Environmental Conditions Associated With Youth Delinquency Events: A Temporal, Meteorological, and Contextual Perspective

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Abstract

Research on youth delinquency has been essential for gaining a deeper understanding of the etiology of delinquent behavior. Studies considering the environmental perspective have increased during the last decade, but relatively little attention has been paid to temporal patterns and weather conditions. The present study explores the seasonality of youth delinquency as well as the association between violent and non-violent youth offenses and temperature, rainfall, level of darkness, type of day, type of place, and companionship, using data gathered by the police along with data obtained from official weather agencies. To this end, we conducted ANOVA and contingency table analyses. Seasonality was found for non-violent crimes. Companionship, semi-public, and public places were all associated with a higher likelihood of non-violent crime, while darkness and public

The study of youth delinquency has been essential for understanding the etiology of delinquent behavior. Several longitudinal and cross-sectional studies conducted with youths have established the multifactorial nature of this phenomenon (e.g., Moffitt, 1993; Wikström, 2004). Research on this issue from individual, social, and environmental perspectives has revealed that variables such as lack of self-control, callousness, inappropriate parental skills, antisocial peers, and risky leisure activities all play an essential role in juvenile delinquency (Janssen et al., 2016; Jolliffe et al., 2017; Tanner et al., 2015). However, relatively little attention has been paid to the environmental characteristics of youth crimes, including meteorological and temporal variables.

The role of meteorological variables in crime has been researched as a physiological relation of weather and behavior (e.g., Anderson, 1989; Rotton and Cohn, 2000) in the temperature-aggression hypothesis. However, from the opportunity perspective, it is suggested that meteorological and temporal variables change people's routine activities. This study is framed by the routine activity approach (RAA) that assumes that predatory crime takes place when an offender and a suitable victim/target are present in the absence of a guardian (Cohen and Felson, 1979). Felson (2016) also suggests that in most crimes, the modus operandi is simple and that delinquency fits into people's daily routines. Therefore, assumptions from this perspective are based on considerations of usual social dynamics and how they shape the use of space. For instance, pleasant weather conditions encourage people—both potential victims and offenders— to engage in more outdoor activities, increasing the likelihood of them sharing space in the absence of a capable guardian, and thus, increasing the likelihood of predatory crimes being committed.

From this approach, there is an extensive body of research exploring the relationship between temporal and meteorological variables and adult crime, including both violent crimes (Ceccato, 2005; Cheatwood, 1995; Sommer et al., 2018; Tompson and Bowers, 2013) and crimes against property (Mburu and Helbich, 2016; Van Koppen and Jansen, 1999; Yan, 2004). To the best of our knowledge, few studies have focused on juvenile delinquency from this point of view. Thus, our main aim was to explore the temporal, meteorological, and other environmental characteristics associated with both violent and non-violent crimes committed by youths.

Theoretical Background

The Importance of Meteorological Conditions and Routine Activities

As mentioned above, the RAA relates the seasonality of crime to the crime opportunities offered by the different seasons from a socio-environmental perspective. Daily, as individuals engage repeatedly in a given pattern of activities, the timeframe and space where and when those activities are carried out shapes

the crime opportunities and, therefore, the crime events. Chapin (1974); (as cited in LeBeau and Corcoran, 1990) differentiates between obligatory and discretionary activities in which people engage. Obligatory activities are those that are mandatory (e.g., going to school or work), while discretionary activities are the ones people choose to engage in (e.g., leisure activities). As those activities contribute to shape crime patterns, when the meteorological conditions cause a change in individual's daily activities, they will also influence spatial and temporal crime patterns. This is more obvious for activities that are discretionary since they can be re-schedule or re-planned. For instance, if the weather is not pleasant, a plan that was meant to be outdoors can be done indoors. However, obligatory activities can also be indirectly modified. Even if they happen on the same place, other routines as urban mobility could be affected. For example, when it rains more individuals choose to go to work by car, or more young people take public transport instead of walking to school. This will affect the stream of people from one place to another, and in consequence also the spatial and temporal coincidence of potential offenders and victims.

Previous research on meteorological variables has confirmed the existence of seasonality for both violent and property crimes (Breetzke and Cohn, 2012; Ceccato, 2005; John et al., 2004; Tennenbaum and Fink, 1994). Specifically, violent and property crimes have been found to peak during the summer months in several parts of the world. For example, John et al. (2004) found that property crime varied significantly between the winter and the summer in various regions of the United States, and in Brazil, Ceccato (2005) found that homicides peaked at their highest levels in summer and autumn.

The association between weather and crime varies according to the type of offense. Warmer weather can make people engage in more discretionary outdoor activities. In this scenario, more suitable victims could converge in time and space with motivated thieves. The presence of more people outdoors could also mean that more capable guardians will be available. However, this concept has been shown to be more complex than the mere presence of people (Reynald, 2018). Some offenders might assess whether bystanders are going to intervene (Brown and Bentley, 1993). Additionally, pleasant weather could be associated to an increase of residential burglaries. Fewer individuals at home, and therefore a lack of guardians at home, would enhance the opportunities for burglars.

Previous research has found evidence of the complex association between weather and different types of crimes. For instance, Towers et al. (2018), using a large dataset from Chicago, found a positive correlation between temperature and certain violent crimes (e.g., assaults). The authors found that including temperature as a factor improved the predictive power of the model, but only for aggravated assaults, batteries, and criminal damage. However, models for crimes against property, such as vehicle theft or fraud, did not show improvement in their predictive accuracy when the temperature was included. Towers et al. (2018) also highlighted the complexity of the association between weather and crime and how it changes according to other factors such as the

hour of the day (see also Tompson and Coupe, 2018) or the type of crime.

With unpleasant weather (a rainy day, for example), people tend to engage in fewer outdoor activities and thus have less contact with others. In this case, there would be fewer opportunities for offenders and suitable victims to converge in a given public space at the same time, at least for certain crime types, such as thefts or robberies. Research on the relationship between rainy weather and crime has yielded mixed results. While some researchers found no evidence of a significant association between crime and rainfall (Simister and Cooper, 2005; Field, 1992), others found that some crimes tended to increase whereas others decreased. For instance, in a study conducted in Boston, Sommer et al. (2018) found fewer instances of violent crime and aggravated assault on rainy days. Conversely, in Tokyo, the number of hit-and-run cases was reported to increase in wet weather conditions (Ikegaya and Suganami, 2008).

Temporal Patterns of Crime

Temporal patterns are also crucial for understanding the occurrence of crime. Daily activities regulate the time we spend at home and outdoors and thus affect our exposure to crime. Moreover, as already mentioned, time schedules could moderate the association of other environmental variables with the crime, such as, for example, the temperature (Tompson and Bowers, 2015; Towers et al., 2018). The warmest days do not hold constant the temperature over the day. Generally, during the hottest days of the year, temperatures are more pleasant in the evening, which can make individuals to look for a fresh indoor place to socialize during the day, and later socialize outdoors. Offenders are also aware of those behaviors and will take advantage of the best opportunities. Again, the temporal interval in which offenders will consider to act will depend on the type of offense.

The lighting level or, conversely, the level of darkness could also be relevant. It can be seen as an indicator of the hour of the day when the crime is committed but also, lighting/darkness can play a role in facilitating crime by increasing the offenders' awareness of the space or by reducing visibility, and therefore, the capability of potential guardians (Pooley and Ferguson, 2017; Tompson and Bowers, 2013). Previous research on temperature and level of darkness in street robberies in London and Glasgow found that level of darkness was more relevant than temperature (Tompson and Bowers, 2013).

Focusing on the day of the week, the discretionary activities during the weekends can create more crime opportunities. When focusing on violent events, consumption of alcohol and other substances by youths during leisure time on the weekends could lead to the presence of more vulnerable, and therefore, suitable victims for theft or robbery, for example, but also to more individuals susceptible to engage in aggressive behavior, such as starting a fight. In nightlife, in addition to substance use, the absence of adults or other kinds of guardians may increase the likelihood of the mentioned crimes. But it can also play a

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role in sexual crimes in which the victim is in a situation of vulnerability and the context provides enough criminogenic risk factors for individuals to offend. Previous research exploring youth delinquency prevalence during weekends and bank holidays versus working days has shown mixed results, but this could be a consequence of the type of crime analyzed (Ceccato, 2005; Tompson and Bowers, 2015). For example, (Ceccato, 2005), studying homicides in Sau Paulo, Brazil, found that weekends and holidays were significant predictors in all applied models, with most killings taking place on weekends during the evenings. Similarly, Pooley and Ferguson (2017) found that most cases of misuse of fire by youths occurred on weekends. In contrast, Tompson and Bowers (2015) reported a statistically significant negative correlation between robberies and weekends and a lack of statistically significant relation with public holidays. From the RAA, it is easily understandable why weekends, public holidays or vacation time would be related to crime frequency in a different way, according to the crime type. The same will happen with other factors that shape people's routines and convergences in space and time. Opportunities are specific for each crime type (Tompson and Coupe, 2018): for example, some crimes will take advantage of concentrations of people in public spaces, while for others, the best opportunity occurs when are hardly any people present.

Other Environmental Event Characteristics: Type of Place and Company

The place where crime occurs has been a matter of interest for scholars studying delinquency from an environmental perspective (Brantingham and Brantingham, 1982; Cohen and Felson, 1979). When engaging in obligatory and discretionary activities, young offenders construct their activity and awareness space. Places that there are familiar to them because they spend a great part of their time there (Brantingham and Brantingham, 1993). For instance, the routes to school, or to their leisure activity nodes. In those places, young offenders will converge with some suitable victims, or they will be aware of the most attractive targets. Previous studies have confirmed that young people tend to offend near the places where they spend most of their time (Bernasco, 2019; Drawve et al., 2015; Trinidad et al., 2021; Weisburd et al., 2009). For instance, the presence of certain facilities—such as shopping areas, movie theaters, or schools—has been associated with an increase of the youth delinquency (Bichler et al., 2014; Trinidad et al., 2021; Weisburd et al., 2009).

Type of place and companions also play a relevant role in youth delinquency. Discretionary activities without specific goals in specific places with peers, identified by Osgood et al. (1996) as "unstructured socializing," could lead young people to commit certain type of crimes. Overall, the presence of peers has been identified as a fundamental risk factor in youth delinquency (Burt and Rees, 2015; Osgood et al., 1996). Research on this topic has found that it can encourage young people to consume substances, to behave aggressively, or to commit acts of vandalism (Burt and Rees, 2015; Hoeben and Weerman, 2016;

Tanner et al., 2015). Often, when young people spend time with their peer groups, they do not participate in structured activities and instead hang out or socialize in an unstructured way. This unstructured socialization with peers in the absence of supervision has been found to be a robust predictor of any type of youth crime, as confirmed by several studies (Hoeben and Weerman, 2014, @hoeben_why_2016; Maimon and Browning, 2010; Osgood et al., 1996). From the RAA, the lack of capable guardians when socializing with peers in locations with a low presence of other citizens could create the perfect setting for a young person to engage in certain types of crimes, for example, vandalism. In previous research concerning the type of place, unstructured socializing in public and semi-public places has been found to be more related to youth delinquency than socializing in private spaces (Hoeben and Weerman, 2014). Therefore, the characteristics of the settings have significant predictive power regarding youth delinquency (Bernasco, 2019).

The Present Study

In the current study, we explore the meteorological, temporal, and environmental characteristics of both violent and non-violent youth crimes in the Basque Country region, located in northern Spain. Specifically, we examine whether temperature, rain, weekend/public holidays, time, and darkness levels are associated with violent and non-violent criminal events. Moreover, we explore whether there are associations between the type of place (crime setting) or companionship (being alone vs. being accompanied) and the occurrence of these events. Additionally, as previous research has found, we examine whether each category of youth offense—violent or non-violent—shows seasonality. Our study aims to contribute further evidence to the (limited) research literature regarding youth delinquency and temporal-meteorological characteristics while offering further insight into the possible reasons for the discrepant findings that currently exist among international studies. Based on previous evidence, our hypotheses are as follows: 1. We expect to find seasonality in violent and non-violent offenses. Specifically, we assume that there will be a higher incidence of both violent and non-violent offenses during the summer months.

2. Regarding meteorological variables and following the RAA, we anticipate that higher temperatures will be associated with more violent offenses (more than non-violent offenses) and that rainfall will be associated with less violent offenses.

3. Concerning temporal patterns, we expect to find that natural darkness will be more strongly associated with violent offenses than non-violent offenses; and that youths will commit more violent offenses than non-violent ones at weekends and public holidays.

4. Finally, we expect that youths will be more likely to commit violent offenses when accompanied in public places. In the following section, we

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will describe the data collection and codification process as well as the analytical strategy employed.

Data and Analytical Approach

Juvenile Crime Events

The data on youth delinquency events were provided by the Basque police (Ertzaintza). A total of 2,174 incidents involving youths aged between 12 and 17 years were recorded in the Basque Country (Spain) over a period of 5 years (2011–2015). For each incident, the police had recorded the following information: the date when the event took place, the people involved (identified with a unique ID), their birth date, their birth country, the type of offense, the neighborhood where the offense took place, and the city. To construct the main variable, we dichotomized the cases by coding them as violent (1) and non-violent (0). The violent events (N = 1,004) included offenses such as homicide, attempted sexual aggression, aggravated assault, and domestic violence. The non-violent events (N = 1,170) included offenses such as crimes against public health (drug-related crimes, such as consumption, possession, or dealing), against traffic safety, motor vehicle thefts, shoplifting, thefts, and vandalism.

Meteorological Information

We collected the meteorological data from the detailed historical information that is registered by the Basque Meteorological agency (Euskalmet[1]) in its weather stations. Once we had identified the date when an event occurred and the neighborhood where it was committed, we were able to gather information on temperature (ºC) and rainfall (mm). To do so, we selected the nearest weather station to the neighborhood where the event was committed and the closest registered hour according to the date and time of the event. The historical data gathered by Euskalmet offers information recorded at ten-minute intervals; thus, if an event occurred at 09:18, we used the data recorded at 09:20.

Darkness and Non-Working Days

To determine the level of darkness for the analyses, we followed the method used by Tompson and Bowers (2013). We divided the day into four shifts (4 a.m.–9.59 a.m.; 10 a.m.–3.59 p.m.; 4 p.m.–9.59 p.m.; and 10 p.m.–3.59 a.m.), and a value of 0 was given to the offenses that took place in the shifts where there is no darkness at all (10 a.m.–3.59 p.m.), whilst those events that occurred in a shift of darkness (10 p.m.–3.59 a.m.) were given a value of 1 (representing 6 hours of darkness). We calculated the proportional time considering the sunrise and sunset hour for the offenses committed in the shifts in which there was a change from daylight to darkness or vice versa.

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[1] http://www.euskalmet.euskadi.eus/s07-5853x/es/meteorologia/datos/mapaesta.apl?e=5

Moreover, to determine whether an event had occurred at the weekend, we followed the criterion used by Tompson and Bowers (2015) and classified the weekend as covering the period from Friday 4 p.m. to Monday 4 a.m. Thus, we codified it as a dichotomous variable (Weekend = 1; Weekday = 0). Regarding public holidays, we used the work calendars obtained from the Department of Employment and Social Affairs of the Basque Government to dichotomously codify the events (Public holiday = 1; Workday = 0).

Type of Places and Companions

We classified the type of places where the event occurred as public (spaces where access is completely free, such as parks, squares, public parking, and streets), private (the home or someone else's home), and semi-public (spaces neither private nor public), following the procedure of Bernasco et al. (2013a). Regarding companions, we assigned a value of 1 to those cases in which more than one person committed the offense and 0 for offenses committed alone.

Analytical Approach

After calculating descriptive statistics, we used various types of analysis. First, a one-way ANOVA was employed to explore the seasonality of violent and non-violent events. To do so, we aggregated the crime events by day forming our dependent variable. We then classified the days of each month in one of the four seasons, which form our independent categorical variable. We assigned each day to one of the four official seasons in our location. Then, we ran the one-way ANOVA for comparing the daily juvenile offense mean for each season.

Second, we conducted a contingency table analysis to explore the association between the studied variables and the type of crime event (violent and non-violent). Some of the variables were categorized and dichotomized in order to run the contingency tables. Temperature, for example, was divided into quartiles, creating four categories: Low (−1.7°C–10.8°C), Mid-low (10.9°C–14.9°C), Mid-high (15°C–19.1°C), and High (19°C–35°C). We then created two levels of temperature: "<19.2°C" and ">19.2°C," which, in our data, corresponded to "non-high temperatures" and "high temperatures." Rainfall was recoded as "Rainy days" and "Non-rainy days." As with temperature, the level of darkness was categorized into quartiles and then dichotomized into "zero or low darkness level" (0–.71) and "almost total or high darkness level" (.71–1) -from now on, we will refer to high darkness as "darkness" and low darkness as "lightness." We also categorized the type of place into two variables: "private spaces" and "semi-public or public spaces". For statistically significant associations, we calculated the odds ratios (OR) as a relative measure of the effect size (Cook and Sheikh, 2000; Field et al., 2012). In addition to the 2×2 contingency tables for each variable and the type of crime event, we also ran a contingency table analysis to study the three-way interaction. We used this type of analysis to explore if the presence of a third variable could affect the association between our depen-

dent and independent variable. To do so, we considered the crime type (violent vs. non-violent) as our dependent variable and used the combination of the previously mentioned independent—categorized—variables to form the three-way interaction tables. First, we tested for homogeneous association among the combination of the three variables: that is, the type of crime with another independent variable (e.g., darkness level) and adjusted by another variable (e.g., rain). We used the Breslow-Day test: if a homogenous association is found, then we can conclude that there is no interaction between two variables while adjusting by a third one Agresti (2006). For those combinations of variables where interaction was found, we then explored the partial 2×2 tables. That is, we explored the conditional association between an independent variable and our dependent variable adjusted by one of the levels of the third variable. If the partial tables showed significant association, then the conditional odds ratios were calculated. The descriptive statistics are displayed in Table 1.

Table 1: Descriptive Statistics for the Independent Variables

Variables	Levels	Frequency	%
Temperature	< 19. 2 ºC	1557	75.36
	> 19. 2 ºC	509	24.64
Total		2066	100
Rain	Yes	1002	48.48
	No	1065	51.52
Total		2067	100
Darkness level	Lightness	1536	73.42
	Darkness	556	26.58
Total		2092	100
Public Holiday	Yes	85	33298
	No	2089	96.09
Total		2174	100
Weekend	Yes	884	40.81
	No	1282	59.19
Total		2166	100
Type of place	Private	636	29.28
	Semi-Public or Public	1536	70.72
Total		2172	100
Companionship	Yes	907	43
	No	1202	57
Total		2109	100

Results

Seasonality

The one-way ANOVA conducted for the violent events did not reveal significant differences between seasons ($F(3,362) = 0.42$, $p> .05$). However, the analysis for non-violent events revealed differences between the spring and summer months in comparison with autumn ($F(3,362) = 5.88$, $p < .001$) (see Figure 1). Specifically, the *post hoc* Scheffe test ($p < .05$) revealed that the mean number of non-violent offenses per day decreases from 3.70 (spring) and 3.44 (summer) to 2.59 (autumn).
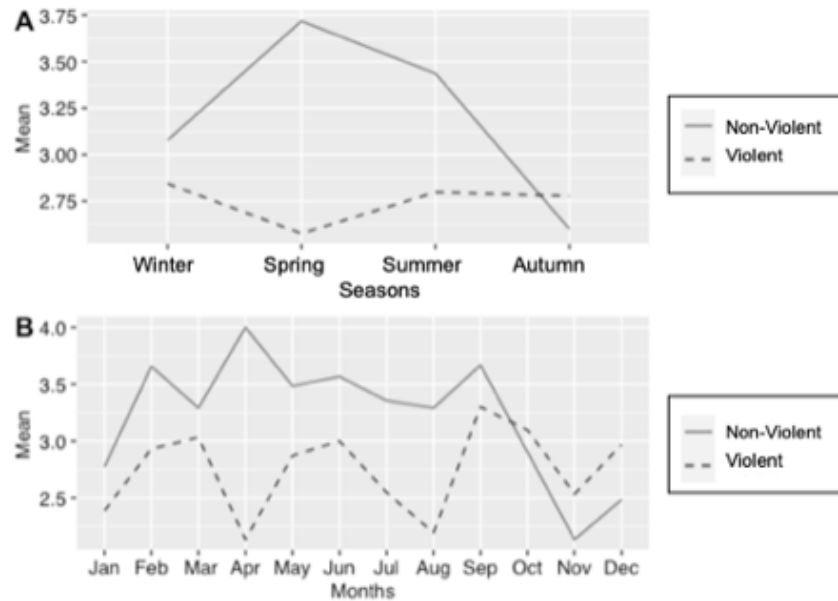
Figure 1: Trends in Youth Crime According to Season and Month

Characteristics of Violent and Non-Violent Crime Events

The results of the Chi-square tests revealed that temperature, rain, and weekends-public holidays were not significantly associated with the type of crime event in our sample. Tables 2 to 5 display the contingency tables showing the observed frequencies of the variables found to be significantly associated with the type of crime. In terms of darkness level (Table 2), we can see that in general, both types of crimes occur more frequently during daylight hours ($N = 1,536$ crime events during lightness hours compared with $N = 556$ events during darkness hours). However, as shown in the contingency Table 2, the

analysis of the standardized residuals revealed that violent crimes are more frequent than expected by chance during dark hours, while non-violent crimes happen less frequently than expected during dark hours. As a result, even if both crime types happen more during lightness hours, a violent crime is more likely than a non-violent one to happen during darkness hours (OR[2] $= 1.59$; 95 % CI[3] [1.31, 1.94]; χ^2 (1, $N = 2{,}092$) $= 22.26$, $p < .001$).

Table 2: Contingency Table for Darkness Level and Type of Crime Event

		Type of Crime Event	Type of Crime Event	
Darkness level		Violent	Nonviolent	Odds
Darkness	Number	304	252	1.21
	Expected	256.48	299.53	
	Std. Residual	2.97	-2.74	
Lightness	Number	661	875	0.76
	Expected	708.53	827.47	
	Std. Residual	-1.77	23743	
Total		965	1127	OR= 1.59

Table 3: Contingency Table for Public Holidays and Type of Crime Event

		Type of Crime Event	Type of Crime Event	
Public Holiday		Violent	Non-Violent	Odds
Yes	Number	49	36	1.36
	Expected	39.26	45.74	
	Std. Residual	1.55	-1.44	
No	Number	955	1134	0.84
	Expected	964.75	1124.26	
	Std. Residual	-0.31	0.291	
Total		1004	1170	OR= 1.62

Table 4: Contingency Table for the Type of Place and Type of Crime Event

		Type of Crime Event	Type of Crime Event	
Type of places		Violent	Non-Violent	Odds
Semi-public & public	Number	475	1061	0.45
	Expected	710.01	825.99	
	Std. Residual	-8.82	8.18	
Private	Number	529	107	4.94
	Expected	293.99	342.01	
	Std. Residual	13.71	-12.71	
Total		1004	1168	OR= 11.04

Table 5: Contingency Table for Companionship and Type of Crime Event

		Type of Crime Event	Type of Crime Event	
Companionship		Violent	Nonviolent	Odds
Yes	Number	291	616	0.47
	Expected	412.86	494.14	
	Std. Residual	-5.99	5.48	
No	Number	669	533	1.26
	Expected	547.14	654.86	
	Std. Residual	5.21	-4.76	
Total		960	1149	OR = 2.66

Figure 2 shows the percentage of violent and non-violent youth offenses according to time. Most violent offenses occur during the afternoon hours. However, a peak of the violent offenses appears between 10 p.m. and 11 p.m., coinciding with the dark hours. Non-violent offenses tend to occur during the late afternoon hours, reaching a peak between 7 p.m. and 8 p.m. Depending on the season, the level of lighting will be low (one could even find a high level of darkness during the winter), or it will be high (during the summer) at those hours of the day.
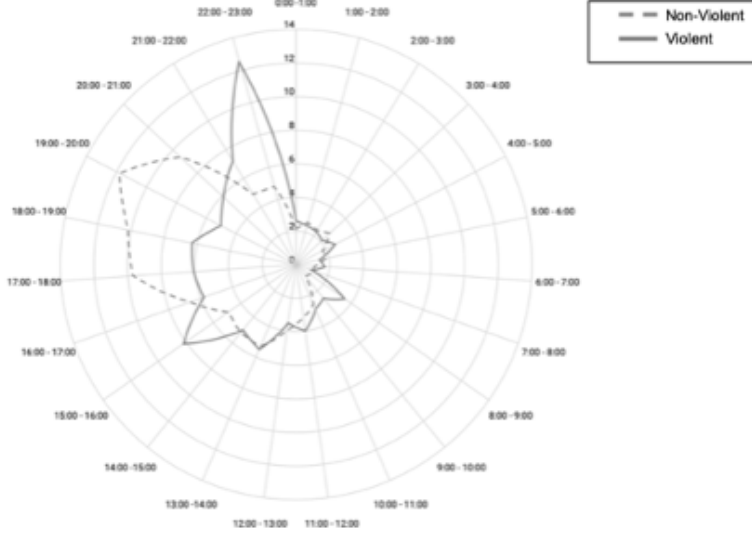
Figure 2: The Percentage of Recorded Youth Offenses According to Time of Day

The results also indicated an association between the type of crime and whether it was committed on a public holiday (Table 3), χ^2 (1, N = 2,174) = 4.68, p < .05. In our sample, most of the crimes have taken place during non-public holidays (N = 2,089). However, the result shows that public holidays raise the odds of violent crimes (OR = 1.62; 95% CI [1.04, 2.51])—but it should be noticed that the crime frequency is lower, mainly due to the few public holidays versus non-public holidays in a year.

The results of the Chi-square test revealed a significant association between the type of crime event and the type of place (Table 4), χ^2 (1, N = 2172) = 494.00, p < .001. Most of the crime events occurred in semi-public and public places. However, when going deeper into the results, we can see how violent crimes are more frequent than expected by chance in private places. More specifically, the odds of violent crimes occurring in a private place was 11.04 times greater than the odds of these taking place in a semi-public or public place (OR^4 = 11.04; 95% CI [8.74, 13.96]).

Finally, a significant association was found between companionship and the type of crime, χ^2 (1, N = 2,109) = 115.83, p < .001. As Table 5 shows, in our sample, most crimes occurred in the absence of a companion. Further exploration of

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[4]OR = odds private/ odds semi-public & public.

this relationship revealed that committing the crime alone raises the odds of the violent crime (OR[5] = 2.66; 95% CI [2.22, 3.18]).

Three-Way Interactions

A limitation of the contingency tables is the lack of control of the covariate effect among the other variables. Considering the nature of our variables, we can expect associations between them. As described in the "Analytical Approach" section, we conducted Breslow-Day tests (see Table 6) in order to identify whether there was interaction between the crime type and each one of the measured independent variables in the presence of a third independent variable. We display only the statistically significant results of the Breslow-Day tests— that is, rejecting the homogenous association—in the Table 6. We then ran the 2×2 partial table analyses—see Tables 7 to 10—with those combinations that showed interaction and calculated the conditional odds ratios to measure the strength of the conditional relation.

Table 6: Three-Way-Interactions: Breslow-Day tests.

Dependent variable	Independent	Covariate	Breslow—Day test on homogeneity of odds ratios
Crime type	Darkness level	Rain	$\chi^2_{BD}(1) = 5.1$, $p = .02$
Crime type	Darkness level	Public holidays	$\chi^2_{BD}(1) = 7.5$, $p = .006$
Crime type	Darkness level	Type of place	$\chi^2_{BD}(1) = 7.5$, $p = .006$
Crime type	Companionship	Type of place	$\chi^2_{BD}(1) = 74$, $p = .000$

Table 7: Three-Way-Interaction Table: Crime Type - Darkness Level - Rain Frequencies and Percentages of Violent Events

		Crime Type	Crime Type	
				Violent
		Violent	Non-Violent	
No	Darkness	172	115	59.93
	Lightness	335	443	43.06
Yes	Darkness	127	135	48.47
	Lightness	317	423	42.84
Total	No	299	250	54.46

[5]OR = odds alone/ odds in company.

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	Crime Type	Crime Type	
Yes	652	866	42.95

Table 8: Three-Way-Interaction Table: Crime Type - Darkness Level - Public Holidays Frequencies and Percentages of the Violent Events

		Crime Type	Crime Type	
				Violent
		Violent	Non-Violent	
No	Darkness	286	233	55.11
	Lightness	634	862	42.38
Yes	Darkness	18	19	48.65
	Lightness	27	13	67.5
Total	Darkness	304	252	54.68
	Lightness	661	875	43.03

Table 9: Three-Way-Interaction Table: Crime Type - Darkness Level - Type of Place Frequencies and Percentages of the Violent Events

		Crime Type	Crime Type	
				Violent
		Violent	Non-Violent	
Semi-Public or Public	Darkness	156	222	41.27
	Lightness	302	811	27.13
Private	Darkness	148	29	83.62
	Lightness	359	63	85.07
Total	Darkness	304	251	54.77
	Lightness	661	874	43.06

Table 10: Three-Way-Interaction Table: Crime Type - Companionship - Type of Place Frequencies and Percentages of the Violent Events

		Crime Type	Crime Type	
				Violent
		Violent	Non-Violent	
Semi-Public or Public	No	223	487	31.41
	Yes	236	559	29.69
Private	No	446	46	90.65

		Crime Type	Crime Type	
	Yes	55	55	50
Total	No	669	533	55.66
	Yes	291	614	32.15

When exploring the three-way interaction between the type of crime, darkness level, and whether it rained, we only found associations in the absence of rain. Specifically, although in general, most crime events happened during daylight hours, during dark hours and in the absence of rain, violent events were more likely to happen ($OR = 1.98$; 95% CI [1.50,2.60]; χ^2 (1) = 23.925, $p = .00$) (see Table 7).

Moreover, the 2 × 2 partial tables (see Table 8) exploring the three-way interaction between crime type, darkness level, and public holidays, showed that the crime type and the darkness level were only associated in workdays (No Public Holiday: χ^2 (1) = 25, $p = .00$; Yes Public Holiday; $\chi^2(1) = 2.1$, $p = 0.1$). In general, most events happened during the daylight on workdays (not public holidays). But when expressly looking at events that happened during darkness workdays, it was more likely for a violent crime to occur ($OR = 1.67$; 95% CI [1.365, 2.041]).

When exploring the interaction between crime type, darkness level, and the type of places, the analysis of the partial tables (see Table 9) showed that the darkness level and crime type were associated only when the type of place was semi-public or public, χ^2 (1) = 23.83, $p = .00$. Overall, most crime events happened during daylight. During the daylight, non-violent crimes were most likely to happen; specifically, 89% more likely ($OR = 1.89$; 95% CI [1.479, 2.408]).

Last, exploring in further detail the interaction between crime type, companionship, and the type of place, the analysis of the 2 × 2 partial table (see Table 10) depicted that there was an association between companionship and the type of crime only in private places, χ^2 (1) = 106.396, $p = .00$. Specifically, in private settings, when being alone, a violent offense was far more likely to happen ($OR = 9.699$; 95% CI [9.99, 15.69]).

Discussion

In the current study, we explored how environmental variables (meteorology, temporal patterns, type of place, and companionship) that can affect youths' routine activities, are associated with violent and non-violent youth crimes. First, our results suggest that there are seasonal variations in the incidence of non-violent crimes. In particular, spring and summer seasons were associated with a higher incidence of non-violent offenses in comparison to autumn, while there were no statistically significant seasonal differences concerning violent offenses. Second, the analyzed variables temperature, rain, and day of the week

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(weekend or weekday) were not associated with the type of crime. Third, our findings suggest that while most of the offenses committed by youths occurred during the hours of daylight, during the hours with higher levels of darkness, violent crimes were more likely to happen than non-violent crimes. Fourth, while most of the crime events happened during non-public holidays days, our results showed that on public holidays violent crimes were more likely than non-violent ones. Fifth, regarding the type of place, violent offenses occurred more often in a private place than in semi-public or public places, whereas non-violent offenses were more frequent in semi-public or public places. Finally, violent crimes occurred more when being alone than in company; meanwhile, non-violent crimes are more frequent in company than alone. Therefore, our results partially support our initial expectations. Hypothesis 1, which anticipated crime seasonality, was only supported for non-violent offenses committed by young people. Our second hypothesis—that high temperatures would enhance the likelihood of violent offenses occurring while rain would make violent offenses less likely to happen—was not supported. Hypothesis 3, which predicted that darkness, weekends, and public holidays would be associated with a higher number of violent offenses, was supported in terms of the relative higher likelihood of crimes occurring during darkness hours in public holidays. Finally, we found no support for Hypothesis 4, in which we anticipated that public places and companions are factors that increase the prevalence of violent crimes.

The seasons in which the weather is pleasant, such as spring or summer, encourage people to participate in more outdoor activities, whilst seasons with adverse weather (autumn and winter) compel people to stay at home. In this regard, from the routine activity approach (Cohen and Felson, 1979), certain meteorological conditions could favor the convergence of potential youth offenders and their victims/targets in a specific space. At least for the case of non-violent events, our findings appear to support this idea since we observed a higher number of these offenses during the spring and summer seasons. In contrast, our findings for violent events committed by young people differ from those reported previously (e.g., Breetzke and Cohn, 2012; Ceccato, 2005). These results partially support Hypothesis 1, showing a degree of seasonality for non-violent events but not for violent events. One plausible explanation for these results could be the number of violent offenses that usually take place in private places, such as the home. Most of those offenses—intimate partner violence or domestic violence ($N = 498$)—would not be expected to depend on seasonal changes. Another possible explanation could be that violent crimes require a higher level of conviction of the transgressor in comparison with non-violent crimes. Therefore, it is possible that violent offenses are less likely to be associated with peripheral factors, such as the meteorological variables studied here.

The temperature was not found to be statistically significantly associated with the type of crime. There are a number of possible explanations for these findings. For example, in our sample, the temperatures found could hardly be considered as high (mean = 14.9°C (SD = 6.02°C); median = 14.9°C; and mode = 12.6°C). When looking at the range of temperatures in which the violent events occurred

in our sample, most of the cases occurred when the temperature was between 10°C and 20°C. It seems logical to assume that these temperatures are not extreme enough to be considered unpleasant. Thus, regardless of the temperature, people engage in their usual activities. Further research, however, is needed to confirm this possibility.

Moreover, according to the assumptions of the RAA, we expected to find that rainy weather would be associated with fewer violent crimes. Initial inspection of our data suggested that this was not the case. Moreover, the analysis of the three-way interaction between the type of crime and the darkness level adjusted by the rain did not reveal much more information than previous contingency tables. Partial contingency tables only showed an association between the darkness level and the type of crime in the absence of rain. In this case, violent crime also was more likely during dark hours and non-violent during daylight hours. One possible reason for the lack of an initial association between rain and type of crime could be the meteorological conditions of the region and how such factors are associated with the leisure time of young people in the Basque Country. According to the Spanish Meteorological Agency, AEMET (AEMET, 2019), the Basque Country is one of the rainiest regions throughout the year, and, therefore, Basque youths have found alternative ways of spending their leisure time outside the home. Thus, despite these weather conditions, the youth can share rented premises with peers or spend time in shopping centers. However, we should also mention that categorizing a day as "rainy" based solely on whether it has rained at some point during the day can be misleading. Indeed, in the Basque Country, it is common to have significant variations in weather conditions during any given day. Therefore, it could be that on days categorized as rainy, no rainfall has been recorded most of the time when the routine activities were carried out, which means that the results related to this variable should be interpreted with caution.

Our results also confirmed an association between darkness and violent offenses, which has previously been reported by other authors (Tompson and Bowers, 2013). As Tompson and Bowers (2013) pointed out, darkness might limit the effectiveness of guardians whilst enhancing the perceived anonymity of potential offenders. It is also important to note that darkness is an essential element to consider when planning the modus operandi of a crime. Indeed, the Spanish Criminal Code considers darkness to be an aggravating factor. However, the association between violent events and the level of darkness is undoubtedly related to the time of day and to certain routine activities. Knowing that some of the high and medium levels of darkness were codified as evening hours, and when inspecting Figure 2, we can infer that most of the violent misbehavior occurs during after-school hours. Regarding violent crimes committed in the private sphere (where the incidence of these crimes is higher than in public), darkness cannot be considered a relevant variable. And if we focus our attention on whether this same type of crime (or even non-violent crime) is committed in the semi-public or public sphere, it seems reasonable to think that evening and night-time are not being used as a cover or refuge for committing crimes but

are instead associated with the routine activities of young people in the absence of natural light, such as inappropriate consumption of alcohol or other toxic substances. In any case, this assumption should be taken with caution since our data did not allow us to test it.

Our findings regarding the type of place and the presence of companions when offending—while contrary to our hypothesis—can shed some light on the meteorological and environmental characteristics associated with violent and non-violent crimes committed by young people. Thus, according to our data, a high number of violent offenses are committed in private places, without company, and in the afternoon-evening hours, which could be explained by the high number of offenses classified as intimate partner violence and domestic violence in our sample, which often take place at home. However, non-violent offenses appear to occur in public or semi-public places, in the company of others, and during the afternoon hours (or daylight hours, see Table 9). To a certain extent, these results could be understood in terms of the premises of the routine activity approach. Felson (2016) suggests that the "hanging out" activities of youths can lead to criminal situations that were unplanned, an idea that is compatible with findings that suggest a link between unstructured and unsupervised socializing with peers and youth delinquency (Bernasco et al., 2013b; Osgood and Anderson, 2004).

The frequency of crime events during public holidays was far lower than during workdays which it is understandable considering that there are a few public holidays over the year. But also, during the public holidays most parents do not have to work, which in terms of RAA could be translated into more capable guardians monitoring youths' activities (Cohen and Felson, 1979). As previous evidence has pointed out, parental monitoring can be a protective factor against delinquency, at least for a certain type of adolescent (Janssen et al., 2016).

We should acknowledge some limitations of our study. First, we only used police records to measure youth delinquency, and it is known that police data are not gathered for research purposes, and therefore information relevant to the aims of our study could be missing. Additionally, and as the literature has repeatedly highlighted, police data can only provide information about those offenses that were reported or where the police intervened, thus excluding those events that have not been officially registered. Future studies could combine police data with self-reported surveys and semi-structured interviews to compile a complete view of the specific situation (see more in Hardie, 2020). There is a need for more detailed information on when and where the offense took place, along with the reasons why youths decided to offend under some conditions and not others. Another limitation is that we measured the level of natural darkness but not artificial light. Future research could systematically analyze the level of darkness and other spatial features of the places where youths have offended by using recently developed fieldwork tools (see, e.g., Ceccato, 2019).

Despite these limitations and the impossibility of inferring causal relationships due to the nature of this design, we believe that our research contributes to the

current literature by showing the association that environmental variables have (or do not have) with the types of crimes committed by juveniles. Moreover, our findings suggest ideas for future research and are also of practical relevance. They highlight the importance of public places and the company of other people as factors in non-violent youth delinquency. As previously mentioned, future studies could examine the specific characteristics of those public spaces where youths gather and offend, while local authorities could improve both formal and informal surveillance to deter youths from offending. Previous research has shown a decrease in crimes against property in areas where the police indirectly let offenders know that the neighbors actively report any misbehavior (e.g., by using posters in high crime concentration areas, Nussio and Céspedes, 2018). We also found that most of the violent crimes occurred when being alone and that more than half of the violent offenses happened in a private place. For these cases, when the youth is alone in the private sphere, contextual influences related to the role of peers or to the design and activities carried out in the urban space will play no role, and individual and familiar level variables could be more relevant.

On the other hand, for those violent offenses happening in public areas, since natural darkness is strongly associated with the timing of certain leisure activities pursued by young people, preventive measures should be aimed not only at improving urban lighting but also at promoting healthy and exciting (but risk-free) forms of entertainment. As a final thought, we must acknowledge that, given the environmental nature of the explored variables, research in other contexts could yield rather different results, and such context-specific characteristics could be vital for designing crime prevention measures that are adapted to each environment. For this reason, there is a need to replicate the findings reported here to establish the juvenile crime patterns of different countries and regions.

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