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**Birthplace effects: Is it population size or density?**

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Submitted to: *Journal of Sports Sciences*

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Submitted: October 2, 2016

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Revised: November 17, 2016

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1 **Abstract**

2 Contextual influences on talent development (e.g., the birthplace effect) have become a  
3 topic of interest for sport scientists. The birthplace effect occurs when being born in a  
4 certain city size leads to participation or performance advantages, typically for those  
5 born in smaller or mid-sized cities. The purpose of this study was to investigate  
6 birthplace effects in Portuguese volleyball players by analysing city size, as well as  
7 population density—an important but infrequently used variable. Participants included  
8 4062 volleyball players ( $M_{age} = 33$ ), 53.2% of whom were male. Using Portuguese  
9 national census data from 1981, we compared participants across 5 population  
10 categories. Additionally, we employed ANOVAs to study expertise and population  
11 density. Results indicated that athletes (male and female) born in districts of 200,000-  
12 399,999 were nearly 2.4 times more likely to attain elite volleyball status, while all  
13 other districts decreased the odds of expert development. For male athletes, being born  
14 in high-density areas resulted in lower chances of achieving expertise, though no  
15 differences existed for female athletes. In the discussion, we explain the impact of these  
16 results on birthplace effect research, and offer suggestions for future directions.

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19 **Keywords:** *birthplace, sport development, youth sport, volleyball*

1                                      Birthplace effects: Is it population size or density?

2                      Researchers have highlighted the importance of birthplace as an important  
3 environmental variable influencing early sport exposure and long-term expertise (Côté,  
4 Baker, & Abernethy, 2007; Côté, MacDonald, Baker, & Abernethy, 2006). Evidence of  
5 birthplace effects was originally observed in Curtis and Birch's (1987) study of  
6 American and Canadian ice hockey players. The authors identified a statistically  
7 significant over-representation of elite ice hockey players born in cities between  
8 100,000 and 499,999 inhabitants, suggesting that an optimal city size facilitated  
9 advancement into professional ice hockey. More recently, Côté and colleagues (2006)  
10 analysed the birthplace of professional American athletes in baseball, basketball, ice  
11 hockey, and golf, discovering the best odds of becoming a professional athlete were for  
12 athletes born in cities with populations between 50,000 and 100,000. Similar results  
13 have been identified when investigating birthplace effects in American football  
14 (MacDonald, Cheung, Côté, & Abernethy, 2009), female golf (MacDonald, King, Côté,  
15 & Abernethy, 2009), various Australian national teams (Abernethy & Farrow, 2005),  
16 and Swedish tennis players (Carlson, 1988). Extending beyond expert attainment,  
17 researchers have also examined participation rates of Canadian youth ice hockey  
18 players, showing a statistically significant association between smaller cities and  
19 increased ice hockey participation (Imtiaz, Hancock, Vierimaa, & Côté, 2014;  
20 Turnnidge, Hancock, & Côté, 2014). Collectively, the results of these studies indicate  
21 that smaller cities facilitate sport participation and performance in large countries such  
22 as Canada, United States, and Australia.

1           Possibly, the early developmental opportunities that exist in smaller cities are  
2 more conducive to talent development when compared to the opportunities that exist in  
3 larger cities (Côté et al., 2006; MacDonald, Cheung et al., 2009; Turnnidge et al., 2014).  
4 The environmental structure of smaller cities in North America, for instance, might  
5 facilitate greater and more diverse sport involvement at younger ages (i.e., sampling;  
6 Côté, 1999), which in turn might lead to increased investment in sport at later stages of  
7 development (Côté et al., 2007; Côté et al., 2006). It has been posited that smaller cities  
8 provide an intimate and supportive environment that offers a number of favourable  
9 conditions for talent development, including easy access to spaces supporting unlimited  
10 and variable play/practice opportunities, early exposure to sport activities, competitions  
11 with older peers or adults, and broad cross-sport experiences (Baker, Schorer, Cobley,  
12 Schimmer, & Wattie, 2009; Côté et al., 2007; Côté et al., 2006; MacDonald, Cheung et  
13 al., 2009; Turnnidge et al., 2014). Alternatively, larger cities may be less conducive to  
14 expert development as they provide less facility access and environmental support for  
15 sport development (Côté et al., 2007; Côté et al., 2006).

16           Though the majority of birthplace studies have shown that being born in a  
17 smaller city is advantageous for attaining sport expertise, there are a few exceptions  
18 across countries, cultures, and sports. For instance, Baker and colleagues (2009)  
19 discovered that optimal city sizes for producing Olympic athletes were 10,000-29,999  
20 in United Kingdom, 250,000-499,999 in United States, 1,000,000-2,499,999 in Canada,  
21 and 2,500,000-4,999,999 in Germany, suggesting that birthplace effects are buffered by  
22 broader sport-specific, sociocultural, and geographical factors. Additionally, Lidor and  
23 colleagues' study (Lidor, Arnon, Maayan, Gershon, & Côté, 2014) with Israeli female

1 ballgame players demonstrated that different sports within the same country produced  
2 mixed findings. While being born in a medium city (50,000-200,000) was  
3 advantageous for achieving expertise in basketball and handball, being born in a very  
4 small city (fewer than 2000 people) was beneficial for expert development in volleyball  
5 players. Overall, these varied findings support the notion that birthplace is a proxy  
6 measure to understand the developmental circumstances of athletes, but results need to  
7 be contextualised within the geographical situation of a country and the sport that is  
8 being examined (Côté et al., 2006).

9         Despite the importance of the aforementioned evidence, theoretical  
10 conceptualizations about the birthplace effect are limited. To our knowledge, the sole  
11 model to explain birthplace effects was by Hancock and Côté (2014)—adapted from a  
12 relative age effects model (Hancock, Adler, & Côté, 2013). Hancock and Côté’s (2014)  
13 model is based on social agents’ (parents, coaches, and athletes) impact on birthplace  
14 effects through Matthew effects (initial advantages that persist over time; Merton,  
15 1968), Pygmalion effects (initial expectations dictate subsequent outcomes; Rosenthal  
16 & Jacobson, 1968), and Galatea effects (external expectations influence individual  
17 behaviours; Merton, 1957). The authors proposed that, compared to parents in larger  
18 cities, parents in smaller cities have fewer safety concerns, leading them to encourage  
19 their children to play outside. Children in smaller cities, then, are provided initial  
20 advantages (Matthew effect) of increased free play, contributing to talent development  
21 (Côté, 1999). Similarly, in smaller cities, coaches facilitate Pygmalion effects through  
22 expectations of long-term participation, enjoyment, and skill development (keys to  
23 expert development; Côté, 1999) rather than focusing on immediate performance of a

1 selected group of children, which might align with sport structures in larger cities  
2 (Hancock & Côté, 2014). Finally, birthplace effects can be linked to Galatea effects  
3 through the big-fish-little-pond-effect (Marsh, Chessor, Craven, & Roche, 1995).  
4 Essentially, young athletes in smaller cities are more likely to have the support of the  
5 entire city, elevating athletes' self-concept and expectations for success, regardless of  
6 whether or not the athletes are more talented than those in larger cities (Balish & Côté,  
7 2014; Hancock & Côté, 2014).

8         While Hancock and Côté's (2014) model provides insights into the birthplace  
9 effect, it is limited (as are most previous birthplace studies) by using birthplace  
10 population as a proxy to examine the impact of a city on an athlete's early development.  
11 Focusing solely on population size provides little information about a city's internal  
12 structure—perhaps contributing to equivocal birthplace effect findings across countries.  
13 For instance, an athlete may be born in a small, but highly dense city. Illustrating this  
14 point, consider the difference between Paris and Toronto. With populations of  
15 2,265,886 and 2,615,060, respectively, the two cities are nearly identical in total  
16 population. Paris, however, has a population density of 21,498 km<sup>2</sup>, while Toronto's  
17 density is 4,149 km<sup>2</sup>. A growing body of literature has highlighted the powerful  
18 influence that urban density has on living standards and social interactions (Dempsey,  
19 Brown, & Bramley, 2012; Fuller & Gaston, 2009; Lawson, 2010; Oakes, Forsyth, &  
20 Schmitz, 2007; Raman, 2010). Targeting density and walking behaviour, Oakes and  
21 colleagues (2007) found that less densely populated areas promoted more leisure  
22 walking activities, thereby increasing general levels of physical activity. In a similar  
23 vein, Fuller and Gaston's (2009) study on European cities demonstrated that low-

1 density cities were more likely to have green spaces, providing citizens with  
2 opportunities to experience nature and increase their quality of life. Additional findings  
3 indicated that low-density cities also promoted stronger social interactions and social  
4 networks (Dempsey et al., 2012; Lawson, 2010; Raman, 2010).

5 This evidence suggests that population density may have an important influence  
6 in determining athletes' early developmental environments, perhaps more so than  
7 population size. Despite the relevance of this evidence, the studies on the influence of  
8 city density in athlete development and expert achievement are scarce. One known  
9 exception was a recent analysis of handball and soccer players (Rossing, Nielsen, Elbe,  
10 & Karbing, 2016). Therein, Rossing and colleagues (2016) examined community size  
11 and density among youth handball and soccer players. Overall, being born in small,  
12 low-density communities increased the likelihood of enrolling as handball or soccer  
13 players. For elite players, however, being born in communities with medium densities  
14 increased the likelihood of attaining elite handball status (there were no differences for  
15 community size), but unexpectedly—and contrary to Hancock and Côté's (2014)  
16 model—soccer players had better odds of achieving expertise when born in medium-  
17 sized, high-density communities. As has been established, birthplace effects can be  
18 quite varied between countries and sports, thus further examinations population density  
19 are warranted.

20 Fittingly, the purpose of this study was to investigate birthplace effects in a  
21 Portuguese volleyball sample. Through examining population size and density, we  
22 intended to illuminate the nuances of the birthplace effect. Additionally, we sought to  
23 examine the birthplace effect among male and female athletes across three competitive

1 standards. Through this endeavour, we aimed to provide a better understanding of  
2 mechanisms that underpin the birthplace effect.

### 3 **Methods**

4 All procedures followed the guidelines stated in the Declaration of Helsinki and  
5 were approved by the ethics committee of the second author's institution.

#### 6 *Participants*

7 Participants were elite Portuguese volleyball players. Players' sex, age,  
8 birthplace, and competitive standard were provided by the Portuguese Volleyball  
9 Federation through a player database spanning from 2000 to 2010. The database  
10 included 4062 volleyball players, 2159 (53.2%) of whom were male, and 1903 (46.8%)  
11 of whom were female. Participants' mean age was 33 years, with a range from 19 to 64  
12 years. In Portugal, elite male and female adult volleyball players compete in a national  
13 competition system composed of first-, second-, and third-league. First-league is the  
14 highest competitive standard and third-league is the lowest competitive standard. For  
15 our sample, 33.9% were first-league players, 42.0% were second-league players, and  
16 24.1% were third-league players. From the database, two assumptions were made.  
17 First, we assumed that birthplace coincided with city of development—a standard  
18 practice in birthplace effects literature (e.g., Côté et al., 2006). Likely, this is not the  
19 case for all participants, so we acknowledge we are unable to account for any possible  
20 childhood migration. Second, the database provided participants' current competitive  
21 standards. Thus, we recognize we were unable to account for athletes who might have  
22 previously attained—or will attain in the future—higher competitive standards.

#### 23 *Data Analysis*



1           For analysis, we used data from Portugal’s 1981 census, as this was  
2 representative of the time during which the majority of participants were children.  
3 Census data in Portugal (Census of Portugal, 1981) provide values for city/town/village  
4 sizes (henceforth termed *cities*), as well as districts/regions (henceforth termed  
5 *districts*). In this paper, we focus on the district data. This was intentionally chosen  
6 due to the nature of Portuguese cities, which are often categorized as smaller than 2000  
7 inhabitants, despite the fact that each city might have no obvious border between it and  
8 other cities. As such, small, geographically clustered cities might not be representative  
9 of a traditional small city. Instead, we used districts to more accurately represent  
10 participants’ birthplaces. Portugal consists of 18 districts and two autonomous regions  
11 (Madeira and Azores), and as there are no discernible differences between the two  
12 categorizations that would have any impact on this study, we chose to simply refer to  
13 them as districts. The smallest district in the sample had a population of 142,905 while  
14 the largest was 2,069,467.

15           Typically, birthplace effect researchers create city size categories for analysis.  
16 Using the manufactured categories, expected and observed proportions of participants  
17 born in each category can be determined. For example, if 20% of the general  
18 population was born in cities of >1,000,000 inhabitants, then 20% of the sample would  
19 also be expected to be born in cities of >1,000,000 inhabitants. The district sizes used  
20 herein, however, did not coincide with city size categories used by previous  
21 researchers<sup>1</sup> (e.g., Côté et al., 2006). Examining the Portuguese census data, it was  
22 evident that the district sizes could be manually separated into five distinct categories:

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<sup>1</sup> In fact, using Portuguese city data—rather than districts—would have led to the same issue, requiring new conceptualizations of city categories.

1 Category 1 (<200,000), Category 2 (200,000-399,999), Category 3 (400,000-599,999),  
2 Category 4 (600,000-799,999), and Category 5 (>799,999).

3         Creating district categories enabled analysis of the birthplace effect in the  
4 traditional manner—that is, total population of each district category. To achieve this,  
5 odds ratios were calculated to determine the probability that participants in each district  
6 category would appear in the database. For interpretation, odds ratios greater than 1.0  
7 (that is, the upper and lower confidence intervals exceed 1.0) indicated that a district  
8 category size produced more volleyball players than expected. Conversely, odds ratios  
9 less than 1.0 (that is, the upper and lower confidence intervals less than 1.0) denoted  
10 that a district category size produced fewer volleyball players than expected. When  
11 confidence intervals intersected 1.0, the odds ratios were statistically non-significant.

12         A unique component of the present study was an additional analysis of  
13 birthplace effects using population density, which might be more indicative of a  
14 district's structure and environment. Separate one-way analysis of variance (ANOVA)  
15 tests were conducted to examine if population density differed according to expertise  
16 (i.e., first-, second-, and third-league). Pearson *r* effect sizes (.10 = small, .30 =  
17 medium, .50 = large; Field, 2013) and power ( $1 - \beta$ ; provided for statistically non-  
18 significant tests) were also calculated to assist in interpreting the results. There were no  
19 univariate outliers in the data, but due to the nature of the data being skewed, the male  
20 and female data violated Levene's test of homogeneity ( $p < .05$ ). For the male data,  
21 square root and  $\text{Log}_{10}$  transformations did not affect the normality of the data; thus, the  
22 Brown-Forsythe correction (with Dunnett's T3 post-hoc test) was used (Tabachnick,  
23 Fidell, & Osterlind, 2001). For the female data, the  $\text{Log}_{10}$  transformation reduced the

1 data skewness, which then did not violate Levene's test of homogeneity ( $p = .42$ ). As  
2 such, the transformed data were used for the ANOVA analysis and Tukey's HSD post-  
3 hoc test (Tabachnick et al., 2001).

#### 4 **Results**

5 Starting with the traditional birthplace effects analysis, odds-ratios indicated  
6 identical patterns for male and female players; thus, all participants are presented  
7 simultaneously. An over-representation of participants were born in district Category 2  
8 (200,000-399,999),  $OR = 2.37$ ,  $CI = 2.22-2.53$ . In other words, athletes born in a  
9 district with 200,000-399,999 inhabitants were nearly 2.4 times more likely to achieve  
10 elite volleyball status. Oppositely, all other district sizes demonstrated under-  
11 representations of participants, meaning being born in any other district reduced the  
12 likelihood of achieving elite volleyball status (see Table 1). This result was pervasive  
13 across competitive standards.

14 \*\*\*\*\* INSERT TABLE 1 NEAR HERE \*\*\*\*\*

15 Transitioning to the population density analysis (see Figure 1), there was a main  
16 effect for elite male volleyball players:  $F(2, 1980.5) = 9.241$ ,  $p < .001$ ,  $r = .09$ . Post-hoc  
17 analysis revealed that first-league players came from less densely populated districts ( $M$   
18  $= 330.73$ ,  $SE = 10.36$ ) than did third-league players ( $M = 392.46$ ,  $SE = 9.59$ ), but no  
19 other group differences existed. Regarding female athletes, there were no group  
20 differences on population density according to expertise:  $F(2, 1902) = 1.559$ ,  $p = .211$ ,  
21  $r = .04$ ,  $1 - \beta = .332$ .

22 \*\*\*\*\* INSERT FIGURE 1 NEAR HERE \*\*\*\*\*

#### 23 **Discussion**

1           The purpose of the current study was to analyse birthplace effects using  
2 population size and density. As we examined an elite sample of male and female  
3 volleyball players, we were able to compare results within each sex, and across  
4 competitive standards. The inclusion of different samples from the same sport and  
5 region strengthened this research. Male and female athletes were 2.4 times more likely  
6 to be represented in the database if they were born in a district of 200,000-399,999  
7 people (the second smallest district size). Meanwhile, all other district sizes had  
8 disproportionately fewer athletes than expected. This result is consistent with previous  
9 literature on birthplace effects in North America and Australia showing that the most  
10 and least populous cities are not effective at producing elite athletes (e.g., Abernethy &  
11 Farrow, 2005; Côté et al., 2006; MacDonald, Cheung et al., 2009; MacDonald, King et  
12 al., 2009; Turnnidge et al., 2014). When analysing population density, elite male first-  
13 league players were more likely to come from less densely populated districts. No such  
14 relationship, however, existed for female athletes. Thus, for male athletes, the  
15 probability of attaining elite volleyball status appears to be facilitated by being born in  
16 smaller, less densely populated districts. Females, on the other hand, are afforded  
17 expertise advantages simply by being born in smaller cities, regardless of population  
18 density.

19           These results, combined with Rossing and colleagues' (2016), provide  
20 compelling evidence that population density should be an important consideration when  
21 examining the birthplace effect. This is not to say that analysing population density is  
22 superior to population size; rather, it indicates that other factors ought to be considered  
23 beyond the number of people who inhabit an arbitrary geographic boundary. These

1 other factors likely include some or all of the eight contextual features of communities  
2 that promote positive youth development and talent in sport: (a) physical/psychological  
3 safety; (b) appropriate structure; (c) supportive relationships; (d) opportunities to  
4 belong; (e) positive social norms; (f) efficacy support; (g) opportunities for skill  
5 building; and (h) integration of family, school, and community (MacDonald, King et al.,  
6 2009; National Research Council and Institute of Medicine, 2002). Resoundingly,  
7 researchers have suggested that these eight features are more prevalent in smaller  
8 communities (e.g., Bale, 2003; Côté et al., 2007; Hancock & Côté, 2014; Kytä, 2002).  
9 Supporting this, researchers have also indicated that less densely populated areas  
10 (regardless of population size) are beneficial for physical/psychology safety (i.e., lower  
11 crime rates; Harries, 2006; Nolan, 2004), opportunities to belong/positive social norms  
12 (i.e., social development; Dempsey et al., 2012; Lawson, 2010; Raman, 2010), and  
13 appropriate structure/opportunities for skill building (i.e., access to green spaces; Fuller  
14 & Gaston, 2009).

15       Rossing and colleagues (2016) highlighted many of these contextual factors. Of  
16 note, the authors emphasized that city structure (i.e., population density) is more  
17 important than population size, as it provides a clearer picture of talent development  
18 opportunities. This could include access to facilities, which in Denmark (the location of  
19 the Rossing et al. study) favour athletes from less dense communities who have access  
20 to more facilities per capita (Kaas, 2013). In cases where birthplace effect trends did  
21 not align with research-based expectations, Rossing and colleagues suggested that it  
22 might have less to do with the city's structure, and more to do with the sport's culture.  
23 For instance, in countries with rich soccer histories, athletes in large, high-density cities

1 might receive the same financial and community support as those athletes in smaller  
2 cities, possibly due to the shared community pride that stems from a club-based soccer  
3 system. Such a hypothesis helps understand the unexpected result for female  
4 Portuguese volleyball players. Specifically, volleyball is the second-most practised  
5 sport (behind soccer) for Portuguese females. This had led to a rich volleyball culture  
6 and tradition throughout the country, which might transcend cities of varying population  
7 densities. Thus, it would seem that total population and population density (and the  
8 underlying mechanisms to which they contribute) play important roles in understanding  
9 the birthplace effect.

10         Considering this interaction further, perhaps there is an ideal population size and  
11 density for grooming talented athletes. To excel in sport, athletes must have access to  
12 appropriate infrastructure, such as facilities, coaches, and teams. This infrastructure,  
13 however, ought not to be overly stratified based on competitive standard (Turnnidge et  
14 al., 2014), which can negatively impact talent development through burnout and  
15 dropout (Fraser-Thomas, Côté, & MacDonald, 2010). Previous literature on birthplace  
16 effects suggests that this ideal balance in infrastructure is met in mid-sized cities (Côté  
17 et al., 2006; MacDonald, Cheung et al., 2009; MacDonald, King et al., 2009; Turnnidge  
18 et al., 2014). In addition to infrastructure, athletes require the appropriate social  
19 structure to attain expertise. It is here that we believe population density plays an  
20 important role.

21         A major consideration here is the effect population density has on access to  
22 resources in terms of existence and safe use. Beginning with the existence, researchers  
23 have indicated that low-density European cities offer more green spaces (Fuller &

1 Gaston, 2009), and public green spaces are positively associated with increased physical  
2 activity among children (Davison & Lawson, 2006). While we cannot state that public  
3 green spaces are a requisite for talent development, such spaces might facilitate the  
4 process. Residents, however, might not use public green spaces unless they feel safe.  
5 A positive relationship exists between population density and crime rates (Harries,  
6 2006; Nolan, 2004); thus, it is possible that high-density cities have a negative impact  
7 on deliberate sport play (Côté, 1999), as residents might feel unsafe using public  
8 resources, which could contribute to long-term performance decrements within that city.  
9 Indeed, studies indicate that crime reduces physical activity (e.g., Davison & Lawson,  
10 2006; Foster & Giles-Corti, 2008), though some researchers suggest that perception of  
11 crime is more of a deterrent for physical activity than actual crime (e.g., Prezza &  
12 Pacilli, 2007). Here, the authors noted that in high-crime areas, if residents did not have  
13 a fear of crime, physical activity rates were unaffected. These findings might explain  
14 why some high-density, high-crime cities produce a disproportionate number of talented  
15 athletes (e.g., Brazilian favelas; Coyle, 2009), though this is a tentative conclusion that  
16 warrants further investigation. Collectively, the evidence intimates that less densely  
17 populated areas potentially provide a social structure that facilitates positive benefits for  
18 athletic development. Consequently, we suggest that future researchers investigate  
19 optimal city size that affords the appropriate infrastructure for talent development, but  
20 also ideal population density that offers the requisite social structure.

21 Integrating this hypothesis with the results herein, it is plausible that for  
22 Portuguese volleyball players (male and female), districts sizes of 200,000-399,999  
23 provide the necessary infrastructure for success. For male players, perhaps the less

1 densely populated areas afford them an appropriate social structure for development.  
2 Curiously, though the results for female athletes were not statistically significant, the  
3 trend exhibited was expertise increased as population density increased. This trend  
4 could be due to a number of reasons: (a) different social structures in place for female  
5 athletes (i.e., regardless of population density, males might be provided more  
6 opportunities for free play than females); (b) social structure is less important than  
7 infrastructure for female athletes due to a lower number of participants; or (c) a  
8 statistical anomaly specific to the studied country. Further research would be required  
9 to explicate these results.

10         Notwithstanding, there are two limitations of this research to be addressed.  
11 First, the present study did not include youth players, which may provide additional  
12 insights into how birthplace impacts talent development and talent yield (Woolcock &  
13 Burke, 2013). As such, it is important that future researchers consider systematic  
14 analysis of population size and density across a larger age range. Second, an extant  
15 challenge in birthplace effect studies is the use population categories. Herein, we  
16 created five population categories, but within each district, there could have been  
17 sizeable variations in population density. Researchers ought to explore methods by  
18 which to limit such variability, enabling stronger within-category consistency.

## 19 **Conclusion**

20         The results herein highlight the complexity of birthplace effects. Additional  
21 studies of birthplace effects are certainly warranted, especially to delineate the  
22 contributions of city size/infrastructure and population density/social structure. Such a  
23 study might involve an epidemiological approach, accounting for the infrastructure and



1 social structure of geographically diverse cities. It is also important to consider how to  
2 create studies that might be generalizable across countries and cultures (which is  
3 currently a challenge in birthplace effects literature). These ideal investigations might  
4 examine city density to country density ratios, facilities per capita, or green spaces per  
5 capita, all with the intent of better understanding how a city's internal structure  
6 contributes to success. Until such time as an appropriate study can be conducted, we  
7 believe it would be remiss to consider population size or population density in isolation.

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