Testing the Trivers-Willard Hypothesis on Polish kings and dukes

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ABSTRACT: The Trivers-Willard Hypothesis (TWH), frequently investigated by evolutionary psychologists, states that human beings may have evolved to produce a greater number of sons when having a high status, and a greater number of daughters when having a low status. To test this hypothesis, we examined the sex of children of Polish high status: kings, dukes, magnates families; and of low status: peasants, burghers and gentry. Our findings do not provide evidence for the Trivers-Willard Hypothesis (TWH), as there were no differences between offspring's sex ratio among any of the investigated social classes (with the exception of magnates families). We draw our conclusions with caution, as historical data carry many limitations.

KEY WORDS: Trivers-Willard hypothesis (TWH), evolutionary psychology, social status, children, sex ratio

Introduction

The Trivers and Willard hypothesis (TWH) (Trivers and Willard 1973) claims that individuals might be able to vary the sex ratio of their offspring in order to maximize one's own reproductive success. According to this hypothesis, when parents have a high status and an access to resources, similar parental investments in sons and daughters result in different reproductive success of the offspring – sons, at the end of their life, are more reproductively successful (have more children) than daughters (Trivers and Willard 1973). Hence, parents should influence the sex ratio of their offspring, based on their own status. When experiencing good life conditions, parents would bring to life more healthy and immunologically competent sons, whereas when experiencing worse life conditions, more environmentally-resistant daughters should be brought to life.

Authors based their assumptions mostly on data from polygamous species of ungulates like red deer (Clutton-Brock et al. 1986), or caribou (Thomas et al. 1989), where males in good condition are very likely to completely exclude other males from mating, hence, for a mother experiencing good conditions, it is far more profitable to have male than female offspring. Authors predict that this model should be true among animals of small brood sizes and some, but not necessarily all, animals with big brood sizes. Further research on animals brought mixed results: the TWH was confirmed in some species, for instance in red deer (Clutton-Brock et al. 1986), whereas the TWH was dismissed in others, for instance White-tailed deer, where females experiencing good conditions produce more female offspring (Verme 1983; 1985). Even though different hypotheses explaining these relationships were suggested, mechanism of this phenomenon remains unclear (Cameron 2004). A meta-analysis of over 400 studies from different mammalian species (excluding humans), showed that only 37% of them confirmed the TWH (Cameron 2004).

As the TWH has been also suggested to apply to humans, it has brought a heated discussion. The original Trivers and Willard paper appeared in 1973, since then, it has been cited 3790 times (as of 2019). Nevertheless, studies brought mixed results. For instance, Hopcroft (2005) study provided evidence that parents' socioeconomic status turned out to be a significant predictor of parental investments in the offspring – sons of wealthy parents attained a higher education in comparison with sons of less wealthy parents, whereas this pattern was reversed among daughters (Hopcroft, 2005). Study on Hungarian gypsy population is also in line with the Trivers and Willard hypothesis (TWH) (Bereczkei and Dunbar 1997). Not only the infants sex ratio was female biased, but also daughters experienced higher parental investments in comparison with sons. What is important, these observations were limited to low status Hungarians. Cameron and Dalerum (2009) examined the children's sex-ratio of American billionaires. Their results showed that the wealthiest leave more grandsons than granddaughters. A similar analysis performed by Betzig and Weber (1995) provided evidence that the sex-ratio bias pattern appears among American presidents and other high government officials. Studies on relationship between the offspring's sex ratio and: height (Kanazawa, 2005), fathers' violence (Kanazawa 2006), and mothers psycho-emotional condition (Mackey, and Coney 1987) also seem to be in concordance with the TWH (Cameron and Dalerum 2009; Shnettler 2013). On the other hand, some studies show only little support for the THW (Koziel and Ulijaszek 2001), while others provide no evidence at all (Kolk and Schnettler 2013).

Due to the inconsistencies in the human studies regarding the TWH (Cameron, and Dalerum 2009; Hopcroft 2005; Kolk and Schnettler 2013; Kozieł and Ulijaszek 2001), in the present study we investigated the sex ratio of the high (e.g., kings, dukes), and low status Poles (e.g., peasants, burghers) living in the XVII–XVIII century.

Material and Methods

Subjects

To examine the TWH we compared the number of sons and daughters among dif-

ferent groups of Polish high status families: kings (Study 1), princes from the Piast dynasty (Study 2), magnates (Study 3), and members of one of the wealthiest families: Radziwiłł family (Study 4). In the last study (Study 5), we compared magnates (from Study 3), and members of Radziwiłł family (from Study 4) with lower-status Poles (peasants, burghers, and gentry from parish of Radom) from the same historical time period.

Sources

We obtained the information about sex-ratio of kings' and dukes' offspring from various historical biographical elaborations (Dworzaczek 1959; Feldman 1984; Ochmann-Staniszewska 2006; Staszewski 1998; Wójcik 1994). Another privileged group, representing almost equal social status as polish rulers, were magnates. We used the data from the following magnates families: Ciechanowieccy, Dąbrowa, Czarnkowscy, Nałęcz,

Firlejowie, Lewart, Kettlerowie; dukes of: Kurlad, Kostkowie, Dąbrowa, Lanckorońscy, Zadora, Leszczyńscy, Wieniawa, Opalińscy, Łodzia, Radziwiłłowie, Rzewuscy, Krzywda, Tarnowscy, Leliwa (Dworzaczek 1959). Only the information about Ciechanowieccy and Radziwiłłowie was taken from different elaborations (Dumin 1997, and Mackiewicz 1990, respectively).

Data of lower status Poles were obtained from the church registry (dated 1630–1730), and included inhabitants of a Polish parish – Radom (peasants, burghers, and gentry) (Piątkowski 2002; 2003).

Results

Using paired-sample *t*-tests we compared the number of sons and daughters of Polish Kings (Study 1, N=48), Piast Dynasty (Study 2, N=45) and Polish magnates dynasties (Study 3, N=11 families, living between 1630 and 1733). As we had only

Table 1. Descriptive statistics of the number of sons and daughters obtained in Studies 1–5

Study	Mean±SD	Range	Paired *t*-test	*p*-value
Study 1 – Polish Kings (N=48)				
Sons	2.58±2.49	0–7	−0.237	0.810
Daughters	2.65±2.82	0–10		
Study 2 – Piasts (N=45)				
Sons	2.00±2.02	0–7	−0.077	0.939
Daughters	2.02±1.74	0–7		
Study 3 – Magnates Families (N=11)				
Sons	29.09±18.39	4–73	−2.4	0.038*
Daughters	23.55±13.65	5–61		
	%	n	χ^2	
Study 4 – Radziwiłł Dynasty				
Sons	53%	196	0.968	0.325
Daughters	47%	177		
Study 5 – low status Poles				
Sons	51%	740	0.363	0.547
Daughters	49%	717		

*Statistical significance at p<0 .05.

Table 2. The number of daughters and sons in the low and high status families with χ^2 and *p*-value

Status	Sons	Daughters	χ^2	*p*-value
Low Status (Study 5)	740	717	2.69	0.10
High Status (Studies 3–4)	516	436		

partial information regarding Radziwiłł dynasty (Study 4), and lower status Poles (Study 5), we used Chi-square tests. For a summary, see Table 1.

Among Polish kings (Study 1) and princes from the Piast dynasty (Study 2), the number of sons and daughters did not differ ($p=0.81$ and $p=0.94$, respectively). Similarly, there were no differences between proportions of male and female children among Radziwiłł dynasty (Study 4) and the low status Poles (Study 5) ($p=0.33$ and $p=0.55$, respectively). Nevertheless, we found a difference in the number of sons and daughters in Polish magnates having more sons than daughters (Study 3, and $p<0.05$).

In the second step, we compared the number of daughters and sons in high status families (magnates from Study 3, and Radziwiłłs from Study 4) with low status control group (Study 5). The raw numbers of each sex children are presented in Table 2, while proportions are presented in Table 2.

Although the proportion of sons seems to be slightly higher among high status participants (table 2), the distribution of sons and daughters did not differ significantly ($\chi^2_{df=1, N=2409} = 2.69$; $p=0.10$).

Discussion

Main goal of the present study was to test the Trivers-Willard Hypothesis (TWH) on historical data regarding the offspring of people of high and low status. In general, our findings do not provide support for the TWH, as Polish king, dukes, peas-

ants, burghers, and gentry had children of both sexes equally often. Only magnates families had significantly more sons than daughters.

Our study adds to a growing body of literature regarding the differences in reproductive success between people considered to have plenty resources, thus having the ability to invest in their children, and people considered to have less or even little resources, unable to provide the best care for their children (Pettay et al. 2007). For instance, Leimar (1996) raised a question, whether Trivers and Willard (1973) hypothesis can be applied in the case of women. Based on a study on lifetime reproductive success, Leimar (1996) suggested that under certain circumstances, high quality women can have a higher reproductive value than high quality men. Our results are in line with other studies (Douhard 2017; Ellis and Bonin 2002; Keller et al. 2001; Kolk and Schnettler 2016; Kozieł and Ulijaszek 2001; Morita et al. 2017), which did not find support for the TWH.

Nevertheless, most of the studies provide evidence rather in favor of the TWH (Barthold et al. 2012; Betzig 2012; Bereczkei and Dunbar 1997; Cronk 2000; Fieder and Huber 2007; Hopcroft 2005; Hopcroft and Martin 2014; 2016; Kanazawa 2005; 2006; Luo et al. 2016; Nettle and Pollet, 2008; Pollet et al. 2009; Voland et al. 1997; Wallner et al. 2012; Weeden et al. 2006), while Lazarus (2002) analysis revealed that 48% (out of 54) studies support the TWH, similarly as in James (2006) analysis, in which the percentage was slightly higher (50%, out of 89

studies). On the other hand, the prevalence of such disproportion may not be surprising due to the publication bias, as results without significant findings tend to be published less often than those reporting significant links (Koricheva 2003; Kotze et al. 2004), which was also shown in the context of the TWH studies (Festa-Bianchet 1996).

One of the strength of our study is the irrefutable difference in the status between kings, dukes, magnates families, and peasants, burghers, gentry, well documented in historical biographical elaborations (Dworzaczek 1959; Feldman 1984; Ochmann-Staniszewska 2006; Staszewski 1998; Wójcik 1994), which allowed us to compare two ends of a status continuum. Schnettler (2013) highlighted the importance of taking into consideration the distinction between heirs and self-made billionaires, when analyzing the TWH among wealth Americans. Nowadays, people's conditions of life can change dramatically, which can distort present findings. In our study, people from different social classes were born and lived in similar conditions throughout their entire life, thus they did not experience any major changes in social position (as such changes were extremely rare at the time: de Vries 1984).

The gentry included in the analysis may seem to disrupt the homogeneity of the social status in the whole sample. However, the gap of the social status between magnates and gentry was much bigger than the gap between the gentry, burghers, and rich peasants, hence it seems justified to treat the group from the fifth study as a whole.

Another thing worth considering is the caveat of the missing data due to the infanticide. We addressed this issue by looking into the statistics of criminal records in XVII–XVIII century. Infanticide cases constituted for less than one per cent of all criminal cases, and were observed mainly among low status women (Kuklo 2009). We also acknowledge the possibility of missing data due to extramarital sex and conception, which was probably not so eagerly reported by historians. Despite the fact that chroniclers claim the historical data are reliable, we are unable to provide flawless evidence. Thus, we bear in mind the limitations above, and cannot draw final conclusions regarding the Trivers-Willard Hypothesis (TWH).

Authors' contributions

PS, SK, PB conceptualization; PB, AN data collection; MKar, MKow data analysis; PS, MKow manusript draft; SK, PB, AN, MKar comments and revisions. All authors read and approved the final version of the manuscript.

Conflict of interest

The authors declare that there is no conflict of interest regarding publication of this paper.

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