Effectiveness of a Road Traffic Injury Prevention Intervention in Reducing Pedestrian Injuries, Barcelona, Spain, 2002–2019

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This study aimed to evaluate the effectiveness of the Safe Routes to School (SRTS) intervention in Barcelona, Spain, at reducing the number of road traffic collisions and injuries in the school environment. It was a pre–post, quasi-experimental evaluation with a matched comparison group. Road traffic injuries were significantly reduced in the intervention schools—especially among school-age pedestrians—but not in the comparison schools. The SRTS program significantly improved road safety among children. (*Am J Public Health*. 2023;113(5):495–499. https://doi.org/10.2105/AJPH.2022.307216)

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Many cities have promoted Safe Routes to School (SRTS) programs to make it easier for children to walk or cycle to school safely. Most studies have found that implementation of these programs increases active travel to school[1–3] and decreases road traffic injuries,[4–10] although there is controversy because of methodological limitations.[11]

INTERVENTION AND IMPLEMENTATION

Barcelona's SRTS program, called *Camí escolar, espai amic* (Safe route to school, friendly space), began with the aim of increasing children's and adolescents' personal autonomy, responsibility, and quality of life on their way to school or while walking around the neighborhood. The program promotes road safety education in schools through an educational program conducted within the school and the community, and through changes in the environment around the school.[12] After initial piloting, full deployment of SRTS began in 2006. Available data allowed us to evaluate a real-life policy with important public health implications. (For more details, see the Appendix, available as a supplement to the online version of this article at http://www.ajph.org).

PLACE, TIME, AND PERSONS

This is a pre–post, quasi-experimental evaluation study, with a matched comparison group. The intervention group was schools with the SRTS program, and the comparison group comprised schools without the SRTS program. The study area was defined as a buffer around the schools with a radius of about 200 meters (656 feet).

The inclusion and exclusion criteria were as follows: of the 152 schools with SRTS, we selected schools whose SRTS implementation year was after 2005 and whose inauguration year (street works and program implemented) was prior to 2016. All of the selected intervention schools had a pre- and postintervention period of at least four years per period; therefore, injury data include the years 2002 to 2019.

Inclusion and exclusion criteria for traffic collisions were as follows: we included traffic collisions with casualties occurring in the study area (buffer with a 200-m radius around the schools) from Monday to Friday from 7:00 AM to 9:30 AM, 12:00 PM to 3:00 PM, and 4:00 PM to 6:00 PM, from September 15 to June 23. Collisions occurring during Christmas and Easter holiday periods were excluded. (For more details, see the Appendix).

Outcome variables included the number of road traffic collisions involving

casualties (total, children [defined as aged 0–16 years], and pedestrian children) and number of people injured (total, children, and pedestrian children).

Exposure variables included population in the area, available family income, and data on motor and active mobility and structure streets (for more detail, see Appendix).

To compare the results in the postintervention period versus the preintervention period, for each outcome measure, we fitted a generalized linear mixed model with Poisson distribution using the logarithm as a link function between expected values and explanatory variables. The explanatory variables included in the model were the group, the period (pre- vs postintervention), the interaction between group and period, and the year. To obtain a more precise fit, the model was also adjusted by the exposure variables.

PURPOSE

This study aimed to evaluate the effectiveness of the SRTS program carried out in Barcelona between 2006 and 2016 in reducing the number of road traffic collisions and injuries in the school environment.

EVALUATION AND ADVERSE EFFECTS

The study included 64 schools with SRTS programs implemented between 2006 and 2016, and 63 comparison schools, reaching 49 092 students in 2018 (intervention and comparison schools). A total of 15.0% of the schools were preschools (students aged 0–3 years), 55.1% were primary schools (students aged 4–11 years), and 29.9% were secondary schools (students aged 12–18 years). The proportion of public schools was higher in intervention than in comparison schools (75% and 60.3%, respectively), but there were no significant differences in the mean number of students per school: 367.8 (95% confidence interval [CI] = 306.7, 428.9) and 405.6 (95% CI = 320.2, 491.0), respectively.

The environmental characteristics of the intervention and comparison schools were similar. Differences were only found in the mean neighborhood income in 2017 and in the concentration of injured pedestrians in the school neighborhood in 2018. Available family income in the intervention school neighborhoods was significatively higher than in the comparison school neighborhoods (relative index = 112.1 and 99.8, respectively). The number of injured pedestrians per 100 meters of street was significatively lower for intervention schools (7.8) than for comparison schools (10.1).

In the intervention schools overall (aggregated), the total number of people injured was 2994 (annual mean = 272.2) in the preintervention period and 2284 (annual mean = 228.4) in the postintervention period. In the comparison schools, this number was 4061 (annual mean = 369.2) and 3196 (annual mean = 319.6), respectively (Table 1).

Per school, in the preintervention period, the annual mean number of injury road traffic collisions involving children and pedestrian children was significantly higher in the comparison schools than in the intervention schools. There were no differences in the annual school mean number of collisions involving children and pedestrian children (Table 1). In the postintervention period, the pattern was the same, although in general the annual school means were lower than in the preintervention period in both the intervention and comparison schools.

When we compared the results of the pre- and postintervention periods, the final adjusted models showed a significant reduction in the risk of collisions and people injured in the intervention schools, with a reduction of 11.7% in the number of injury collisions, 41.1% in the number of injury collisions involving children, and 43.3% in the number of injury collisions involving children pedestrians. For people injured, there was a reduction of 9.1% in the total injured, 36.6% in the number of children injured, and 39.9% in the number of children pedestrians injured (Table 2).

Among the comparison schools, there were no significant changes in outcomes between the pre- and postintervention periods (Table 2).

The significant difference in percentage change in the post- versus the preintervention period between intervention and comparison schools (significance of the interaction between intervention group and period) showed that the reduction in the intervention schools in the number of injury collisions involving children and pedestrian children could be attributable to the implementation of the SRTS program (Table 2).

SUSTAINABILITY

The SRTS program is currently beginning a new phase, with a greater focus on increasing safety in front of the school (*protegim les escoles*: we protect the schools).

PUBLIC HEALTH SIGNIFICANCE

The SRTS program, carried out in Barcelona between 2006 and 2016, showed a significant reduction in injuries in the intervention schools, which

TABLE 1— Injury Traffic Collisions and People Injured in Areas Surrounding Schools With an SRTS Program (200-Meter Buffer) and in Areas Surrounding Comparison Schools, by Intervention Period: Barcelona, 2002–2019

	Intervention Schools (n = 64)				Comparison Group Schools (n = 63)				
	All Schools Total	All Schools Annual Mean (95% CI)	Per School Range	Per School Annual Mean (95% CI)	All Schools Total	All Schools Annual Mean (95% CI)	Per School Range	Per School Annual Mean (95% CI)	Per School *P*[a] (Intervention/ Comparison)
No. of road traffic collisions with injuries									
Preintervention	2994	272.2 (180.3, 364.1)	0–28	6.0 (5.6, 6.5)	4061	369.2 (249.1, 489.2)	0–37	8.2 (7.5, 8.9)	.001
Postintervention	2284	228.4 (119.9, 336.9)	0–28	5.7 (5.2, 6.2)	3196	319.6 (168.8, 470.4)	0–50	8.2 (7.3, 9.0)	.002
No. of collisions involving any injured person aged 0–16 y									
Preintervention	240	21.8 (13.2, 30.5)	0–4	0.5 (0.4, 0.5)	262	23.8 (14.5, 33.1)	0–4	0.6 (0.5, 0.6)	.033
Postintervention	120	12 (6.6, 17.4)	0–4	0.3 (0.2, 0.4)	169	16.9 (8.9, 24.9)	0–6	0.4 (0.4, 0.5)	.022
No. of collisions involving any injured pedestrians aged 0–16 y									
Preintervention	135	12.3 (6.8, 17.7)	0–3	0.3 (0.2, 0.3)	124	11.3 (6.7, 15.8)	0–3	0.3 (0.2, 0.3)	.76
Postintervention	66	6.6 (2.8, 10.4)	0–3	0.2 (0.1, 0.2)	97	9.7 (4.7, 14.7)	0–4	0.2 (0.2, 0.3)	.053
No. of people injured									
Preintervention	3478	316.2 (207.2, 425.2)	0–34	7 (6.4, 7.6)	4774	434 (292.4, 575.6)	0–47	9.6 (8.8, 10.5)	.001
Postintervention	2715	271.5 (141.7, 401.3)	0–33	6.8 (6.2, 7.4)	3720	372 (199.8, 544.2)	0–58	9.5 (8.5, 10.5)	.005
No. of injured persons aged 0–16 y									
Preintervention	251	22.8 (13.6, 32.1)	0–4	0.5 (0.4, 0.6)	288	26.2 (15.5, 36.8)	0–6	0.6 (0.5, 0.7)	.02
Postintervention	131	13.1 (7.1, 19.1)	0–4	0.3 (0.3, 0.4)	177	17.7 (9.2, 26.2)	0–6	0.5 (0.4, 0.5)	.024
No. of injured pedestrians aged 0–16 y									
Preintervention	136	12.4 (6.8, 17.9)	0–3	0.3 (0.2, 0.3)	131	11.9 (7.0, 16.8)	0–4	0.3 (0.2, 0.3)	.74
Postintervention	70	7 (3.0, 11.0)	0–3	0.2 (0.1, 0.2)	98	9.8 (4.7, 14.9)	0–4	0.3 (0.2, 0.3)	.06

Note. SRTS = Safe Routes to School.

[a]Significance of the nonparametric Wilcoxon rank-sum test (Mann-Whitney).

TABLE 2— Mean Number of Adjusted Annual Injury Collisions and Injured People, Adjusted Relative Risk, and Pre–Post Percentage Change in Surrounding Areas of Intervention and Comparison Schools: Barcelona, 2002–2019

	Intervention Schools (n = 64)				Comparison Group Schools (n = 63)				
	Adjusted Annual Mean Per School	SE	RR (95% CI)	Post/Pre % Change (95% CI)	Adjusted Annual Mean Per School	SE	RR (95% CI)	Post/Pre % Change (95% CI)	*P*[a]
No. of road traffic collisions with injuries									.14
Preintervention	4.72	0.34	1 (Ref)	1 (Ref)	5.03	0.36	1 (Ref)	1 (Ref)	
Postintervention	4.16	0.30	0.88 (0.80, 0.97)	−11.7 (−19.9, −2.7)	4.83	0.35	0.96 (0.88, 1.05)	−4.1 (−12.3, 5.0)	
No. of collisions involving injured persons aged 0–16 y									.019
Preintervention	0.43	0.04	1 (Ref)	1 (Ref)	0.44	0.04	1 (Ref)	1 (Ref)	
Postintervention	0.25	0.03	0.59 (0.47, 0.73)	−41.1 (−52.6, −27.0)	0.37	0.03	0.84 (0.68, 1.03)	−16.5 (−32.3, 3.1)	
No. of collisions involving injured pedestrians aged 0–16 y									.003
Preintervention	0.20	0.03	1 (Ref)	1 (Ref)	0.19	0.02	1 (Ref)	1 (Ref)	
Postintervention	0.12	0.02	0.57 (0.42, 0.77)	−43.3 (−58.3, −22.7)	0.20	0.03	1.05 (0.79, 1.38)	4.5 (−21.2, 38.5)	
No. of people injured									.87
Preintervention	5.44	0.39	1 (Ref)	1 (Ref)	6.14	0.44	1 (Ref)	1 (Ref)	
Postintervention	4.94	0.36	0.91 (0.82, 1.00)	−9.1 (−17.7, 0.4)	5.63	0.41	0.92 (0.84, 1.01)	−8.2 (−16.5, 0.9)	
No. of injured persons aged 0–16 y									.1
Preintervention	0.43	0.04	1 (Ref)	1 (Ref)	0.47	0.04	1 (Ref)	1 (Ref)	
Postintervention	0.28	0.03	0.63 (0.50, 0.81)	−36.6 (−50.4, −18.8)	0.39	0.04	0.82 (0.66, 1.03)	−17.8 (−34.3, 2.9)	
No. of injured pedestrians aged 0–16 y									.011
Preintervention	0.20	0.03	1 (Ref)	1 (Ref)	0.20	0.03	1 (Ref)	1 (Ref)	
Postintervention	0.12	0.02	0.60 (0.44, 0.82)	−39.9 (−55.9, −18.0)	0.20	0.03	1.00 (0.76, 1.34)	0.5 (−24.5, 33.6)	

Note. CI = confidence interval; RR = relative risk. Surrounding area defined as within a 200-meter buffer. Adjusted models include the explanatory variables, intervention group, period, the interaction between both terms and year, and the exposure variables, number of students of the school (log), number of inhabitants in the neighborhood (log), kilometers traveled by motor vehicles in the study area (log), and a quadratic term for the latter effect.

[a]Significance of the interaction between period and type of school (intervention, comparison), which allows us to assess whether the differences between intervention and comparison schools can be attributed to the intervention. It shows whether the difference pre–post in the intervention group is significantly different from the difference pre–post in the comparison group.

was not observed in the comparison schools. There was a notable decrease in the number of injured pedestrians, especially school-age pedestrians, which is the target population of the SRTS.

These results are relevant for two reasons. On the one hand, injuries were significantly reduced in the intervention schools but not in the comparison group, in the context of increasing road traffic injury rates in the city (although with decreasing severity). On the other hand, our results provide evidence of the effectiveness of the SRTS program in improving road safety and reducing road crashes and injuries, particularly among children, when there is controversy in the scientific literature.[9,11] Our study aimed to overcome the limitations reported in previous studies by using a quasi-experimental study, which controlled for major confounding factors through the study design and statistical analysis.

This study evaluates the health impacts of a policy developed outside the health sector. It provides evidence on how an infrastructure intervention contributes to health benefits, implementing health in all policies and reducing social inequities. AJPH

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CONTRIBUTORS

K. Pérez and E. Santamariña designed and conceptualized the study. K. Pérez and J. Ferrando did the literature review. E. Santamariña and L. Badiella analyzed the data. All authors contributed to results and discussion. K. Pérez drafted the initial article, and all authors contributed to subsequent edits of the revised article.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

HUMAN PARTICIPANT PROTECTION

The present article did not require institutional review board approval because we do not report human participant data.

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