Adaptive Human Behavior and Physiology (2020) 6:185–193
https://doi.org/10.1007/s40750-020-00132-6

ORIGINAL ARTICLE

Parasite Prevalence and Income Inequality Positively Predict Beardedness Across 25 Countries

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Received: 20 January 2020 / Revised: 12 March 2020 / Accepted: 18 March 2020 /
Published online: 14 April 2020

Abstract

Objectives Sexually dimorphic characteristics can signal high genetic fitness and parasite resistance in intersexual selection; and individuals choose and prefer mates who appear resistant to parasites. Furthermore, sexually dimorphic traits can indicate intrasexual competitiveness. Beards are a sexually dimorphic trait, and in the current study we investigate the relationship between pathogen prevalence, income inequality and beardedness in men.
Methods Using publicly available data from The World's Muslims' dataset (PEW Research Center), encompassing more than 14,000 individuals from 25 countries, we test the hypotheses that men wear beards where the pathogen stress is higher and male-male competition is more prevalent.
Results Our results show that beardedness in men is predicted by pathogen prevalence as well as GINI coefficient.
Conclusion Overall, the results of this study provide support for the Hamilton-Zuk parasite-mediated sexual selection hypothesis, indicating that men wear beards in environments where the parasitic stress is higher (in order to signal their vigor, health, and ability to resist parasites in such environments), and where there is more prevalence of male-male competition (indicated by higher wealth inequality).

Keywords Facial hair · Beards · Parasite stress · Cross cultural · Sexual selection

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s40750-020-00132-6) contains supplementary material, which is available to authorized users.

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Sexually dimorphic secondary sex characteristics refer to distinct differences between males and females of one species, including differences in size and/or appearances. These sexually dimorphic characteristics have evolved under sexual selection pressure (Darwin 1871), and can act as primary cues in the perception and evaluation of physical attractiveness (Barber 1995; Rhodes et al. 2005). Sexually dimorphic features can also signal health and genetic quality (Thornhill and Gangestad 1999; Puts et al. 2012). For example, sexual dimorphic masculine features in human male faces are positively associated with health and could be considered a reliable signal of an individual's genetic quality (Thornhill and Gangestad 2006).

Adaptation to environmental conditions and pathogens has shaped human social cognition and behavior (Schaller 2011). According to the parasite theory of sexual selection, individuals choose and prefer mates who appear resistant to parasites, because they are more likely to produce genetically resistant offspring and provide better parental care (Hamilton and Zuk 1982; Thornhill and Gangestad 1993). Accordingly, physical attractiveness is a primary signal of parasite resistance and high genetic fitness (Gangestad and Buss 1993; Grammer and Thornhill 1994; Thornhill and Gangestad 1993). Moreover, it follows that as parasite prevalence increases, both men and women will place more value on potential mates with good health, heredity, and higher attractiveness (Gangestad and Buss 1993; Gangestad et al. 2006). In general, as masculine facial features in men seem to be indicators of resistance to parasites and diseases (Rhodes et al. 2003; Rhodes 2006; but see Scott et al. 2010 for contrary results) it follows that women from regions with lower health and higher pathogen prevalence should show higher preferences for masculine traits in men's faces (DeBruine et al. 2010, 2012; Penton-Voak et al. 2004; but see the following studies for contrary and/or null results: Dixson et al. 2017b; Marcinkowska et al. 2019; McIntosh et al. 2017).

The human beard is a sexually dimorphic characteristic that is regulated by androgens after puberty and is a signal of masculinity, dominance, and strength (Addison 1989; Dixson and Brooks 2013; Neave and Shields 2008; Randall 2008). Phylogenetic evidence from male nonhuman primates with polygynous mating systems (Dixson et al. 2005) and large social group sizes with multilevel social organizations (Grueter et al. 2015) supports the role of human beardedness as sexually selected ornaments that signal social status and dominance involving male-male competition and attractiveness to females. Consistent with this, it is reported that women prefer men with beards over clean-shaven faces (Dixson and Brooks 2013; Dixson et al. 2018b; Stower et al. 2019; for contrary results see Dixson et al. 2016, 2018a, b; Janif et al. 2014; Muscarella and Cunningham 1996). Moreover, McIntosh et al. (2017) reported that pathogen disgust in women was associated with higher preference for bearded men. They suggested this association could be explained in light of a parasite resistance handicap hypothesis (Hamilton and Zuk 1982), as bearded men can signal their genetic quality by maintaining beards despite the fact that facial hair could be hazardous due to its potential for hosting pathogens (McIntosh et al. 2017). On the other hand, according to the ectoparasite avoidance hypothesis (Rantala 1999, 2007), reduced body hair, indicating less potential harboring environment for ectoparasites, could be considered more attractive in mate selection (McIntosh et al. 2017). Both the hypotheses have found support in a recent study where women's preferences for facial hair were negatively associated with their reported disgust towards ectoparasites and positively associated with self-reported

pathogen disgust (Clarkson et al. 2020). In the current study, we test Hamilton-Zuk parasite-mediated sexual selection hypothesis by examining the relationship between men's actual beardedness and pathogen prevalence across 25 countries, drawing from data of more than 14,000 male participants.

In addition to *intersexual* selection, masculine men may fare better in *intrasexual* competitions (Frederick and Haselton 2007), as sexual dimorphic morphological characteristics in men (masculine features) can also signal men's fighting ability, competitiveness, and resource holding ability (Barber 1995; Berglund et al. 1996; Symons 1995). By amplifying masculine and dominance features in male faces (Dixson et al. 2017a; Dixson and Vasey 2012), and eliciting faster and more accurate responses to angry facial displays (Craig et al. 2019), facial hair seems to play an important role in human male-male intrasexual competition. Consistent with this, the practice of wearing facial hair is more frequent in larger urban centers, presumably where intrasexual competition is higher (Dixson et al. 2017c). Therefore, we also hypothesize that beardedness is more prevalent where intrasexual male competition over resources is more intense. Specifically, we hypothesize human males' intrasexual competition is more robust where income inequality is more prevalent (Brooks et al. 2010). We examine this possibility by considering the relationship between men's actual beardedness and individual income security and national-level income inequality.

Note that because the reasons for choosing to wear a beard are multifaceted, we also consider: (1) the importance of religion, as all the participants were Muslims and wearing a beard is a common practice for Muslim men (Ball and Haque 2003) and hence having beard might indicate religiosity (González 2011); (2) marital status and age of the participants, as men who are younger and not married may have different incentives for wearing a beard compared to older and/or married men (i.e., the incentives of younger, single men, are more likely to make contact with factors relevant to the parasite resistance handicap hypothesis); and finally (3) for the effect of social and normative pressures to wear a beard as a conformity-norm of the society, we controlled for governmental vertical restriction (Conway III et al. 2017).

Method

Data were acquired from The World's Muslims' dataset, created and maintained by the Pew Research Center, which in face-to-face interviews surveyed respondents from October 2011 to November 2012. A total of 32,604 individuals from 26 countries (Afghanistan, Albania, Algeria, Azerbaijan, Bangladesh, Bosnia-Herzegovina, Egypt, Indonesia, Iran, Iraq, Jordan, Kazakhstan, Kosovo, Kyrgyzstan, Lebanon, Malaysia, Morocco, Niger, Pakistan, Palestine, Russia, Tajikistan, Thailand, Tunisia, Turkey, Uzbekistan) participated in the survey. All participants were over 18 years of age at the time of participation. Participants were assigned to six age categories (18–25, 26–35, 36–45, 46–55, 56–65 and over 66 years of age). Marital status was limited to those who were 1- married and live with a partner, and 2- who have never been married. We excluded those identified as widowed, separated, or divorced, as their sexual relationship was not clear. Our dataset was limited to the male participants with data on their facial hair status. Also, Afghanistan was identified as an outlier and removed from the analysis, as the number of individuals wearing a beard in Afghanistan is greater than

1.5 times the interquartile range, most likely due to enforcement by political laws. After the exclusion of female participants and other individuals who provided inappropriate answers or those who refused to answer the questions of our interests (see below), the final number of countries was 25 and the number of participants was 14,032.

Measures

Beard Status

Beard status of the participants was extracted from question Q121 of the survey in which the interviewer indicated whether the respondent had a beard or not (1-Yes and 2-No).

Income Level

For the income level the participants were asked how they would describe their personal economic situation (Q7 of the survey): "1-very good", "2-somewhat good", "3-somewhat bad" or "4-very bad". Those participants with codes "8-don't know" and "9-refused" were removed from analysis.

Importance of Religion

Question 36 of the survey (Q36) asked participants "How important is religion in your life?" and the responses were "1-very important", "2-somewhat important", "3-not too important", or "4-not at all important". Those participants with the codes "8-don't know" and "9-refused", were excluded from analysis.

Cross Cultural Indices

The data for the GINI index (an indicator of income inequality within nations) and sex ratio were obtained from the World Bank. The GINI index for Palestine was unavailable and was therefore calculated as the average of the GINI scores for the other countries. Similarly, the sex ratios for Kosovo and Palestine were unavailable, so the average sex ratio of the other countries was applied to both. Pathogen prevalence was obtained from Fincher and Thornhill (2012). Data for pathogen prevalence for Kosovo and Palestine were calculated as the average pathogen prevalence score for the other countries. Governmental restriction scores were obtained from Conway III et al. (2017) vertical legal restriction index for each country. Data for legal restriction index for one country, Kosovo, was calculated as the average of the values for the other countries.

Data Analysis

A mixed effects logistic regression (i.e., a multilevel regression model) was conducted to test the effect of pathogen prevalence and GINI as predictors of beard status, with country nested within geographical region as a random effect. The importance of religion and income level at individual level were added as control variables to the model. The national indices (values for GINI, sex ratio, pathogen prevalence and legal

restriction index) were z-scored and added as national level control variables. Geographical region classifications were assigned as per the World Bank's "Country and Leading Groups" classification. All data were analyzed in R (version 3.4.1), using the lme4 (Bates et al. 2015) and lmerTest (Kuznetsova et al. 2017) packages. Data are available in an ESM data file.

Results

Table 1 shows the fixed effects from the model predicting beard status. Results show parasite prevalence (parasite stress) and GINI coefficient predicting beard status, suggesting that men wear beards where pathogens are more prevalent and income inequality is higher. However, no significant association between individual income level and beard status was observed. Also, there was a significant, positive relationship, between importance of religion and beard status, meaning that religiosity predicts beardedness. The relationship between legal restriction index and beardedness was significant, indicating where there are higher governmental vertical restrictions, the prevalence of wearing a beard is higher. Also, the relationship between age and beardedness showed that the practice of wearing a beard increases with age. Finally, results showed that practice of wearing a beard in married men is higher than single men.

Discussion

Results of the current study show that parasite prevalence predicts beard status, with the percentage of men wearing beards increasing as the parasite prevalence increases. This supports the Hamilton-Zuk parasite-mediated sexual selection hypothesis (Hamilton and Zuk 1982; Møller and Saino 1994) which suggests ornaments can reliably indicate health and vigor and reflect an individual's ability to resist parasites in the environment. Our results also dovetail with a previous study showing that pathogen disgust in women is associated with higher preference for bearded men (Clarkson et al. 2020;

Table 1 The fixed effects for the model predicting men facial hair status ($N = 14{,}032$, across 25 countries)

	Estimate (Std. Error)	z-value	*p* value
Intercept	1.78(.34)	5.16	<.001***
Age	−.29(.01)	−15.31	<.001***
Marital Status	.25(.06)	3.88	<.001***
Income Level	.01(.02)	.45	.651
Importance of Religion	.20(.04)	2.83	<.001***
Parasite Stress	−.53(.20)	−2.59	.009*
Legal Restriction	.01(27)	.01	.986
GINI	−.32(.14)	−2.30	.021*
Sex Ratio	−.06(.12)	−.50	.611

McIntosh et al. 2017). And similarly, our work converges with previous investigations indicating that women primed with pathogenic cues prefer more masculinized faces of men (Little et al. 2010; Watkins et al. 2012). It should be noted, however, that not all studies have found a significant relationship between preference for men's facial masculinity and pathogens (e.g., Dixson et al. 2017b; McIntosh et al. 2017), or between beardedness and pathogens, with a recent instance being the study of Dixson et al. (2019a, b) who failed to uncover a relationship between women's preference for men's beardedness and parasite prevalence. This might be because they investigated the relationship between women's preference for beards and parasite prevalence, while the current study examined men's actual behavior and parasite prevalence.

Sexually dimorphic traits such as beards are not only important in intersexual selection; they can also play role in intrasexual competition by signaling information about a man's masculinity and associated factors such as fighting ability and/or resource holding power (Berglund et al. 1996). While our study did not reveal a relationship between men's beards and income insecurity at an individual level, income inequality at a national level (as indicated by the GINI coefficient) showed a relationship. In other words, while beards do not seem to be a robust and reliable indicator of an individual's income situation, it could be more prevalent in regions where inequality in wealth distribution is higher. This supports a previous result that showed women from lower average income countries have a stronger preference for men with beards (Dixson et al. 2017c). One might therefore speculate that beards are important for intersexual signaling (e.g., attracting women) as well as intrasexual signaling (e.g., male-male competition).

Contrary to our expectation, we found that men select to wear a beard more as they age, and having a beard was higher in older married men than single younger men. We suggest that these findings might be related to the fact that religiosity predicts beardedness in Muslim populations, and the importance of religion increased with age in our sample ($r = .34$, $p < .001$). Therefore, the importance of religion may play a key moderating role in the relationship between beardedness and age. Similarly, as men age and become more religious, the chance of being married increases. Hence the finding that the prevalence of beardedness is higher for older married men than younger single men. Another possibility for why men wear beards as they age could be a response to female choice for a cue of long-term paternal investment. It has been shown that mothers report a stronger preference for beardedness when judging parenting skills, but not attractiveness, compared to women without children (Dixson et al. 2019a). In addition, women in long-term relationships with bearded men report higher reproductive success compared to women in long-term relationships with non-bearded men (Štěrbová et al. 2019). However, the results of our study did not show a significant relationship between legal restriction index and beardedness, which suggests that wearing a beard in Islamic countries may not necessarily be influenced by normative values. Indeed, as our sample was focused solely on Muslim participants, our study invites a future cross-cultural investigation. For instance, it is known that there is a relationship between being a devoted Muslim and having a beard (Hopkins 2004). Thus, an open and crucial issue for future research is to determine what components of our results are preserved in a non-Muslim sample, and what aspects are altered. This will suggest what factors in choosing to wear a beard are – or are not – sensitive to cultural influences. This will help to reveal the extent that our present study's support

for the Hamilton-Zuk parasite-mediated sexual selection hypothesis (Hamilton and Zuk 1982; Møller and Saino 1994) is common across a broad range of cultures.

Acknowledgements Authors are grateful to Mark Schaller for his valuable comments on an earlier draft of this paper.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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