Street lighting

Toolkit technical report

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Plain language summary

The objective of this technical report is to review the evidence on the effect of streetlighting on the involvement of children and young people in crime and violence. The intervention is usually described as "improved streetlight", where the brightness of lights is increased and hence improved, or the implementation of new lighting technologies such as light-emitting diode (LEDs) or smart lights. The settings can vary from very specific places (e.g., alleys, road segments) to broader settings (e.g., communities or neighbourhoods).

This technical report is based primarily on a recent systematic review and meta-analysis by Welsh et al. (2021).

From a rational choice perspective, changes to the physical environment where crimes occur, such as improved streetlighting, can cause reductions in the numbers of crimes committed. This is because it changes the balance of "potential rewards and inherent risks" by increasing the likelihood of detection. Other arguments for a positive effect of improved streetlighting are increased informal surveillance, and the effects it might have on the community including an increased likelihood of reporting crime and suspicious behaviour. There are also arguments for possible adverse effects.

Welsh et al. (2021) included 17 primary evaluations that examined the impact of improved streetlighting on crime. In total, 6 evaluations were conducted in the UK. All UK evaluations reported the impact of improved streetlighting on crimes measured at night and during the day.

Overall, the findings from this systematic review and meta-analysis indicates that improved streetlighting had a very small undesirable impact on violent crime outcomes, which some have this is because reporting and detection increases. There is however a large positive effect on property crime, and so an effect on crime overall.

There is a large significant effect from studies from the UK, but not those from the US. However, when evaluations that account for the time of day of the crime, the results for UK and US were similar. In other words, when only evaluations that measured the impact of

streetlighting on crime measured both during the day and at night were included, the mean effect for evaluations conducted in the UK or the US were comparable.

The evidence rating is 2 for this effect, marked down for the indirect nature of the effect size (i.e., the effect size represents all crimes recorded, not specifically crimes committed by young people), the low confidence in the review as measured using the AMSTAR tool and the unclear information about heterogeneity between effect sizes.

There is no implementation evidence, but an old paper (i.e., Cozens et al., 2003) suggested the standards for street light placement were inappropriate.

Three of the studies included in Welsh et al. (2021) reported a cost-benefit analysis. All three reported a positive benefit-to-cost ratio reaching as high as 4 to 1.

More studies will help develop a better understanding of the heterogeneity of the effect and a more evidence regarding the cost effectiveness.

Objective and approach

The objective of this technical report is to review the evidence on the effect of streetlighting on the involvement of children and young people in crime and violence. This technical report is based primarily on a recent systematic review and meta-analysis by Welsh et al. (2021). The following inclusion and exclusion criteria were used to inform the selection of systematic reviews.

Inclusion criteria

Included in this technical report were systematic reviews and meta-analyses of the effectiveness of streetlighting on crime and violence outcomes. Welsh et al. (2021) published the most recent (and updated) systematic review and meta-analysis of improved and increased streetlighting on crime outcomes.

Exclusion criteria

Reviews were excluded for the following reasons:
- Review was a previous version of a more recent updated systematic review and meta-analysis. For example, the review by Welsh et al. (2021) was an update of an

earlier systematic review and meta-analysis of streetlighting on crime outcomes (Welsh & Farrington, 2007).

- Review was an additional publication of an existing review. For example, Welsh et al. (2022) was the journal article publication of Welsh et al. (2021).
- Review was concerned with other, related, situational crime prevention approaches, such as CCTV (Piza et al., 2019) as these were considered for a separate Toolkit strand.

Outcomes

Multiple crime-related outcomes are typically included in reviews of the effectiveness of streetlighting. Welsh et al. (2021) examined the impact of streetlighting on both violent crime and property crime. Welsh et al. (2021) also reported the effects on crimes by the time of day they were committed. For example, they report the impact of improved streetlighting from evaluations that only measured crimes committed at night and separate effects from evaluations that measured crimes committed during the day and at night.

Description of interventions

Welsh et al. (2021) outline that streetlighting as an intervention can be generally described as "improved streetlight", where the brightness of lights is increased and hence improved, or the implementation of new lighting technologies such as light-emitting diode (LEDs) or smart lights.

Welsh et al. (2021) also included evaluations that examined the impact of reduced streetlighting, which have been evaluated in the UK. For example, the review included an evaluation in Essex by Davies and Farrington (2020) that examined the impact of 'part-night lighting', which Welsh et al. (2021) explain as streetlights being switched off between the hours of 11.30pm and 5.30am. Similarly, the review included an evaluation by Perkins et al. (2015) conducted in local authorities in England and Wales that examined the impact of permanently switching off streetlighting and part-night switching off of streetlight (between 12am and 6am).

Implementation setting and personnel

When used for crime prevention, improved streetlighting can be implemented in an array of public places. Welsh et al. (2021) included some evaluations of streetlighting in very specific

places (e.g., alleys, road segments) or broader settings (e.g., communities or neighbourhoods).

Theory of change/presumed causal mechanisms

Improved streetlighting is an examples of situational crime prevention. However, the implementation or improvement of streetlighting is not always undertaken in order to reduce the occurrence of crime (Welsh et al., 2021). Sometimes, local authorities or those responsible for such changes may improve or implement streetlighting for the prevention of road traffic accidents (Beyer & Ker, 2009; Welsh et al., 2021).

In a recent review of CCTV, Piza et al. (2019) outline the main presumed causal mechanisms in situational crime prevention, which are based on the theory of choice. These arguments also apply to streetlighting and so inform this section of this report. We also draw on arguments from Pease (1999).

The theory of choice applied to improved streetlighting is based on the idea that changes to the physical environment where crimes occur can cause reductions in the numbers of crimes committed. Fundamentally, this relies on a 'rational choice' perspective (Piza et al., 2019) whereby, crime can be prevented by reducing the number of opportunities for an offence to be committed and increasing the risk of offences being detected. The rational choice perspective specifies that when faced with an opportunity to commit and offence, an offender will make a decision based on the "potential rewards and inherent risks" associated with the offence (Piza et al., 2019; p. 137). As such, situational crime interventions such as streetlighting and CCTV surveillance work by targeting these factors, particularly by increasing the inherent risks, that is the likelihood of offences being detected.

Pease (1999) suggests that, in addition to deterrence from increased risk of detection, streetlighting can reduce crime at night by more people spending time outside in their gardens or in the street. This informal surveillance, as well as greater visibility for any police presence, may impact the decision to commit an offence. He also suggests that daytime crime may also be reduced by streetlighting because of signalling effects. That is, introducing or improving streetlighting may signal that the area is not vulnerable to crime and/or that the local authority is serious about tackling crime. This may in turn encourage the reporting of crime and suspicious behaviour. Also, streetlighting may increase community pride which

may make people less likely to move away, therefore reducing the number of 'for sale' signs which encourage burglary. Finally, CCTV may increase the detection and apprehension of suspects therefore removing antisocial individuals from the area.

There is also the possibility of undesirable impacts of streetlighting on crime. Davies and Farrington (2020) found that when streetlights were switched off, burglary and vehicle crime increased, but violent crime decreased. They suggested that this was because fewer people went outside in the dark without streetlights. It follows that if streetlighting is therefore improved, there may be increases in violence or undesirable activities such as drug dealing.

In contrast, based on their finding that streetlighting actually had a desirable impact on crimes during the night and during the day, Welsh et al. (2021) suggest that a key mechanism in the effectiveness of streetlighting may be centred around community investment and pride. This would result in a form of informal social control as the key mechanism in streetlighting rather than increased surveillance or deterrence.

Evidence base

Descriptive overview

Welsh et al. (2021) included 17 primary evaluations that examined the impact of streetlighting on crime. In total, 6 evaluations were conducted in the UK. All UK evaluations reported the impact of streetlighting on crimes measured at night and during the day.

Welsh et al. (2021) included 21 evaluations in their systematic review of the impact of streetlighting on different crime outcomes (e.g., violent crime and property crime) of which 17 were included in the meta-analysis. Seven of these evaluations were conducted in the UK, including cities and towns such as Birmingham, Bristol, Dover, Dudley, Maldon and Stoke-on-Trent (Welsh et al., 2021). The remaining evaluations were conducted in the US ($n = 12$), Brazil ($n = 1$) or South Korea ($n = 1$). The majority of evaluations of streetlighting included in the systematic review were conducted in residential areas ($n = 6$) or city centre locations ($n = 5$). In addition, evaluations included in the systematic review examined the impact of streetlighting in residential and commercial areas ($n = 3$), public housing complexes ($n = 2$), or 'other' locations ($n = 4$)[1].

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[1] These numbers were estimated for the purpose of this technical report using information presented in Table 1, pp. 24 – 27 of Welsh et al. (2021).

A mean effect size for violent crime was computed using data from 13 evaluations and an effect size for property crime was computed using data from 15 evaluations. Most of the evaluations (*n* = 17) included by Welsh et al. (2021) used non-randomised quasi-experimental designs, described as evaluations that used both experimental and control conditions and measured crime outcomes before and after implementation of an intervention. One evaluation used a randomised controlled design.

Assessment of the evidence rating

We have confidence that, at the time of writing, the review by Welsh et al. (2021) represents the best available evidence on the effectiveness of CCTV surveillance and streetlighting on crime outcomes. Our decision rule for determining the evidence rating is summarised in the technical guide.

A modified version of the AMSTAR2 critical appraisal tool was used to appraise the reviews that inform the current technical report. According to this tool, the review by Welsh et al. (2021) was rated 'low'.

Welsh et al. (2021) included 21 evaluations of streetlighting in their systematic review, of which 17 evaluations were included in the meta-analysis. They included a variety of interventions in the review, but the primary focus was streetlighting that was implemented in public places. For example, they included improved streetlighting, different lighting technologies, and applications of lighting such as 'switch-off lighting schemes'. They included different evaluation methodologies, with the minimum quality requirement being that evaluations included before-and-after measures of crime in experimental and control areas (Welsh et al., 2021). Evaluations also had to report an outcome of crime and there had to be at least 20 incidences of crime in experimental and control areas before the intervention. Evaluations with fewer than 20 incidences of crime in the experimental and control areas would be too small to be included in this review.

Welsh et al. (2021) reported a robust and thorough search strategy, including multiple database searches and contacts with experts in the field, and clearly outline their included keywords. No information about whether or not searches and screening were performed in duplicate is provided.

Information about included studies is provided by Welsh et al. (2021) but a risk of bias assessment was not preformed. Welsh et al. (2021) reported the results of a meta-analysis using appropriate methods but information about the heterogeneity between effect sizes is not reported. The confidence intervals for each effect size is reported. A moderator analysis to investigate any possible reasons for heterogeneity was undertaken (Welsh et al., 2021). The authors declare the sources of funding for the review, but do not declare any conflict of interests or lack of conflict of interests.

Welsh et al. (2021) report an indirect effect of streetlighting on the involvement of children and young people in crime and violence. The mean effect size for violent crime was chosen as our headline impact estimate. It is considered an indirect effect because the effect size includes violent crimes committed by adults and a separate effect for children and young people could not be computed.

There was no information provided by Welsh et al. (2021) in relation to the amount of heterogeneity between included studies. Visual inspection of the forest plot for violent crime suggests a moderate level of heterogeneity. Our confidence in the effect estimate is rated as 'low' based on the AMSTAR rating and because the mean effect does not refer to crimes attributed to children and young people specifically. The authors included both randomised and non-randomised designs in their analysis, but the numbers of evaluations using different methodologies is not provided. Thus, the evidence rating is 2, marked down for the indirect nature of the effect size, the low confidence in the review as measured using the AMSTAR tool and the unclear information about heterogeneity between effect sizes.

Impact

Summary impact measure

Overall, the findings from a systematic review and meta-analysis indicates that streetlighting had a very small undesirable impact on violent crime outcomes - an increase of less than 1%. This may be because streetlighting increases reporting and detection of crime.

Welsh et al. (2021) also reported the mean effect size from 13 evaluations that reported the impact of streetlighting on violent crime. Overall, the effect size suggests that streetlighting

had a null impact although the mean effect size is very small (less than 1%) and not statistically significant (RES = 0.99; 95% CI 0.87, 1.13).

Table 1

Mean effect sizes for offending outcomes from Welsh et al. (2021) review

Review	*n* studies	ES (RES)	95% CI	% change	Evidence rating on crime and violence
Welsh et al. (2021); all offending outcomes	17	RES = 1.16 d = 0.082	(1.06, 1.27)	-10.7%	2
Welsh et al. (2021); violent offending*	13	RES = 0.99 d = -0.006	(0.87, 1.13)	+0.8%	2
Welsh et al. (2021); property offences	15	RES = 1.14 *d* = 0.072	(1.03, 1.27)	-10.4%	2

Note: ES = the weighted mean effect size; RES = odds ratio; * = headline impact estimate

Moderators and mediators

Welsh et al. (2021) reported a number of additional mean effect sizes. Particularly relevant to the current technical report is the mean effect size for evaluations conducted in the UK. Based on 6 evaluations, the mean effect size suggested that streetlighting had a desirable impact on crime rates (RES = 1.21; 95% CI 1.03, 1.42, *p* = .024).

Evaluations conducted in the US were associated with a smaller and non-significant, but still desirable, impact on crime rates (RES = 1.10, 95% CI 0.98, 1.23, *p* = .099). However, when considering time of day of crime, the results for UK and US were similar. Welsh et al. (2021, p. 34) reported mean effect sizes for a "like-with-like comparison" to examine the difference between evaluations conducted in the UK and those conducted in the US. When only evaluations that measured crime that occurred both during the day and at night, the mean effect sizes for the impact of streetlighting on crime was similar in UK evaluations (RES = 1.21,

95% CI 1.03, 1.42, *p* = .024; *n* = 6 evaluations) and in US evaluations (RES = 1.25, 95% CI 1.02, 1.53, *p* = .035; *n* = 6 evaluations).

Although the review found that there was no desirable impact on violent crime, the mean effect size for property crime suggested that streetlighting was associated with a reduction in this type of crime (RES = 1.14, 95% CI 1.03, 1.27, *p* = .018).

Implementation and Cost analysis

Implementation

No studies of implementation were found. But relevant issues for studies and interventions mentioned in the literature raised in a paper from some years ago are:

- Since mechanisms for the effects of streetlighting include increased reporting and detection of crime, then the effects shown in official crime figures will not be the true effect (which will be under-estimated; Cozens et al., 2003). However, UK evaluations included by Welsh et al. (2021) have used victimisation surveys (Painter & Farrington, 1997, 1999) or self-reported offending surveys (Painter & Farrington, 2001).
- The standards used to determine the appropriate lighting given to an area are not based on sound scientific criteria, so high-risk areas may remain underlit (Cozens et al., 2003).

Costs

Three of the studies included in Welsh et al. reporting cost-benefit analysis. All three reported a positive benefit-to-cost ratio reaching as high as 4 to 1.

What do we need to know? What don't we know?

Much of the evidence base for streetlighting is relatively old. It would be useful for have a continuing flow of evaluations to confirm current findings and allow for a greater explanation of the identified heterogeneity and in turn better inform policy. Future evaluations should include cost-benefit analysis and try to better differentiate the impact of streetlighting interventions on crimes involving children and young people in particular.

Qualitative research about the perceived impact of streetlighting would help shed light on the potential causal mechanisms.

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Annex 1: Effect size calculation

This annex shows the calculation based on the results and assumptions given in the text. We assume 200 crimes recorded in study areas, evenly divided between treatment and control areas. That means there are 100 recorded observations in the control group and 100 recorded observations the treatment group. Assuming that 17% of the crimes recorded in the control group involved a violent offence, the mean effect sizes reported by Welsh et al. (2021) can be easily transformed to a relative percentage change in violence.

If the effect size for the violent crime is RES = 0.99 (Welsh et al., 2021), then using the table below and the formula for an RES, we can estimate the value of X. The RES is estimated as: A*D/B*C, where A is the number of observed crimes that did not involve a violent offence in the treatment group, B is the number of observed crimes that did involve a violent offence treatment group, C is the number of observed crimes that did not involve a violent offence in the control group, and D the number of observed crimes that did involve a violent offence in the control group. Therefore, the value of X is 17.14 for violent crime outcome reported by Welsh et al. (2021). Mathematically, an RES (relative effect size) is similar to an odds ratio.

	No violence	Violence	Total
Treatment	100-x	x	100
Control	83	17	100

Therefore, the relative change in crime is $(17 - 17.14)/17 = +0.8\%$.

The prevalence of violent crime is likely to vary between studies and study areas. Furthermore, it can be influenced by a number of different factors such as the type of behaviour, the type of report (i.e., self-reported or official records of arrests or convictions),

or the time frame in which behaviours occurred (i.e., the past 3 months or lifetime prevalence). If we were to adjust our assumption that 17% of crimes recorded in control areas involved violence, the relative change in the intervention area is not greatly affected.

For example, if we assume that 33% of crimes recorded in the control area involved violence, following the implementation of streetlighting, the 2x2 table would be as follows for and the value of X is 33.22. Therefore, the relative change is +0.67% (i.e., (33 – 33.22)/33).

	No violence	Violence	Total
Treatment	100-x	X	100
Control	67	33	100

Similarly, if we assume that 5% of crimes recorded in the control area involved violence, following the implementation of streetlighting, the value of X is 5.05 and the relative change is +1%. Given the difference in the assumed prevalence of violent crime amongst observed crimes, the percentage relative reduction does not vary in a similar fashion.

To transform the mean effect size for the overall crime outcome, we used the assumption that 25% of crimes recorded in the control area involved violence. Sensitivity analysis then used 10% and 40% assumptions. Table 4 shows this further.

Table 4

Variation of the relative reduction in outcomes reported by Welsh et al. (2021).

	Welsh et al. (2021); violent crime RES = 0.99		Welsh et al. (2021); all crime RES = 1.16

Assumed number of observations involving violence	Relative change	Assumed number of observations involving violence	Relative change
5%	+1%	10%	12.6%
17%	+0.8%	25%	10.72%
33%	+0.67%	40%	8.75%

Note. Assumed percentage of crimes involving violence are for control areas.