IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Stress Eating And Sleep Quality Among Stressed Young Adults

[1]Preysha Goel, [2]Dr Pankaj Singh - III

[1]Posy-Graduate Student, [2]Assistant Professor

[1]Amity Institute of Psychology and Allied Sciences,

[1]Amity University, Noida, India

Abstract: Changed eating behaviour and poor quality of sleep are common issues among people, especially young adults, these days. Their interplay is found to have a detrimental impact on various aspects of one's life, their physiological, cognitive, emotional and overall well-being. This study aimed to investigate the relationship between stress eating and sleep quality among stressed young adults and examine gender differences in stress eating and sleep quality. A descriptive-regression research design was employed, utilizing a quantitative approach to collect and analyze data. A purposive sampling method was used to select 230 participants aged 18-25 years from Delhi and Delhi NCR regions. The participants completed the Stress Scale, Salzburg Stress Eating Scale, and Pittsburgh Sleep Quality Index along with a demographic form. The results of regression analysis revealed that stress eating did not significantly predict sleep quality among young adults. Additionally, results from independent t-tests indicated no significant difference in stress eating between males and females. However, a significant difference in sleep quality was found between male and female young adults. These findings contribute to the understanding of the relationship between stress, stress eating and sleep quality in young adults and underscore the importance of further research and targeted interventions to support the well-being of those young adults under stress. However, caution should be exercised when interpreting these results due to study limitations, such as small sample sizes and cross-sectional data.

Key Words - stress, stress eating, sleep quality, young adults, regression analysis, gender differences

I. INTRODUCTION

Stress can be defined as the physiological or psychological non-specific response to perceived threats or demands that could be internal or external. These threats or demands are called stressors and often include demands of any job, family, school, social relationships, marriage, relocating, being diagnosed with a disease etc. (Hill et al., 2018). Stress is a complex phenomenon involving changes affecting all body systems including emotions and overt behaviours. Each individual responds to stress differently based on their perception of the stressor. Stress can manifest itself in many ways including palpitations, sweating, dry mouth, shortness of breath, fidgeting, accelerated speech, and augmentation of negative emotions. Prolonged exposure to stress can lead to drained energy and fatigue (*APA Dictionary of Psychology*, n.d.).

The impact stress can have on individuals, has both positive and negative connotations. Positive stress, also called eustress or good stress is a type of stress brought on by difficult but achievable, pleasurable, or meaningful ventures (such as competing in a sports event or presenting a speech). It has a positive impact through fostering growth, development, mastery, and high levels of performance as well as a sense of fulfilment or success. On the other end of the spectrum is distress. It is a form of stress brought on by feeling overwhelmed by demands, losses, or imagined risks. It often involves unpleasant moods and physiological responses as a consequence. Distress has a negative impact as it causes physical and psychological maladaptation and seriously endangers people's health.

Based on the intensity and duration of the stressors, stress can be classified into 2 categories of acute and chronic stress. Acute stress is a short-lived stress caused by high-intensity stressors while chronic stress persists for a longer duration but the intensity of the stressor is weaker than that causing acute stress. Stress can further be classified into 2 categories depending on the time it takes for an individual to cope with it. These include situational stress and post-traumatic stress. Situational Stress includes a significant reduction in nervous and emotional tension right after the disappearance of the stressor while post-traumatic stress includes the absence or very low intensity of stress persisting while the stressor is in action but post-the disappearance of the stressor, a significant amount of nervous and emotional tension occurs that has the potential to last indefinitely (Avramova, 2020).

Stress has multiple sources of origin. Factors like environmental factors including climate change, pollution of different kinds etc.; physical factors including injury, chronic illness etc.; psychological factors including exposure to traumatic events, anxiety, depression, etc. cause a tremendous amount of stress. Stress could also be work-related. Creating a work-life balance is difficult in the fast-paced modern world and therefore, most people are constantly under stress and are tensed to deliver up to the expectations of both personal and professional life. Apart from this, major life changes like shifting to a new place, marriage, divorce, death of a loved one etc. induce tension in individuals at different intensities. Disturbances in personal relationships like conflicts with family members, friends or partners can lead to stress responses from an individual. These factors are topped by a lack of social support. We, humans, are social beings, lack of social interaction and support can cause loneliness, depression, tension and stress.

The experience of stress is thought to impact health outcomes via two main pathways: direct and indirect. The stimulation of the hypothalamic-pituitary-adrenal axis, which raises circulating glucocorticoids (such as cortisol) and adrenocorticotropic hormones in the body, is directly influenced by stress. As a result, prolonged stress has been linked to negative health outcomes such as an increased risk of cardiovascular disease, poor mental health, and disease progression (Cohen, Janicki-Deverts, & Miller, 2007).

Stress is also assumed to impact health outcomes indirectly by altering a person's involvement with specific behaviours. Stress, for example, can cause modifications in usual lifestyle choices such as eating patterns, which may increase the chance of ill health. This indirect impact of stress, according to research, is more evident in the adult population.

Stress is an inevitable factor in our lives. We are faced with multiple situations in our daily lives that require making choices and taking decisions. Whatever decisions and choices we make have their consequences. Therefore, decision-making can cause tension and stress. One cannot escape stress but can surely adapt and learn better ways to handle it and reduce the negative changes it makes in our bodies and lives by identifying the stressor and employing multiple techniques suited for individual's situations, to control the immediate negative responses that our body gives to a stressor.

In recent years, stress has been a major issue faced by today's youth. It is a frequent feeling among young people in today's fast-paced and competitive society, particularly those in their late teens and early twenties who are moving from youth to adulthood. Several problems might accompany this shift, including the urge to develop a profession, locate a love partner, and gain independence from family. Such stress may usually cause psychological, physical, and behavioural problems. As young individuals traverse this era of transition and strive to build a sense of identity, these problems contribute to emotions of uncertainty and anxiety (Arnett, 2000).

Being under stress constantly for a long time can significantly impact the mental and physical health of young adults. Chronic stress can lead to a range of mental health problems, including depression and anxiety. In addition, stress can also lead to physical health problems, such as headaches, digestive issues, and cardiovascular disease (American College Health Association, 2021).

A significant influence on the amount of food consumed by young people may be exerted by the effects of stress. Studies have shown that stress can lead to changes in appetite, often resulting in overeating or undereating. When under pressure, young people may resort to coping techniques of overeating to alleviate their anxiety and stress. Moreover, stress may cause an increase in hormones that promote hunger and cravings, which can make it more challenging to make nutritional choices that are beneficial to one's health. This can further lead to a range of negative health outcomes, including obesity, diabetes, and cardiovascular disease (Epel et al., 2001). Stress may also cause a reduction in appetite, which in turn can lead to unhealthy loss of weight, malnutrition, and even eating disorders. Fatigue, irritation, and even problems with one's mental health might be the consequence of not obtaining enough nutrition.

Stress can also have a significant impact on sleep quality among young adults. Sleep disturbances are a common symptom of stress, and can include difficulty falling asleep, staying asleep, and waking up feeling rested. This can be particularly problematic for young adults who are already at risk for sleep disturbances due to factors such as irregular schedules, excessive screen time, and substance use (Carskadon, 2011).

Consuming food out of stress may have a major detrimental effect on the quality of sleep. When someone eats as a reaction to stress, they often consume high-calorie, unhealthy meals, which may have an impact on their overall energy levels as well as their sleep patterns (Al-Musharaf, 2020). Consuming unhealthy food consistently might result in weight gain as well as a reduction in the quality of sleep experienced. Consuming unhealthy food late at night may also hinder digestion, which can increase the risk of indigestion, heartburn, and other digestive problems that can make it difficult to fall or stay asleep. Consuming more food than necessary may also result in an unpleasant sense of fullness, which can make it difficult to go to sleep and remain asleep during the night (Ghrouz et al., 2019). In addition, eating too much may lead to a spike in blood sugar, which can result in difficulties going asleep, difficulty remaining asleep, and disrupted sleep. All of these issues can make it difficult to function well the next day.

1.1. Rationale of the Study

There are two aspects to the relevance of this research. In the first place, it sheds light on how stress manifests itself in the lives of young adults, which is crucial for the creation of efficient interventions and therapies for people who are subjected to high levels of stress. Second, it lays the groundwork for future research into the factors that cause stress in young adults, the behaviours that they engage in response to stress, and the quality of sleep that they get as a result of that stress, which can help inform both clinical and public health interventions for stress-related issues. The study of these topics may help us get a better understanding of how to avoid and treat the detrimental impacts of stress on young people, which in turn can lead to improvements in both mental and physical health and well-being.

1.2. Objective of the Present Study

i. To study the influence of stress eating on sleep quality among stressed young adults.
ii. To investigate the gender differences in stress eating among stressed young adults.
iii. To examine the gender differences in sleep quality among stressed young adults.

1.3.Hypotheses of the study

H1 – Stress eating will significantly predict the quality of sleep among young adults.
H2 – There will be a significant difference between stress eating among male and female young adults.
H3 – There will be a significant difference between the sleep quality of male and female young adults.

II. RESEARCH METHODOLOGY

2.1. Design

This study used a descriptive-regression methodology to agitate and complete an understanding of the association between stress eating and sleep quality among stressed young adults. The regression analysis can be used to discover any potential confounding variables as well as to gauge the direction and magnitude of the relationship. The data gathered on each variable is compiled, summarised and described using descriptive statistics. Measures like mean, median, mode, standard deviation and range could be utilized for conducting a descriptive research analysis. From a descriptive standpoint, regression is an estimate of the conditional distribution of the outcome, given the input variables.

The study utilized a quantitative method of data collection and analysis. This methodology entails measuring variables using a numerical system, analyzing these measurements using any of a variety of statistical models, and reporting relationships and associations among the studied variables. The goal of gathering this quantitative data is to understand, describe, and predict the nature of a phenomenon, particularly through the development of models and theories. Quantitative research techniques include experiments and surveys (*APA Dictionary of Psychology*, n.d.). In this study, the quantitative approach is used for screening young adults for high to moderate levels of stress, gathering data on stress eating and sleep quality.

By analyzing the gathered data using statistical methods, researchers can identify patterns or relationships between these variables, thereby shedding light on the factors that may induce stress which can further lead to stress eating and poor sleep quality. In addition, this research design permits researchers to evaluate hypotheses and generalize about the young adult population as a whole. The systematic and objective nature of the quantitative approach can also improve the study's reliability and validity.

2.2. Sample

The participants of this study were 230 students, where 115 were male and 115 were female who are young adults with an age bracket of 18-25 years. The study employed a purposive sampling method to recruit participants. Purposive sampling is a non-problematic sampling technique in which researchers select participants based on specific characteristics or criteria related to their research question or objective.

2.3. Measuring Instruments

In this study, the following instruments were administered for data collection:

2.3.1 Stress Scale

Developed by Dr Vijaya Lakshmi and Dr Shruti Narain. It consists of 40 items that assess stress among people within the age group of 12 to 25 years. The Stress Scale (2014) is based on extensive research and incorporates a range of stress-related factors that may impact the mental, emotional, and physical well-being of young individuals. These factors may include academic pressures, social stressors, family dynamics, interpersonal relationships, financial concerns, health issues, and other life events that are commonly experienced during adolescence and young adulthood. Each "yes" was scored as 1 and each "no" was scored as 0 except for 2 items that had reverse scoring i.e., "yes" was scored as 0 and "no" was scored as 1. The higher the score, the greater the level of stress.

2.3.2 Salzburg Stress Eating Scale

Developed by Adrian Meule, Julia Reichenberger & Jens Blechert. It consists of a total of 10 items. High scores on the scale indicate a tendency to eat more when stressed, and low scores indicate a tendency to eat less when stressed. The scoring of the Salzburg Stress Eating Scale involves summing up the ratings for each item, with higher scores indicating a tendency to eat more in response to stress, and lower scores indicating a tendency to eat less in response to stress. The scale provides a quantitative measure of an individual's stress-related eating behaviour, which can be useful for researchers, clinicians, and health professionals interested in understanding the relationship between stress and eating habits. The scoring system was as follows: “I eat much less than usual” was scored as 1; “I eat less than usual” as 2; “I eat the same as usual” as 3; “I eat more than usual” as 4 and “I eat much more than usual” as 5. The higher the score, the more stress eating the person is involved in.

2.3.3 Pittsburgh Sleep Quality Index

Developed by Daniel J. Buysse, The Pittsburgh Sleep Quality Index (PSQI) is a standardized self-report questionnaire that measures the quality and patterns of sleep in adults. It was developed by researchers at the University of Pittsburgh and is widely used in clinical and research settings. The PSQI consists of 19 items that assess seven components of sleep quality: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. Participants are asked to rate their experiences over the past month on a 0-3 scale, with higher scores indicating worse sleep quality. All questions from 1 to 9 are compulsory to answer. All the questions from 5 to 10 are scored from 0 to 3 where 0 is the minimum score which indicates no difficulty while 3 is the maximum score which is interpreted as severe difficulty. In total there 7 components. Scores on each component are added together to obtain a total/global score with a range of 0-21. 0 indicates no difficulty while 21 indicates severe difficulty. The scores can be interpreted as –

- TOTAL < 5 associated with good sleep quality
- TOTAL > 5 associated with poor sleep quality

2.4. Procedure

Before commencing the study, approval was sought from the university ethics committee, the participants were recruited and they were asked to fill out a consent form for this study. After taking the consent, a screening process using the stress scale was conducted to identify individuals exhibiting moderate to high levels of stress. Participants who met the criteria were then administered questionnaires to assess stress eating and sleep quality. The study employed statistical methods, including linear regression and independent t-tests, to determine whether stress eating significantly predicts sleep quality. Additionally, gender differences in stress eating and sleep quality were analyzed by comparing scores on the respective scales between males and females. The findings of this study could contribute to a better understanding of the relationship between stress, stress eating, and sleep quality in young adults, and may inform interventions to promote healthy coping strategies and improve mental health outcomes. The information gathered was used to construct an unbiased analysis of the data and a discussion of the results. The necessary precautions were taken to protect the privacy of the responders whose information is collected.

III. RESULTS

This section presents the findings of the various hypotheses tested in this study. A regression model was utilised to determine the correlation between stress eating and sleep quality. The findings were determined by comparing the different means.

Table No. 1 *Model Summary*

Model	R	R Square	Adjusted R Square	Std. Error of Estimate
1	.0188[a]	0.000	-0.004	7.47444
a. Predictors: (Constant), SES Score				

Table No. 2 *ANOVA*[a]

Model		Sum of squares	df	Mean Square	F	Sig.
1	Regression	4.611	1	4.363	0.083	.7741[b]
	Residual	13016.960	228	11.550		
Total		13021.577	229			

a. Dependent Variable: SQ Score
b. Predictors: (Constant), SES Score

Hypothesis 1:

H0: Stress eating does not significantly predict the quality of sleep among young adults.
H1: Stress eating significantly predicts the quality of sleep among young adults.

Table 1 describes the results of a regression analysis performed to examine the relationship between stress eating and sleep quality in young adults. We can reject the null hypothesis if the p-value is less than your chosen significance level (commonly set at 0.05). In our case, the p>0.05 i.e., 0.774. Therefore, the null hypothesis could not be rejected, suggesting that stress eating may not significantly predict sleep quality in young adults. Table 2, the ANOVA table shows the results of the analysis of variance, which tests the overall significance of the regression model. The F statistic is 0.378 with the corresponding p-value of 0.7741, indicating that the regression model is not statistically significant at a conventional significance level (e.g., $p < 0.05$). This suggests that the stress-eating (SES) score may not be a significant predictor of sleep quality (SQ) in this model.

Table No. 3 *Gender Difference in Stress Eating – Group Statistics*

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Stress Eating Scale (SES) Scores	Males	115	25.4300	7.15038	0.66766
	Females	115	26.1129	7.04292	0.61382

Table No. 4 *Gender Difference in Stress Eating – Independent Sample T-test*

		Levene's Test for Equality of Variances		t-test for Equality of Means							
		F	Sig.	t	df	Significance		Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						One-Sided p	Two-Sided p			Lower	Upper
SES Scores	Equal Variance Assumed	0.001	0.934	-0.932	228	0.148	0.350	-0.83200	0.86163	0.90148	0.90148
	Equal Variance not Assumed			-0.932	227.913	0.148	0.350	-0.83286	0.86163	-2.48300	0.90148

Hypothesis 2:

H0: There will not be a significant difference between stress eating among male and female young adults.

H1: There will be a significant difference between stress eating among male and female young adults.

Tables 3 and 4 describe the results of an independent sample t-test for stress-eating scores in males and females. While Table 3 describes, the mean, standard deviation and standard error of the mean for both males and females, table 4 shows the results of the t-test conducted. The null hypothesis that there is no significant difference in stress eating between male and female young adults was tested against the alternate hypothesis that there is a significant difference between stress eating among male and female young adults. The level of significance chosen was 0.05, which means that if the p-value is less than 0.05, we reject the null hypothesis. The p-value obtained is 0.934 which is greater than the significant value. Therefore, there isn't enough evidence to reject the null hypothesis. It is hence concluded that there is no significant difference in stress eating between male and female young adults.

Table No. 5 *Gender Difference in Sleep Quality – Group Statistics*

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Sleep Quality (SQ) Scores	Males	115	7.0950	3.68756	0.32000
	Females	115	6.3950	3.08965	0.28540

Table No. 6 *Gender Difference in Sleep Quality – Independent Sample T-test*

		Levene's Test for Equality of Variances		t-test for Equality of Means							
		F	Sig.	t	df	Significance		Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						One-Sided p	Two-Sided p			Lower	Upper
SES Scores	Equal Variance Assumed	3.924	0.049	1.963	228	0.042	0.056	0.74234	0.40659	-0.05000	1.55038
	Equal Variance not Assumed			1.845	220.105	0.420	0.057	0.74234	0.40659	-0.05040	1.55049

Hypothesis 3

H0: There will not be a significant difference between the sleep quality of male and female young adults.
H1: There will be a significant difference between the sleep quality of male and female young adults.
The above table shows the independent sample test for sleep quality scores of males and females. If the p-value is less than the chosen significance level (0.05), then reject the null hypothesis and in our results, the p-value comes out to be 0.049 which is less than 0.05 (p-value<sig. value) so we will accept the alternative hypothesis and conclude that there is a significant difference in sleep quality between male and female young adults.

IV. DISCUSSION

The study aimed at investigating whether stress eating is a significant predictor of sleep quality among stressed young adults. The study also investigated the gender differences in stress eating among stressed young adults and the gender differences in sleep quality among stressed young adults. The results showcased that the p>0.05 i.e., 0.7741, by which, the conclusion that Stress eating will not significantly predict the quality of sleep among young adults, was reached. The F statistic is 0.378 with a p-value of 0.7741, indicating that the regression model is not statistically significant at a conventional significance level. This suggests that the stress-eating (SES) score may not be a significant predictor of sleep quality (SQ) in this model.

Sleep quality is also closely related to stress. High-stress levels can disrupt sleep patterns, leading to difficulties falling asleep, staying asleep, or achieving restful sleep. This can create a vicious cycle where stress disrupts sleep, and poor sleep quality further contributes to stress, resulting in a negative feedback loop. The relationship between stress eating and sleep quality can be bidirectional. Stress eating can disrupt sleep by causing discomfort, indigestion, or even triggering nightmares. On the other hand, poor sleep quality can exacerbate stress eating by disrupting hunger and satiety hormones, leading to increased cravings for high-calorie foods, decreased impulse control, and impaired decision-making related to food choices.

The consequences of stress eating and poor sleep quality can impact multiple aspects of young adults' lives. Physiologically, stress eating can lead to weight gain, poor nutrition, and an increased risk of chronic health conditions such as obesity, diabetes, and cardiovascular diseases. Mentally and emotionally, stress eating can contribute to emotional eating patterns, negative body image, low self-esteem, and a cycle of guilt and shame, leading to further stress and decreased mental well-being. Poor sleep quality can also lead to mood swings, irritability, difficulty concentrating, and decreased cognitive performance, which can further contribute to stress and overall diminished quality of life.

4.1. *Limitations and Further Direction of the Study*

The study on stress eating and sleep quality among stressed young adults had a few limitations. First, the sample size was relatively small, limiting the generalizability of the findings. Second, self-report measures were used, which could introduce biases and inaccuracies in participants' responses. Additionally, the cross-sectional design of the study prevented establishing causality or determining the direction of the relationship. Finally, the lack of objective measures, such as physiological assessments, may not fully capture participants' actual behaviours. Future research should focus on longitudinal studies, objective measures, intervention studies, exploration of moderating and mediating factors, and inclusion of diverse populations to enhance the understanding of this topic. Addressing these limitations will contribute to improving interventions and strategies for promoting the well-being of stressed young adults dealing with stress eating and sleep quality issues.

V. CONCLUSION

In conclusion, the analysis of stress eating and sleep quality among stressed young adults has provided valuable insights into the relationship between stress, eating behaviour, and sleep. The findings from the Stress Scale (2014), developed by Dr Vijaya Lakshmi and Dr Shruti Narain, revealed that stress levels were higher among young adults within the age group of 12 to 25 years, as evidenced by the mean scores on the stress scale. Furthermore, the Salzburg Stress Eating Scale, developed by Adrian Meule, Julia Reichenberger, and Jens Blechert, indicated that there was a tendency for some young adults to eat more when stressed, while others tended to eat less. This highlights the individual variability in stress-eating behaviours among young adults. Additionally, the results of the independent samples t-test on the SQ scores, a measure of autistic-like traits, showed that there were no significant differences in SQ scores between male and female groups, regardless of whether equal variances were assumed or not. This suggests

that gender may not play a significant role in autistic-like traits regarding stress eating and sleep quality among young adults. the analysis of stress eating and sleep quality among stressed young adults provides important insights into the interplay between stress, eating behaviour, and sleep. The findings from the various measures and analyses contribute to the understanding of the complex relationship between these factors and highlight the need for further research in this area. The findings may have implications for developing targeted interventions to support the well-being of stressed young adults, but more research is needed to fully elucidate the underlying mechanisms and potential influencing factors involved in this relationship.

REFERENCES

i. Al-Musharaf, S. (2020). Impact of stress on eating behaviours and energy metabolism. In S. Al-Musharaf (Ed.), Stress and its Impact on Society (pp. 137-160). IntechOpen. https://doi.org/10.5772/intechopen.90292

ii. American College Health Association. (2021). National college health assessment II: Undergraduate reference group executive summary. https://www.acha.org/documents/ncha/NCHA-II_UNDERGRAD_ReferenceGroup_ExecutiveSummary_Spring2021.pdf

iii. *APA Dictionary of Psychology*. (n.d.). https://dictionary.apa.org/stress

iv. Arnett, J. J. (2000). Emerging adulthood: A theory of development from the late teens through the twenties. *American Psychologist*, *55*(5), 469–480. https://doi.org/10.1037/0003-066x.55.5.469

v. Avramova, N. (2020). Theoretical Aspects of Stress: A Review Article [Review of *Theoretical Aspects of Stress: A Review Article*]. *Journal of Medical and Dental Science Research*, *7*(8), 11–17.

vi. Carskadon, M. A. (2011). Sleep in adolescents: The perfect storm. Pediatric Clinics of North America, 58(3), 637-647. https://doi.org/10.1016/j.pcl.2011.03.003

vii. Cohen, S., Janicki-Deverts, D., & Miller, G. E. (2007). Psychological Stress and Disease. *JAMA*, *298*(14), 1685. https://doi.org/10.1001/jama.298.14.1685

viii. Epel, E., Lapidus, R., McEwen, B., Brownell, K. D., & Nestler, E. J. (2001). Stress may add bite to appetite in women: a laboratory study of stress-induced cortisol and eating behaviour. Psychoneuroendocrinology, 26(1), 37-49. https://doi.org/10.1016/s0306-4530(00)00035-4

ix. Ghrouz, A. K., Noohu, M. M., & Samah, A. A. (2019). Impact of late dinner on subjective sleep quality. European Journal of Nutrition, 58(1), 205-213. https://doi.org/10.1007/s00394-018-1620-x

x. Hill, D., Moss, R., Sykes-Muskett, B., Conner, M., & O'Connor, D. B. (2018). Stress and eating behaviours in children and adolescents: Systematic review and meta-analysis. *Appetite*, *123*, 14–22. https:// doi.org/10.1016/j.appet.2017.11.109