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# Development and validation of a stress response measure: the Daily Stress Response Scale (DSRS)

## BACKGROUND

To date, there is a lack of measures for capturing a broad spectrum of psychophysiological stress reactions that can be administered on a daily basis and in different contexts. A need for such a measure is especially salient in settings where stress processes can unfold momentarily and substantially fluctuate daily. Therefore, the main aim of the current study was to develop and validate the Daily Stress Response Scale (DSRS), an instrument capturing a broad spectrum of psychophysiological stress reactions that can be administered in real time and in different contexts.

## PARTICIPANTS AND PROCEDURE

The study was conducted in the early stages of the COVID-19 pandemic in Europe. Participants were 7228 (81% female) Polish university students. The data were collected anonymously through self-completion questionnaires. The DSRS was subject to confirmatory factor analyses (CFA).

## RESULTS

The DSRS is a 30-item, easy-to-use stress response measure with excellent psychometric properties. Based on CFA results, the scale consists of two subscales, psychological and physiological stress response, which form associations with related external criteria.

## CONCLUSIONS

The DSRS is a reliable and valid measure of psychological and physiological stress reactions that can be used to assess the stress response to daily stressors, including those of an acute nature, such as a crisis, trauma, or surgery.

## KEY WORDS

Daily Stress Response Scale (DSRS); stress response; confirmatory factor analysis (CFA); criterion-related validity; coefficient omega

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## BACKGROUND

Stress is an important construct in psychological and medical research. However, stress is broadly defined and the term is used to refer to various processes, including exposure to potentially stressful situations, perception of those potentially stressful situations, and neural responses to those events (Epel et al., 2018). Although some existing stress scales contain items referring to situations which may induce stress reactions (e.g., workplace stress scales such as the Nursing Stress Scale; Gray-Toft & Anderson, 1981), the perception of stress is a transactionally based process, guided by a person's cognitive appraisal of an event and individual sensitivities to stress. This indicates that the same situation can be stress-inducing for one person and neutral for another (Hobfoll, 1989; Lazarus & Folkman, 1984). On a biological level, response to stress is mediated by two major stress systems: the hypothalamus-pituitary-adrenal (HPA) axis and the sympathetic nervous system (SNS). Together, the activation of these systems orchestrates various psychological (e.g., feelings of anxiety, frustration, tension, and rumination) and physiological (e.g., increased heart rate, accelerated breathing, muscle tension) processes (Desborough, 2000; Epel et al., 2018; Gagnon & Wagner, 2016; Payne, 1999).

Although most aspects of the stress response are adaptive (e.g., breathing accelerates to allow for extra oxygen supply), repeated psychophysiological reactivity can occur when a person perceives a discrepancy between the demands of the situation and their ability to cope with those demands (Caplan, 1983). In such maladaptive stress processes, an individual may experience elevation in affective states, such as anxiety and worry, as well as in physiological states, such as vigilant preparedness reflected in the over-activation of the SNS (Epel et al., 2018). Notably, increased levels of stress over an extended period of time have been associated with negative mental health (e.g., depression, anxiety, substance abuse) and physical health (e.g., cardiovascular disease, high blood pressure, obesity, diabetes) outcomes (Cohen et al., 2007; Hammen, 2005). Exposure to extremely stressful events (i.e., an acute stressor) may increase the risk of cardiovascular problems (Holman et al., 2008) and post-traumatic stress disorder (PTSD; Shalev et al., 1998). Prior research has also indicated that stress experienced during hospitalisation can lead to reduced outcomes in patients undergoing surgery, including post-operative delirium (e.g., Cerejeira et al., 2013). In addition, stress can be indirectly related to suicidality. Specifically, Cheng and Chan (2007) reported that exposure to stressful events increased suicidality through intensifying depression, substance use, and death acceptance.

To date, there is a lack of measures for capturing a broad spectrum of psychophysiological stress re-

actions that can be administered repeatedly. A need for such a measure is especially salient in contexts where stress processes can unfold momentarily and substantially fluctuate on a daily basis, for example stress responses to a crisis, trauma, surgery, or hospitalisation. In such contexts, measures assessing stress over a one-week or one-month period are not suitable as they fail to capture the momentary and changing nature of stress reactions. In addition, measures with a longer reporting time period are subject to retrospective reporting bias. This is a serious limitation in the context of stress measurement because stress can affect autobiographical memory recall (Pezdek, 2003). Assessment of stress reactions which would allow for frequent repeated sampling of participants' experiences in real time aligns with the ecological momentary assessment (EMA) method, which is hailed for its ability to minimise recall bias and maximise ecological validity (Shiffman et al., 2008).

The current study was conducted in the early stages of the COVID-19 pandemic, i.e., when crisis-induced stress was very likely to occur. The time of widespread outbreaks of infectious diseases can be emotionally challenging and stressful to all persons affected, and in particular those subgroups of the population that are at an increased risk of mental health problems. One such vulnerable group is university students (Wang et al., 2020). Theoretically, high sensitivity to stress among university students is not surprising. Specifically, young university students (aged 18-24 years) are in a transitional developmental stage between late adolescence and adulthood. "Emerging adulthood" is a difficult stage of development as it requires young adults to gain independence and self-sufficiency, as well as to build and maintain intimate relationships. Achieving these important developmental milestones can be stress-arousing and anxiety-provoking (Arnett, 2004; Meadows et al., 2006; Zirkel, 1992; Zirkel & Cantor, 1990). At the same time, all university students, regardless of their developmental stage, have to face stressors associated with academic and financial demands that may have an adverse effect on their mental health (Dusselier et al., 2005). In considering the volume and diversity of demands that students have to deal with, any additional strain can be appraised as particularly negative or threatening.

## THE CURRENT STUDY

Taken together, there is a need for a measure of stress that is easy to administer and score and can reliably assess a broad pattern of physiological and psychological responses repeatedly and in real time. Therefore, the first aim of the current study was to develop the Daily Stress Response Scale (DSRS) – a self-report scale designed to assess psychological

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and physiological reactions to daily stressors, including acute stressors, in a context-free manner. Another aim was to examine the psychometric properties (including factor structure, coefficient omega, and criterion-related validity) of the DSRS. The evaluation of the DSRS factor structure was achieved using confirmatory factor analysis. The evaluation of criterion-related validity was accomplished through the strategy of correlating the DSRS subscale scores with two previously validated self-report measures of stress and several self-report measures of traits related to the construct of stress (depression, anxiety, and suicidality). In considering students' standing as a vulnerable population in terms of sensitivity to stress, the scale was validated among a large sample of university students during the early stages of the COVID-19 crisis.

## PREDICTIONS

Given that response to stress is a mixture of physiological and psychological processes, we predicted that the DSRS would be best captured by two latent factors – the psychological and physiological stress response. We also predicted that the DSRS scores would form moderate to strong positive correlations with the scores on already established measures of stress. Since those existing instruments consist predominantly of items assessing psychological reactions to stress, we predicted that those correlations would be stronger for the psychological subscale of the DSRS. Further, we predicted that both DSRS subscales would form moderate positive correlations with depression and anxiety scores. Finally, since the relationship between stress and suicidality appears to be indirect (see Cheng & Chan, 2007), we predicted that the DSRS subscales would form weak positive correlations with suicidality. Given the lack of research in the area distinguishing between psychological and physiological responses to stress, we did not form any *a priori* hypotheses regarding which DSRS subscales would form stronger associations with depression, anxiety, and suicidality.

## PARTICIPANTS AND PROCEDURE

### PARTICIPANTS

The present analyses are based on data collected among Polish university students in the early stages of the COVID-19 pandemic (March-April 2020). In total, 11,380 individuals accessed our online survey link and 10,056 consented to participate in the study, giving an 88% response rate. A total of 409 participants did not meet the study inclusion criteria (i.e., being a student at a Polish university and being flu-

ent in Polish). Of the 9,647 participants who met the study inclusion criteria, 7,228 (81% female) returned satisfactory data. Therefore, the total completion rate was 75%. Age ranged from 18 to 61 years ( $M = 22.79$ ,  $SD = 4.40$ ,  $Me = 22$ ). As for the level of study, 1,761 (24.5%) participants were first year undergraduate students, 1,273 (17.7%) were second year undergraduate students, 1,384 (19.3%) were third year undergraduate students, 1,385 (19.3%) were first year Master's or fourth year medical students, 1,264 (17.6%) were second year Master's or fifth/sixth year medical students, and 114 (1.6%) were postgraduate taught or postgraduate research students. As for the subject of study, 1,480 (20.6%) participants were psychology students, 1,075 (14.9%) were medical sciences students (including medicine, nursing, and paramedic science), and 4,638 (64.5%) were enrolled on other courses (such as engineering, law, administration, biology, archaeology, and architecture). The vast majority of participants (97.5%) were Caucasian and born in Poland, which reflects the composition of Polish society.

### DATA COLLECTION

Ten large universities from all regions of Poland as well as the Students' Parliament of the Republic of Poland, which is an organisation that brings together local governments from all universities, participated in the study. Students were invited to participate in the study via email invitations sent by university representatives and announcements made on official institutional social media sites. The data were collected anonymously through self-completion questionnaires. Informed consent was requested from each participant and ethical clearance was obtained from the research and ethical committees at all relevant institutions.

### SCALE DEVELOPMENT PROCEDURES AND OTHER INSTRUMENTS

The *Daily Stress Response Scale* (DSRS) was developed to assess the daily stress response. Item generation for the DSRS relied on theoretical considerations and discussions with a panel of experts (psychologists and medical doctors). Initially, we assembled 26 items reflecting psychological (emotional and cognitive) stress reactions and 26 items reflecting physiological stress reactions. The initial item pool was sent to 20 medical doctors and psychologists who were asked to evaluate the clarity and conciseness of scale items, assess whether each item taps into the construct we intended to measure, and to advise us on which items should and should not be included in the final version of the scale. As a result of this

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content validity exercise, the item pool was reduced to 30 items (15 for each dimension). Therefore, the DSRS is a 30-item measure assessing psychological (15 items) and physiological (15 items) reactions to stress. For each statement, respondents are asked to indicate on a 5-point Likert scale (0 – *never*, 1 – *rarely*, 2 – *occasionally*, 3 – *a lot of the time*, 4 – *nearly all the time*) to what extent it applied to them during the last 24 hours. Scores on each subscale range from 0 to 60, with higher scores indicating increased levels of psychological or physiological stress. In the current sample, Cronbach's  $\alpha$  values for psychological and physiological stress responses were .95 and .91, respectively.

The short form of the *Depression Anxiety Stress Scales* (DASS; Lovibond & Lovibond, 1995; Polish adaptation: Makara-Studzińska et al., 2022) is a 21-item measure that includes three subscales assessing symptoms of depression (7 items), anxiety (7 items), and stress (7 items). For each statement, respondents are asked to use a 4-point Likert scale to indicate to what extent it applied to them during the last week, from 0 (*did not apply to me at all*) to 3 (*applied to me very much or most of the time*). Scores on each subscale range from 0 to 21, with higher scores indicating increased levels of depression, anxiety, or stress. In the current sample, Cronbach's  $\alpha$  values for depression, anxiety, and stress scores were .87, .84, and .88 respectively.

The *Depressive Symptom Inventory – Suicidal-ity Subscale* (DSI-SS; Joiner et al., 2002; Metalsky & Joiner, 1997) is a 4-item self-report questionnaire designed to identify the frequency and intensity of suicidal ideation and impulses. In the current study, respondents were asked to report on suicidal ideation and impulses over the past 24 hours. Scores on each item range from 0 to 3 and, for the inventory, from 0 to 12, with higher scores reflecting greater severity of suicidal ideation. The Polish version of the DSI-SS was developed using the translation/back-translation method. Discrepancies were resolved by discussion. Cronbach's  $\alpha$  for the entire sample was .93.

The *Perceived Stress Scale* (PSS; Cohen et al., 1983; Polish adaptation: Juczyński & Ogińska-Bulik, 2009) is a 10-item measure assessing how different situations affect an individual's feelings and perceived stress. Respondents are asked to indicate how often they had certain feelings and thoughts in the last month on a 5-point Likert scale from 0 (*never*) to 4 (*very often*). Total scale scores range from 0 to 40, with higher scores indicating increased levels of stress. Cronbach's  $\alpha$  in the current sample was .85.

*Lie scale.* To control for social desirability bias, we used three items from the Eysenck Personality Questionnaire-Revised Lie scale (Eysenck et al., 1985). These were: (1) "Are all your habits good and desirable ones?"; (2) "Have you ever taken anything (even a pin or button) that belonged to someone else?"; (3) "Have

you ever said anything bad or nasty about anyone?" The items were scored using a yes/no format. Total scores ranged from 0 to 3, with higher scores indicating greater social desirability in responses. Socially desirable responding was operationalised as an overall score at or above 2. Three hundred and sixty-eight (368) participants recorded a score of 2 and 42 participants recorded a score of 3. These participants were excluded from analyses. The Polish version of the scale was developed using the translation/back-translation method. Discrepancies were resolved by discussion.

## ANALYTICAL PROCEDURE

Descriptive statistics were calculated using SPSS version 26. The dimensionality and construct validity of the DSRS were assessed using confirmatory factors analysis (CFA). Two competing models of the DSRS were specified and tested using Mplus version 7.4 (Muthén & Muthén, 2010) with WLS estimation. Model 1 is a one-factor solution in which all 30 DSRS items load on a single latent factor of stress reaction. Model 2 is a correlated two-factor solution where 15 items load on the psychological stress response factor and the remaining 15 items load on the physiological stress response factor.

The overall fit of each model and the relative fit between models were assessed using a range of goodness-of-fit statistics: the  $\chi^2$  statistic, the comparative fit index (CFI; Bentler, 1990), and the Tucker-Lewis index (TLI; Tucker & Lewis, 1973). Fit is considered acceptable if the CFI and TLI values are above .90 and good if they are above .95 (Van de Schoot et al., 2012). The root mean square error of approximation (RMSEA; Steiger, 1990) with 90% confidence interval is also presented. RMSEA values of about .05 or less indicate a good error of approximation in the population (Browne & Cudeck, 1993).

Criterion-related validity for the DSRS subscales was assessed using a series of pairwise correlation coefficients calculated in SPSS. In addition, the reliability of the DSRS was examined using coefficient omega (McDonald, 1999).

## RESULTS

Descriptive statistics for two DSRS factors (psychological stress reactions and physiological stress reactions), PSS, DASS stress, DASS anxiety, DASS depression, and suicidality are presented in Table 1.

Fit indices for two alternative models of the DSRS are presented in Table 2. The two-factor correlated model provides the best fit to the data based on all statistics (CFI = .98, TLI = .98, RMSEA = .045, 90% CI [.044, .046]).

**Table 1***Descriptive statistics for the continuous variables*

Variables	<i>M</i>	<i>SD</i>	Observed Min.	Observed Max.
DSRS Psychological	27.86	14.33	0	60
DSRS Physiological	12.43	10.48	0	60
PSS	21.06	6.90	0	40
DASS Stress	17.03	10.78	0	42
DASS Anxiety	9.21	9.11	0	42
DASS Depression	14.28	10.80	0	42
Suicidality	1.30	2.09	0	12

*The Daily Stress Response Scale (DSRS)*

Note. DASS – Depression, Anxiety and Stress Scale; DSRS – Daily Stress Response Scale; PSS – Perceived Stress Scale.

**Table 2***Fit indices for two alternative models of the Daily Stress Response Scale*

Models	$\chi^2$	<i>df</i>	CFI	TLI	RMSEA	90% CI
1. One-factor	6650.70*	405	.97	.96	.049	[.048; .050]
2. Correlated 2 factors	5848.75*	404	.98	.98	.045	[.044; .046]

Note. \*Indicates  $\chi^2$  is statistically significant ( $p < .05$ ).

The appropriateness of the two-factor correlated model of the DSRS has also been determined based on parameter estimates. As shown in Table 3, all items displayed statistically significant factor loadings. All factor loadings were acceptable, ranging from .88 to .98 for the psychological stress response subscale and .77 to .95 for the physiological stress response subscale.

To assess the criterion-related validity of the DSRS, the DSRS subscale scores were associated with external variables. Table 4 shows that although both DSRS subscales formed significant positive associations with external criteria, most of those associations varied in strength. Specifically, the DSRS psychological subscale scores formed moderate to strong positive correlations with the PSS, DASS stress, DASS anxiety, and DASS depression scores. The DSRS physiological subscale scores were moderately correlated with the PSS, DASS stress, and DASS depression scores, as well as strongly correlated with DASS anxiety scores. The correlations between both DSRS subscale scores and suicidality scores were positive yet weak. All these associations were in line with our predictions.

Reliability of the DSRS factors was investigated using coefficient omega (McDonald, 1999). The results suggest that both psychological (.99) and physiological (.98) factors demonstrate excellent reliability (calculations based on a two-factor solution).

## DISCUSSION

Past research demonstrated that increased levels of stress over an extended period of time as well as exposure to extreme stress can lead to negative mental health and physical health consequences, including depression, anxiety, substance abuse, PTSD, suicidality, post-operative delirium, cardiovascular disease, high blood pressure, obesity, and diabetes (Cerejeira et al., 2013; Cheng & Chan, 2007; Cohen et al., 2007; Hammen, 2005; Holman et al., 2008; Shalev et al., 1998). Whenever possible, therefore, stress responses in contexts known to be stress-inducing should be monitored in real time to allow for more effective prevention of long-term negative outcomes. However, there is a lack of context-free, easy to administer measures that comprehensively cover both psychological and physiological aspects of the stress response and yield themselves to the EMA methodology. To address these limitations, the main aim of the current study was to develop and validate the Daily Stress Response Scale. The DSRS was found to be captured by two factors – psychological and physiological stress responses. The results of the present study also provide strong support for the criterion-related validity of the DSRS as a measure of stress.

As predicted, the DSRS was found to encompass two correlated factors, which is consistent with the fact that stress is experienced at physiological (e.g.,

**Table 3**

Standardized factor loadings for the two factors of the Daily Stress Response Scale (DSRS) (correlation between the two latent variables = .89)

DSRS items	PS	PH	DSRS items	PS	PH
I have felt upset.	.92		I have experienced breathing difficulties (e.g., fast or heavy breathing, shortness of breath) even in the absence of physical exertion.		.93
I have felt anxious.	.92		My heart has been beating fast even in the absence of physical exertion.		.94
I have felt tearful.	.91		I have felt tension in the muscles of my body (e.g., tension in the neck or shoulders).		.82
I have felt uneasy.	.95		I have had abdominal pains (e.g., stomach cramps or a dull ache in the tummy).		.84
I have been feeling overwhelmed.	.94		My mouth has felt dry.		.77
I have felt afraid.	.95		I have vomited or felt like vomiting.		.84
I have been unable to concentrate.	.90		I have felt chest pains.		.88
My thoughts have been mostly negative.	.95		I have been experiencing pulsing in my ears.		.86
My thoughts have been racing.	.88		My heart has been racing.		.95
I have been worried.	.95		In general, I have been sweating more than usual.		.84
I have been thinking over and over about things that have upset me.	.96		I have had difficulty swallowing foods, without any apparent physical reason.		.88
I have been easily distracted.	.90		I have had a pounding feeling in my head or chest.		.92
I have been thinking over and over about things that have made me nervous.	.95		I have felt lightheaded or dizzy.		.87
I have found it difficult to shake off negative feelings.	.97		I have felt tired.		.83
I have found it difficult to shake off negative thoughts.	.98		I have been shaking or shivering.		.88

Note. PH – Physiological subscale; PS – Psychological subscale. All factor loadings are statistically significant at  $p < .001$ . All items are measured on a 5-point Likert scale (0 – *never*, 1 – *rarely*, 2 – *occasionally*, 3 – *a lot of the time*, 4 – *nearly all the time*). Instructions for respondents: “Below is a list of common symptoms of stress. Please indicate how often in the last 24 hours, including now, you have felt or experienced each of the following symptoms”.

increased heart rate, accelerated breathing, muscle tension, dry mouth) and psychological (e.g., feelings of anxiety, frustration, tension, and rumination) levels (Epel et al., 2018; Payne, 1999). In contrast, the currently available, most frequently utilised measures of stress (such as the PSS and DASS stress) are typically shown to be represented by only one factor, which does not reflect the complex nature of stress as a construct experienced in the body as well as in the mind. This also limits the predictive utility of those measures. More specifically, such instruments do not allow researchers to ascertain whether psychological and physiological stress responses predict different outcomes. Our criterion-related validity analyses

showed that both the PSS and DASS are more strongly related to the DSRS psychological factor than the physiological factor. This was expected and indicates that stress as assessed by these commonly used instruments is more of a reflection of the psychological reaction rather than the physiological reaction to stressors. Thus, future studies using the DSRS could contribute to a better understanding of predictors and consequences of physiological stress.

Interestingly, we found that the DSRS psychological subscale scores formed a strong positive relationship with the DASS depression scores, whereas the DSRS physiological subscale scores were strongly associated with anxiety scores. This finding is consis-

**Table 4***Associations between the two DSRS factors (psychological and physiological) and external variables*

Variable	DSRS Psychological	DSRS Physiological	PSS	DASS Stress	DASS Anxiety	DASS Depression	Suicidality
DSRS Psychological	–	.66*	.68*	.73*	.62*	.71*	.39*
DSRS Physiological		–	.49*	.59*	.77*	.55*	.33*
PSS			–	.71*	.54*	.67*	.39*
DASS Stress				–	.70*	.76*	.40*
DASS Anxiety					–	.65*	.37*
DASS Depression						–	.55*
Suicidality							–

*The Daily Stress Response Scale (DSRS)*

Note. DSRS – Daily Stress Response Scale; PSS – Perceived Stress Scale; DASS – Depression, Anxiety and Stress Scale; \* $p < .001$ .

tent with the conceptual distinction between the two disorders. Namely, depression is a mood disorder defined by having the feelings of guilt, helplessness, and worthlessness, that is, symptoms strongly grounded in cognitive and emotional processes. Symptoms of anxiety, in turn, are associated more frequently with physiological reactivity, such as feeling on edge or restless, and irritability. Although anxiety and depression are theoretically distinct, empirical investigations demonstrating differences between the two have been rare, and anxiety and depressive disorders were shown to be bidirectional risk factors for one another (Dobson, 1985; Jacobson & Newman, 2017). Therefore, the current finding is important in that it points to possible developmental pathways to anxiety and depression. However, longitudinal research is needed to explore this possibility.

There are certain limitations to this study that need to be considered. First, the results are based on self-report data which are subject to social desirability bias. However, we tried to control for this by including a lie scale and establishing stringent criteria for excluding responses from analyses. Another limitation of the study is that the majority of participants were female. Even though women make up approximately 60% of the student population in Poland, in our study the discrepancy between female and male participants was larger (80% vs. 20%). However, our sample composition reflects the gender composition of Polish medical students, 75% of whom are female (statistical data from Studencka Marka, n.d.). Still, future studies evaluating the DSRS should aim for a more gender-balanced sample. We also recommend that future studies be conducted with more diverse populations facing different types of stressors, including hospital patients awaiting minor and major surgery. It is advisable that such studies also collect data on surgery-related adverse outcomes, such as post-operative delirium, depression, and anxiety, to

determine a cut-off score on the DSRS that differentiates between patients with and without those adverse outcomes. An improved understanding of a patient's stress response can aid clinicians in reducing the risk of adverse outcomes. For example, patients with a particularly pronounced stress response prior to surgery could be targeted for psychological or educational interventions reducing stress and anxiety levels. In addition, the DSRS may be particularly useful for studying stress and its outcomes among war-affected populations and refugees, including those recently affected by the Russian invasion of Ukraine. Finally, since the DSRS was developed to enable the measurement of stress reactions repeatedly over a period of time, future studies with the DSRS should utilise the EMA methodology. If necessary and justified by the context, such studies could reduce the DSRS reporting period from the last 24 hours to the last 12 hours or less.

Overall, the DSRS is a 30-item, easy-to-use stress response measure with excellent psychometric properties. Based on CFA results, the scale consists of two subscales, psychological and physiological stress response, which form associations with related external criteria. The psychological stress response factor was more closely related to existing measures of stress than the physiological stress response factor. Future studies should evaluate the psychometric properties of the DSRS in greater depth and validate the measure using populations drawn from various settings, including those known to be particularly stress-inducing.

#### REFERENCES

- Arnett, J. (2004). *Emerging adulthood: The winding road from the late teens through the twenties*. Oxford University Press.

- Bentler, P. M. (1990). Comparative fit indexes in structural models. *Psychological Bulletin*, *107*, 238–246. <https://doi.org/10.1037/0033-2909.107.2.238>
- Browne, M. W., & Cudeck, R. (1993). Alternative ways of assessing model fit. In K. Bollen & J. Long (Eds.), *Testing structural equation models* (pp. 136–162). Sage.
- Caplan, R. D. (1983). Person-environment fit: Past, present, and future. In C. L. Cooper (Ed.), *Stress research* (pp. 35–78). Wiley.
- Cerejeira, J., Batista, P., Nogueira, V., Vaz-Serra, A., & Mukaetova-Ladinska, E. B. (2013). The stress response to surgery and postoperative delirium: evidence of hypothalamic–pituitary–adrenal axis hyperresponsiveness and decreased suppression of the GH/IGF-1 axis. *Journal of Geriatric Psychiatry and Neurology*, *26*, 185–194. <https://doi.org/10.1177/0891988713495449>
- Cheng, S. T., & Chan, A. C. (2007). Multiple pathways from stress to suicidality and the protective effect of social support in Hong Kong adolescents. *Suicide and Life-Threatening Behavior*, *37*, 187–196. <https://doi.org/10.1521/suli.2007.37.2.187>
- Cohen, S., Janicki-Deverts, D., & Miller, G. E. (2007). Psychological stress and disease. *JAMA*, *298*, 1685–1687. <https://doi.org/10.1001/jama.298.14.1685>
- Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, *24*, 385–396. <https://doi.org/10.2307/2136404>
- Desborough, J. P. (2000). The stress response to trauma and surgery. *British Journal of Anaesthesia*, *85*, 109–117. <https://doi.org/10.1093/bja/85.1.109>
- Dobson, K. S. (1985). The relationship between anxiety and depression. *Clinical Psychology Review*, *5*, 307–324. [https://doi.org/10.1016/0272-7358\(85\)90010-8](https://doi.org/10.1016/0272-7358(85)90010-8)
- Dusselier, L., Dunn, B., Wang, Y., Shelley II, M. C., & Whalen, D. F. (2005). Personal, health, academic, and environmental predictors of stress for residence hall students. *Journal of American College Health*, *54*, 15–24. <https://doi.org/10.3200/JACH.54.1.15-24>
- Eysenck, S. B., Eysenck, H. J., & Barrett, P. (1985). A revised version of the psychoticism scale. *Personality and Individual Differences*, *6*, 21–29. [https://doi.org/10.1016/0191-8869\(85\)90026-1](https://doi.org/10.1016/0191-8869(85)90026-1)
- Epel, E. S., Crosswell, A. D., Mayer, S. E., Prather, A. A., Slavich, G. M., Puterman, E., & Mendes, W. B. (2018). More than a feeling: a unified view of stress measurement for population science. *Frontiers in Neuroendocrinology*, *49*, 146–169. <https://doi.org/10.1016/j.yfrne.2018.03.001>
- Gray-Toft, P., & Anderson, J. G. (1981). The Nursing Stress Scale: Development of an instrument. *Journal of Behavioral Assessment*, *3*, 11–23. <https://doi.org/10.1007/BF01321348>
- Gagnon, S. A., & Wagner, A. D. (2016). Acute stress and episodic memory retrieval: Neurobiological mechanisms and behavioral consequences. *Annals of the New York Academy of Sciences*, *1369*, 55–75. <https://doi.org/10.1111/nyas.12996>
- Hammen, C. (2005). Stress and depression. *Annual Review of Clinical Psychology*, *1*, 293–319. <https://doi.org/10.1146/annurev.clinpsy.1.102803.143938>
- Hobfoll, S. E. (1989). Conservation of resources: a new attempt at conceptualizing stress. *American Psychologist*, *44*, 513–524. <https://doi.org/10.1037/0003-066X.44.3.513>
- Holman, E. A., Silver, R. C., Poulin, M., Andersen, J., Gil-Rivas, V., & McIntosh, D. N. (2008). Terrorism, acute stress, and cardiovascular health: a 3-year national study following the September 11th attacks. *Archives of General Psychiatry*, *65*, 73–80. <https://doi.org/10.1001/archgenpsychiatry.2007.6>
- Jacobson, N. C., & Newman, M. G. (2017). Anxiety and depression as bidirectional risk factors for one another: a meta-analysis of longitudinal studies. *Psychological Bulletin*, *143*, 1155–1200. <https://doi.org/10.1037/bul0000111>
- Joiner Jr, T. E., Pfaff, J. J., & Acres, J. G. (2002). A brief screening tool for suicidal symptoms in adolescents and young adults in general health settings: Reliability and validity data from the Australian National General Practice Youth Suicide Prevention Project. *Behaviour Research and Therapy*, *40*, 471–481. [https://doi.org/10.1016/S0005-7967\(01\)00017-1](https://doi.org/10.1016/S0005-7967(01)00017-1)
- Juczyński, Z., & Ogińska-Bulik, N. (2009). Skala Odczuwanego Stresu – PSS-10 [The Perceived Stress Scale – PSS-10]. In Z. Juczyński (Ed.), *Narzędzia pomiaru stresu i radzenia sobie ze stresem* [Measurement tools in promotion and health psychology (pp. 11–22)]. Pracownia Testów Psychologicznych Polskiego Towarzystwa Psychologicznego.
- Lazarus, R., & Folkman, S. (1984). *Stress, appraisal, and coping*. Springer.
- Lovibond, P. F., & Lovibond, S. H. (1995). The structure of negative emotional states: Comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories. *Behaviour Research and Therapy*, *33*, 335–343. [https://doi.org/10.1016/0005-7967\(94\)00075-U](https://doi.org/10.1016/0005-7967(94)00075-U)
- Makara-Studzińska, M., Tyburski, E. M., Załuski, M., Adamczyk, K., Mesterhazy, J., & Mesterhazy, A. (2022). Confirmatory factor analysis of three versions of the Depression Anxiety Stress Scale (DASS-42, DASS-21, and DASS-12) in Polish adults. *Frontiers in Psychiatry*, *12*, 770532. <https://doi.org/10.3389/fpsy.2021.770532>
- Meadows, S. O., Brown, J. S., & Elder, G. H. (2006). Depressive symptoms, stress, and support: Gendered trajectories from adolescence to young adulthood. *Journal of Youth and Adolescence*, *35*, 89–99. <https://doi.org/10.1007/s10964-005-9021-6>
- McDonald, R. P. (1999). *Test theory: a unified approach*. Erlbaum.
- Metalsky, G. I., & Joiner, T. E. (1997). The hopelessness depression symptom questionnaire. *Cogni-*



- ive Therapy and Research, 21, 359–384. <https://doi.org/10.1023/A:1021882717784>
- Muthén, L. K., & Muthén, B. O. (2010). *Mplus user's guide* (6th ed.). Muthén & Muthén.
- Payne, R. (1999). Stress at work: a conceptual framework. In J. Firth-Cozens & R. Payne (Eds.), *Stress in health professionals: Psychological and organisational causes and interventions* (pp. 3–16). John Wiley & Sons Ltd.
- Pezdek, K. (2003). Event memory and autobiographical memory for the events of September 11, 2001. *Applied Cognitive Psychology, 17*, 1033–1045. <https://doi.org/10.1002/acp.984>
- Shalev, A. Y., Sahar, T., Freedman, S., Peri, T., Glick, N., Brandes, D., Orr, S. P., & Pitman, R. K. (1998). A prospective study of heart rate response following trauma and the subsequent development of posttraumatic stress disorder. *Archives of General Psychiatry, 55*, 553–559. <https://doi.org/10.1001/archpsyc.55.6.553>
- Shiffman, S., Stone, A. A., & Hufford, M. R. (2008). Ecological momentary assessment. *Annual Review of Clinical Psychology, 4*, 1–32. <https://doi.org/10.1146/annurev.clinpsy.3.022806.091415>
- Steiger, J. H. (1990). Structural model evaluation and modification: an interval estimation approach. *Multivariate Behavioral Research, 25*, 173–180. [https://doi.org/10.1207/s15327906mbr2502\\_4](https://doi.org/10.1207/s15327906mbr2502_4)
- Studencka Marka (n.d.). *Studenci ze względu na płeć – ogółem i typy uczelni* [Students by gender – general and types of university]. Retrieved from <https://www.studenckamarka.pl/serwis.php?s=73&pok=2058>
- Tucker, L. R., & Lewis, C. (1973). A reliability coefficient for maximum likelihood factor analysis. *Psychometrika, 38*, 1–10. <https://doi.org/10.1007/BF02291170>
- Van de Schoot, R., Lugtig, P., & Hox, J. (2012). A checklist for testing measurement invariance. *European Journal of Developmental Psychology, 9*, 486–492. <https://doi.org/10.1080/17405629.2012.686740>
- Wang, C., Pan, R., Wan, X., Tan, Y., Xu, L., Ho, C. S., & Ho, R. C. (2020). Immediate psychological responses and associated factors during the initial stage of the 2019 coronavirus disease (COVID-19) epidemic among the general population in China. *International Journal of Environmental Research and Public Health, 17*, 1729. <https://doi.org/10.3390/ijerph17051729>
- Zirkel, S. (1992). Developing independence in a life transition: Investing the self in the concerns of the day. *Journal of Personality and Social Psychology, 62*, 506–521. <https://doi.org/10.1037/0022-3514.62.3.506>
- Zirkel, S., & Cantor, N. (1990). Personal construal of life tasks: Those who struggle for independence. *Journal of Personality and Social Psychology, 58*, 172–185. <https://doi.org/10.1037/0022-3514.58.1.172>

## DAILY STRESS RESPONSE SCALE (DSRS)

*The DSRS is a self-report scale designed to assess psychological and physiological reactions to daily stress in a context-free manner.*

Below is a list of common symptoms of stress. Please indicate how often in the last 24 hours, including now, you have felt or experienced each of the following symptoms.

Never (0)	Rarely (1)	Occasionally (2)	A lot of the time (3)	Nearly all the time (4)
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Agata Debowska,  
Beata Horeczy,  
Daniel Boduszek,  
Dariusz Dolinski,  
Claudia C. von  
Bastian

1. I have felt upset.
2. I have felt anxious.
3. I have felt tearful.
4. I have felt uneasy.
5. I have been feeling overwhelmed.
6. I have felt afraid.
7. I have been unable to concentrate.
8. My thoughts have been mostly negative.
9. My thoughts have been racing.
10. I have been worried.
11. I have been thinking over and over about things that have upset me.
12. I have been easily distracted.
13. I have been thinking over and over about things that have made me nervous.
14. I have found it difficult to shake off negative feelings.
15. I have found it difficult to shake off negative thoughts.
16. I have experienced breathing difficulties (e.g., fast or heavy breathing, shortness of breath) even in the absence of physical exertion.
17. My heart has been beating fast even in the absence of physical exertion.
18. I have felt tension in the muscles of my body (e.g., tension in the neck or shoulders).
19. I have had abdominal pains (e.g., stomach cramps or a dull ache in the tummy).
20. My mouth has felt dry.
21. I have vomited or felt like vomiting.
22. I have felt chest pains.
23. I have been experiencing pulsing in my ears.
24. My heart has been racing.
25. In general, I have been sweating more than usual.
26. I have had difficulty swallowing foods, without any apparent physical reason.
27. I have had a pounding feeling in my head or chest.
28. I have felt lightheaded or dizzy.
29. I have felt tired.
30. I have been shaking or shivering.

Items 1-15 – psychological response to stress.

Items 16-30 – physiological response to stress.

## DAILY STRESS RESPONSE SCALE (DSRS) – POLISH VERSION

DSRS to skala samoopisowa, zaprojektowana do oceny psychologicznych i fizjologicznych reakcji na codzienny stres w sposób bezkontekstowy.

Poniżej znajduje się lista typowych objawów stresu. Wskaż, jak często w ciągu ostatnich 24 godzin, w tym teraz, odczuwałeś/aś lub doświadczałeś/aś każdego z następujących objawów.	Nigdy (0)	Rzadko (1)	Czasami (2)	Często (3)	Prawie cały czas (4)
1. Byłem/am zasmucony/a.					
2. Byłem/am zaniepokojony/a.					
3. Chciało mi się płakać.					
4. Czułem/am się niespokojny/a.					
5. Czułem/am się przytłoczony/a.					
6. Odczuwałem/am obawę.					
7. Nie byłem/am w stanie się skoncentrować.					
8. Moje myśli były w większości negatywne.					
9. Miałem/am gonitwę myśli.					
10. Martwiłem/am się.					
11. Wciąż myślałem/am o rzeczach, które mnie zasmuciły.					
12. Łatwo było mnie zdekoncentrować.					
13. Wciąż myślałem/am o rzeczach, które sprawiły, że byłem/am zdenerwowany/a.					
14. Trudno mi było pozbyć się negatywnych uczuć.					
15. Trudno mi było pozbyć się negatywnych myśli.					
16. Miałem/am trudności z oddychaniem (np. ciężki lub szybki oddech, brak tchu), nawet kiedy nie wykonywałem/am żadnego wysiłku fizycznego.					
17. Moje serce szybko biło, nawet kiedy nie wykonywałem/am żadnego wysiłku fizycznego.					
18. Czułem/am napięcie w mięśniach (np. napięcie szyi lub ramion).					
19. Miałem/am bóle brzucha (np. skurcze lub tępy ból).					
20. Czułem/am suchość w ustach.					
21. Wymiotowałem/am lub chciało mi się wymiotować.					
22. Odczuwałem/am bóle w klatce piersiowej.					
23. Czułem/am pulsowanie w uszach.					
24. Moje serce waliło jak szalone.					
25. Pociłem/am się bardziej niż zwykle.					
26. Miałem/am trudności z połknięciem jedzenia bez wyraźnego fizycznego powodu.					
27. Odczuwałem/am pulsowanie w głowie lub klatce piersiowej.					
28. Kręciło mi się w głowie.					
29. Czułem/am się zmęczony/a.					
30. Trząsałem/trząsałam się lub drżałem/am.					

*The Daily Stress Response Scale (DSRS)*

Elementy 1-15 – psychologiczna reakcja na stres.

Elementy 16-30 – fizjologiczna reakcja na stres.