Hormones and the Human Alpha Female

Monika K. Sumra*

Department of Anthropology, University of Toronto Scarborough, Toronto, ON, M1C 1A4, Canada

* **monika@bunkaleadership.com**

Abstract

The concept of the alpha female has become widely accepted as a form of female identity in the West. Though relationships between hormone concentrations and alpha-related traits have been demonstrated in alpha nonhuman primates, this has not been examined in the case of the human alpha female. The present study examined the associations of testosterone and cortisol, as well as 3 other hormones, estradiol, oxytocin, and progesterone derived from hair samples, with 11 variables related to the expression of the alpha female identity in a small non-random sample (N=126) of self-identified alpha and non-alpha women in North America. The results revealed statistically significant differences between these groups. When compared to non-alpha women, alpha women scored higher than non-alphas in measures for masculinity, leadership, low introversion, self-esteem, and exhibited lower hair cortisol levels. Alphas exhibited slightly lower estradiol and oxytocin levels than non-alphas though these differences were non-significant. Similar non-significant differences were also found in the case of sexual experience, sexual dominance, testosterone, and progesterone. Though cortisol was not associated with masculine traits, it was positively and significantly associated with leadership. Cortisol was also negatively and significantly associated with strength and a measure for femininity. Progesterone, testosterone, and oxytocin were positively and significantly associated with enjoying sex, as was oxytocin with playing a dominant role in sexual encounters. Surprisingly, testosterone was not

associated with alpha status nor with the measure of masculinity, and estradiol was not associated with any of the variables. The results imply that women who identify as alpha may experience less physiological stress than non-alpha females as measured by their lower cortisol levels.

Introduction

The influence of hormones includes "intrinsic feedbacks of social context and social behavior on hormones" [1-16]. Behavior is driven by internal and external/environmental stimuli which act on neural systems [16]. The reciprocal relationship between hormones and social behavior demonstrates that hormones do not determine behavior but may increase or decrease the probability of the expression of a given behavior [16]. Given that dominance as a behavioral strategy can be used to gain or maintain high status in society, it is not surprising that a large body of literature has focused on understanding how biological factors, specifically hormones, may influence dominance behaviors [8].

The cross-disciplinary interest in the relationship between social status and hormones is not new [14, 17-26]. Previous research has demonstrated that hormones, specifically cortisol, progesterone, estradiol (primary in women of reproductive age), testosterone, and the peptide hormone oxytocin, correlate with behavioral traits deemed as "alpha" in women [8, 26-35]. For example, attributes including self-assertion, confidence, conceit, forcefulness, control, and willfulness have been associated with higher circulating testosterone levels in women, and lower levels with absence of these alpha traits [28].

Along with engaging in aggressive behaviors, alpha female individuals have also been found to behave in a more cooperative and communal manner [36]. For example, alpha female bonobos maintain cohesion through affiliation while also engaging in aggressive behaviors to keep males away from food [37]. Animal studies have revealed that increased levels of oxytocin are associated with behaviors that promote affiliation, cooperation and prosociality (performing acts that benefit or help others) with other females [38,39]. Communal behavior or affiliation has also been shown to be associated with the expression of the alpha female identity [40]. Research in humans, however, has yet to be conducted. The peptide hormone oxytocin has a special relevance to female behavior because its effects are strongly modulated by estrogen [41]. Estradiol has been linked to dominance behavior. In one-on-one dominance contests, women who expressed higher power motivation also had higher circulating estradiol levels both before and after the contest, compared to women who had lower power motivation [32].

When it comes to hormones and alpha status, much of the research within this context has focused primarily on a specific masculine trait, aggression. For example, Gladue (1991) [42] found that both testosterone and estradiol, were positively correlated with aggression in men. In women however, these correlations were negative [42]. Cashdan [23], examined hormones and competitive aggression in 30 women and found that women with low levels of testosterone were less likely to express their competitive feelings through verbal aggression than women with higher levels of testosterone. That study, however, also found that estradiol was not related to competitive tactics. Women with high estradiol levels reported fewer competitive interactions in athletics than did other women. Aggression has been associated with high testosterone and low cortisol levels in women [26], as well as negatively associated with estradiol levels [32].

While some research has found social rank to be associated with stress in primates as measured by elevated cortisol levels [25, 43, 44], other research has found no association [25]. There is evidence to support that high levels of estradiol and high levels of progesterone are associated with low levels of aggression and that estradiol may also influence behaviors in women other than aggression including dominance, assertiveness, and risk-taking behaviors [26].

More recently, there has been a focus on understanding how hormone levels may jointly influence dominance and other status-seeking behaviors in humans with respect to leadership. Mehta and Josephs [30], examined hormone regulation of dominance in women leaders. They contend that leadership is one of the most important domains within which to study status and social dominance. For their study men and women were randomly assigned to the position of a leader or follower and then asked to complete a leadership task in a simulated competition (how to move blocks to make a specific design). These interactions were video-taped, observations recorded, and each identified leader was rated in terms of dominance. Mehta and Josephs [30] developed a 12-item scale that indexed dominance in leaders. These items assessed dominance as characterized by behaviors linked to, motivation to gain high status including assertiveness, confidence, being energetic, enthusiastic, extraverted, and verbally fluent, display leader-like and directive behavior, being decisive, displaying masculinity and an expansive posture. Using salivary samples, their results revealed that testosterone interacted with cortisol to predict dominance in leaders – that is, dominance in leaders can be predicted by the joint regulation of testosterone and cortisol, where low cortisol and higher testosterone together, are related to increased dominance [30]. In their study on leadership position and circulating testosterone and cortisol levels in male executives, Sherman et al. [14] evaluated the relationship between salivary

92 cortisol and testosterone levels and a measure of attained status – the number of subordinates
93 over which the executive had authority. They found that executive males who exhibited high
94 testosterone and low cortisol levels were more likely to occupy high-status positions whereas
95 low-testosterone, low-cortisol executives were more likely to occupy lower status positions [14].
96 Testosterone has also been implicated in sexual behavior of women [29]. For example, Udry [45]
97 found that though testosterone was positively related to interest in sexual behavior for both males
98 and females, for females specifically, this interest is only expressed in the absence of a father and
99 low participation in team sports [45].
100
101 When it comes to estradiol, progesterone, and the peptide hormone oxytocin however, research is
102 scant. Where research in this area has been undertaken, oxytocin has been found to potentially
103 increase aggression in women by lowering perceptions of danger that would normally inhibit
104 women from retaliating. Low levels of aggression have also been associated with elevated levels
105 of estradiol and progesterone [26]. Though testosterone is required for the expression of
106 masculine traits such as aggression in most vertebrates, including mice and humans, estrogen
107 also plays a role [46]. The enzyme aromatase converts testosterone into estrogen and thus
108 increased levels of testosterone lead to increased levels of estrogen [46]. Despite the dual
109 requirement of estrogen and testosterone for the expression of masculine behaviors, how these
110 dual hormonal pathways are expressed by alpha females has not been examined.
111
112 Although it has been established that hormones respond to social context and vice versa [35],
113 what is not clear is how these responses are shaped by social norms related to gender, in this
114 case, a specific archetype of female identity, the alpha female. What is absent from the literature

is whether variability in the expression of female identity, specifically between alpha and non-alpha women, may, or may not be connected to neuroendocrine expression. The present research tests the relationships between hormonal and behavioral traits of the alpha female to gain greater insight into our understanding of the alpha female identity from a biosocial perspective. The results of the present study provide an opportunity to better understand whether hormones may represent a biological expression of the alpha female identity. Specifically, the present research seeks to understand the associations between cortisol, testosterone, and alpha female attributes as well as how other hormones such as estradiol, progesterone, and oxytocin, may also play a role in the expression of this female identity. Examined alongside results from recent research on the expression of the alpha female identity which found masculine traits to be a predictor of alpha status [40], it is predicted that alpha women will exhibit higher testosterone but lower cortisol levels than non-alpha females. It is also predicted that testosterone will be positively associated with masculine traits.

Methods

Participants, recruitment and exclusion

Recently, Sumra [40] conducted an extensive review and textual analyses of the academic and popular literature of the human alpha female to examine the social construction and expression of the alpha female identity in a small non-random sample of North American women (N=398). In that study [40], participants completed a 96-question survey and were asked questions in the end of this survey about the alpha female identity. Participants could not go back to change their answers. Included at the end of that survey was a definition of the alpha female following which

women were asked to respond yes, no, or maybe as to whether they considered themselves an alpha female based on that definition. That review revealed 2 predominant alpha female representations in the academic and popular literature – one more masculine versus one more feminine – and 21 variables likely to be associated with the expression of the alpha female identity. That study [40] found that the alpha female was a recognized socially constructed female identity. Univariate analysis revealed positive and highly significant differences in self-reported mean scores between alpha (N=94) and non-alpha (N=304) females for 10 variables related to expression of the alpha female identity. In that study [40], the measure of masculine traits was identified as the only predictor of alpha female status as per the multiple regression model. Interestingly, both alpha and non-alpha women scored the same for the measure of feminine traits. Further, both groups scored higher for feminine traits than masculine traits. Participants for the present study were recruited from Sumra's [40] previous study. As chemical birth control or hormonal therapy may influence hormone levels, women who indicated either were excluded. A total of 32 alpha and 94 non-alpha women remained for a total of 126 participants. The present study evaluates the potential associations between 5 specific hormones (cortisol, estradiol, progesterone, oxytocin, and testosterone), and 10 alpha female -related traits which include measures of masculinity, leadership, strength, low introversion, self-esteem, life satisfaction, sexual experience, initiating sex, enjoying sexual intercourse, and playing a dominant role in sexual encounters, which were found to be associated with the expression of the alpha female identity in Sumra's 2019 [40] study. The average age category for the sample across all women was 35-37 years, and the average education level was a bachelor's degree. For those women who were employed the average income was approximately $58,000.00 annually.

Measures

Bem Sex Role Inventory (BSRI) – Masculine and Feminine Personality Traits

Since its development over four decades ago, the *Bem Sex Role Inventory* or BSRI [47] has been the most commonly used and repeatedly validated measure of gender roles and traits [48]. The original BSRI [47] includes 60 dichotomous items divided into 3 subscales - masculinity, femininity, and neutral. Each subscale includes 20 adjectives that represent typical masculine, feminine, and 20 neutral traits in Western society. The condensed versions of the BSRI-M and BSRI-F based on a total of 10 alpha female related behavioral traits in Sumra's 2019 work [40] were used in the present study. These versions exhibited adequate internal consistency for both the BSRI-M (Cronbach's α=0.64) and the BSRI-F (Cronbach's α=0.72). Respondents were asked to score each item on a 5-point Likert Scale from *never* (1) to *always* (5). Means for masculine and feminine categories were calculated to derive corresponding masculinity and femininity scores. Higher masculinity scores indicate higher affiliation with masculine traits, higher feminine scores indicate higher affiliation with feminine traits, equal scores in both masculine and feminine traits indicate androgyny, and low scores in both masculinity and femininity indicate an undifferentiated gender.

The Alpha Female Inventory (AFI) Leadership, Strength and Low Introversion (extroversion)

The subscales of the Alpha Female Inventory (AFI) developed by Ward, Popson, and DiPaolo [49], was used to measure leadership (AFI-L), strength (AFI-S), and extroversion (AFI-LI). The AFI [49] is a 14-item measure of alpha female personality. Items are scored on a 5-point Likert

scale from *strongly disagree*-1 to *strongly agree*-5 and summed, with higher scores indicating greater levels of leadership (the desire to be a leader, dominant, and assertive), strength (perceived superiority and physical strength), and low introversion (as an index of extroversion). Defined by Ward, Popson, and DiPaolo [49] as "being quiet and withdrawn from social situations", low introversion, is considered a proxy measure of extroversion. AFI-LI items are reverse-coded where higher scores indicate lower levels of being quiet and withdrawn.

Rosenberg Self-Esteem Scale (RSES) – Self-Esteem

The Rosenberg Self-Esteem Scale (RSES) [50] is a validated measure of self-esteem. Composed of 10 items that assess both positive and negative feelings about the self or "self-worth", it is the most widely used self-report instrument of confidence and self-esteem [51]. The RSES is unidimensional and items are scored on a 4-point Likert-type scale ranging from *strongly disagree* (0) to *strongly agree* (3) [51]. The RSES was modified to reflect an additional choice of *neutral* (3) to avoid neutral response bias. Research suggests that because negatively worded items may be interpreted differently by different groups, using the RSES may have limited value [52]. Inclusion of a neutral avoids responses at the extreme ends of the RSES [52]. The resulting scale was a 5-point Likert scale ranging from *strongly disagree* (1) *to strongly agree* (5). Some questions were also reworded for simplicity and clarity. Items were summed, and higher scores indicated greater self-esteem.

Sexual dominance aspects – Frequency, Dominant Role, Sexual Experience, Initiating, and Enjoying Sex

Five aspects of sexual dominance previously used in Sumra's 2019 study [40] were assessed. These included sex frequencies, playing a dominant role in sexual encounters, taking initiative in sexual encounters, enjoyment during sex, and sexual experience.

Life Satisfaction

The present study also included an assessment of life satisfaction. A single question was asked, "Describe the level of satisfaction and fulfillment you feel in your life". Responses were scored on a 5-point Likert scale (0-none, 1-low, 2-moderate, 3-high, and 4-extremely high).

Hair Hormone Analysis

Hair has become recognized as a reliable substrate for measuring hormone concentrations in animals and humans [53-58]. When compared to other methods of sampling such as blood, urine, and saliva, hair sampling is considered most non-invasive, and samples can be collected by non-health care professionals [55]. Unlike urine, saliva, and blood, hormone concentrations in hair are expressed over a longer period of time rather than at a given point in time [59]. In the field of hair hormone analysis, most research in this area has focused primarily on the assessment of chronic stress and the analysis of the stress hormone cortisol in hair [60]. Saliva, blood, and urine are subject to circadian variation in hormone secretion resulting in fluctuating levels over a 24-hour period [61]. For example, salivary, blood, and urinary cortisol levels are typically measured over a 24-hour period usually starting with a first morning sample with subsequent samples taken at intervals throughout the day. Single urine samples collected at any given time reflect cortisol secretion since the last urinary void. Only urine collected throughout the day captures cortisol secretion over a 24-hour period [59]. Where urine samples can provide hormonal profiles for a

24-hour period, saliva and serum provide "point estimates" for cortisol secreted prior to collection (~20 minutes for saliva and <3 minutes for blood) [62].

For the present study, hair samples were sent to a commercial lab (Viagaurd Accu-Metrics, Toronto, Canada) for measurement of cortisol, estradiol, testosterone, progesterone, and oxytocin concentrations. Use of a special collection kit ensured the root ends faced the same direction. Hair were cut close to the scalp to ensure that the sample was collected between periods of dying hair, if hair was dyed on a regular basis. All kits were sealed and stored in individual envelopes. Samples were prepared using the first 3 centimeters of hair closest to the scalp which were washed in isopropyl alcohol by soaking for 5 minutes followed by a rinse. Any hair follicles that were present were cut to ensure that only hormones from the hair shaft were extracted. Because the hair roots had been removed, only hormone concentrations from the hair shaft were extracted. Hair shaft samples were cut into small pieces with surgical scissors then weighed in a 1.5mL tube. The weight of the samples ranged between 0.69 and 3.67 mg. The samples were then ground to a fine powder prior to an overnight extraction in methanol. The supernatant from each of the extractions was then removed and evaporated until completely dry. Once the methanol had been removed, each sample was re-suspended in 250µL of phosphate-buffered saline (PBS) at pH 8.0. The samples were vortexed for 1 min until the extract was dissolved. The cortisol, estradiol, testosterone, progesterone, and oxytocin extracted from the hair were measured using gas chromatography/mass spectrometry with standards for each of these hormones as reference. The dissolved supernatant for each hormone was compared with the standard and normalized with the weight of the hair to give pg/mg values. The respective analytical errors were assessed by replicate measures of cortisol, estradiol, testosterone, progesterone, and oxytocin standards and determined to be ±7 pg/mg.

250

251

Ethics Statement

253 This research, including the method of obtaining informed consent, was approved by the
254 University of Toronto's Research Ethics Board (Protocol #27117). Informed consent was
255 obtained for each phase of the present study from all participants. Signed consent forms were
256 obtained from those participants who provided hair samples before data collection which were
257 retained by the primary author. Terms of service were adhered to for all social media websites
258 where data were collected.

259

Statistical Analyses

261 Descriptive statistics including the mean, median and standard deviation were run for all
262 variables. These included 5 hormone variables CORT (cortisol), EST (estradiol), PROG
263 (progesterone), OXY (oxytocin,) and TEST (testosterone), and the 10 alpha female behavioral
264 variables and the measure of feminine traits identified in Sumra's [40] 2019 study. Differences
265 between the alpha and non-alpha groups were assessed using nonparametric Mann-Whitney U-
266 tests. All statistical tests were conducted using the Number Cruncher Statistical Systems (NCSS)
267 statistical software package [63].

268

Results

270 The results from the Mann-Whitney U tests revealed that when compared to non-alpha females,
271 alpha females (N=32) had significantly higher mean scores for masculine traits (BSRI-M),
272 leadership, low introversion, and self-esteem (RSES), and exhibited lower cortisol (CORT)

levels than non-alpha females (N=94) (Table 1). Small but non-significant differences in strength, BSRI-F, life satisfaction, initiates sex and enjoys sex were also found. Alpha females exhibited slightly lower levels of estradiol (EST) and oxytocin (OXY) than non-alphas, and although they scored higher in sexual experience, playing a dominant role in sexual encounters (Dom_Role_Sex), testosterone (TEST), and progesterone (PROG) than non-alpha women, these differences were not significant statistically.

The results from the nonparametric correlation analysis revealed a number of significant relationships (Table 2). Cortisol was positively correlated with leadership and negatively correlated with strength and feminine traits (BSRI-F). Progesterone and oxytocin were positively correlated with sexual enjoyment (Enjoys Sex) as was testosterone. Oxytocin was also positively correlated with playing a dominant role in sexual encounters (Dom_Role_Sex), and negatively correlated with masculine traits (BSRI-M). Estradiol (EST) was not correlated with any of the variables. Leadership position in the workplace as measured by management level is included in (Table 3). Approximately 44% of alpha females held a mid to upper management position versus 35% of non-alpha females.

Table 1. Results from univariate analyses for alpha and non-alpha female groups

	Alpha			Non-Alpha			
Variable	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**P-value (Mann-Whitney U Test)**
Masculine Traits (BSRI-M)	32	3.806	0.395	94	3.534	0.456	**<0.001**
Feminine Traits (BSRI-F)	32	4.187	0.451	94	4.1	0.467	0.358
Leadership	32	20.219	3.338	94	18.096	3.642	**<0.05**
Strength	32	16.75	2.639	94	15.925	2.352	0.099
Low Introversion	32	13.75	2.747	94	12.425	3.244	**<0.05**
Self-Esteem (RSES)	32	39.719	6.624	94	37.181	5.98	**<0.05**
Life Satisfaction	32	2.5	0.824	94	2.531	0.786	0.846
Sexual Experience	32	1.875	1.039	91	1.538	0.981	0.102
Initiate Sex	32	2.688	1.029	91	2.582	0.844	0.569
Enjoy Sex	31	4.194	1.138	91	4.022	1.053	0.444
Dom Role_Sex	32	2.406	0.797	91	2.242	0.848	0.339
CORT	32	28.389	6.531	94	31.765	7.309	**<0.05**

EST	32	0.866	0.311	94	0.931	0.327	0.324
PROG	32	28.064	8.145	94	26.218	8.814	0.299
OXY	32	7.967	1.922	94	8.122	2.088	0.711
TEST	32	0.746	0.313	94	0.661	0.344	0.202
Education	32	3.213	1.252	94	3.398	1.026	0.124
Employment	32	3.249	0.761	94	3.046	0.739	0.175
Income	32	3.638	1.789	94	3.579	1.702	0.842

290

291

292

293

294

Table 2. Nonparametric Spearman correlations among variables used in the study (N=126) *P<0.05, **P<0.01, ***P<0.0001

	Leadership	Strength	Low Int.	Self-Esteem RSES	Masc. Traits BSRI-M	Fem. Traits BSRI-F	Life Sat.	Enjoys Sex	Init.Sex	Dom_Role_Sex	Sex Exp	CORT	EST	PROG	OXY	TEST
Leadership	1															
Strength	0.270**	1														
Low Int.	0.473***	0.393***	1													
Self-Esteem RSES	0.485***	0.381***	0.474***	1												
Masc. Traits BSRI-M	0.438***	0.515***	0.542***	0.322***	1											
Fem. Traits BSRI-F	0.062	0.085	0.164	0.13	0.168	1										
Life Sat.	-0.192*	-0.062	-0.137	-0.157	-0.023	0.132	1									
Enjoys Sex	0.095	0.048	0.065	-0.053	0.069	-0.05	0.122	1								
Initiates Sex	0.018	-0.047	0.04	0.043	-0.002	-0.019	0.135	0.548***	1							
Dom_Role_ Sex	0.061	0.01	0.065	-0.021	0.017	-0.014	0.198*	0.357***	0.553***	1						
Sex Exp	0.098	-0.002	0.059	0.126	0.194*	-0.019	-0.075	0.183*	0.018	-0.005	1					
CORT	0.177**	-0.182**	-0.003	0.091	0.115	-0.187*	0.023	-0.02	0.03	0.017	-0.003	1				
EST	0.073	-0.02	-0.063	0.027	-0.09	-0.016	0.114	-0.062	0.055	0.013	-0.069	0.163	1			
PROG	0.037	-0.083	-0.029	0.063	-0.089	-0.085	0.029	0.243**	0.079	0.097	0.047	0.071	0.096	1		
OXY	0.021	-0.113	-0.09	-0.107	-0.231**	0.066	-0.092	0.196*	0.147	0.259**	0.028	-0.108	0.1	0.104	1	
TEST	0.137	-0.155	0.138	0.019	-0.062	0.068	0.046	0.024	-0.05	0.039	0.078	-0.139	0.078	0.019	0.197*	1

295

Table 3. Management position and alpha status

Position	**alphas**	**%**	**non-alphas**	**%**	**P-value**
Non to low mgmt	N=18	0.56	N=61	0.65	0.597
Mid to upper mgmt	N=14	0.44	N=33	0.35	
	32		94		

Discussion

The present study examined the relationship between 5 hormones (cortisol, estradiol, progesterone, oxytocin, and testosterone) and 11 alpha female variables in a small non-random sample of women in North America (N=126). As predicted, alpha women exhibited higher testosterone and lower cortisol levels than non-alpha women. Only the difference in cortisol levels between alpha and non-alphas, however, was statistically significant. Within this context, these results are consistent with similar research in humans [13,14], and non-human primates [20] and contribute to the growing research on dual-hormone patterns with respect to testosterone and cortisol [15, 64]. For example, Sapolsky [20], found that in stable dominance hierarchies of wild olive baboons, subordinate males exhibited higher cortisol levels than alpha males. In Sherman et al.'s [14] study, high testosterone and low cortisol predicted the number of subordinates among male business executives. Other research on the association between cortisol levels and alpha status, however, have revealed mixed results [18, 65].

Alpha individuals are found both to have higher [18, 65] and lower cortisol levels than non-alphas [13, 14, 18, 21]. According to Sapolsky and Ray [65], when it comes to nonhuman primates, dominance style problematizes the validity of low cortisol levels as a marker for alpha status. For example, Sapolsky and Ray [65] found that low cortisol levels are not necessarily a feature of all dominant male baboons in stable hierarchies. Low cortisol levels are exhibited by alpha males who engage in a particular style of dominance in alpha males who display a high degree of social skillfulness, control, and predictability over social hazards, such as, the ability to distinguish between winning or losing a fight [65]. In contrast, alpha males without this skillset were found to have cortisol concentrations as high as subordinate males [65]. Further Sapolsky

and Ray [65] found that male baboons who held longer alpha tenure had exhibited lower cortisol levels [65]. This suggests that cortisol levels in alpha individuals may fluctuate over time. In the case of the present research, perhaps the longer a woman identifies as an alpha female, the lower her cortisol levels may be. The results of the present study revealed a positive association between cortisol levels and leadership scores across all women. This result is significant for future research that examines the relationship between cortisol levels in women and leadership position in the workplace.

The finding that testosterone is not correlated with masculine traits in the present group of women is inconsistent with previous research that have found masculine traits to be positively correlated with testosterone concentration in women. For example, Baucom, Besch, and Callahan's [27] study of 84 undergraduate students who completed Baucom's Masculinity and Femininity Scales [66] as well as the BSRI and an Adjective Check List, found that women with higher masculinity scores exhibited higher testosterone levels than women with higher femininity scores. They also found that women with higher testosterone levels perceived themselves as self-directed, action-oriented, and resourceful [27]. It is important to note however, that Baucom, Besch, and Callahan [27] stated that masculine-sex-typed females (women who scored higher for masculine traits than feminine traits) exhibited "somewhat" higher testosterone levels than more feminine-sex-typed females (women who scored higher for feminine traits than masculine traits).

Limitations and Future Research

The results of the present research are subject to several important limitations. First, the present study relies on self-identification and does not include data on how those women would be identified by others (e.g. as alpha or non-alpha). Though self-identification and alpha-identity perception (positive, neutral, or negative) could be considered measurable aspects of identity, they are not the only ones. Entativity, or the degree to which groups are perceived by outsiders or non-group members represents another dimension [67]. The opinions and perceptions of non-alpha women and men, and particular self-identified alpha women, may also provide insight into the social construction of the alpha female identity.

The present study is also limited by non-random sampling, and therefore may include some bias, the nature of which is unknown. It is also potentially limited by small sample sizes for both the non-alpha and alpha sampling groups. It is therefore possible that the results do not accurately reflect the differences between these groups of women in North America. Both of these sampling limitations might affect the generalizability of the results to a larger population beyond the scope of the present study.

Similar to Sherman et al. [13], the present findings raise the possibility that higher testosterone levels in conjunction with lower cortisol levels may predispose women to regard themselves as alpha female. Though hormones can affect many aspects of human behavior, the correlations between specific hormones and specific behaviors are often weak and are likely influenced by many factors [68]. As data were collected through the survey and focus groups, self-identified alpha females were not observed in their natural environments limiting insight into how

365 behaviors may be mediated or enhanced by hormones within different social contexts. This is
366 important because humans have complex social lives operating in varying contexts, belong to
367 different social groups and hierarchies, and perform a variety of social roles [22]. Within this
368 context, a self-identified alpha female may not necessarily mean that she is all alpha, all of the
369 time [40]. Future ethnographic research focused on the daily lived experiences and the various
370 contexts of the alpha female may provide greater insight into the potential fluidity and variation
371 in the hormonal expression of the alpha female identity.
372
373 Future research that evaluates the relationships between testosterone and cortisol, and female
374 leaders who are considered alpha and non-alpha, may shed light on whether these particular
375 hormones do in fact play a role in the likelihood of occupying a leadership position for women
376 more generally, and more importantly, may also provide the opportunity to gain deeper insight
377 into a potential variant of leadership itself – the alpha female leader. Additionally, the result that
378 leadership is positively associated with stress warrants follow-up research on alpha females who
379 occupy leadership roles.

380 It is important to note that there have been very few examples in the literature of oxytocin being
381 measured in hair. In one study by Hamel [69], it was determined that hair likely does not provide
382 a good means for measuring long-term oxytocin levels, and that oxytocin may not be
383 incorporated into hair in the same way as cortisol. It is unclear in that study, however, whether
384 the extraction of oxytocin from hair, or measurement by enzyme immunoassay (EIA) is the basis
385 of that determination in that study. As such, it is unclear whether the measurement of oxytocin
386 by mass spectrometry in the present study mitigates the problems with measuring oxytocin in
387 hair suggested by Hamel [69].

Conclusions

The present research contributes to and has direct implications for research on dominance and status-seeking behaviors in humans, specifically research on the human alpha female. It also has direct implications for future leadership and alpha leadership research, and for the study of social hierarchy in organizational research, including research that examines associations between hormones and the attainment of social and professional status [13,14]. The finding that alpha women exhibit lower cortisol levels than non-alpha women also has implications for research on the relationship between alpha status and stress in humans.

Consideration of the findings of the present study alongside with those of Sumra [40], which found that masculine traits predicted alpha status, raises more food for thought on what it means to be an alpha female from a biosocial perspective. Alpha females associate leadership, self-esteem, and being less introverted more with their identity more than other women and they are less stressed as indexed by the hormone cortisol. Thus, the answer to the question "are hormone levels associated with being an alpha female", for this group of women, is yes, however, only in the case of cortisol.

Acknowledgments

I would like to thank Dr. Michael Schillaci in the Department of Anthropology at the University of Toronto Scarborough for his support, advice, and critical input.

References

1. Zak PJ, Kurzban R, Matzner WT. The Neurobiology of Trust. Annals of the New York Academy of Sciences. 2004;1032: 224–227. doi:10.1196/annals.1314.025

2. Zak P, Kurzban R, Matzner W. Oxytocin is associated with human trustworthiness. Hormones and Behavior. 2005;48: 522–527. doi:10.1016/j.yhbeh.2005.07.009

3. Zak PJ. The Neuroeconomics of Trust. SSRN Electronic Journal. 2005; doi:10.2139/ssrn.764944

4. Bos PA, Terburg D, Honk JV. Testosterone decreases trust in socially naive humans. Proceedings of the National Academy of Sciences. 2010;107: 9991–9995. doi:10.1073/pnas.0911700107

5. Stanton SJ, Labar KS, Saini EK, Kuhn CM, Beehner JC. Stressful politics: Voters' cortisol responses to the outcome of the 2008 United States Presidential election. Psychoneuroendocrinology. 2010;35: 768–774. doi:10.1016/j.psyneuen.2009.10.018

6. Stanton SJ, Beehner JC, Saini EK, Kuhn CM, Labar KS. Dominance, Politics, and Physiology: Voters Testosterone Changes on the Night of the 2008 United States Presidential Election. PLoS ONE. 2009;4. doi:10.1371/journal.pone.0007543

7. Anderson C, Kilduff GJ. Why do dominant personalities attain influence in face-to-face groups? The competence-signaling effects of trait dominance. Journal of Personality and Social Psychology. 2009;96: 491–503. doi:10.1037/a0014201

8. Mehta PH, Josephs RA. Testosterone and cortisol jointly regulate dominance: Evidence for a dual-hormone hypothesis. Hormones and Behavior. 2010;58: 898–906. doi:10.1016/j.yhbeh.2010.08.020

9. Feldman R, Gordon I, Zagoory-Sharon O. Maternal and paternal plasma, salivary, and urinary oxytocin and parent-infant synchrony: considering stress and affiliation components of human bonding. Developmental Science. 2011;14: 752–761. doi:10.1111/j.1467-7687.2010.01021.x

10. Gettler LT. Applying socioendocrinology to evolutionary models: Fatherhood and physiology. Evolutionary Anthropology: Issues, News, and Reviews. 2014;23: 146–160. doi:10.1002/evan.21412

11. Weisman O, Zagoory-Sharon O, Feldman R. Oxytocin administration, salivary testosterone, and father–infant social behavior. Progress in Neuro-Psychopharmacology and Biological Psychiatry. 2014;49: 47–52. doi:10.1016/j.pnpbp.2013.11.006

12. Jaeggi AV, Trumble BC, Kaplan HS, Gurven M. Salivary oxytocin increases concurrently with testosterone and time away from home among returning Tsimane hunters. Biology Letters. 2015;11: 20150058–20150058. doi:10.1098/rsbl.2015.0058

13. Sherman GD, Lee JJ, Cuddy AJC, Renshon J, Oveis C, Gross JJ, et al. Leadership is associated with lower levels of stress. Proceedings of the National Academy of Sciences. 2012;109: 17903–17907. doi:10.1073/pnas.1207042109

14. Sherman GD, Lerner JS, Josephs RA, Renshon J, Gross JJ. The interaction of testosterone and cortisol is associated with attained status in male executives. Journal of Personality and Social Psychology. 2016;110: 921–929. doi:10.1037/pspp0000063

15. Sherman GD, Rice LK, Jin ES, Jones AC, Josephs RA. Sex differences in cortisols regulation of affiliative behavior. Hormones and Behavior. 2017;92: 20–28. doi:10.1016/j.yhbeh.2016.12.005

16. Soares MC, Bshary R, Fusani L, Goymann W, Hau M, Hirschenhauser K, et al. Hormonal mechanisms of cooperative behaviour. Philosophical Transactions of the Royal Society B: Biological Sciences. 2010;365: 2737–2750. doi:10.1098/rstb.2010.0151

17. Mazur A, Booth A. Testosterone and dominance in men. Behavioral and Brain Sciences. 1998;21: 353–363. doi:10.1017/s0140525x98001228

18. Sapolsky RM. The endocrine stress-response and social status in the wild baboon. Hormones and Behavior. 1982;16: 279–292. doi:10.1016/0018-506x(82)90027-7

19. Sapolsky RM. Individual Differences in Cortisol Secretory Patterns in the Wild Baboon: Role of Negative Feedback Sensitivity*. Endocrinology. 1983;113: 2263–2267. doi:10.1210/endo-113-6-2263

20. Sapolsky RM. Hypercortisolism Among Socially Subordinate Wild Baboons Originates at the CNS Level. Archives of General Psychiatry. 1989;46: 1047. doi:10.1001/archpsyc.1989.01810110089012

21. Sapolsky R. Testicular function, social rank and personality among wild baboons. Psychoneuroendocrinology. 1991;16: 281–293. doi:10.1016/0306-4530(91)90015-l

22. Sapolsky RM. Social Status and Health in Humans and Other Animals. Annual Review of Anthropology. 2004;33: 393–418. doi:10.1146/annurev.anthro.33.070203.144000

23. Cashdan E. Hormones, Sex, and Status in Women. Hormones and Behavior. 1995;29: 354–366. doi:10.1006/hbeh.1995.1025

24. Carré J, Olmstead N. Social neuroendocrinology of human aggression: Examining the role of competition-induced testosterone dynamics. Neuroscience. 2015;286: 171–186. doi:10.1016/j.neuroscience.2014.11.029

25. Feng X, Wu X, Morrill RJ, Li Z, Li C, Yang S, et al. Social correlates of the dominance rank and long-term cortisol levels in adolescent and adult male rhesus macaques (Macaca mulatta). Scientific Reports. 2016;6. doi:10.1038/srep25431

26. Denson TF, O'Dean SM, Blake KR, Beames JR. Aggression in Women: Behavior, Brain and Hormones. Frontiers in Behavioral Neuroscience. 2018;12. doi:10.3389/fnbeh.2018.00081

27. Baucom DH, Besch PK, Callahan S. Relation between testosterone concentration, sex role identity, and personality among females. Journal of Personality and Social Psychology. 1985;48: 1218–1226. doi:10.1037//0022-3514.48.5.1218

28. Grant VJ, France JT. Dominance and testosterone in women. Biological Psychology. 2001;58: 41–47. doi:10.1016/s0301-0511(01)00100-4

29. Booth A, Granger DA, Mazur A, Kivlighan KT. Testosterone and Social Behavior. Social Forces. 2006;85: 167–191. doi:10.1353/sof.2006.0116

30. Mehta P, Josephs R. Social Endocrinology: Chapter 9: Hormones and Social Motivation. In Frontiers in Social Psychology, ed. D. Dunning, pp. 171-189, New York: Psychology Press.

31. Madison G, Aasa U, Wallert J, Woodley MA. Feminist activist women are masculinized in terms of digit-ratio and social dominance: a possible explanation for the feminist paradox. Frontiers in Psychology. 2014;5. doi:10.3389/fpsyg.2014.01011

32. Stanton SJ, Schultheiss OC. Basal and dynamic relationships between implicit power motivation and estradiol in women. Hormones and Behavior. 2007;52: 571–580. doi:10.1016/j.yhbeh.2007.07.002

33. Mccarthy MM, Mcdonald CH, Brooks PJ, Goldman D. An Anxiolytic Action of Oxytocin is Enhanced by Estrogen in the Mouse. Physiology & Behavior. 1996;60: 1209–1215. doi:10.1016/s0031-9384(96)00212-0

34. Ziegler TE. Female sexual motivation during non-fertile periods: A primate phenomenon. Hormones and Behavior. 2007;51: 1–2. doi:10.1016/j.yhbeh.2006.09.002

35. Anders SMV, Steiger J, Goldey KL. Effects of gendered behavior on testosterone in women and men. Proceedings of the National Academy of Sciences. 2015;112: 13805–13810. doi:10.1073/pnas.1509591112

36. Hawley PH, Little TD, Card NA. The myth of the alpha male: A new look at dominance-related beliefs and behaviors among adolescent males and females. Int J Behav Dev. 2008;32(1):76–88. https://doi.org/10.1177/0165025407084054.

37. Stanford CB. The Social Behavior of Chimpanzees and Bonobos: Empirical Evidence and Shifting Assumptions. Current Anthropology. 1998;39: 399–420. doi:10.1086/204757

38. Carter CS. Neuroendocrine Perspectives On Social Attachment And Love. Psychoneuroendocrinology. 1998;23: 779–818. doi:10.1016/s0306-4530(98)00055-9

39. Bartz JA, Hollander E. The neuroscience of affiliation: Forging links between basic and clinical research on neuropeptides and social behavior. Hormones and Behavior. 2006;50: 518–528. doi:10.1016/j.yhbeh.2006.06.018

40. Sumra MK (2019) Masculinity, femininity, and leadership: Taking a closer look at the alpha female. PLoS ONE 14(4): e0215181. https://doi.org/10.1371/journal.pone.0215181

41. Campbell A. Attachment, aggression and affiliation: The role of oxytocin in female social behavior. Biological Psychology. 2008;77: 1–10. doi:10.1016/j.biopsycho.2007.09.001

42. Gladue BA. Aggressive behavioral characteristics, hormones, and sexual orientation in men and women. Aggressive Behavior. 1991;17: 313–326. doi:10.1002/1098-2337(1991)17:6<313::aid-ab2480170603>3.0.co;2-z

43. Sapolsky RM. The Influence of Social Hierarchy on Primate Health. Science. 2005;308: 648–652. doi:10.1126/science.1106477

44. Beehner JC, Bergman TJ. The next step for stress research in primates: To identify relationships between glucocorticoid secretion and fitness. Hormones and Behavior. 2017;91: 68–83. doi:10.1016/j.yhbeh.2017.03.003

45. Udry JR. Biological Predispositions and Social Control in Adolescent Sexual Behavior. American Sociological Review. 1988;53: 709. doi:10.2307/2095817

46. Wu MV, Manoli DS, Fraser EJ, Coats JK, Tollkuhn J, Honda S, et al. Estrogen masculinizes neural pathways and sex-specific behaviors. Cell. 2009;139: 61–72. doi: doi: 10.1016

47. Bem SL. The measurement of psychological androgyny. J Consult Clin Psychol. 1974 Apr;42(2):155–62. doi.org/10.1037/h0036215 PMID:4823550.

48. Carver LF, Vafaei A, Guerra R, Freire A, Phillips SP. Gender differences: examination of the 12-item bem sex role inventory (BSRI-12) in an older Brazilian

population. PLoS One. 2013 Oct;8(10):e76356. https://doi.org/10.1371/journal.pone.0076356 PMID:24098482.

49. Ward RM, Popson HC, DiPaolo D. Defining the alpha female: A female leadership measure. J Leadersh Organ Stud. 2010;17(3):309–20. https://doi.org/10.1177/1548051810368681.

50. Rosenberg M. Society and the adolescent self-image. Princeton (NJ): Princeton University Press; 1965. https://doi.org/10.1515/9781400876136.

51. Blascovich J, Tomaka J. Measures of self-esteem. In: Robinson JP, Shaver PR, editors. Measures of personality and social psychological attitudes. San Diego (CA): Academic Press; 1991. pp. 115–60. https://doi.org/10.1016/B978-0-12-590241-0.50008-3.

52. Schmitt DP and Allik J. Simultaneous administration of the Rosenberg Self-Esteem Scale in 53 nations: Exploring the universal and culture-specific features of global self-esteem. J Pers Social Psychol. 2005;89(4):623-42.

53. Gleixner A, Meyer HHD. Detection of estradiol and testosterone in hair of cattle by HPL/EIA. Fresenius Journal of Analytical Chemistry. 1997;357: 1198–1201. doi:10.1007/s002160050330

54. Yang HZ, Lan J, Meng YJ, Wan XJ, Han DW. A preliminary study of steroid reproductive hormones in human hair. The Journal of Steroid Biochemistry and Molecular Biology. 1998;67: 447–450. doi:10.1016/s0960-0760(98)00120-4

55. Sauvé B, Koren G, Walsh G, Tokmakejian S, Uum SHV. Measurement of cortisol in human Hair as a biomarker of systemic exposure. Clinical & Investigative Medicine. 2007;30: 183. doi:10.25011/cim.v30i5.2894

56. Gow R, Thomson S, Rieder M, Uum SV, Koren G. An assessment of cortisol analysis in hair and its clinical applications. Forensic Science International. 2010;196: 32–37. doi:10.1016/j.forsciint.2009.12.040

57. Stalder T, Kirschbaum C. Analysis of cortisol in hair – State of the art and future directions. Brain, Behavior, and Immunity. 2012;26: 1019–1029. doi:10.1016/j.bbi.2012.02.002

58. Holland BJV, Frings-Dresen MHW, Sluiter JK. Measuring short-term and long-term physiological stress effects by cortisol reactivity in saliva and hair. International Archives of Occupational and Environmental Health. 2011;85: 849–852. doi:10.1007/s00420-011-0727-3

59. Uum SHMV, Sauvé B, Fraser LA, Morley-Forster P, Paul TL, Koren G. Elevated content of cortisol in hair of patients with severe chronic pain: A novel biomarker for stress. Stress. 2008;11: 483–488. doi:10.1080/10253890801887388

60. Slezak JK, Ström JO, Theodorsson E. Testosterone-like immunoreactivity in hair measured in minute sample amounts - a competitive radioimmunoassay with an adequate limit of detection. Scientific Reports. 2017;7. doi:10.1038/s41598-017-17930-w

61. Genuth SM. The Adrenal Glands, 949-979. St. Louis, MO: Moseby Year Book; 1993.

62. Manenschijn L, Schaap L, Schoor NMV, Pas SVD, Peeters GMEE, Lips P, et al. High Long-Term Cortisol Levels, Measured in Scalp Hair, Are Associated With a History of Cardiovascular Disease. The Journal of Clinical Endocrinology & Metabolism. 2013;98: 2078–2083. doi:10.1210/jc.2012-3663

63. Hintze J. NCSS and PASS Number crunches statistical systems. Utah: Kaysville; 2004.

64. Carré JM, Archer J. Testosterone and human behavior: the role of individual and contextual variables. Current Opinion in Psychology. 2018;19: 149–153. doi:10.1016/j.copsyc.2017.03.021

65. Sapolsky RM, Ray JC. Styles of dominance and their endocrine correlates among wild olive baboons (Papio anubis). American Journal of Primatology. 1989;18: 1–13. doi:10.1002/ajp.1350180102

66. Baucom DH. Independent CPI Masculinity and Femininity Scales: Psychological Correlates and a Sex-Role Typology. Journal of Personality Assessment. 1980;44: 262–271. doi:10.1207/s15327752jpa4403_8

67. Abdelal R, Herrera YM, Johnston AI, McDermott R. editors. Measuring Identity – A guide for social scientists. New York (NY): Cambridge University Press; 2009. https://doi.org/10.1017/CBO9780511810909.

68. Eisenegger C, Haushofer J, Fehr E. The role of testosterone in social interaction. Trends in Cognitive Sciences. 2011;15: 263–271. doi:10.1016/j.tics.2011.04.008

69. Hamel AF. Interactions between Hypothalamic-Pituitary-Adrenal (HPA) Axis, oxytocin system, and behavior in differently reared rhesus monkeys (Macaca mulatta). https://scholarworks.umass.edu/dissertations_2/362. 2015.

Supporting Information

S1 File. Rosenberg Self Esteem Scale.

S2 File. BSRI-M and BSRI-F.

S3 File. Alpha Female Sexuality Profile.

S4 File. Alpha Female Inventory (AFI).