

1 **A comprehensive study of dog bites in Spain, 1995-2004**

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22

23 **Abstract**

24 Dog bites in humans are a complex problem embracing public health and animal
25 welfare. To prevent dog bites it is necessary to have comprehensive epidemiological
26 data that allow the identification of associated risk patterns. This study was aimed at
27 investigating the problem posed by dog bites in Spain. The epidemiology of medically
28 attended dog bite-related incidents reported in Aragón was analysed from 1995-2004.
29 Bite incidents were mostly associated with (1) low-population areas (71.3/100,000
30 inhabitants); (2) males and children, particularly those aged 5-9; (3) single injuries
31 directed to the head and neck area in children and to the extremities in adults; (4) young,
32 male, medium to large, owned dogs that were known to the victim; (5) summer months,
33 and (6) specific circumstances such as human interference with knocked down and
34 fighting dogs. In the light of these risk patterns, a wide range of specific preventive
35 measures could be proposed.

36

37 *Keywords:* Dog bites, Epidemiology, Risk factors, Public health, Canine aggression

38

39 **Introduction**

40 Dog bites in humans are a complex phenomenon in which three main types of
41 elements come into play and interact to some extent, namely the victim, the animal and
42 the scenario (reviewed by Overall and Love, 2001; Palacio et al., 2005). Data on dog
43 bites come mainly from studies in hospitals and public health departments (Arini et al.,
44 2002; Kahn et al., 2003; Ostanello et al., 2005; Schalamon et al., 2006), and most of the
45 available scientific literature has analysed information related to the victim whereas the
46 characteristics of the biting dog and the circumstances surrounding the incident remain
47 less well documented (AVMA, 2001; Palacio et al., 2005; Messam et al., 2007; Reisner
48 et al., 2007).

49
50 Fortunately, only a very small proportion of dog bites results in the death of the
51 victim (Sacks et al., 2000). However, the consequences of the injuries (Calkins et al.,
52 2001; Peters et al., 2004) and the treatment expenses (Weiss et al., 1998; Hoff et al.,
53 2005) have turned dog bites into an issue of considerable public health importance. On
54 the other hand, the development of aggressive behaviour in dogs often leads to
55 euthanasia or relinquishment to shelters, which poses a problem in terms of animal
56 welfare (Hunthausen, 1997; Fatjó et al., 2006).

57
58 Experts stress that many non-fatal (DeKeuster et al., 2006; Mills and Levine, 2006)
59 and fatal dog attacks (Sacks et al., 2000; De Munnynck and Van de Voorde, 2002)
60 could be prevented. In order to provide suitable and effective preventive measures it is
61 essential therefore to start by examining all of the epidemiological data. This would
62 facilitate the definition of geographical high-risk areas, as well as the identification of
63 patterns associated with dog bites with regard to the victim, the animal and the trigger

64 factors. It is important to emphasise that multiple studies are needed since the incidence
65 of dog bites and some associated risks may vary according to the area of study. These
66 differences might in turn determine the shaping of the prevention strategy plan (AVMA,
67 2001).

68

69 In Spain there is little scientific literature on the subject of dog bites (Gracia et al.,
70 1992; Knobel et al., 1997; Palacio et al., 1998; Méndez et al., 2002). Our team has
71 carried out a complete research in the Valencia region (León-Artozqui et al., 2004;
72 León, 2006) but to our knowledge, no other similar studies have been performed to date.
73 The purpose of the present study was to investigate the problems posed by dog bites by
74 analysing the epidemiology of medically attended dog bite related-incidents in Aragón
75 over a 10-year period. The incidence was calculated in a high- and a low-population
76 area and incidents were described from a three-fold perspective by looking at the victim,
77 the animal and bite scenario related factors.

78

79 **Materials and methods**

80 Dog bite-related incidents reported between 1995 and 2004 to the Public Health
81 department of Aragón were collected. The region (47,719.2 km²) is situated in the
82 North-East of Spain and comprises three provinces with a total of 730 municipalities.
83 According to specified public health criteria, these municipalities are grouped into 44
84 Veterinary Areas (VA).

85

86 Information for each VA was obtained from the Rabies Control and Prevention
87 Programme, where staff from the Public Health Centre (e.g., primary care centre,
88 emergency department etc.) who attended the victim had completed a record sheet

89 relating to the incident and reported it to the Public Health authorities within the
90 respective VA. Subsequently, the dog had been subjected to an observation period,
91 carried out by Official Veterinarians.

92

93 Human demographic data (total population and distribution according to sex and age
94 range) were extracted from the 2001 Official Census. At that time, the population
95 totalled 1,204,215 inhabitants and, of these, 53.6% lived in the region's capital area.

96

97 In order to avoid bias and to detect possible geographical risk areas, data on the
98 number of cases were divided into two, namely a high-population area (average density:
99 337.6 inhabitants/km²), and a low-population area (average density: 12.2
100 inhabitants/km²). The former consisted of the VA made up of the region's capital (a
101 major city) plus some adjacent municipalities, and the latter grouped the rest of the
102 VAs, made up of towns and villages. Only post-1997 data were available in the high-
103 population area.

104

105 The types of injuries were classified according to WHO recommendations (WHO,
106 1996).

107

108 *Statistical analysis*

109 The annual incidences of dog bite-related incidents over the 10-year period (1995-
110 2004) were first calculated for the high- and the low-population areas. The average
111 annual incidence (weighted mean by population density) was expressed as the number
112 of bites incidents per 100,000 inhabitants. The relationship between the incidence of

113 dog bites and the population density of the VA was also studied using the Spearman
114 correlation test.

115

116 Secondly, a unifactorial descriptive analysis was performed for all available
117 variables related to the victim, the animal and the scenario of the incident. In addition,
118 some variables related to the victim (sex, age and injury site) were analysed in order to
119 detect possible risk factors in the occurrence of bite incidents. A Case-Control study
120 was designed and Odds Ratio (OR) and Confidence Interval (CI) were calculated.
121 Variables were considered positively associated with dog bite-incidents when $OR > 1$
122 (risk factor), and negatively when $OR < 1$. The Chi-square test was used to determine the
123 statistical significance of the association.

124

125 Calculations were carried out using the statistical programme StatView for
126 Windows (SAS Institute, 1992-1998). Estimations of OR and CI were performed using
127 the epidemiological programme Win Episcope 2.0 (Thrusfield et al., 2001). The level of
128 significance was set at $P < 0.05$.

129

130 **Results**

131 A total of 4186 dog bite-related incidents were reported between 1995 and 2004 in
132 Aragón but the availability of information differed among the different sections of
133 study.

134

135 *Incidence*

136 The average annual incidence of dog bites during the period of study depended on
137 the area, namely 12.8/100,000 inhabitants in the high-population area and 71.3/100,000

138 inhabitants in the low-population area. A negative and significant correlation was
139 detected between the population density of the VA and the incidence of dog bites ($r_s = -$
140 0.38 ; $P = 0.013$).

141

142 *Victims*

143 Demography

144 The number, proportion and OR of dog bite related-incidents according to sex and
145 age group of the victim are shown in Table 1. Both variables were significantly
146 associated with the occurrence of dog bites ($P < 0.001$). Males comprised 62% of the
147 victims and were a risk factor. Children in the age group 0-14 represented the victims in
148 almost one-third of the cases (30%) and the risk of being bitten was three times that of
149 people aged 15 years or more. Among children, those most at risk were the age group 5-
150 9. Fig. 1 shows the incidence of dog bite related-incidents in male and female victims
151 according to the different age ranges.

152

153 Injury characteristics

154 More injuries ($n = 3710$) were single (93%) rather than multiple bites (7%). Wounds
155 with skin penetration accounted for 90% of total reported cases ($n = 3780$). The
156 remaining were not penetrating wounds (9%) or lesions with intact skin (1%). During
157 the period of study, no fatal dog attack was registered.

158

159 On the whole, dog bite injuries ($n = 3805$) were mostly sustained to the upper (45%)
160 and lower (42%) extremities, followed by the head and neck area (9%) and the trunk
161 (4%). Hands were the most frequently affected area (55%, 781/1724) with a
162 preponderance of upper extremities injuries. Fig. 2 shows the sites of injuries against the

163 age groups. Children <15 years had a significantly greater risk ($P<0.001$) of being bitten
164 on the head and neck area (OR= 7.4; CI= 5.8-9.2) and also on the trunk (OR= 1.9; CI=
165 1.3-2.6). Those aged 0-4 showed four times the risk (OR= 4.1; CI= 3.0-5.6) of receiving
166 wounds to the head and neck area. On the other hand, people >15 years were
167 significantly more likely to be bitten on the hands (OR= 1.5, CI= 1.3-1.8) and the lower
168 extremities (OR= 1.7; CI= 1.4-1.9). No significant differences in the likelihood of
169 sustaining wounds to the upper extremities (hands not included) were found between
170 the two age groups.

171

172 *Animals*

173 Dog characteristics

174 The sex of the dog was known in 1039 of reported incidents. Male dogs accounted
175 for approximately 63% ($n= 650$) of the incidents. Fig. 3 shows the distribution of biting
176 animals according to their age ($n= 657$). Dogs <4 years old were involved in 62% ($n=$
177 405) of the episodes. With regard to the breed ($n= 2118$), individuals belonging to the
178 so-called 'dangerous breeds' were responsible for only 3% ($n= 64$) of the incidents,
179 whereas individuals within other breeds such as German Shepherd or crossbreed dogs
180 accounted for 22% ($n= 456$) and 20% ($n= 432$) of bites, respectively (Table 2).

181

182 Most biting dogs (84.5%) were immunised against rabies and in 80% of the
183 incidents the dog was subjected to the required observation period following the bite
184 episode. The animal was reported to have been euthanased in 1.6% of the reports.

185

186 Relation with the victim

187 The vast majority ($n= 3802$; 97%) of the biting animals were owned, whereas
188 supposed stray animals were involved in only 3% ($n=112$) of cases. Information relating
189 to the dog ownership was specified or inferred in 1378 (36%) reports. Of these, a total
190 of 12% of the incidents involved dogs unfamiliar to the victim (strays not included). In
191 the rest of the incidents ($n= 1218$), the dog mainly belonged to the victim's family
192 (57%), a neighbour (28%), a relative (12%) or a friend (3%).

193

194 *Bite scenario*

195 Temporal distribution

196 Reported incidents peaked during the summer months (36%), particularly during
197 August (14%). Of the bite incidents 26%, 21% and 17% were sustained during the
198 spring, autumn and winter, respectively. Slightly more injuries were reported during the
199 weekends (33%).

200

201 Circumstances of the incident

202 Available information regarding the circumstances surrounding the incidents ($n=$
203 169) is summarised in Table 3. The specific contexts 'attempting to aid a knocked down
204 dog' and 'attempting to separate fighting dogs' accounted for a third (33%) of the cases
205 in which this information was collected.

206

207 **Discussion**

208 *Incidence and geographical distribution of dog bites*

209 Incidence was higher in the low-population (71.3/100,000) than in the high
210 population area (12.8/100,000). We had previously found similar results in the Valencia
211 region (19.8/100,000 in the capital area and 71.5/100,000 in the region as a whole;

212 León, 2006). This indicated similar epidemiology in spite of the different geographical
213 and demographic patterns of the two regions. Several other studies have reported similar
214 results to those we found in the low-population area (Knobel et al., 1997; Tompson,
215 1997; Borud and Friedman, 2000; Ostanello et al., 2005) but differed for the values in
216 the densely populated area, except for one revised report (Chomel and Trotignon, 1992).
217 Finally, it is important to note that the present study is focused on the epidemiology of
218 medical-attended dog bites, and that real incidence (attended cases together with non-
219 attended cases) would be therefore underestimated (Beck and Jones, 1985; Guy et al.,
220 2001c).

221

222 Several factors may account for the differences between the areas of study. Factors
223 relating to the physical environment have been suggested as playing a role in the
224 incidence of dog bites. High population density, heavy traffic and relative lack of open
225 spaces characterise major cities, in contrast to small towns or villages. The potentially
226 hazardous city life may lead dog owners to restrain their dogs more from roaming freely
227 and unattended (Harris et al., 1974). This might in turn raise people's awareness, thus
228 promoting, albeit indirectly, more responsible dog-ownership, and ultimately therefore
229 reducing the number of incidents (Rosado et al., 2007). In contrast, the perception of
230 greater security in the low-density, and especially rural areas, could result in less control
231 of dogs, thus increasing the risk of incidents. People from rural areas have been found to
232 be three times more likely to have been bitten by dogs during their lifetime than city
233 dwellers (Wake et al., 2006).

234

235 On the other hand, it is important to note that several low-density VAs with high
236 incidence values were also tourist areas, mostly the mountainous districts. Great

237 numbers of people (and their pets) visit these locations, and reduced supervision of the
238 dogs, could increase the likelihood of bite incidents (León, 2006). Factors related to
239 psychology and culture could also influence the incidence of dog bites depending on the
240 area (Beck and Jones, 1985; Messam et al., 2007). We therefore suggest that low
241 density, rural and/or tourist areas may constitute geographical high-risk bite locations.

242

243 *Characteristics of the victims and their injury patterns*

244 Our results show that males and children <15 years old, particularly those aged 5-9,
245 were at significantly higher risk. This demographic pattern has been reported elsewhere
246 (Beck and Jones, 1985; Thompson, 1997; Ozanne-Smith et al., 2001; Feldman et al.,
247 2004; Ostanello et al., 2005; Schalamon et al., 2006; León, 2006). Children's limited
248 experience or skills in recognising a dog's body language and in perceiving hazardous
249 situations might trigger the occurrence of biting incidents (Mathews and Lattal, 1994;
250 Lakestani et al., 2005). The extreme curiosity showed by children aged 5-9, together
251 with a marked decrease in adult supervision, may largely explain the high incidence in
252 this group (Love and Overall, 2001). In contrast, some studies have focused on
253 veterinary or behavioural practices (rather than on records of medical attendance for dog
254 bites) and found adults to be the most common victims (Guy et al., 2001c; APBC,
255 2005). The latter might support the idea that more dog bites among children result in
256 medical attention in comparison with adults, either by the severity and location of the
257 wounds or by a possible parental sense of responsibility (Guy et al., 2001c).

258

259 As shown by the results (Fig. 1), no gender differences in the incidence of dog bites
260 were detected in smaller children (0-4 years old) in contrast to children between the
261 ages of 5 and 14. It has been suggested that boys are socialised to engage in more risk-

262 taking behaviours and learn to play more roughly than girls (Mathews and Lattal, 1994).
263 Independently of the nature of these trends, the existence of demographic patterns in
264 dog bites (males and children) point towards an important role of human factors in the
265 likelihood of being bitten by a dog (Mathews and Lattal, 1994; Love and Overall, 2001;
266 Kahn et al., 2003).

267

268 Most injuries were single dog bites with skin penetration at the extremities.
269 However, two patterns of injury sites were observed, depending on the age of the
270 victim. Victims >14 years of age showed a significantly higher risk of being bitten on
271 the hands and the lower extremities, consistent with previous reports (Guy et al., 2001;
272 Airini et al., 2002; Benson et al., 2006). It is likely that these body regions were used by
273 the victim in ‘provoking’ or in protecting the individual against the dog attack (Palacio
274 et al., 2005). On the other hand, children had significantly greater risk of wounds in the
275 head and neck area, especially those aged 0-4 years old, and also on the trunk. Previous
276 studies have reported similar results (Beck and Jones, 1985; Ozanne-Smith et al., 2001;
277 Feldman et al., 2004; Ostanello et al., 2005). The small size of children and their
278 tendency to hug a dog’s head might well increase the risk of being bitten in these sites
279 (Mathews and Lattal, 1994; Brogan et al., 1995).

280

281 *Characteristics of the biting dogs and their relationship with the victims*

282 By and large, the dog’s profile tended towards a young, male animal. Males have
283 often been reported to bite or behave aggressively more frequently than females
284 (Wright, 1991; Chomel and Trotignon, 1992; Beaver, 1993; Ozanne-Smith, 2001;
285 APCB, 2005). One bias of the higher percentage of bites from male dogs might be that
286 the rate is in direct proportion to the population sex ratio (Wright, 1991; Overall and

287 Love, 2001). Nevertheless, studies have demonstrated that the male is significantly
288 over-represented when compared with a non-aggressive control population, curiously
289 both in offensive as well as in defensive forms of aggression (Gershman et al., 1994;
290 Bamberger and Houpt, 2006; Fatjó et al., 2007). Testosterone levels in males might, in
291 part, explain the results in the case of offensive aggression (Nelson and Chiavegatto,
292 2001), although not at first in the case of fear-related aggression. In the present study,
293 there was no information available regarding the neuter status of biting dogs.

294

295 The correlation between neutering and aggression towards people, however, is
296 complex and some studies have found intact males to be more frequently involved in
297 episodes (Beaver, 1993; Gershman et al., 1994; Messam et al., 2007), whereas neutered
298 dogs accounted for more bites in others (Guy et al., 2001a; APBC, 2005; Reisner et al.,
299 2007). Future research on clinical ethology and neuroendocrinology of canine
300 aggression will help to throw further light on the subject.

301

302 Published data regarding the age of biting dogs are scarce. Reviewed studies show
303 that relatively younger animals (<5 years) were involved in most of the cases, including
304 fatal dog attacks (Wright, 1991; Beaver, 1993; Gershman et al., 1994; Guy et al., 2001a;
305 León, 2006). This finding might be related to the fact that some forms of aggression
306 appear when the dog reaches sexual and/or social maturity (Love and Overall, 2001). In
307 the present study, it is worth mentioning that a great proportion of biting dogs were <1
308 year of age, and especially puppies <6 months. This might be partly explained by
309 typical puppy behaviour, since playing, learning about social interactions and exploring
310 activities involve the use of their mouths and teeth (Love and Overall, 2001). Moreover,
311 some puppies, especially those that have been early-weaned, may exhibit uninhibited

312 bite control when interacting with humans (Manteca, 2002). Considering the high
313 involvement of dogs <1 year old in bite incidents, prevention of play-biting should be of
314 the utmost importance. On the other hand, another plausible explanation for this trend is
315 a bias in data records as there is a tendency to record the age of the animal more
316 frequently in the case of puppies in noting that they lack the mandatory vaccination
317 against rabies.

318

319 With regard to breed, individuals within the German Shepherd breed and crossbred
320 dogs were responsible for most of the bites, coinciding with several studies (Klaassen et
321 al., 1996; Horisberger, 2002; Kahn et al., 2003; León, 2006; Schalamon et al., 2006;
322 Messam et al., 2007). A recent investigation in the present region of study (Aragón),
323 which focused specifically on the dangerous breeds issue, showed that only the German
324 Shepherd was significantly over-represented among the most biting breeds when
325 considering a reference canine population (Rosado et al., 2007). However, although
326 German Shepherds and other breeds may have a higher tendency to behave more
327 aggressively than others (Hart and Hart, 1985; Bradshaw et al., 1996; Takeuchi and
328 Mori, 2006), caution should always be exercised when dealing with the complex
329 binomial ‘breed-aggressiveness’. Facts such as the current high intra-breed variation
330 (Svartberg, 2006) and the relevance of non-genetic factors in displaying aggressive
331 behaviour towards people (Heath, 2005) should always be taken into account.

332

333 Similar to the breed-related trends, the relation between animal size and the
334 seriousness of the inflicted (non-fatal) wounds is of concern. According to our findings
335 (Table 2), most reported purebred individuals were large- and medium-sized dogs (≥ 15
336 kg). Similar results (Gershman et al., 1994; Horisberger, 2002; Kahn et al., 2003), in

337 combination with our own, might suggest that these dogs provoke more injuries that
338 require medical attention than do small dogs. In contrast, the study by Guy et al.
339 (2001c) showed non-significant differences in the bodyweight of dogs that had or had
340 not caused bites requiring medical assistance. Furthermore, the mean weight of biting
341 dogs was significantly lower than that of non-biting dogs (Guy et al., 2001b).

342

343 Certain factors may have contributed to the higher proportion of larger individuals
344 in the present study and it is possible that victims showed less tolerance towards
345 aggression from larger dogs, and wished to report the case to the authorities. It is also
346 possible that people perceive that bites by larger dogs are a more serious injury, thus
347 increasing the pursuit for medical attention (Guy et al., 2001b).

348

349 Consistent with previous reports, the vast majority of biting dogs were owned
350 (Chomel and Trotignon, 1992; Mathews and Lattal, 1994; Méndez et al., 2002; Kahn et
351 al., 2003; Schalamon et al., 2006), and had been suitably immunised against rabies
352 (Knobel et al., 1997). This finding supports the idea that strays are responsible only for
353 a minor proportion of the incidents, at least in industrialised countries, where stray
354 populations are more highly controlled. However, it is important to note that not all
355 owned dogs stay under the owner's control all of the time. It has been suggested that
356 free-ranging owned dogs may be more aggressive than strays when approached,
357 particularly when they are closer to home (Overall and Love, 2001). This picks up the
358 thread of the discussion on the geographical risk areas since most of these partially
359 unrestrained dogs may be found in low-populated areas, especially in the rural
360 environment.

361

362 In the present study, information regarding dog-victim relationship was not present
363 for all incidents. From the complete records, it can however be concluded that most
364 biting dogs were familiar to the victim to some extent, in agreement with previous
365 findings (Chomel and Trotignon, 1992; Benson et al., 2006; De Keuster et al., 2006;
366 Schalamon et al., 2006). The family pet was involved in about one-half of those cases.
367 This result might even be an underestimate, as owners are less likely to seek medical
368 attention or to report the incident when their own pet bites them (Wright, 1991). In the
369 other cases, a dog belonging to familiar owners (friends or relatives) or living near the
370 victim's setting (building or street) was responsible for the bite.

371

372 Finally, most dogs were subjected to official observation, and <2% of biting dogs
373 were euthanased. Although significant, this proportion could be a considerable
374 underestimate. Aggression represents an important non-medical cause of euthanasia in
375 dogs (Mikkelsen and Lund, 2000), followed by abandonment or relinquishment to
376 shelters, and poses important questions of canine welfare (Hunthausen, 1997; Fatjó et
377 al., 2006). On the other hand, many canine aggression problems can be satisfactorily
378 controlled with suitable treatment, although it is the authors' impression that only a
379 small proportion of victims is referred to a behaviourist veterinarian after an incident. In
380 addition, if no measures are taken to deal with the problem, more bite episodes may
381 occur. A previous history of biting has been shown to exist in several fatal dog attacks
382 (Sacks et al., 1996).

383

384 *Temporal scenario and circumstances surrounding the incidents*

385 From the present results, it can be seen that there are different patterns to the
386 conditions under which a dog bite take place. As shown in previous reports, more

387 incidents occurred during warm seasons, especially during the summer months,
388 coinciding with the holiday period (Chomel and Trotignon, 1992; Borud and Friedman,
389 2000; Schalamon et al., 2006). During this time, people and dogs spend more time
390 together and children are less supervised by parents, thus increasing the risk for
391 incidents. Considering this risk period, a high incidence of dog bites might be expected
392 in the tourist areas (e.g. mountain and/or rural settings). On the other hand, incidents
393 were slightly more frequent at weekends, coinciding again with typical free time and
394 recreation activities (León, 2006).

395

396 Data regarding the circumstances of the incidents were collected in relatively few
397 cases. Two specific contexts, namely ‘attempting to aid a knocked down dog’ and
398 ‘attempting to separate fighting dogs’ were more frequently reported. These are related
399 to pain-induced or redirected aggression, respectively, two categories of aggression not
400 usually witnessed by behaviourists but occasionally described in dog bite reports
401 (Horisberger, 2002). Recently, Benson et al. (2006) pointed out that the same two
402 contexts increase the likelihood of being bitten to the hand. Non-specific contexts such
403 as manipulating the dog in an aversive way accounted for an important proportion of
404 cases, which denotes the high prevalence of canine defensive aggression directed
405 towards humans (Bamberger and Houpt, 2006; Fatjó et al., 2007).

406 Several circumstances appeared to be preceded by an interaction between the victim
407 and the dog (Table 3). Some authors agree with this finding (Chomel and Trotignon,
408 1997; Kahn et al., 2003; Schalamon et al., 2006), while others felt that most incidents
409 were unprovoked (Avner and Baker, 1991). In this regard, it is important to know which
410 circumstances represent provocation for dogs, since some casual or benign interactions
411 from humans to animals may be conducive to aggression in some dogs (Reisner et al.,

412 1994; 2007). A detailed behavioural and medical history may be necessary to assess
413 adequately the nature of the aggression for each case.

414

415 **Conclusions**

416 If dog bites are to be prevented and controlled, it is essential to understand the
417 problem in a broad perspective and to identify related risk factors. The present results
418 suggest that there are patterns associated with dog bites. Firstly, low-populated settings
419 constituted geographical risk areas. Secondly, the human populations most at risk were
420 males and children, especially those aged 5-9. Thirdly, two different injury site patterns
421 were found according to the age of the victim, namely the head and neck area in
422 children and the extremities in adults. Fourthly, the typical biting animal was a young,
423 male, medium to large owned dog that was known to the victim. Fifthly, incidents
424 followed a seasonal pattern, peaking during the summer months. Lastly, interfering with
425 dogs that have been knocked down and fighting dogs were reported as specific
426 circumstances conducive to bites.

427

428 In the light of these findings, awareness raising should be tackled not only in major
429 cities but also in low populated areas, especially during the warmer weather. Age-
430 specific educational programmes should be carried out with the aim of promoting
431 responsible ownership and safe interactions with dogs. Public health professionals
432 should encourage the owners of biting dogs to visit a behaviour specialist.

433

434 The main value of this study is its comprehensive and long-term nature. It is hoped
435 that the work will be helpful in the investigation and prevention of dog bites both in
436 Spain as in other countries, especially those in the EU.

437

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442

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608
609

610 **Table 1.** Distribution and risk factor analysis of dog bite-related incidents according to
 611 sex and age of victims.
 612

Factor	Group	<i>n</i>	%	OR	CI
Sex	Males	2529	62.2	1.69	1.58-1.80
	Females	1538	37.8	0.59	0.56-0.63
Age (years)	0-14	1038	30.3	3.02	2.82-3.24
	0-4	244	23.5	0.64	0.55-0.74
	5-9	452	43.5	1.61	1.42-1.81
	10-14	342	32.9	0.91	0.80-1.03
	15-64	1916	55.9	0.65	0.61-0.70
	≥ 65	473	13.8	0.58	0.53-0.64

613 *n*= number of victims in each group; OR= Odds Ratio, CI= Confidence Interval

614
 615

616 **Table 2.** Distribution of dog bite related incidents according to dog's breed (top ten).

Breed	n	%
German Shepherd	456	21.5
Crossbreed dogs ^a	432	20.4
Mastiff	140	6.6
German Shepherd crosses	110	5.2
Shepherd-type dogs ^b	110	5.2
Cocker Spaniel	81	3.8
Siberian Husky	79	3.7
Belgian Shepherd	50	2.4
Rottweiler	44	2.1
Poodle	41	1.9
Others	533	25.2
Total	2118	100

617

618 Sorted by decreasing proportion of involvement.

619 ^a Generic term to name mongrels and mixed dogs.

620 ^b Non-purebred dogs that people describe as 'German Shepherd-like' animals according
 621 to morphological and/or functional aspects.

622

623

624 **Table 3.** Main circumstances of dog bite related- incidents.
 625

Circumstances of the incidents	<i>n</i>	%
Manipulating the dog in an aversive way (vaccinating, inducing pain or fear, grabbing or restraining, putting down to sleep or giving medication)	35	21
Attempting to aid a knocked down dog	29	17
Attempting to separate fighting dogs	27	16
Passing the dog (walking, running or cycling)	27	16
Playing with/near the dog	17	10
Interacting with a bitch with offspring	15	9
Entering or surrounding the dog's space	12	7
Disturbing the dog while eating	2	1
Others	5	3
Total	169	100

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631 **Figure legends**

632 **Figure 1.** Incidence of dog bite-related incidents (per 100,000 inhabitants) according to
633 age of male and female victims.

634 **Figure 2.** Distribution of the injury sites according to the age group of the victim.

635 **Figure 3.** Distribution of age in biting dogs.