Original Paper: Stress and Health

Assessment of stress levels of students centering on the Stressometer and the GHQ28 General Health Questionnaire

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Abstract

Objective: We measured the stress levels of university students using a Stressometer and studied connections with mental health levels using the Japanese version of GHQ28 (General Health Questionnaire).
Methods: Taking advantage of the annual medical examination conducted on students, we measured stress levels (TNR) using a Stressometer (manufactured by the French company TNR) and assessed the level of mental health on the basis of GHQ28.
Results: 13.0% of the 445 students showed high stress levels of 70TNR and above. Having performed a GHQ28 survey (a score of 28 representing the highest possible score and a score of 6 points and above indicating a low level of mental health) on 22 randomly selected students with high stress levels and 19 students with normal stress levels (36 TNR and below). In the case of students with high stress levels, the average overall GHQ28 score was 9.0. In comparison with students with normal stress levels (average score of 5.3), the level of mental health was significantly lower ($p<0.02$). In the case of students whose overall GHQ28 score was 6 points or more, the average value for stress levels was 75.9 TNR. This result was significantly higher than that for students with scores of 5 points or less (average 44.8 TNR) ($p<0.02$). In the case of students with high stress levels, one particularly notable feature was the social activity disorders (Category C) with points in different GHQ factor scales.
Conclusion: It is possible that measurement of stress levels using a Stressometer may be useful for assessing mental health levels. This is a research topic that will require further study in the future.

Keywords

Stressometer, stress levels, GHQ28, mental health level, social activity disorder

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Introduction

It seems likely that various stressors with different strengths and durations of continuity have effects on both the mind and the body and cause tension in the sympathetic nervous system and excess secretions of stress hormones such as catecholamine and cortisol. But the question of how to recognize stressors in these processes is affected greatly by individual personality features and there are enormous individual differences in subsequent stress-coping behavior. However, if behavior in response to stressors is inappropriate, mental disorders such as depression will appear through emotional irregularities, and it has further suggested that lifestyle diseases (diabetes and high blood pressure) may be caused by abnormalities in internal secretions, metabolism and the autonomous nervous system.[1] In order to avoid the occurrence of stress reactions, there is a need for rest, recreation and relaxation. Such emotional irregularities can be prevented by performing certain special training methods aimed at self-protection (e.g. autogenic training, the gradual muscular relaxation method, and the deep-respiration method). In other words, there are people who are able and others who are not able skillfully to avoid being attacked by various stressors (stress factors) due to personality factors and ability to withstand stress. But even in the case of people who are not able to avoid attack by stressors, stress reactions can be mitigated if there is a supportive environment in the form of people in the vicinity who are responsive to and are able to understand the person's feelings and emotions.

Many attempts have been made to assess levels of stress that find expression through such complex mechanisms. The methods involved range from analysis of genetic manifestation profiles[3] to the filling out of mental health survey forms. [4,5] But it is no easy matter to find a method that makes it possible to quantify concisely the levels of varied stress reactions for single individuals.

In this study we took advantage of the opportunity provided by the medical checkups carried out on students at a medical welfare university engaged in the training of experts in the field of care and management of invalids to assess the state of stress among university students employing a Stressometer researched and developed in France and a Japanese version of General Health Questionnaire GHQ28.

Targets and method

Medical checkup

A medical checkup was carried out between March 28 and April 13 (with May 30 set aside for those students unavailable during that period) at the Kawasaki University of Medical Welfare on all the 4,000 or so students at the university, which is divided into three faculties and eleven departments. Stress levels of 445 students, centering on those enrolled at the university, were then measured using a Stressometer. The stress levels of students that had not received a medical examination so far that year were then similarly measured on Monday, May 30. Nineteen students with values measured with the Stressometer of 36 TNR (tremor of the nervous system at rest) and under and 22 students with values of 70 TNR and over were then selected at random and were all asked to fill out there and then a GHQ28 form prepared by Nihon Bunka Kagakusha Co., Ltd., concerning the state of their health. Five to seven minutes were required to fill out the form.

It should be added that this research has been approved by the Ethics Committee of Kawasaki University of Medical Welfare (No. 018).

Measurement of stress levels

Stress levels were measured using a Stressometer manufactured by the French company TNR. Standing in the standard measuring position (SMP), each subject was asked to grasp the sensor handle with the dominant hand and wait for around ten seconds while the display in the Continuous mode stabilized at 50 TNR or below. The machine was then switched to the Measurement mode and the stress level was measured after 20 seconds (TNR unit: sine curve tremor with amplitude of 1 μm taken as 6 TNR units).[6,7] The subjects waited in a standing position for at least five minutes before the measurements were made. In the case of a measurement of 100 TNR or more, the subject was told to re-assume a relaxed posture after which a second measurement was taken. This machine consists of a piezoelectric accelerometer connected to an electronic circuit, and the measurement results are displayed in TNR units on a panel (a tremor monitor that measures tremors with an amplitude of between 3 and 20 Hz). After analog/digital conversion of the accelerometer, the signals are analyzed by this method and by computer. The average value of stress levels measured on more than 20,000 subjects in France, where this machine was developed, is said to have been between 35 and 40 TNR.[6,7]

Assessment of mental health levels using a Japanese version of GHQ28

Developed by Goldberg et al,[8] GHQ28 is a mental health survey form that accords with WHO standards. Its appropriateness and reliability have been thoroughly studied and it is used widely today throughout the world.[9] In terms of content, the factor scale is divided into four categories, namely physical symptoms (A), anxiety and insomnia (B), social activity disorder (C), and depressive tendencies (D), and there are seven questions in each category (total of 28 questions). The higher the GHQ score, the poorer the state of the subject's mental health. Taking account of sensitivity and specificity, the demarcation point (critical point) is considered to be 5 or 6. Around 90% of all patients suffering from neural disorders have a score of 6 points or more, while 86% of healthy patients have a score of 5 points or less.[10] With reference to the extensive results of research conducted in the past,[10,11,12,13] in the present study we took a GHQ score of 5 points or less as indicating a student with a good degree of mental health and a score of 6 points or above as indicating a student with a problem of some kind, i.e. in poor mental health. In the score classification based on differing factor scales, it was assumed that a problem of intermediate degree or above was evident in the case of a score of 4 or more points out of a full score of 7 points with A and B and in the case of a score 3 or more points out of a full score of 7 points with C and D.[10]

Uchida-Kraepelin test

In the context of clinical psychology tests, the present test is a kind of character or personality test. Its aim is to reveal personality features by investigating emotional reactions when the subject is placed in a stimulatory environment. Created by the Psychological Technology Research Institute in Japan, it is a method for diagnosing work aptitude through the performance of simple mental tasks. The method employed on this occasion for subjecting eight of the students whose stress levels were measured to mental tasks (stress) involved use of only the first half (15 minutes),[5] before and after which stress

levels were re-measured using the Stressometer. No special method of relaxation was devised before the subject was subjected to the application of stress.

Statistical processing

The results obtained were indicated in terms of average value ± standard deviation. Significant difference was verified using the Student *t* test, and a significant difference was considered to be evident when $p<0.05$.

Results

Stress levels

Stress levels (TNR) measured on 445 students with a Stressometer were classified into the categories of 36 and under, 37 to 69, and 70 and above. The numbers of students in each category and gender frequency are shown in **Table 1**. Most students (87.0%) came within the 69 TNR and below range, while 13% of students showed high stress levels of 70 TNR and above. In terms of gender, there was a significantly higher number of male students than female students demonstrating high stress levels ($p<0.01$). Furthermore, in terms of the measurements conducted in the morning and the afternoon, a higher result was obtained for the frequency of students with high stress levels in the case of values measured in the afternoon (18.6%; 11.7% in the morning) ($p<0.01$). Looking at the numbers of students with levels of 70 TNR and above in terms of university year, the order was second-year students followed by third-year and then fourth-year students. The figure of 16.8% for second-year students (12.8% for third-year students) was significantly higher than the 7.9% recorded for fourth-year students ($p<0.01$).

Correlation with GHQ28

In addition to measuring stress levels on the extra day set aside for medical checkups, we studied the relationship between stress levels and mental health using 41 students who had completed the GHQ28 form. We assessed the mental health levels of 19 randomly selected students (6 male and 13 female) with stress levels of 36 TNR and under (i.e. normal stress levels) and 22 students (10 male and 11 female) with high stress levels of 70 TNR and above. The results of studying the connection with stress levels were as described hereunder. The average score in the GHQ28 test on this occasion was 7.24 ± 4.91, and the proportion of students with scores of 5 points or less (i.e. in good mental health) was 39.0%, while the proportion of students with scores of 6 points or more (i.e. in poor mental health) was 61.0%. The results for the mental health of students soon after the beginning of the new term who had been unable to receive or had not received a medical checkup on the prescribed day and actually received their checkup a month later were compared with the results published in earlier reports. Almost identical levels of results were obtained for average values (7.79 ± 5.69 points) [10,12] and for the proportional frequency of students with scores of 6 and above (university students 60%, healthy subjects 10%, neurotics 90%)[10,12].

A comparison between the total GHQ28 scores (total of 28 points) of students with normal stress levels of 36 TNR and under, and students with high levels of stress of 70 TNR and above indicated that the total scores of the former (5.3 ± 4.1) were significantly lower than the total scores of the latter (9.0 ± 5.0) ($p<0.02$) (**Figure 1**). Next, comparing the stress levels (TNR) of students with total GHQ scores of 5 and less with those of students with

scores of 6 and above, it was found that the average values for stress levels were higher in the latter case (75.9 ± 45.4) than in the former (44.8 ± 33.2) ($p<0.02$) (**Figure 2**). A comparison was also made between the numbers of students with high stress levels of 70 TNR and above in the two groups of subjects with total GHQ scores of 5 and below and of 6 and above, as a result of which it was found that the number of students with high stress levels was significantly higher in the 6 points and above group (average 68%, 31% in the 5 and below group, $p<0.02$).

We then investigated the features of the mental health levels of students in the high stress level and low stress level groups on the basis of a GHQ28 factor schedule divided into categories A, B, C and D. As a result, in the scores (7 representing full points) indicating social activity disorders (Category C: Leading an active life; everything going well; sense that life is worth living; work is proceeding smoothly; things can be decided on easily, etc.), in the cases of students with normal stress levels and students with high stress levels, the scores were 0.8 ± 1.3 and 2.0 ± 1.6 respectively, indicating that the score for the former was significantly lower than that for the latter ($p<0.02$) (**Figure 3**). Because Category C is three points and above, the numbers of students considered to have problems on the level of intermediate and above was two in the former case and seven in the latter case. We investigated the correlation between points in Category C and TNR and discovered a significant tendency towards a correlation between the two ($p=0.060$). Points in Category A (physical symptoms, state of mental and physical health: feel like taking pick-me-ups, feel tired, feel ill, experiencing headache or heaviness in the head, etc.) were 2.9 ± 2.1 and 1.7 ± 1.8 in the cases of students with high stress levels and those with normal stress levels respectively, indicating that there was a stronger tendency among the former than the latter ($p=0.054$). Furthermore, in categories A (4 points and above), B (4 points and above), C (3 points and above) and D (3 points and above) classified according the various factor scales in GHQ28, we studied stress levels (TNR) and the proportions (%) of students with high stress levels (70 TNR and above) in the case of students with problems of an intermediate level and above and of students without problems, but we found no categories in which there were significant differences.

Uchida-Kraepelin test

We compared stress levels before and after testing in the case of eight students on whom the Uchida-Kraepelin test (15 minutes of the first half only) had been performed as a mental test load. As a result we were unable to obtain results indicating that stress levels had risen after the Uchida-Kraepelin load in the case of students with high stress levels (**Figure 4**). The number of cases on which tests were performed on this occasion was extremely small, and detailed studies will be needed in the future involving performance of a full Uchida-Kraepelin test (30 minutes for the first and second halves) to discover what kind of changes occur in stress levels on a diachronic basis.

Discussion

Measurement of stress levels using a Stressometer: Basic data on measurement

Before embarking on this research, we conducted a basic study on methods of measurement using the Stressometer. When five consecutive measurements were carried out at one-minute intervals on the same test subjects (seven healthy students aged between 21 and 32, including one male), there were cases of increase (e.g. 25-33-33-33-46; maximum value 1.8 times the minimum value) and other cases of decrease (34-43-11-15-

22; maximum value 3.1 times the minimum value). No obvious tendencies could thus be observed. Although the range of variation was within the range 1.5 to 4.0 times, all measurement values were distributed within a range of 10 to 46 TNR. Variations in measured values on this scale are likely to be due to posture during measurement, the hand (wrist) that grips the sensor, and the amount of tension in the muscles of the forearm and upper arm. No differences between left and right were observed even when the sensor handles of two different Stressometers were grasped with the left and right hands and simultaneous measurement was performed. Repeated measurements were made between five and fifteen times a day, including measurements made at home, and the times and activities were recorded. Although changes were evident before and after bathing, before and after defecation and urination, before and after meals, and before and after physical activity, we were unable to discover any activities (factors) involving increase or decrease common to the seven subjects.

On the basis of the above, it is clearly important to stabilize the posture during measurement (the elbow joints should be a slight distance away from the trunk and not in contact with it during measurement, and the forearms should be bent downwards at an angle of 45 degrees), to ensure that there is no tightening of the muscles not only in the upper limbs but also in the shoulders and other parts of the body, not to move the body, and to enable relaxation without talking. It is necessary also to instruct subjects to keep their eyes open, look downwards and breathe slowly. Ideally the person in charge of the test should be the same person, because he will be able to provide the subjects with the same advice and ensure that they are assuming the correct posture. A yet more appropriate method of measurement involves getting the subject to relax for ten minutes before the measurement, providing him with a simple explanation of how the measurement is going to be carried out, and then measuring on three consecutive occasions. Rather than adopting the middle of the three measured values, the lowest value should then be adopted as the measured value. Moreover, in cases such as the present group examination, care should be taken to ensure that there is no vibration inside the room. Improvements need to be made in the future so that variations in TNR and amplitude during the 20-second measurement period are displayed on a panel in a clearly visible manner. There is also a need for devices such as a warning lamp that will light up if the sensor handle is being gripped too strongly or if the posture during measurement is incorrect.

Tremor

Tremor is the most frequently observed type of involuntary movement observed in the course of routine medical examinations and may occur in one part of the body or all over the body. Tremor is evident especially among highly-strung individuals and especially at times such as mental tension, fatigue and excitement, and during cold spells. Depending on its manner of appearance it may classified into tremor while at rest, postural tremor and tremor while in motion. As to the properties and condition of tremor, frequency (rhythmic, muscular discharge frequency) refers to the number of tremors per second, while amplitude (the extent of the tremor) refers to whether the tremor is small or large in scale. Most tremors occur symmetrically in both hands, but cases have been observed of tremor in the head and the voice. Tremor can be divided into physiological tremor and abnormal (pathological) tremor (including essential tremor and Parkinson’s disease, etc.) caused by central disorders of the motor nerves. The connection with the former type is of principal concern in connection with the present study.[6]

Physiological tremor refers to tremor evident in connection with posture and during activity and is not evident while a subject is at rest. It occurs rapidly at between 8 and 13 times per second (8 to 13 Hz) and varies depending on frequency and amplitude. The mechanism by which it occurs is not altogether clear, but it is thought to be connected with beta-adrenalin receptors in the muscles and the spinal reflex arc.[14] On the other hand, essential tremor may appear as early as infancy and adolescence. It is common within the same family, and it has been reported that the rate of occurrence in people over the age of 40 is between 0.4% and 5.6%.[15] As with physiological tremor, muscular activity is not evident during rest, and it appear while maintaining a posture and during physical activity.

The influence of stress on tremor

As regards assessment of levels of stress using the Stressometer, we need to be aware in advance of normal individual stress levels (basic values) and their daily variation, and we should preferably be able to assess changes in stress levels (TNR) so that it is possible to calculate the extent to which stress levels increase as a consequence of application of stress. The precondition here is that there is no error in measurement technology so that it is possible to measure stress levels repeatedly with the correct posture. As indicated by the R (at rest) of TNR, this machine measures minute tremors in the hand during rest, and physiological tremor not evident while at rest is therefore as far as possible excluded. However, considering that tremor arising due to stress is measured in terms of amplitude (TNR) within a determined rhythmic range (3 to 20 Hz), it is likely to be difficult to distinguish changes attributable to stress from some types of physiological tremor (assuming that stress is not involved).

A number of reports have been published on how physiological stress has the effect of increasing the amplitude of tremor. For instance, there is a report to the effect that physiological tremor increases in unstable conditions and in conditions of emotional stress,[16] and another indicating that tremor is reduced if increase in the release of catecholamine from adrenal glands is prevented by beta-blockers.[17] It has also been reported that minute tremors of the whole body can be observed by applying stress and reduced by a dosage of propranolol.[18] Other reports indicate that mental stress not only induces physiological tremor in healthy subjects,[16] but that it also encourages pathological tremor in essential tremor patients,[19] and even increases tremor originating in Parkinson's disease.[20] By injecting subjects with stress hormones such as adrenalin, it is possible to induce tremor on an experimental basis.[21] However, such changes disappear after 15 minutes.

Clear distinctions, however, cannot be drawn as regards whether all the tremors that can be measured with the Stressometer are ascribable to mental stress loads, whether measurements have been made as the result of partial incorporation of physiological stress, and the extent or the proportion of such stress included in the measurement. Further studies will have to be carried out to clarify these matters. It will be necessary in particular to examine the correlation with biological parameters relating to level of stress such as adrenalin in the blood, noradrenaline density, pulse and blood pressure, temperature of the skin and electrical resistance. Study will also be required of matters such as the effects on stress levels of (TNR) of nutrition and foods (stress-resistant foods),[22] beta-blockers, sleeping pills, anti-depressants and other drugs.[23]

Stress levels of students: Connection with GHQ28

The present study is of interest in that it has demonstrated that stress levels measured using a Stressometer are related in various ways to the extent of mental health assessed by means of GHQ28. It is particularly interesting that a correlation or a correlative tendency was observed in the case of students with strong social activity disorders (Category 3) or of physical symptoms (Category A). However, it is easy to understand the high frequency of high stress levels among students with extensive physical symptoms, but further study is needed of why high stress levels are indicated in the case of students complaining of social activity disorders. As in the case of earlier reports in connection with GHQ28,[10,11,12,13] the present study has shown that students today are subject to excessive stress and that remedial action of some kind needs to be taken to enhance responsive behavior, to strengthen resistance to stress, and to find ways in which to relieve stress.

There is a report to the effect that strengthening of stress levels has been measured by means of mental stress loads in the form of the Uchida-Kraepelin test (first half, 15 minutes), but such results were not obtained in the present highly restricted study. However, we will need to await further studies to discover whether a method involving the subject grasping a pencil for 15 minutes with his dominant hand and then writing down on a sheet of paper a succession of replies to sums involving addition has any influence on TNR measurement using the Stressometer (in which the sensor is held in the dominant hand).

Our conclusion is that measurement of stress levels using the Stressometer may prove useful for assessing mental health levels, and that this is a topic that will require further research in the future.

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Explanation of figures and tables

Table 1: Categories of stress levels among students, corresponding numbers of students and gender frequency

Figure 1: Total GHQ28 scores (max. 28 points) for students with normal stress levels (36 TNR or under) and with high stress levels (70 TNR or above)
5.3 ± 4.1 with normal stress levels (n=19) and 9.0 ± 5.0 with high stress levels (n=22).
*$p<0.02$

Figure 2: Stress levels for students with a total GHQ score of 5 or under and of 6 or above
44.8 ± 33.2 with a score of GHQ5 or under (n=16) and 75.9 ± 45.4 with 6 or under (n=25)
*$p<0.02$

Figure 3: Scores (max. 7 points) in the factor scale C category (social activity disorders) of GHQ28 for students with normal stress levels (36 TNR or under) and high stress levels (70 TNR or above)
0.8 ± 1.3 with normal stress levels (n=19) and 2.0 ± 1.6 with high stress levels (n=22)
*$p<0.02$

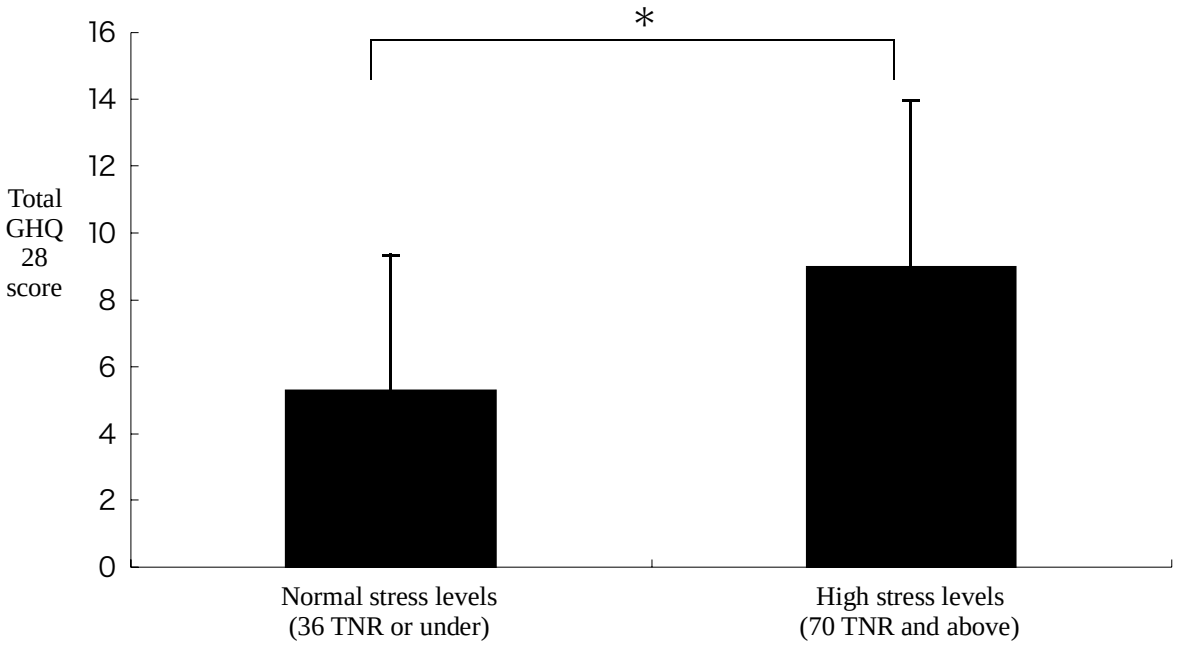
Figure 4: Variations in stress levels (TNR) before and after mental stress loads based on the Uchida-Kraepelin test

Table 1

Stress levels	Male (%)	Female (%)	Total
36 and under	51 (29.3)	129 (47.6)	180 (40.5)
37 to 69	90 (51.7)	117 (43.2)	207 (46.5)
70 and above	33 (19.0)	25 (9.2)	58 (13.0)
Total	174 (100)	271 (100)	445 (100)

Frequency of students with levels of 70 TNR and above: The figure for men (19%) was significantly higher than that for women (9.2%) ($p<0.01$).

Figure 1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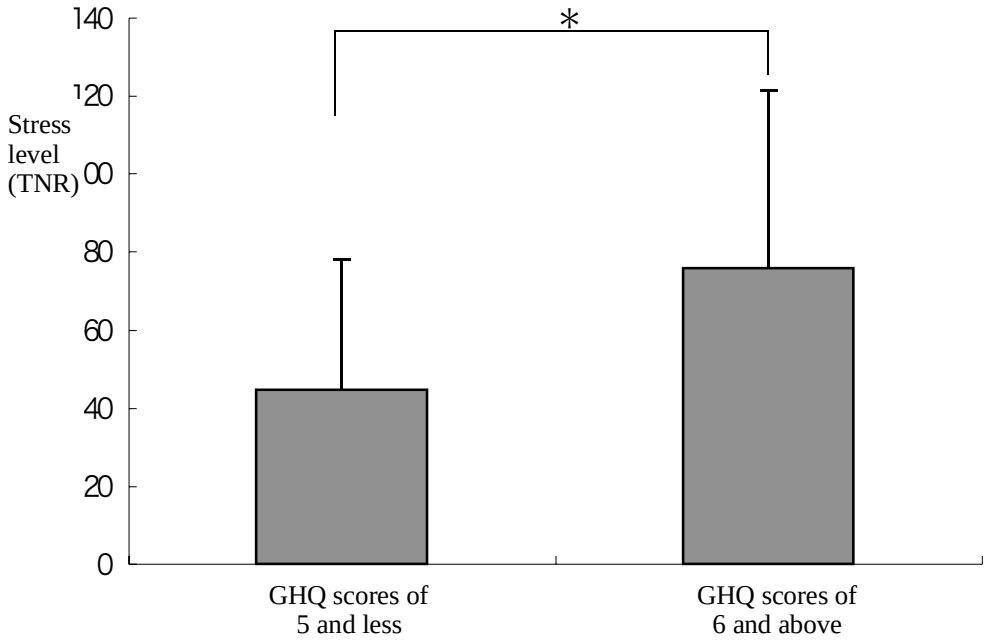
Total GHQ 28 score
Normal stress levels (36 TNR or under)
High stress levels (70 TNR and above)

Figure 2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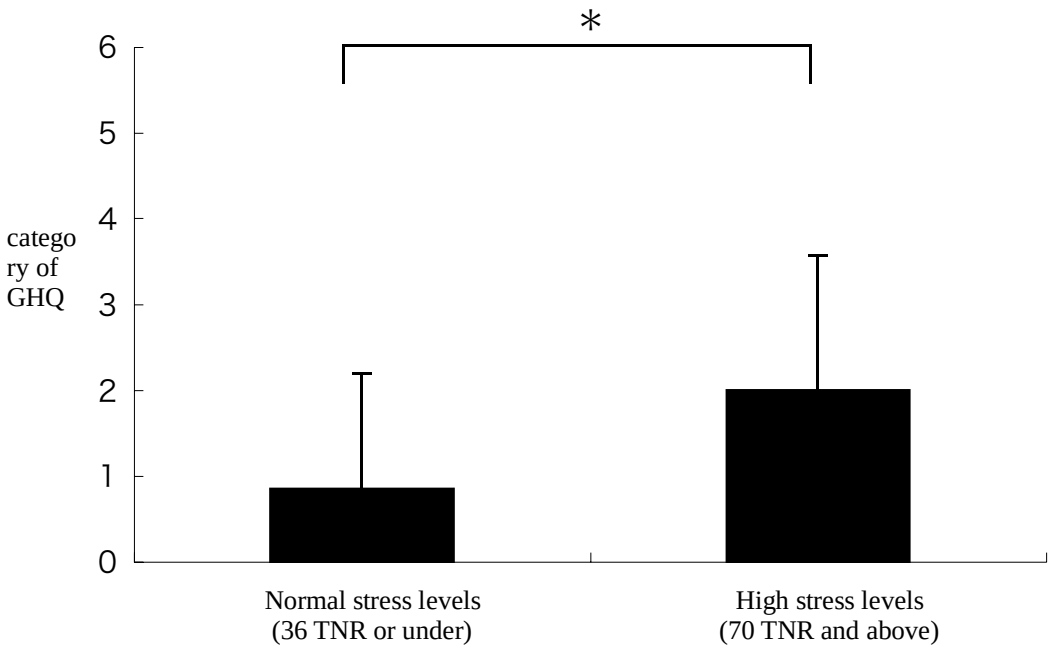
Stress level (TNR)
GHQ scores of 5 and less
GHQ scores of 6 and above

Figure 3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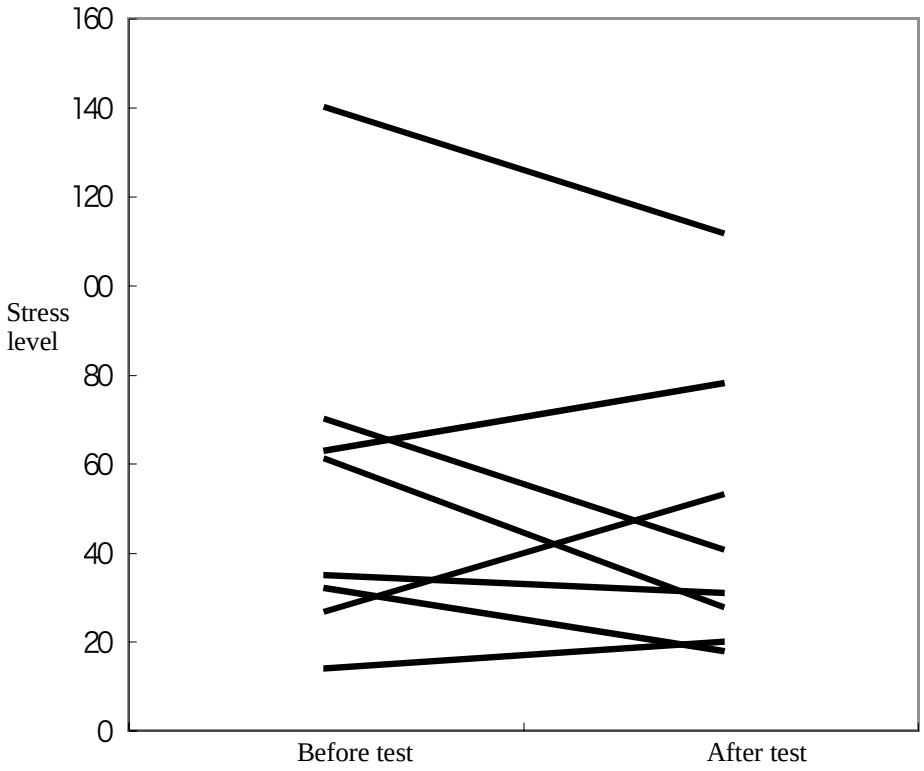
category of GHQ
Normal stress levels
(36 TNR or under)
High stress levels
(70 TNR and above)

Figure 4


160
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120
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Stress level
Before test
After test