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ORIGINAL PAPER

Gender Differences in Acculturation, Stress, and Salivary Cortisol Response Among Former Soviet Immigrants

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Abstract Post-immigration adaptation is characterized by chronic and acute acculturative stressors. Salivary cortisol is a commonly used hormonal marker of stress, but few studies have investigated its use as an indicator of acculturative stress and adjustment in immigrants. The purpose of this study was to examine relationships among predictors of adjustment (environmental and language mastery), self-reported stress outcomes (depressive symptoms, perceived stress, alienation), and salivary cortisol response in immigrants from the former Soviet Union. The sample included 137 married men and women aged 42–80 who lived in the U.S. for 1–13 years. Results indicated that while men and women had similar values for cortisol response, relationships among adjustment measures, stress outcomes, and cortisol differed by gender. Among men, environmental mastery significantly reduced depressive symptoms, perceived stress, and cortisol response. Among women, environmental mastery also reduced depressive symptoms, perceived stress, and alienation, but language mastery increased cortisol response and decreased alienation.

Keywords Salivary cortisol · Stress · Acculturation · Immigrant health · Gender

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Background

Social determinants affect both physical and mental health. It has been clearly documented across academic disciplines that poorer and less-educated individuals experience more diseases, higher mortality rates and worse mental health than their wealthier counterparts, and the effects of low socioeconomic status (SES) persist throughout adulthood and older ages [1, 2]. Increasing numbers of research studies now integrate biological measures into the study of social determinants of health and examine how biological risk factors change across the life course. However, while some biological factors are associated with increased health risks as people age, others are not [3]. Total cholesterol, for example, has not been shown to increase mortality among older adults [4–6], but elevations in the stress hormone cortisol has been linked with increased risk for cognitive decline [7, 8] and risk for onset of new depression [8]. These findings demonstrate the need for combined examination of the social environment and biology on physical and mental health and how they interact across the life course.

One key social determinant of mental health traditionally studied among immigrants is acculturative stress [9], and salivary cortisol is a potential biological counterpart [10]. Although acculturative stress is not an inevitable consequence of migration, many studies suggest that the demands and challenges of living in a new and unfamiliar cultural milieu can be quite stressful [11, 12]. Salivary cortisol is frequently used today as a reliable biological measure of psychological stress [13, 14], but most studies that examine post-migration acculturative stress use only self-report measures to demonstrate mental health outcomes, particularly with regard to chronic stress among midlife and older immigrants. Using a combination of

subjective and objective measures may provide a broader assessment of the complexities of acculturative stress that will facilitate interventions to reduce health disparities between immigrants and their native-born counterparts in the United States. This study will expand existing literature by examining relationships between predictors of acculturative stress and both self-report and biological stress measures, focusing on an understudied group of immigrants: immigrants from the former Soviet Union who immigrated as married couples at midlife and older ages.

Acculturative Stress

Research on the concept of stress and its psychological, physiological, and health-related manifestations dates back to the 1950s [15]. Although much controversy exists over the exact definition of stress, most researchers agree that it is considered a state brought about by environmental events in which demands exceed an individual's personal and social resources. The concept of acculturative stress refers to a particular type of stress in which the stressors are identified as having their source in the process of acculturation. Existing and related research finds that challenges of immigration, such as learning an unfamiliar language and mastering a new cultural milieu [16], can be stressful and have important implications for mental health and family relationships [12, 17, 18].

The trajectory of self-reported acculturation over time is variable and likely related to an iterative process of mastery and change that may be accompanied by feelings of confusion, sadness, and loss [19]. Rudmin [20] argues for limiting the concept of acculturation to that of second-culture acquisition, thus separating out the *process* from the *outcomes* of acculturation. However, the process of acculturation is commonly associated with a particular set of stress-related psychosocial outcomes, such as depressed mood, heightened anxiety, and feelings of marginality and alienation [21–23]. For example, shorter length of residence in the new country, sometimes used as a proxy measure of acculturation, has been associated with lower acculturation and higher depression scores [24]. These mental health correlates may contribute to or be a result of acculturative stress; unfortunately, it remains difficult to establish directionality or to attribute stress specifically to acculturation, given the everyday stressors experienced by immigrants as well as non-immigrants. On the other hand, Rudmin [20], in a review of the literature on constructs, measurements, and models of acculturative stress, argues that measures of acculturative stress needs to move beyond traditional mental health screening measures such as self-reported stress and depression. In fact, he argues against measuring acculturative stress through psychological instruments at all, recommending it be limited to physiological measures such as cortisol [20].

Demographic predictors of acculturative stress include age, gender, size of the co-ethnic immigrant group, as well as length of stay in the new country, education, employment, and marital status. Those who immigrate as midlife or older adults have more difficulty adapting than their younger counterparts because they have more difficulty learning a new language and mastering cultural and social conventions [25, 26], and the effect of age on acculturative stress appears particularly strong among older immigrant women [18, 27].

Depressed mood has a higher reported prevalence for women than men across ethnic backgrounds [28, 29]. Gender differences in acculturative stress, often measured as depression, also generally show higher prevalence for women [30]. For example, high rates of depressive symptoms have been documented for Asian, Hispanic, and Eastern European immigrants [31–33]. Smaller immigrant groups that are unable to reside in large homogeneous ethnic enclaves, such as those from the former Soviet Union (FSU), may be at increased risk because they have less access to special foods, ethnic social networks, and other resources that contribute to positive mental health among immigrants [34–36]. Results on the direction and effects of employment and marital status remain mixed [37].

Correlates of Acculturative Stress Among Immigrants from the Former Soviet Union

Differences across immigrant groups in the impact of acculturation have not been clarified, particularly for some groups, such as those from the FSU, who may be understudied due to their smaller representation compared with other cohorts of immigrants. As members of a large wave who left the FSU following its dissolution in 1989, people who emigrated from the FSU during the past 20 years came primarily for reasons of economic hardship, political repression, and religious discrimination. Although more recent immigrants from FSU countries represent a broader spectrum of ethnic backgrounds, the initial waves of immigrants from former Soviet Republics were comprised primarily of Jews from Russia, Ukraine, and Belarus who largely settled with their families in urban areas. In 1999, combined immigration from the former Soviet Republics of Russia and Ukraine ranked fifth in the United States among countries from which legal immigrants were admitted, and they comprised the largest group accepted with refugee status throughout the 1990s [38]. Soviet Jewish emigration exceeded one million people, and close to one-half million were estimated to have immigrated to the United States between 1991 and 2000 [39]. FSU

immigrants report particularly high levels of distress and somatic complaints after immigration; although these are in part due to premigration health care inadequacies and social disruption, issues related to acculturation and the immigration process are related to distress as well [22, 40].

A past history of depressive symptoms, gender, and age all play a role in increased risk of psychological distress among immigrants from the FSU. Depressed mood and anxiety have been found to be much higher for immigrants from the FSU than average U.S. norms, especially for those who were older and those who lacked English proficiency [41]. Russian immigrants who immigrated at midlife and older ages are more likely to live in neighborhoods with higher rates of poverty, acculturate slower, and experience more social alienation than those who came to the United States earlier in life [19]. In part because of their previous employment status, and educational levels, immigrants from the FSU to the United States had high expectations for their new lives, and subsequently experienced significant disappointment, demoralization, and alienation [32, 40]. Women tend to report more distress than men [42], though some findings differ for retired married men who reported greater distress than women [43]. Haasen et al. [22] found a significant correlation between acculturation stress and mental distress for Russian immigrants to Germany. Immigrants from the FSU, particularly women, tend to report higher scores on depression scales than other immigrant groups, at levels that approach those of psychiatric samples [32]. Even many years post-migration, older women from the FSU continue to report feelings of isolation and social alienation from the mainstream [40].

Salivary Cortisol Response

Exposure to or anticipation of stress causes an activation of the hypothalamus–pituitary–adrenal (HPA) axis that results in the release of a hormone called cortisol. Cortisol levels follow a diurnal rhythm which adjusts to sleep patterns. The hormone levels normally start to gradually rise in the late stage of night sleep, followed by a steep rise within 30 min after awakening, when they reach their highest point. After remaining high up to 1 hour after awakening, the hormone levels start to decline, first relatively steeply (up to about 4:00 p.m.), and then more gradually, reaching nadir at midnight [44]. Salivary cortisol is a good reflection of blood cortisol levels and is a simple, non-invasive biomarker of psychological stress [13].

Salivary cortisol response is commonly measured in several different ways, including initial awakening cortisol level, cortisol awakening response (CAR), diurnal rhythm of cortisol production throughout the day (diurnal slope), and total daily cortisol production: area-under-the-curve (AUC) [45]. There is, however, lack of consensus in the literature as to which of these measures is best to use in studies of health and illness [46]. Cortisol awakening response is believed to be a good measure of basal cortisol because it is the least affected by random daily stresses and confounders [47]. However, this measure may not be reliable under situations of prolonged stress. Prolonged or chronic stress can lead to disregulation of the HPA axis, which is reflected in changes in cortisol levels and diurnal patterns, most commonly a flattening of a daily cortisol curve (lower morning levels and higher evening levels) [48]. Numerous studies have shown that measuring cortisol right after awakening and then within next 30–60 min (CAR) may be a good measure of HPA functioning and demonstrates good intra-individual stability over time [49–51]. Nevertheless, there is evidence to suggest that, for individuals with chronic stress, diurnal cortisol patterns or AUC may be a more appropriate measure of cortisol response than CAR [52].

Relatively little research has been reported on cortisol response for immigrants. Most studies specific to immigrants and refugees have largely examined those who have experienced extreme post-traumatic stress [53–55]. Despite consensus that immigration is an acute stressor, acculturation (a longitudinal process) may also result in chronic stress. Studies of Mexican–Americans suggest that an attenuated CAR and higher AUC predicts depression independently of history of childhood trauma, and higher acculturation was associated with an attenuated CAR [56, 57]. In a study of Hispanic and non-Hispanic family caregivers of patients with dementia, all caregivers were found to have higher levels of cortisol than noncaregivers, but Hispanics had flatter cortisol slopes and more perceived depression symptoms than non-Hispanic Whites, regardless of caregiving status [50]. Korenblum et al. [51] reported that Soviet Union-born Jewish immigrants to Germany had higher salivary cortisol concentration, measured by AUC, than German-speaking immigrants from the FSU and native Germans, and cortisol levels were also significantly correlated with self-reported anxiety and depression.

Predictors of Cortisol Response

Cortisol production is affected by age, gender, and personal or environmental influences, including SES, smoking, physical activity, obesity, sleep, and medications such as hormone replacement therapy [58]. Although findings regarding the effects of gender and age on the HPA axis vary in magnitude and (in some cases) direction, both are considered key independent variables. With respect to age, the most consistent finding is that cortisol levels and reactivity to stress increase with age, especially in the very old [59]. Gender differences appear most often as a differential response to stressors [60, 61], and studies suggest

that cognitive and/or emotional responses to distressing situations could result in differential cortisol secretion. These gender differences have been documented across age and type of stressor, in both acute and chronic contexts [14, 62, 63]. For example, women's waking cortisol was more sensitive to an acute examination stressor protocol [64], and women have also been found to be more sensitive than men to the influence of chronic work stress [47].

Studies examining the effect of chronic lifestyle and environmental strains on cortisol response have shown that there may be an absence of an early morning peak in cortisol response or a rise later in the day [65]. For example, low SES has been shown to be associated with a flattened or blunted diurnal pattern and a persistence of high levels of cortisol throughout the day [66]. Agbedia and colleagues found blunted diurnal decline in older adults with low SES, but no SES-related differences in awakening cortisol level, CAR or AUC [46]. In addition, a number of studies have reported that lifestyle behaviors such as smoking affect cortisol levels [67, 68]. Chronic stress or daily hassles have been shown to be associated with various mental health conditions, particularly depression [50, 69]. Sher proposed that cortisol secretion due to daily hassles contributes to development of depression and elevated cortisol may worsen the condition in depressed patients [70].

The objectives of this study are twofold: (1) examine relationships among acculturative adjustment (language and environmental mastery), psychological stress outcomes (depressed mood, anxiety, and alienation), and salivary cortisol response; and (2) examine gender differences in predictors of salivary cortisol response. We will focus on the diurnal cortisol response measured by AUC analysis, which is consistent with previous research on chronic stress [13, 52]. We expect that self-reported acculturation measures will be significantly associated with stress outcome measures and salivary cortisol, even after confounding variables are included in the models. We also expect that the significant predictors of cortisol response will differ for men and women.

Methods

Participants

Participants in this study comprised a subsample of a longitudinal study of the influence of acculturation and family adaptation on health outcomes among midlife women from the FSU and their husbands. They were recruited from urban and suburban neighborhoods of the Chicago Metropolitan Area through announcements on Russian-language radio; advertisements in Russian-language newspapers; flyers in neighborhood businesses, clinics, community groups, and English as a second language (ESL) classes; and word of mouth. Prospective participants called the project telephone number, which was answered by a voicemail message in Russian. They were screened for eligibility over the telephone by Russian-speaking project staff. Women were eligible for enrollment in the study if they had immigrated directly from the FSU fewer than 8 years prior to entry into the study, were 40–74 years of age, were able to read and write Russian fluently, were married or partnered, and had at least one child living in the United States. Exclusion criteria included hospitalization for psychotic mental illness in the U.S., currently taking antipsychotic medication, or having a debilitating illness [41].

Following the first two years of data collection, husbands of the participants were invited to enroll in the study as well. Men were eligible if they were married to a woman in the primary study and were fluent in the Russian language. Of the 226 women enrolled in that study at baseline, 154 had husbands who subsequently enrolled in the study. All were immigrants from the FSU.

One hundred of the 226 women enrolled in the study were randomly chosen to participate in the salivary cortisol component. Of these 100 women, 69 had husbands who were also in the study and agreed to contribute cortisol samples, but one had incomplete data; thus 137 total husbands ($n = 68$) and wives ($n = 69$) are included in these analyses. The Institutional Review Board of the investigators' university approved all components of this research.

Data Collection

Data collection for self-report questionnaires and physical measures, with the exception of salivary cortisol specimens, took place individually at participants' homes or in groups of 5–10 at a convenient community meeting room. Data were collected separately but concurrently for husbands and wives. After participants provided written informed consent, questionnaires were self-administered in Russian in the presence of the bilingual staff. All questionnaires were translated into Russian using back translation and modified committee methods [71, 72]. A modest cash payment was provided as travel and time reimbursement after each session.

Salivary cortisol samples were collected by participants using the Salivette^{TM} (Sarstedt, Inc., Newton, NC, USA) collection system on weekdays. Materials and directions were given to participants at the conclusion of their data collection visits. Participants were instructed to collect saliva specimens for 1 day on awakening, 40 minutes later, before lunch, and before dinner [45]. The actual time of collection was recorded, and the sample was stored in the participant's refrigerator. The participants were instructed not to consume beverages (including alcohol), eat, smoke,

exercise, or brush their teeth within 30 minutes before each saliva collection. In most cases, salivary cortisol samples were collected within 2–3 days of completion of the self-report questionnaires. Data for the present analyses were collected in 2003–2004 (third visit for women, baseline visit for men).

Salivettes were picked up by study staff and brought to the laboratory within 1–2 days of collection, where they were centrifuged at 1,000×*g* for 5 min at 4 °C. The resultant saliva sample was divided into two aliquots and stored at −20 °C for not longer than 4 weeks before cortisol level was measured by the Coat-A-Count radioimmunoassay method (RIA; Diagnostic Products Corp., Los Angeles, CA, USA). Samples were thawed at room temperature on the morning of cortisol measurement. Assays were run in duplicate according the manufacturer's instructions with modifications. The Coat-A-Count RIA was designed to measure total serum cortisol (i.e., both plasma protein bound [90 %] and free [10 %] fractions). Salivary cortisol represents the free fraction of total serum cortisol. Therefore, to measure salivary cortisol, the volume of unknown salivary sample was increased to 200 μL, the reference standards provided by the manufacturer were diluted tenfold to construct a standard reference curve, and the incubation time was increased to 3 hour at room temperature. Unknown salivary cortisol values (μg/dL) were obtained by comparison to a standard curve. Interassay coefficient of variation was ±7.3 %, and the intra-assay coefficient of variation ranged from 1.6 to 2.3 %. To establish reliability of the modified Coat-A-Count RIA method in our laboratory, the cortisol concentrations in five random salivary samples were measured by an enzyme immunoassay (EIA) kit (Diagnostic Systems Laboratories, Webster, TX, USA) and by RIA. The Pearson's correlation coefficient between assays was high ($r = 0.99$, $p = 0.01$).

Measures of Acculturation

Language Mastery

Three questions on the Acculturation and Assimilation Scale [4] were used: "How well do you…understand conversational English, read English, speak English." A 4-point Likert scale was used (1 = *not at all* to 4 = *very well*). Cronbach's alpha has been previously reported as 0.97 [73]; for the men in this sample, it was 0.90 and for women 0.86.

Environmental Mastery

The Environmental Mastery subscale of Ryff's [74] Well-being Scale was used to represent perceived personal control in one's life and environment. The 14-item scale used a 6-point Likert format (1 = *strongly agree* to 6 = *strongly disagree*). Six items were reverse-scored, and a mean score was used. Higher scores represent higher levels of environmental mastery. Sample items included "I do not fit very well with the people and the community around me" and "I have been able to build a home and lifestyle for myself that is much to my liking." Cronbach's alpha was reported as 0.90 [74], and was 0.84 for both men and women in this study.

Measures of Stress Outcomes

Symptoms of Depressed Mood

These were measured using the Center for Epidemiologic Studies Depression Scale (CES-D) [75]. The CES-D is a 20-item self-report instrument which was scored using a 4-point scale to indicate how frequently the respondent experienced symptoms during the previous 2 weeks (0 = *none of the time* to 3 = *all of the time*). Four positively worded statements were reverse-coded. The items were summed for a possible total score ranging from 0 to 60. A score of 16 has been designated as an arbitrary cut-off point to suggest clinical depression for referral or further evaluation. The Cronbach's alpha was 0.85 in a general population [75]; for this study, internal consistency was 0.86 for men and 0.87 for women.

Perceived Stress

To measure stress, Cohen's Perceived Stress Scale was used [76]. This scale measures the degree to which one appraises life experiences as stressful. The 14-item instrument uses a 5-point Likert scale (0 = *never* to 4 = *very often*). Sample items include "how often have you felt nervous and 'stressed'" and "felt confident about your ability to handle personal problems." The Cronbach's alpha was reported as 0.84–0.86 in the original samples [76]; for this sample, the alphas were 0.73 for men and 0.80 for women.

Alienation

Alienation was measured by the Alienation Scale developed by Nicassio [77]. This is a 10-item instrument that measures immigrants' perceived social and cultural estrangement in the United States. Sample items include "It is difficult for me to understand the American way of life" and "I feel all alone in America." Items were rated on a Likert scale (1 = *strongly disagree* to 4 = *strongly agree*), and mean scores were calculated after several items were reverse-coded. Cronbach's alpha was reported as 0.75 [77]; for this sample, the alpha was 0.82 for men and women.

Measure of Salivary Cortisol

Estimated diurnal cortisol from AUC-trapezoid analysis was used to estimate the total daily exposure to "free" cortisol. Because this variable was skewed to the left, a log-transformed version, called log-AUC, was created to normalize the distribution. Log-AUC as a variable had a very small range of all negative values (−2.8 to −0.9); therefore, no additional transformations were performed.

Statistical Analysis

Analysis began by examining mean level differences in all variables for men and women using *t* tests for continuous measures and Chi square tests for dichotomous measures. Next, bivariate analyses examined Pearson correlations (Spearman results were comparable and therefore not presented) among all variables in the analyses. Lastly, multivariate linear regression analyses examined associations between measures of acculturative stress (environmental and language mastery) and all measures of stress, both self-reported and measured by salivary cortisol. Because no associations were found between awakening cortisol and any measure of stress, these results were not presented. All models include covariates for age (years), years in the United States, employment status (currently employed vs. not employed), education (university graduate vs. any other level of education), and smoking status. Supplemental models (not presented) examined potential suppressor effects of control variables in models for both men and women.

Results

Sample Characteristics

The 137 participants ranged in age from 44 to 78 and lived in the United States for an average of 6 years. Table 1 displays the descriptive statistics for all variables in the analysis separately by gender. On control variables, men (mean age = 64.2) were significantly older than women (mean age = 61.0), but men and women did not differ significantly on years in the United States. Men were, however, much more likely to smoke: 22 % of men and 7 % of women were smokers. There were no significant differences between men and women with respect to education or employment, with both groups having university degrees but not active employment on average. For acculturative measures, men and women had similar average environmental mastery scale values (3.8 vs. 3.7), but women had significantly higher average language mastery (2.6 compared to 2.3 among men). Both men and women exhibited high levels of stress-related outcomes, with women having significantly higher values on most measures. Specifically, women reported a significantly higher average of symptoms of depressed mood as measured by CES-D score (21.6) and perceived stress score (1.9), compared to men at 18.1 and 1.7, respectively. Men and women did not differ significantly on the alienation scale.

Table 1 Cortisol response, self-reported stress, acculturative stressors, and demographic characteristics by gender

	Males ($n = 68$)		Females ($n = 69$)		p value
	Mean	SD	Mean	SD	
Cortisol measures					
AUC cortisol conc. (μg/dL)	0.2	0.1	0.2	0.1	0.33
Log-AUC cortisol conc. (μg/dL)	−1.7	0.4	−1.8	0.5	0.16
Self-reported stress measures					
CES-D	18.1	7.3	21.6	9.1	0.01
Perceived stress	1.7	0.5	1.9	0.4	0.00
Alienation	2.5	0.4	2.5	0.5	0.34
Acculturative stressors					
Environmental mastery	3.8	0.6	3.7	0.7	0.17
Language mastery	2.3	0.6	2.6	0.6	0.00
Demographic characteristics					
Age	64.2	8.1	61.0	8.1	0.01
Years in US	6.2	2.1	5.7	2.1	0.10
	N	%	*N*	%	
Smoker					
No	54	78.3	63	92.7	0.02
Yes	15	21.7	5	7.3	
Education					
Non-University grad	18	29.0	13	24.5	0.59
University graduate	44	70.9	40	75.5	
Employment					
No	41	66.1	35	66.0	0.99
Yes	21	33.9	18	34.0	

p Values are based on *t* tests for continuous variables and Chi square tests for dichotomous variables

With respect to cortisol values, men and women did not differ significantly on mean values for AUC cortisol values or log-AUC cortisol values. On average, AUC cortisol values for men and women were 0.2 μg/dL (or approximately 5.2 nmol/L) with a minimum of 0 μg/dL and a maximum of 2.2 μg/dL (0–60.7). Men and women also had similar raw cortisol values, as displayed in Fig. 1. Among men and women, cortisol values rose from awakening to

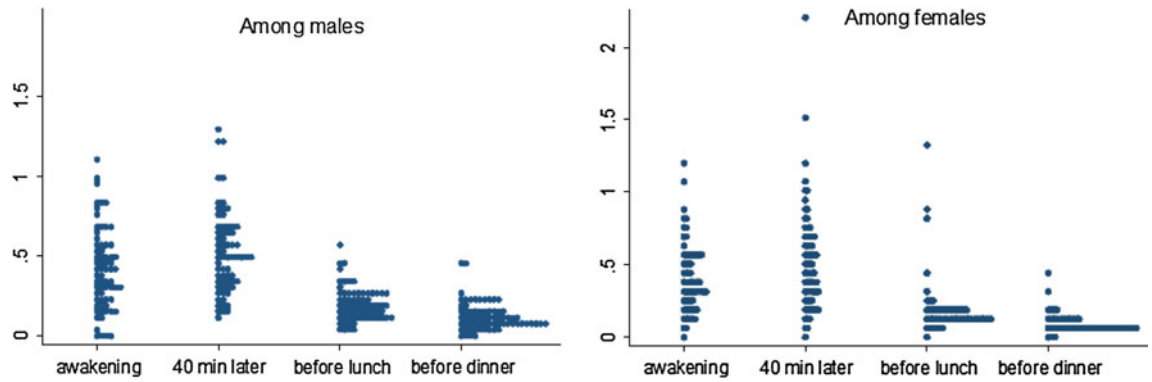

Fig. 1 Cortisol concentration values across time by gender

40 minutes later, where there was a peak, and then a steady decline over the course of the day. There was a slight difference in variation between men and women, with women having a slightly larger range of values within each measurement time point.

Bivariate Results

Next we examined zero-order Pearson correlations among all variables in the models, as displayed in Table 2. Again, due to significant mean level differences in reporting as well as theoretical underpinnings for gender differences in response to stress, correlations were run separately for men and women. Results for women are presented above the diagonal, and results for men are below.

In Table 2, we began by examining the correlations among the measures of acculturative stress (environmental and language mastery), the self-reported measures of stress (CES-D, perceived stress, and alienation), and log-AUC cortisol. We were surprised to see that there were no significant bivariate correlations between log-AUC cortisol and any other variables among men or women. However, measures of acculturative stress and self-reported stress were highly correlated, and measures of self-reported stress were significantly correlated with each other. Among men, we found that environmental mastery was significantly correlated with CES-D in the expected direction ($r = -0.41$) and inversely related to perceived stress ($r = -0.51$). Additionally, CES-D and perceived stress were significantly and positively related ($r = 0.56$). Results of correlations among individual self-reported stress measures were very similar

Table 2 Zero-order correlations between self-reported stress and cortisol measures separately by gender (females [$n = 69$] above the diagonal; males [$n = 68$] below the diagonal)

	Environ. mastery	Language mastery	CES-D	Perceived stress	Alienation	Log-AUC cortisol	Age	Time in US	Smoke status	Educ	Employ
Environ. mastery	1.00	0.20	−0.59**	−0.65**	−0.37**	0.18	0.09	0.23*	−0.07	−0.09	0.08
Language mastery	0.04	1.00	−0.22	−0.12	−0.27*	0.16	−0.24*	0.16	0.28*	0.25*	0.37**
CES-D	−0.41**	0.15	1.00	0.73**	0.26*	−0.10*	−0.06	−0.20	−0.04	−0.12	−0.23
Perceived stress	−0.51**	0.02	0.56**	1.00	0.17	−0.14	−0.07	−0.21	−0.06	−0.03	−0.23
Alienation	−0.22	−0.18	0.24*	0.16	1.00	−0.14	0.08	−0.24*	−0.01	0.09	−0.24
Log-AUC cortisol	−0.23	−0.09	0.02	0.14	−0.02	1.00	0.10	0.04	−0.11	−0.19	−0.19
Age	0.33**	−0.27*	−0.09	−0.10	−0.18	0.07	1.00	0.22*	−0.28*	0.13	−0.79**
Time in US	0.33**	0.11	−0.11	−0.09	−0.14	0.08	0.24*	1.00	−0.06	−0.04	0.01
Smoke status	−0.01	0.26*	0.14	−0.12	0.04	−0.01	−0.38**	−0.18	1.00	0.05	0.30*
Education	−0.12	0.20	0.22*	0.10	−0.03	−0.21	0.03	−0.13	0.08	1.00	−0.02
Employment	−0.37**	0.28*	0.04	0.13	0.04	0.15	−0.67**	−0.08	0.26*	0.07	1.00

** $p < 0.01$; * $p < 0.05$

among women. A strong, significant, and positive correlation was found between CES-D and perceived stress ($r = 0.73$). Environmental mastery was significantly and inversely associated with CES-D ($r = -0.59$), and environmental mastery was also significantly and inversely associated with perceived stress ($r = -0.65$).

Multivariate Results

Table 3 presents the results of the multivariate regression results examining if acculturation measures were predictive of self-reported stress outcomes and cortisol response, separately for men and women. Among men, environmental mastery was significantly and inversely associated with log-AUC cortisol. Higher environmental mastery was also significantly related to reporting fewer depressive symptoms and lower perceived stress among men. No significant associations between language mastery and self-reported stress or cortisol response were found among men.

Consistent with results among men, higher environmental mastery was significantly related to fewer depressive symptoms and lower perceived stress among women. Higher environmental mastery was also negatively related to alienation scores for women. In contrast to results among men, however, environmental mastery was not associated with cortisol response, but higher language mastery was significantly and positively associated with log-AUC cortisol and inversely associated with alienation.

There are two results where the bivariate results and multivariate results disagree, suggesting the possibility of a suppressor effect. Interaction effects were tested and confirmed that there were no significant interactions in the model for men or women. The first instance was the relationship between environmental mastery and log-AUC among men, and the second was the relationship between language mastery and log-AUC among women. Unfortunately, there was not one clear suppressor variable in either instance. Among men, age, time in the United States, and university education were clearly strong and significant predictors of log-AUC. Among women, university education and employment were the strongest significant predictors of log-AUC. In both instances, including one or more of the additional controls increased the significance of the independent variable from non-significant to significant. With the small sample size and limited power, it was impossible to determine if one clear variable was a true suppressor. It was likely that one or a combination of factors may have acted as suppressors in these models.

Discussion

This is one of few reported studies of acculturation, stress, and cortisol response in immigrant samples. Compared to studies that examined cortisol response in refugees, the immigrants in this sample moved to the United States voluntarily and experienced comparatively less immigration-related trauma. Nevertheless, they demonstrated outcomes of acculturative stress that included elevated scores on depressed mood and relationships between selected predictors of acculturative stress and both self-report and biological stress measures. Further, gender differences in predictors of stress outcomes were found that suggest that men and women respond to challenges of immigration in different ways.

In terms of acculturation levels, men and women in the current study had similar perceived environmental mastery, but women had significantly higher average language mastery. The literature is not consistent in terms of findings regarding whether women acculturate at a different rate than men, and rates appear to differ by cultural group [78, 79]. The mean scores on CES-D in this sample were 18.1 for men and 21.6 for women, considerably higher than the expected U.S. norms of 7.9–9.2 [75]. The scores for this

Table 3 Multivariate regression analysis examining the effect of acculturative stressors on self-reported stress and cortisol measures among males and females separately

	Log-AUC		CES-D		Perceived stress		Alienation	
	b	SE	b	SE	b	SE	b	SE
Among males								
Environmental mastery	−0.22*	0.09	−5.58**	1.62	−0.39**	0.10	−0.15	0.09
Language mastery	−0.08	0.10	1.44	1.83	0.06	0.12	−0.11	0.10
Among females								
Environmental mastery	0.09	0.10	−6.18**	1.39	−0.33**	0.06	−0.23**	0.08
Language mastery	0.31*	0.14	−2.96	2.44	−0.07	0.11	−0.27*	0.12

All models include covariates for age, time in the US, education, employment status, and smoking status. Each cell reflects a separate regression equation

** $p < 0.01$; * $p < 0.05$

sample were also higher than some other immigrant groups, including Koreans (14.76; [80]), Vietnamese (16.11; [81]), and Mexicans and Central Americans (15.5 and 17.5, respectively; [33]). Also consistent with other immigrant studies, women reported significantly higher depression and perceived stress scores than men [82], and these gender differences were higher in our sample compared to those of others' [33, 81]. This may be because it is culturally more acceptable to endorse selected symptoms of depression (particularly for Russian women), rather than higher absolute levels of depression [41]. This question is as yet unresolved, and we do not know if it affected the findings of this study.

Consistent with previous research on salivary cortisol, men and women in the current study had similar values on cortisol response. Our range of values was consistent with values from previous studies [83], though our overall mean was lower than would be expected. This may be because we did not make any exclusion based on initial awakening response, and because our sample was older than participants in most reported studies. With respect to cortisol values, men and women in the current study did not differ on mean values for AUC cortisol values, log-AUC cortisol values, or the percentage in the highest quartile, despite the fact that they were significantly older than women and much more likely to smoke.

The lack of significant correlations between the self-reported stress and salivary cortisol scores suggests that they may measure different types of stress outcomes; the physiological response to acculturative stressors may not be captured by subjective measures of depressive symptoms, perceived stress, and alienation. Findings conflict in the literature. Pruessner et al. [84] found significant associations between symptoms of depression and cortisol awakening response in young men, but that relationship was found only for participants with mild levels of depression. On the other hand, Semmer, Grebner, and Eltering argued that lack of convergence between self-report and physiological measures of stress did not invalidate either [85]. They suggested that replacing one with the other was not necessarily more reliable, as they may measure different response levels. Rather, those authors recommended a combination of methods or thoughtful choice of one over the other based on theoretical and practical considerations. Despite the lack of convergence between self-report and cortisol response, we did find similar significant relationships between acculturative stress and self-reported stress outcomes, as well as between acculturative stress and cortisol measures.

In this study, we found significant gender differences in the relationships between predictors and stress outcomes. Environmental mastery was significantly negatively associated with self-reported stress outcomes for both men and women, though language acquisition was related only to alienation for women. Feeling one is comfortable and able to navigate and control the external environment may represent adapting to new cultural surroundings with lower stress response.

Despite similarities in cortisol response, environmental mastery was associated with reduced cortisol response for men only. The expected role of men from the FSU involves serving as liaison between family and the outside world. Feeling as though one is fulfilling that role may serve to reduce stress of acculturation and result in lower cortisol production for men. Age, time in the United States, and university education were also possible suppressor variables, whereby including them in the model increased the significance of the relationship between environmental mastery and cortisol response. This suggests that age, time in the United States, and educational status also play a key role in cortisol response among men. Among women, however, higher language mastery was significantly and positively associated with being in the highest quartile of cortisol and log-AUC cortisol. This finding is more difficult to interpret. External employment is associated with acculturation status, but whether or which one is causative is not clear. Language acquisition has been found to be negatively associated with traditional sex-role attitudes in Hispanics [86]. Because women from the FSU tended, at least initially, to have jobs in the community and become fluent in English more quickly than their husbands, they took on a stronger role as spokesperson for the family. This role, which may contradict the gender role with which the family is familiar, may produce stress arising from within-family dynamics. This theory is consistent with our finding that, among women, education and employment status were involved in the relationship between language mastery and cortisol response by acting as suppressors.

It is also possible that for men from the FSU, who are less acculturated than their wives, cultural adjustment is facilitated by settling into a Russian-speaking community of fellow FSU immigrants. This community becomes the new cultural environment they need to master to adjust successfully. Women, however, may be more likely to have to adjust to the United States mainstream culture, for which they become family liaisons. Therefore, their higher language proficiency sets up a stage for higher life stress, as this proficiency may indicate greater involvement with the highly unfamiliar cultural mainstream.

Our findings are consistent with other studies that suggest men and women have different cognitive and emotional responses to similar stressors [60, 61], and the differences in responses are reflected in the gender differences in relationships between salivary cortisol and acculturative stressors found in this study. Gender differences in the *causes* of distress have also been found in other immigrant groups. For

example, for South Asian Indians, lack of extended family support was an important contributor to stress for women, but cultural conflict within families and lower social status were significant for men [87].

Study Limitations

There are a number of limitations to this study. Salivary samples were collected four times over the course of 1 day. Although some investigators collected samples more frequently or across two or more days, a one-day schedule with 3–4 samples is frequently used in epidemiological studies [45]. This timetable is acceptable as a field method to improve retention and decrease cost. A possible threat to the reliability of this method is that findings represent state rather than trait characteristics [88], and some caution is suggested in interpreting our results. Although we assume that chronic stress reactions remain relatively constant, they are punctuated by acute stress that might be higher on 1 day than another. Future studies might employ and compare different saliva collection protocols. Another limitation is that the sample size was relatively small due to cost and availability constraints. However, it did include a random sample of the women in the larger study and their husbands. A larger sample might have had more power to identify additional differences between the wives and husbands.

The study used only two measures of acculturative adjustment. Although we assume that language and environmental mastery represent a range of new behaviors and attitudes that reflect acculturation levels, specific instruments that address other dimensions of acculturation and adaptation might provide a broader perspective. Family structure may affect acculturation, as well as daily stress. Although having at least one child living in the United States was a criterion for participation, we were not able to control for age or number of children in the home at the time of data collection.

Generalizability of the findings is limited by inclusion of a convenience sample of recent immigrants from the FSU and of a particular age (range = 44–78). Collecting a random sample is difficult in this and other small immigrant groups because they tend to live in mixed immigrant or non-immigrant neighborhoods [35], and locating individuals by ethnicity is extremely problematic. However, our sample was similar to reported immigration data during the decade following the fall of the USSR in terms of the Republics from which they emigrated (Russia, Ukraine, and Belarus) and a majority being of Jewish ethnic background. In addition, because most immigrants from the FSU were eligible to enter the United States under family reunification criteria, the proportion of married couples may be higher for them than immigrants from other countries or immigrants from the FSU who settled in other countries [32]. Including married couples reduces the variability that would affect the sample because they are more likely to receive social support from partners than a mixed sample. Nevertheless, the men's and women's data were not completely independent and must be interpreted with this limitation in mind. As is the case with other groups that immigrate at older ages, we would expect future cohorts to differ with respect to early life experiences, education, economic situation, and marital status [12, 89]; therefore, results from this study are most applicable to this specific population. Few studies are available that used cortisol measures with immigrant samples, making it difficult to compare our findings to others'. Future studies might include immigrants from other countries and make comparisons among them. Finally, the analysis is cross-sectional, which precludes any causal inferences.

New Contribution to the Literature

This study provides a unique opportunity to examine the impact of acculturation for immigrants who, in contrast to refugees, voluntarily moved to a more pluralistic society. This study suggests that likely predictors of acculturative stress are related to physiological measures, strengthening the rationale for use of less expensive self-report instruments in community-based research. Although our findings also suggest that salivary cortisol might be useful as a biomarker of acculturative stress, we do recommend replication in different cultural groups. The differences found between men and women in terms of environmental mastery and language acquisition suggest the need to examine other potential measures of the acculturative process, their differential cultural and gender role meanings, and their implications for post-immigration adaptation.

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