibility. In R. V. Clarke (Ed.), *Crime prevention studies: Vol. 1* (pp. 147–155). Criminal Justice Press.

Chatterton, M. R., & Frenz, S. J. (1994). Closed-circuit television: Its role in reducing burglaries and the fear of crime in sheltered accommodation for the elderly. *Security Journal*, *5*(3), 133–139.

Cheong, J. S., & Hwang, E. G. (2012). A study on the crime prevention effect of CCTV: Focusing on the basic district areas of cheonan and asan cities. *Korean Journal of Public Safety and Criminal Justice*, *46*, 183–209.

Cho, Y. I. (2009). A study on the increasing plan of the crime control effectiveness of the closed circuit TV (CCTV) for the crime prevention. *Korean Journal of European Public Administration*, *6*, 27–54.

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Lee, J. L. (2008). Assessing the impact of open-street CCTVs in Cheonan and Asan areas. *Modern Society and Public Administration*, *18*(2), 107–132.

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Maguire, M., & Wood, F. (1998). *The impact of the CCTV system in penarth town centre, december 1997 to june 1998*. Report presented to Vale of Glamorgan, County Borough Council. Cardiff University, School of Social Sciences.

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Squires, P. (1998b). *CCTV and crime reduction in Crawley: An independent evaluation of the Crawley CCTV system*. University of Brighton, Health and Social Policy Research Centre.

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Squires, P. (2003). *An independent evaluation of the installation of CCTV cameras for crime prevention in the whitehawk estate, Brighton*. University of Brighton, Health and Social Policy Research Centre.

Squires, P., & Measor, L. (1996). *CCTV surveillance and crime prevention in Brighton: Follow-up analysis*. University of Brighton, Health and Social Policy Research Centre.

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Tilley, N. (1993a). *The prevention of crime against small businesses: The safer cities experience (No. 45)*. Home Office, Crime Prevention Unit.

Tilley, N. (1993b). *Understanding car parks, crime and CCTV: Evaluation lessons from safer cities (no. 42)*. Home Office, Crime Prevention Unit.

Verga, S. L., & Douglas, A. J. (2008b). *Initial statistical analysis of the effects of closed-circuit surveillance on rates of crime*. Toronto Police Service, Operational Research Team, Centre for Security Science.

Wells, H., Allard, T., & Wilson, P. (2006). *Crime and CCTV in Australia: Understanding the relationship*. Bond University, Centre for Applied Psychology and Criminology.

Yim, M. H., & Hong, J. H. (2008). Directions of crime prevention policy through the analysis of crime prevention effects of CCTV. *Korean Policy Sciences Review*, *12*, 77–101.

Author, Publication Date, and Location	Reason for Not Including Program	Author, Publication Date, and Location	Reason for Not Including Program
James & Wynne (1985), Melbourne, Australia	Too few crimes occurred in the pre-intervention period	Gill & Turbin (1998, 1999), Leeds and Sheffield, UK	No control area
Burrows (1991), UK	No control area	Maguire & Wood (1998), Penarth, UK	No control area
National Association of Convenience Stores (1991), multiple sites, USA	No control area	Squires (1998a), Burgess Hill, UK	No crime data for control area
Poyner (1992), North Shields, UK	No control area	Squires (1998b), Crawley, UK	No comparable control area
Carr & Spring (1993), State of Victoria, Australia	No control area	Squires (1998c), East Grinstead, UK	No crime data for control area
Tilley (1993a), Salford, UK	No control area	Beck & Willis (1999), multiple sites, UK	No control area
1. Tilley (1993b), Hull, UK	No comparable control area	Ditton & Short (1999), Glasgow, UK	No control area
2. Tilley (1993b), Lewisham, UK	No control area	1. Sivarajasingam & Shepherd (1999), Cardiff, UK	No control area
3. Tilley (1993b), Wolverhampton, UK	No comparable control area	2. Sivarajasingam & Shepherd (1999), Swansea, UK	No control area
Chatterton & Frenz (1994), Merseyside, UK	No control area	3. Sivarajasingam & Shepherd (1999), Rhyl, UK	No control area
Davidson & Farr (1994), Mitchelhill Estate, Glasgow, UK	No control area	1. Taylor (1999), Leicester (Belgrave), UK	No control area
Brown (1995), King's Lynn, UK	No crime data for experimental or control areas	2. Taylor (1999), Leicester (West End), UK	No control area
Squires & Measor (1996), Brighton, UK	No comparable control area	Fairfield City Council (2002), multiple sites, Australia	No control area
Bromley & Thomas (1997), Cardiff and Swansea, UK	No control area	Goodwin (2002), Devonport, Australia	No control area
1. Blixt (2003), city in Sweden	No comparable control area	5. Wells et al. (2006), Indooroopilly Station, Queensland, Australia	No control area
2. Blixt (2003), Helsinborg, Sweden	No comparable control area	6. Wells et al. (2006), Ipswitch Station, Queensland, Australia	No control area
3. Blixt (2003), small community, Sweden	No comparable control area	7. Wells et al. (2006), Morayfield Station, Queensland, Australia	No control area
Squires (2003), Brighton, UK	No control area	8. Wells et al. (2006), Nundah Station, Queensland, Australia	No control area
Gill & Hemming (2004), Lewisham, UK	No comparable control area	9. Wells et al. (2006), Southbank Station, Queensland, Australia	No control area
Harada et al. (2004), Tokyo, Japan	No comparable control area	10. Wells et al. (2006), Strath-pine Station, Queensland, Australia	No control area
Coupe & Kaur (2005), multiple sites, UK	No control area	11. Wells et al. (2006), Surfer's Paradise, Queensland, Australia	No comparable control area
Eifler & Brandt (2005), multiple sites, Germany	No control area	King et al. (2008), San Francisco, CA, USA	No control area
Gill et al. (2006), multiple sites, UK	No control area	Lee (2008), South Korea	No control area
Gill et al. (2006), multiple sites, UK	No control area	McLean et al. (2008), Northeastern City in the US	No control area

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Author, Publication Date, and Location	Reason for Not Including Program	Author, Publication Date, and Location	Reason for Not Including Program
1. Wells et al. (2006), Beenleigh Station, Queensland, Australia	No control area	1. Verga & Douglas (2008), North York Division 31, Toronto, ON	No control area
2. Wells et al. (2006), Bethania Station, Queensland, Australia	No control area	2. Verga & Douglas (2008), Scarborough Division 42, Toronto, ON	No control area
3. Wells et al. (2006), Broad Beach, Queensland, Australia	No comparable control area	Yim & Hong (2008), UNK	No control area
4. Wells et al. (2006), Brunswick Station, Queensland, Australia	No control area	Cho (2009), UNK	No control area
Park & Choi (2009), South Korea	No control area	Priks (2015), Stockholm, Sweden	No separate control areas
Office of the City Auditor (2009), Seattle, WA, USA	Unreliable crime data; imprecise location of occurrence	Liedka et al. (2016), Universities in the U.S.	No pre-installation measures of crime
Sousa & Kelling (2010), MacArthur Park in Los Angeles, CA, USA	No control area	1. Lim et al. (2016), Chuncheon, South Korea	Too few crimes occurred in the pre-intervention period
Alvarado et al. (2011), College Park, MD, USA	No control area	2. Lim et al. (2016), Chuncheon, South Korea	Too few crimes occurred in the pre-intervention period
Flight & Hulshof (2011), Amsterdam, the Netherlands	No control area	Munyo & Rossi (2016), Montevideo, Uruguay	No separate control areas
Gondek & Tabaczniuk (2011), Walbrzych, Poland	No control area; also, did not identify precise treatment areas	Gomez et al. (2017), Medellin, Colombia	No separate control areas
La Vigne et al. (2011), Downtown Baltimore, MD, USA	No control area		
Ratcliffe et al. (2011), Philadelphia, PA, USA	No control area		
Cheong & Hwang (2012), South Korea	No control area		
Park (2012), Cincinnati, OH, USA (Corryville, Price Hill, and Millvale)	No separate control area.		
Reid and Andresen (2012), Surrey, BC	No control area		
McLean et al. (2013), Schenectady, NY, USA	No control area		
Shah & Braithwaite (2013), Chicago, IL, USA)	No control area		
Priks (2014), Stadiums in Sweden	No separate control area		
Gomez et al. (2015), Medellin, Colombia	No separate control area		
Moon et al. (2015), "J City", South Korea	Too few crimes occurred in the pre-intervention period		