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Research article

## Is Silence Golden? Chronic Stress and Psychophysiological Indicators' Changes over Time in International Students: A Pilot Study

Iuliia Muzychenko<sup>1</sup>, Irina Apollonova<sup>1</sup>, David Evans<sup>2</sup>

<sup>1</sup>Bauman Moscow State Technical University,  
5 2nd Baumanskaya St, bldg 1, Moscow, 105005, Russian Federation  
<sup>2</sup>Purdue University,  
610 Purdue Mall, West Lafayette, IN 47906, United States of America  
 iuliia.muzychenko@mail.ru

**Abstract.** Most people assume studying or working abroad would be stressful – but would one ever think that it could be detrimental to the health? Stress literature relates cross-cultural transactions to the chances of gaining higher levels of chronic stress. This paper reports the results of two studies on international students in Moscow in 2018. Specifically, Study 1 assessed how cross-cultural transactions perceived to affect health state during the first 6 months of their relocation. Study 2 aimed to investigate if the psychological stress linked to relocation to a different country can possibly lead to psychobiological effects of chronic stress. In Study 1, qualitative methods were applied to conduct 21 interviews with international students. In Study 2, a longitudinal pilot study was conducted for 10 foreign students during the first 2–5 ( $M = 3.6$ ) months of their relocation. Stress related to cross-cultural transactions was expected to affect subjective well-being and health variables. The health state was a relatively silent topic in the interview participants of Study 1. The results of Study 2 showed that the participants had changes in the resting heart rate (RHR) baseline. Perceived chronic stress related to cross-cultural transactions may affect psychophysiological state; however, the affect varies depending on a person. Further research is required for the data consistency and for identifying non-invasive objective risk markers and individual stress pathways, with the goal of identifying “at-risk” students and providing treatment options before any serious harm is done to their health.

**Key words:** international students, chronic stress, maladjustment, resting heart rate, wearables

### Introduction

*A lot of people, they couldn't face these challenges or couldn't get over the language barrier or the new culture barrier, they started to hate being here. I know this type of people, like, really, they want to go home or they are not happy about being here, I think it's because they couldn't face any of these challenges (E05P3). (International student describing his experience in Russia)*

Enhancing country-to-country interactions has contributed to the emergence of a large number of initiatives, such as the “Development of the export potential of the Russian education system”, an important part of which is cooperation in

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the field of education. In 2017, within the framework of this program, The Ministry of Education and Science announced one of the main components of this program – to strengthen support services for foreign students. Internationalization is a critical key factor for improvements of national educational systems issues in modern higher education (Altbach, Knight, 2007), and, of course, it is necessary to pay special attention to international students' adaptation (Bykova et al., 2018).

Previous research demonstrated that adaptation of foreign students in Russia is conducted at different mental, emotional, intellectual, and physical load levels that leads to low performance, assignment satisfaction (Latipov et al., 2017), psychological maladjustment (Tarasova, 2017), and even to somatic negative outcomes (Pyrkova, 2016). In accordance with the theories of stress, students, when they travel to another country, immediately gain about ten categories (at least 213 points) from the Holmes and Rahe scale (Holmes, Rahe, 1967), and thereupon join the group with the moderate risk of illness. A laboratory-based study reported that frequency of stressors appearance didn't affect heart rate variability, but the greater perception of stress did (Sin et al., 2016). Brosschot states that the use of stressors is usually highly helpful in stress research in living creatures, but the stress response can appear without stressors or threats at all, e.g., stress response can be detected in lonely animals or humans without facing actual threats (2017). Brosschot and colleagues argue that due to the ability to represent past and future stressful events (perseverative cognition), chronic stress response can occur even without any stressor or threat in the present. According to the Generalized Unsafety Theory of Stress (GUTS), stressors are not important for the occurrence of a prolonged stress effect, lack of environmental perception as safe is enough for the appearance of chronic stress (Brosschot et al., 2016a; 2017), which in turn may cause psychophysiological negative outcomes (Everly, Lating, 2013; Slavich, 2016; McEwen, 2008).

When a person moves to another country there are a number of changes that follow along the way, these changes can be compromised in terms of unsafety continuously and unconsciously (Brosschot et al., 2017), which can potentially explain cross-cultural adaptation during first 3–6 months of the relocation that were demonstrated to be most stressful for expatriates and called as “cultural shock” (Draine, Hall, 2000). Van Aswegen (2008) conducted a longitudinal study with 82 expatriates over a period of ten years which indicated a 38% decrease in the levels of self-assessed emotional and physical health after six months on assignment in a foreign country compared with pre-departure. The review of the literature hasn't identified longitudinal studies that would reveal objective information about changes in expatriate's health after the relocation, but research on social isolation, loneliness, renewal of social ties and some other related studies on phenomena similar to conditions that might accompany the first months of relocation report impairment of mental and physical well-being (Cacioppo, Cacioppo, 2014), the present study aims to address this gap in cross-cultural literature.

In this article, authors first seek to identify whether students felt that cross-cultural adjustment process was actually enough to affect their well-being and health in Russia; second, the researchers seek to obtain objective information via

the help of wearable devices. Past research mostly identified main negative effects that come from the relocation to Russia in international students (e.g. see Tarasova, 2017). However, in the same time, studies conducted on foreign students in Russia report that they face different difficulties in different regions (Chebotareva, 2011) therefore in the present article students who relocated to Moscow, Russia to study at Bauman Moscow State Technical University (BMSTU) in 2018 were examined. This study applies definition of “a foreign student” or “an international student” as an individual who leaves their home country and travels to another for the purpose of study as a temporary citizen (Farcas, Gonçalves, 2016).

The relevance of this study is dictated by the fact that increasing one’s self-regulatory capacity would be highly beneficial to one and the connectivity of one with the community by introducing satisfaction and integrity (McCraty, Zayas, 2014). Psychological stress itself is usually measured via three possible methods: self-report, invasive and noninvasive psychobiological health markers. Self-report is the most common way of assessing psychological stress in relation to cross-cultural adjustment and its outcomes. Research trends support that overall psychological stress can have huge implications for expatriates’ health and well-being (Van Aswegen, 2008; Truman et al., 2011). However, information gathered with the self-report method is subjective, hard to monitor consistently and it studies mostly the psychological side of the psychophysiological stress response. Brosschot and colleagues (2017) point out that even though humans can sometimes notice and report some of the stressful experiences, since the default stress response and generalized unsafety are largely unconscious, people may not be aware of many cases that are stressful to us, and therefore self-report cannot be used solely. That is why a wearable objective tool can be an asset to the stress assessment.

In the first study, an exploratory approach was employed in the context of health and wellbeing in order to understand better the subjective challenges that get in the foreign students’ way of obtaining a great learning experience at BMSTU, Moscow, Russia. Therefore, it focuses on the qualitative aspects of stressful experiences.

In the second study, the major focus was on objective parameters, and continuously measured participants’ pulse rate during their first 2–5 months of relocation. Thus, the resting heart rate (RHR) was measured with wearable devices along with analyzing daily routines of students. On top of that questionnaires were distributed, they included questions about cross-cultural adaptation, personal qualities and stressful life events monthly and collected bibliographical information about health.

The aim was identified as the following: firstly, to check if the stress of relocation was perceived as affecting health and wellbeing when abroad, secondly, to see whether the first months of cross-cultural relocation cause the amount of chronic stress that is enough to cause the changes in the resting heart rate baseline, thirdly, to see if the changes have some certain tendencies according to the time spent abroad.

The theoretical contributions of this study were identified as the following: firstly, the cross-cultural adaptation process is investigated through the prism of the GUTS theory and try to combine objective and subjective information to see it

as a complete picture, secondly, there are not that many studies that use RHR as a psychobiological health marker of chronic stress, especially in the expatriate literature, in spite of the fact that it is the simplest and the most accurate to measure, and, thirdly, this article examines how recent stressful life events related to relocation can influence RHR baseline changes in expatriate students during the first months of their relocation to Russia.

The following main research questions were identified: Does cross-cultural transaction lead to changes in RHR? What do the empirical findings mean in a broad context of stress and cross-cultural adaptation?

### **Study 1**

As was mentioned by international specialists, the early terminations rate for the last couple of years was 1–2% of the international students' total number, and some of the common reasons for leaving before the graduation are different climate settings, bad infrastructure and the expectations about education that were not met. In this section, the findings in the context of well-being and health problems that they experienced during the first half of the year in Russia as a part of their assignments were presented. It was anticipated that the findings would assist in reporting the full picture of outcomes. Following this idea, the Cerny-Smith Adjustment Index (Cerny et al., 2007) was employed because of its detailed classification of stressful experiences, and, in this article, the focus is on those that fell in its psychological and physical domains. Psychological stands for negative thoughts and negative feelings, and physical stands for health issues.

In this article, we propose the data analysis interviews, questionnaires and check the baseline heart rate data. By that, we look at heterogeneity of this phenomena (different emotional stability and different heart rate baselines) to develop some ideas of how personality may change the heart rate's.

### **Method**

*Design.* We employed inductive thematic analysis, which primarily has a descriptive and exploratory orientation (Guest, 2014) and followed Lincoln and Guba's trustworthiness criteria as recommended by Nowell and colleagues for thematic analysis (Nowell et al., 2017). The study protocol was reviewed and approved by BMSTU authorities. Participants were recruited using census-based sampling over five months between May and November 2018. After the series of follow-ups (3 emails), 19 foreign students were recruited for the interviews, also, 2 students sent back detailed opinions about the topic and declined to attend the semi-structured interview (the response rate is 2.4%). Some relevant comments of international educational specialists on the topic of health and well-being are introduced in the results section of this article as well. Follow-ups and a long time of data collection were an attempt to reduce recruitment bias.

The interview guidelines were developed with the advisory of group members in order to reduce potential data collection bias and were translated into English using the back-translation method. The semi-structured interview questions were originated from the literature review and included topics such as knowledge and understanding of cross-cultural adjustment process, common stressors during

the cross-cultural adaptation period, and reactions to the adjustment process in students' lives.

*Sample.* Participants of the interview were from such countries as Germany, France, Iran, Kazakhstan, Netherlands, Bulgaria, China, Italia, Syria, Afghanistan, Armenia, Mongolia. The biggest part of the participants were male (84%) with the small part of participants being female (16%). The time each of them spent in Russia at the moment when the interview took place varied from 1 month to more than a year, with the majority (70%) no longer than 6 months (these are the most difficult ones when relocated to Russia and abroad in general) (Draine, Hall, 2000; Baklashova, Kazakov, 2016; Kamara, 2012). This is what gave us a chance to capture the fresh impressions. To protect the identity of the individuals, the further personal identifiers were not mentioned since they don't enrich the collected and analyzed information presented in the results section (Kaiser, 2009). All procedures in the studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

*Data collection and data analysis.* Due to the cross-language nature of the study, the interviews were conducted in two languages: English (7) and Russian (12) according to the stated preference of each of the subjects. Their level of language was Upper-Intermediate and higher. The interview length varied from 13 to 73 min with a mean of 20 min, and the field notes and tape records were used as additional methods of data collection to reduce investigator bias. All interviews were conducted privately and rapport was established by a period of informal talk. The first author conducted all the interviews in order to ensure consistency in the questions asked of all participants and undertook verbatim transcriptions. The interviews with educational cooperation specialists were conducted last, both in Russian. Inductive thematic analysis of the interview content was used to identify categories and key themes. Following the development of codes from the data analysis, major themes were identified, later on, they were grouped according to the CSAI stress categories. In the present article only the psychological and physical domains are discussed and described as an integrated whole.

## **Results**

*When they feel they are not adapted, it also affects the university and their studying. Because they don't feel good about it, so they cannot get used to the university. So, it's like the earlier he is adopted, the better he can study. <...> I saw it with my own eyes, because I had some classmates that couldn't attend the class because they were not adapted for the situation. So, they can skip it, and when you skip a class, it happens again, you skip for a week, and then for the second week (E09P9).*

Stress has been recognized as a reason of morbidity and mortality of many diseases and as a risk factor for different risk behaviors in our lives, foreign students are at a higher risk since they face many additional challenges related to changes that come along with the relocation, assignments, and also because they are generally going through the life changes. The present article provides a current snapshot, therefore advancing our understanding of foreign students' stress outcomes in the context of the health and wellbeing.

International educational specialists pointed out that there were some notable advantages that students from different regions could use. Students who come from the CIS countries usually face the least problems due to the fact that they share with Russia a common cultural ground after the Russian Empire and the USSR times. Many of them still study Russian language as the second language and that helps them to get integrated. Students who come from Asian regions (e.g. China, Myanmar, Vietnam) use an advantage of huge countrymates' communities at BMSTU and in Moscow in particular. There are only Syrian students who have a comparably large community among the middle east countries, moreover, they are sent by the same organization that creates an additional support resource when they arrive in Russia. European students have a similar mentality, that and good knowledge of English help them to adapt in Moscow.

However, the adjustment process in Moscow was different for everyone, it's difficult to say that there is one similar way of how it progresses over time or what particular adapting strategies one may choose to employ, which corresponds with the results of the previous studies – a multi-regional study that involved more than 300 students (Chebotareva, 2011) didn't reveal any general patterns reflecting the dynamics of intercultural adaptation of foreign students in Russia as a whole.

In the same time, those who stayed in Russia longer than 6 months seemed to be adjusted better than those who were just relocated, especially for the first time, which also correlated with the results of the previous studies. Baklashova and Kazakov state that students experience increased levels of problems, or so-called "transitional difficulties", once they move to Russia (Baklashova, Kazakov, 2016), Kamara (2012) also found out that 59.9 % of foreign students in Russia are experiencing elevated levels of stress during the first year of study, while another study on foreign students in Russia (Fomina, 2004) reported that foreign students by the fourth year of studies begin to feel almost at home in some aspects of their lives. All of that corresponds with the U-Curve Adjustment to a new culture (Black, Mendenhall, 1991).

*Yes, my moods were sometimes down <...> when in the evenings I was thinking "Why did I do that [came to Russia]? Where am I? What am I doing here?" (P02P5).*

In the group of 21 students, events related to psychological and physical stress were mentioned 17 times. The students were telling general situations or outcomes that they or their friends faced in Russia: weather changes and its relation to frequency of sicknesses or mood changes, changes in food habits or weight gain, fatigue or overall health state. Therefore, researchers investigated respondents' relative silence on this specific topic. According to the previous longitudinal studies on expatriates relocation that used quantitative and qualitative methods, there is much evidence that long periods of relocation, or a general change of environment may affect health state, physical and psychological well-being of a person, some great examples are studies on emotional burn-out, levels of depression, stress, chronic fatigues in expatriates and foreign students in particular (e.g. see Van Aswegen, 2008; Truman et al., 2011).

Some worth mentioning examples are following for illustrating how basic situations in the cross-cultural context could be perceived as critical and therefore

could have dramatic negative outcomes for adults who decided to enroll in an educational program abroad. For instance, social aspects such as social rejection in the new environment, may become that one thing that can affect all spheres of life:

*He can not get along with the new social group and maybe become abandoned because of some of his own reasons. That usually happens when the community is not well educated, if a person becomes an outcast only because he is different from others. And that affects everything when he can't adapt in the community of students like he is, he can't overall adjust properly, and all bad outcomes start happening. A person starts studying badly, he begins feeling like a fish out of water, and the problems begin. The person starts self-destructing, destroying himself <...> And something can not go smoothly for this person, and then he puts it on a waiting list until later, problems accumulate and that can lead to negative outcomes (E11P4).*

Fresh adults who have just graduated from school, many of them leave their homes for the first time, they enter a university, they start living independently from their parents, and that is a huge amount of stress, one student said:

*Well, I think that the majority of students are just kids who has just finished school and they feel very unaccustomed. It's not like that they didn't live in a foreign country alone, they also didn't live apart from their parents <...> Well, me, for example, I know Russian and I lived in Russia for several years before, but anyway, studying at university, especially at BMSTU, is very challenging. You don't understand everything and not always have a person to ask a question. And if this stress is about studies, you usually can relax at home next to the close people, but here you don't have that (E12P3).*

### **Discussion**

According to statistical report of the medical insurance company that provides its services to about 73% of international students at BMSTU, on average, they receive 1–2 incoming phone calls from 1–2 foreign students on a daily basis. Meanwhile, the “health” topic was found to be relatively silent, students felt uncomfortable talking about the subject and it’s understandable – one’s health is a private matter. Moreover, given the fact that many adults don’t know yet how to manage stressful situations successfully or in the right way, they may meet the “dark side” of chronic stress – psychophysiological negative outcomes. And due to the fact that many people prefer not to share any information related to health with strangers or acquaintances, it makes at least the first several months become a vicious circle because when they move abroad, they need to create their social groups from scratch.

It is known that when a source of acute stress is removed, the body returns to a state of homeostasis, but chronic tonic status may, over time, serve as a basis for a host of psychiatric and psychophysiological disorders (Latipov et al., 2017). Health specialists can detect such outcomes as burn-out, depression or fatigue and others when they have already taken place. What’s more, it is well-known that they are forming as a reaction to stressful events that are emotionally demanding for an individual, but is there a way to detect that transitioning state from “healthy” to “sick” and, consequently, to prevent negative outcomes from appearing? The results of the study suggest that cross-cultural stressors affect lives of students in Russia in the similar way that they affect lives of expatriates in the previous studies, and they may also experience chronic stress outcomes related

to health and well-being. To answer the previously mentioned question, wearable technologies were applied in an attempt to monitor the health state changes under chronic stress in a group of foreign students at BMSTU during their first months of relocation, the details can be found in the following sections.

## Study 2

There has been much research utilizing biofeedback as a way to determine the stress associated with different mental tasks or even work/study load in healthy subjects, and even those with chronic diseases, such as PTSD, cardiovascular diseases and others (Mora et al., 2017; Seo, Lee, 2010). Many of these studies showed that chronic stress state is associated with many factors, the primary ones are lower HRV, increased blood pressure, higher cortisol levels and pulse rate (Juster et al., 2011). Although it has long been assumed that stress has an impact on health, scientists have only recently developed the tools that are necessary to assess biological processes that link experiences of stress with disease progression (Slavich, 2016; Muzychenko et al., 2018).

Today, wearable sensors allow continuous long term beat-to-beat monitoring along with many other variables, they are used widely for Quantified Self movement, when people use available “secondary” diagnostic technologies for self-monitoring or so called “self-hacking” - improving healthy habits such as food intake, more sleep, managing stress and increasing productivity (Piwek et al., 2016). Currently, only about 5% of wearables have been formally validated and around 10% of them have been used in research (Peake et al., 2018). One of the first indicators that has been indicated with stress are the ones indicated with cardiovascular activity. Pulse rate is the easiest indicator to detect even without use of wearable technologies, plus, wearables can effortlessly provide detailed longitudinal data for further analysis. Resting pulse rate was associated with stressful life events and allostatic load. Heart rate (HR) is the most frequently used and noninvasively measured vital health indicator in diverse settings (Schubert et al., 2009; Sacha, 2014; Lee et al., 2014). The typical RHR value in healthy people is normally between 50 and 90 beats per minute (bpm), 71 beats/min for males and 74 beats/min for females in adults (Ostchega et al., 2011; Nanchen, 2018). These are approximate values, every person’s measurements vary, but, undoubtedly, higher RHR could indicate stress and a disadvantage in the population at high risk of chronic diseases (Zhang et al., 2016).

The following goals were identified: first, to determine if the first few months of cross-cultural relocation cause the amount of chronic stress that is enough to cause the changes in the heart rate baseline, second, to detect if the changes have some certain trends according to the amount of time spent abroad. Thus, RHR was measured via wearable devices along with the analysis of students’ daily routines, and the research team distributed surveys that included questions about personal qualities, cross-cultural adaptation and stressful life events every month and collected bibliographical information about health state.

Three main research questions were identified: Could changes in RHR be caused by cross-cultural relocation? If yes, are there any trends? What do the measured findings mean in the wide context of stress and cross-cultural adjustment?



**Method**

*Design.* For monitoring RHR Sony Smartband 2 was used, that was “emerging” or “promising” by Peake’s classification (Peake, et al., 2018), since it was used in the previous research (González-Landero et al., 2018; Georgiou et al., 2018; El-Amrawy, Nounou, 2015). Pulse rate is the easiest indicator to detect even without use of wearable technologies, plus, wearables can effortlessly provide detailed longitudinal data for further analysis. To analyze the data such tools like Talend, DBeaver, SQL Server and SPSS were used. An ELT system was developed to capture data from hundreds of activity journals and health tracker files. A cloud database was created to support the analysis, RHR was identified according to the measurements and activity journals, RHR trends were found for each participant. The results were analyzed using the visualizations that we created.

*Sample.* Expatriates that had relocated for attending classes at BMSTU to Moscow, Russia were used as the population for this study, we contacted students with the help of International Students Center. 1 female and 12 males were monitored. Due to inconsistency reasons, some data was not included in the final set, 10 students were included in the final set of data (see Table 1) with a mean age of 21.3, Russian language proficiency varied from Beginner to Intermediate, during the program there were several early program terminations due to different reasons, therefore 8 cases with approximately similar length were used to illustrate the results of the study. BMSTU authorities approved the study protocol; consent was obtained from all study participants, and was in accordance with the Russian Federal Law No 152-FZ “On Personal Data” from 27.07.2006 year.

Table 1

**Sample characteristics. Study 2**

|  |          | Mean = 21.2, SD = 2.3476 |
|--|----------|--------------------------|
| Age  |          |                          |
| Gender   | Male     | 90%                      |
|  | Female   | 10%                      |
| Education                                      | Bachelor | 70%                      |
|  | Master   | 30%                      |
| Previous exchange program experience           |          | 10%                      |
| Has a chronic disease                          |          | 0%                       |
| Had cross-cultural training before the arrival |          | 30%                      |
| Smokes   |          | 10%                      |
| Drinks alcohol                                 |          | 60%                      |
| Does sports                                    |          | 90%                      |

*Data collection.* The students were provided with the wearables and assigned individual on-line activity journals (health journal forms). Activity journals updates accompanied health data collection on a weekly basis. Students could contact the researcher any time and discuss any questions via an online support chat. The data collection reminders were sent to the group a day prior to the data collection. Three tests were the milestones for the entire experiment, students were asked to answer questions about their personality, about their cross-cultural adjustment, wellbeing and some other variables. The main focus of the present article are the heart rate data results.

*Data analysis.* The zero measurements were excluded. Average value was calculated for each day accounting for the “waking up” time from the participants’ ac-

tivity journals, plus 15 min before/15 min after it was further determined if, according to the accelerometer data, there was no extensive walking detected. The outliers were detected by 1.5 IQR rule, the data was trimmed within 0–8% per participant, influential cases were detected and further investigated with Cook's distance and standardized DFBeta, cases were excluded when the raw data and the activity journals suggested they could be. The final number of excluded cases (outliers and/or influential cases) didn't exceed 13% per an individual sample (see Table 2).

Table 2

| Outliers and influential cases   |                              |                   |                   |
|----------------------------------|------------------------------|-------------------|-------------------|
| Participants of the final sample | Cases that meet the criteria | Outliers detected | Influential cases |
| 1                                | 60                           | 5                 | 3                 |
| 2                                | 29                           | 1                 | 1                 |
| 3                                | 25                           | 0                 | 1                 |
| 4                                | 64                           | 4                 | 3                 |
| 5                                | 75                           | 5                 | 2                 |
| 6                                | 64                           | 3                 | 4                 |
| 7                                | 20                           | 0                 | 0                 |
| 8                                | 32                           | 1                 | 1                 |
| 9                                | 67                           | 2                 | 0                 |
| 10                               | 78                           | 0                 | 0                 |
| 11                               | 54                           | 2                 | 0                 |

### Results

During the first several months of relocation, average RHR could either gradually increase or decrease. The mean RHR was 60.55 (SD = 8.65). The partial plots for 7 out of 10 participants showed linear relationship, and  $r$  varied from 0.27 to 0.45, therefore, time variable could account for 8–17% of variance in RHR baseline during the first months of relocation. The 2nd participant whose data was found to be significant was interpreted separately because of a shorter time of enrollment (see Table 3). In other words, if one is trying to explain why by the end of the first couple of months RHR baseline has some changes, it might be said that these changes may be explained by many different reasons, and the relocation time could be one of them.

Do our results mean that if there is some correlation then they are accounted for only by the relocation? Not necessarily, but as it was mentioned before, many of factors that could be influential accompany cross-cultural transitions and may possible be the triggers the prolonged stress response.

The linear models for participants, overall, result in significantly good degrees of prediction of the outcome variable RHR ( $p < 0.05$ ). The b coefficients for 7 participants represented a significant contribution to predicting RHR by the time of the stay in an unfamiliar environment of a foreign country according to the results of  $t$ -test that was conducted for each of them separately.

In a month, RHR baseline changed levels on average by 2 beats per month during the experiment. That can indicate that some people are more sensitive than others to the changes, or perceive higher allostatic load. 5% of variance in the results can be due to the poorer heart rate recovery after sleep was earlier found to be associated with shorter time spent asleep (Mezick et al., 2014), that is a quite regular phenomenon in college students.

Table 3

| Results of linear regression analysis per individual participants |       |       |                   |                     |                  |                     |       |          |
|---|-------|-------|-------------------|---------------------|------------------|---------------------|-------|----------|
| Participants  | F     | Sig.  | B0 and SE         | 95% CI              | B1 and SE        | 95% CI              | r     | r square |
| 1   | 6.672 | 0.013 | 64.846;<br>0.835  | (63.168;<br>66.524) | -0.029;<br>0.011 | (-0.052;<br>-0.007) | 0.343 | 0.118    |
| 2   | 4.491 | 0.044 | 56.9840;<br>0.118 | (52.138;<br>61.830) | 0.249;<br>0.118  | (0.008;<br>0.491)   | 0.384 | 0.147    |
| 3   | 4.525 | 0.045 | 67.961;<br>2.033  | (63.745;<br>72.177) | -0.239;<br>0.113 | (-0.473;<br>-0.006) | 0.413 | 0.171    |
| 4   | 3.676 | 0.06  | 54.698;<br>1.163  | (52.367;<br>57.030) | 0.048;<br>0.025  | (-0.002;<br>0.099)  | 0.250 | 0.063    |
| 5   | 0.423 | 0.517 | 55.977;<br>1.217  | (53.549;<br>58.404) | -0.018;<br>0.027 | (-0.073;<br>0.037)  | 0.079 | 0.006    |
| 6   | 0.002 | 0.965 | 53.770;<br>1.272  | (51.227;<br>56.314) | -0.001;<br>0.026 | (-0.053;<br>0.051)  | 0.006 | 0.000    |
| 7   | 4.665 | 0.045 | 76.541;<br>3.781  | (68.597;<br>84.484) | -0.323;<br>0.149 | (-0.637;<br>-0.009) | 0.454 | 0.206    |
| 8   | 5.352 | 0.028 | 64.449;<br>2.032  | (60.337;<br>68.662) | 0.066;<br>0.028  | (0.008;<br>0.124)   | 0.401 | 0.160    |
| 9   | 7.192 | 0.009 | 49.345;<br>0.674  | (47.998;<br>50.692) | 0.038;<br>0.014  | (0.010;<br>0.066)   | 0.320 | 0.102    |
| 10  | 0.015 | 0.902 | 89.946;<br>1.980  | (86.003;<br>93.889) | -0.003;<br>0.028 | (-0.059;<br>0.052)  | 0.014 | 0.000    |
| 11  | 6.973 | 0.011 | 76.105;<br>2.142  | (71.803;<br>80.406) | -0.084;<br>0.032 | (-0.148;<br>-0.020) | 0.350 | 0.122    |

### Discussion

Potential stress factors that lead to cardiovascular diseases are lack of support, crisis or conflict in family life, bullying at school and difficulties adjusting there, depression, anxiety, type D personality, genetic predisposition, financial strain and many others, e.g. see (Hellhammer et al., 2010). Thus, chronic stress influences individual health differently. Previous research indicated self-reported health decreases in expatriates when relocated for a long time to another country (Van Aswegen, 2008; Truman et al., 2011). The trendline of RHR was changing over time, therefore it can be concluded that the ANS was slowly transitioning to the dysregulated state under the stressful conditions.

As it can be seen (Figure), the overall data can be represented with a linear line with quite good level of the unique RHR variance's explanation. There are changes of about 2 beats in the baseline per month. The data collected doesn't allow to reject the idea that the changes in RHR are caused by the cross-cultural transactions and all changes that accompany them. In spite of the fact that RHR measurement can be an indirect sign that a person enters a chronic stress state, its level can be elevated due to many reasons. Therefore, the proposed daily activity journal should be used along with the wearable technologies and questionnaires. Nowadays, growing technologies in combination with machine learning methods (Mora et al., 2017) can be used to design a deeper analyzation on a personal level to uncover events or clues that can point at particular stressors that trigger stress reactions for particular individuals (Peake et al., 2018; Sawka, Friedl, 2018). More data is still needed to give more accurate results. However, it's quite difficult to recruit the students for such longitudinal study, that can be mentioned as a limitation of the study.

The pilot study's results show that participants have changes in the RHR baseline and thus are consistent with those of previous chronic stress research.

However, the results were heterogeneous and require future research to clarify individual pathways. The findings provide insights to researchers as well as to expatriates and educational specialists about how stress might be related to expatriate psychophysiological adjustment when relocated. It also highlights the need for support mechanisms, health promotion practices with focus on personality qualities to ease transitions and reduce stress. If individuals at risk and their pathways to illness can be identified, preventive interventions can be designed and put into practice. Moreover, this kind of wearable usage could popularize effective, affordable and safe healthcare and support for health and wellbeing among international students.

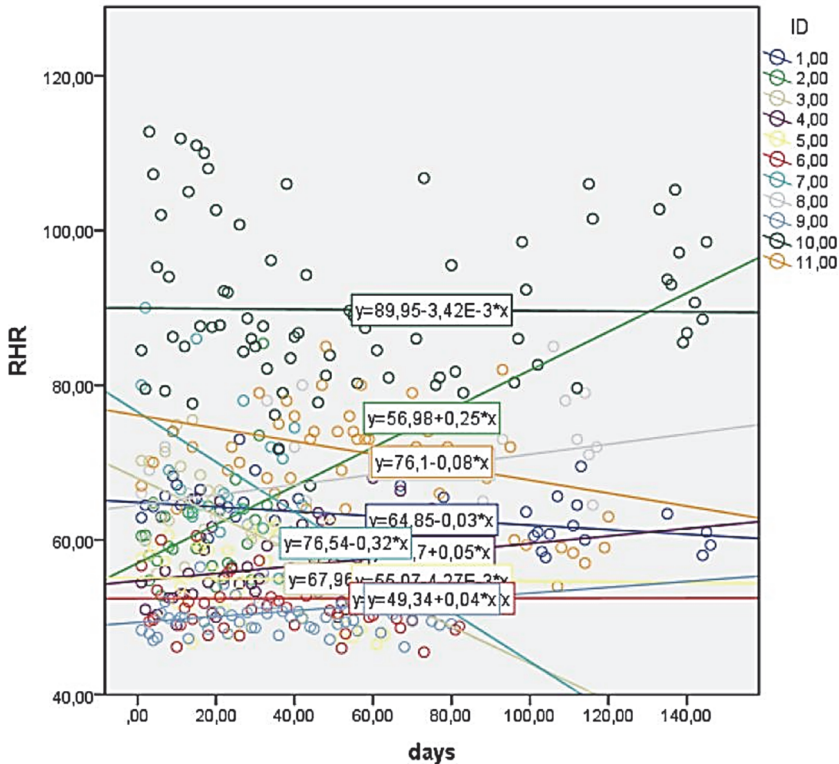


Figure. Outcome: RHR, beats per minute, vs. Time, days

### Limitations

Even though we captured real-life stress responses (what regular lab-based studies can't do) the generalizability of our findings is limited to some extent, due to a relatively small sample and positive selection of the longitudinal participants. The participants who withdrew from the study could potentially be our target group as they might have been affected by stressful conditions the most. The fact that the measurements didn't start before the arrival could be the second limitation. The pre-arrival period could give us a better chance to gather more information about RHR baseline. The third limitation is that nowadays, wearable devices' validity and reliability are still a growth zone, and recent comparisons showed up to 25% error for tracking health variables during physical activity (Piwiek et al., 2018), and some of the sources point out that the right methods should be chosen to reliably quantify the prediction accuracy, as well as the quality of the results (e.g. see Demasi et al., 2017; Saeb et al., 2016).

Fortunately, the resting phase is the most accurate to measure. The studies show that wearable devices measure heart data from very good to excellent when in rest (ranging from 0.85 to 0.99) (Georgiou et al., 2018), therefore errors are believed to influence the results within range. After all, the inclusion of an objective psychobiological health marker for chronic stress monitoring is also important due to the fact that even if safety cues are available, they are often left unnoticed, which appears to be firmly linked with ANS dysregulation (Sin et al., 2016). There has been considerable interest in identifying differences in vulnerability to potential pathogenic effects of stress with the emphasis in genetic as well as psychological factors (Cohen et al., 2007), and there have been already identified a considerable number of cognitive and personality factors that may make individuals more resilient to stress (Leger, 2016). Moreover, there has been evidence that several interventions on stress may help to improve academic performance, stress-related biological reactivity, and psychophysiological health (e.g. see Black, Slavich, 2016). It is also important to mention that many stress assessment techniques have been tested and validated to meet cultural context, yet, there still remains a lack of “gold standard” (Cunningham, 2015). More work will be needed to identify risk markers and individual pathways to being “chronically stressed out” while paying more attention to methodological limitations.

### **Conclusion**

The results of the Study 2 haven't revealed one singular pattern of the changes in heart rate baseline as the reflection of changes in the state of ANS balance under chronic stress pressure. However, the changes are present, they emphasize the existence of adapting to demands of daily life in the new environmental conditions, and in order a) to test whether they related to the fact of cross-cultural transaction and b) to test if these changes have some patterns in relation to personality traits, more further research is needed.

The results of the Study 1 support the idea that students sense emotional pressure on individual level, by and large, this pressure comes in different forms from all levels of social structure of the new environment. The respondents of the Study 1 reported that they had experienced some negative outcomes in health and well-being context, but the topic of health remains relatively silent. Given the facts, that many young adults still learn how to handle challenging situations, and that expatriates, in general, ask for early termination mainly due to the maladjustment reason, it indirectly highlights the importance of further research of chronic stress in international students. Their example may serve as a case of mild, yet suddenly higher, levels of chronic stress due to many changes that intrinsically accompany the relocation to a new country.

Looking at the broader context of chronic stressful situations, this example may serve for better understanding of chronic stress and help to form the right method to assess its impact on the human body using cheap and widely available wearables that support non-invasive techniques of health state assessment. Moreover, machine learning in Big Data analysis would help to form the best tool that complies with 4P principles of personalized medicine – predictive, preventive, personalized, and participatory.

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**Bio notes:**

*Iuliia Muzychenko*, is independent researcher, Bauman Moscow State Technical University (Moscow, Russia). ORCID: 0000-0002-8896-3615. E-mail: iuliia.muzychenko@mail.ru

*Irina Apollonova*, Ph.D., Doctor of Technical Sciences, is Head of Department, Associate Professor of Biomedical Telemetry, Biomedical Statistics, PhD Supervisor at Biomedical Engineering Department, Bauman Moscow State Technical University (Moscow, Russia). ORCID: 0000-0003-2908-6541, ResearcherID Web of Science: AAE-5433-2021. E-mail: apollonova-i@yandex.ru

*David Evans*, is independent researcher, Purdue University (West Lafayette, USA). E-mail: dave83707@gmail.com


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Исследовательская статья

**Молчание золото?  
Хронический стресс и динамика психофизиологических  
показателей у иностранных студентов:  
пилотное исследование**

**Ю.Н. Музыченко<sup>1</sup>  , И.А. Аполлонова<sup>1</sup> , Д. Эванс<sup>2</sup>**

<sup>1</sup>Московский государственный технический университет имени Н.Э. Баумана,  
*Российская Федерация, 105005, Москва, ул. 2-я Бауманская, д. 5, стр. 1*

<sup>2</sup>Университет Пердью,  
Соединенные Штаты Америки, IN 47906, Уэст-Лафайетт, Purdue Mall, 610  
 iuliia.muzychenko@mail.ru

**Аннотация.** Большинство людей считают, что учеба или работа за границей – это стресс, но насколько это может нанести вред здоровью? Литература о стрессе связывает межкультурные взаимодействия с шансами получить более высокий уровень хронического стресса. В статье представлены результаты двух исследований иностранных студентов, обучавшихся в Москве в 2018 г. В частности, в исследовании 1 оценивалось, насколько межкультурные взаимодействия воспринимаются как влияющие на состояние здоровья в течение первого полугодия пребывания в новой стране. Исследование 2 было направлено на изучение того, может ли психологический стресс, связанный с переездом в другую страну, привести к психофизиологическим последствиям хронического стресса. В исследовании 1 применялись качественные методы: проведено 21 интервью с иностранными студентами. В исследовании 2 проведено лонгитюдное пилотное исследование для 10 иностранных студентов в течение первых 2–5 месяцев (M = 3,6) с их переезда. Ожидалось, что стресс, связанный с межкультурными взаимодействиями, повлияет на субъективное самочувствие и показатели здоровья. Результаты первого исследования показали, что состояние здоровья было относительно «молчаливой», то есть редко упоминаемой темой в интервью. Результаты второго исследования свидетельствуют, что у участников были изменения исходного уровня частоты сердечных сокращений в состоянии покоя. Таким образом, воспринимаемый хронический стресс, связанный с межкультурными взаимодействиями, может влиять на психофизиологическое состояние; однако эффект варьируется в зависимости от индивидуальных различий. Необходимы дальнейшие исследования для согласования данных и

выявления неинвазивных объективных маркеров риска и индивидуальных путей развития стресса с целью выявления «групп риска» студентов и предоставления вариантов профилактики до того, как их здоровью будет нанесен какой-либо серьезный вред.

**Ключевые слова:** иностранные студенты, хронический стресс, дезадаптация, частота сердечных сокращений в покое, носимые устройства

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**Сведения об авторах:**

*Музыченко Юлия Николаевна*, независимый исследователь, Московский государственный технический университет имени Н.Э. Баумана (Москва, Россия). ORCID: 0000-0002-8896-3615. E-mail: iuliia.muzychenko@mail.ru

*Аполлонова Ирина Александровна*, доктор технических наук, заведующая кафедрой биомедицинской инженерии, Московский государственный технический университет имени Н.Э. Баумана (Москва, Россия). ORCID: 0000-0003-2908-6541, ResearcherID Web of Science: AAE-5433-2021. E-mail: apollonova-i@yandex.ru

*Эванс Дэвид*, независимый исследователь, Университет Пердью (Уэст-Лафейетт, США). E-mail: dave83707@gmail.com