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Research Paper

On the associations between videoconference fatigue, burnout and depression including personality associations

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ABSTRACT

Videoconference fatigue (hereafter VC fatigue) presents a new psychological construct, which gained momentum in course of the COVID-19 pandemic with the rise of videoconferences taking place in everyday (work-)life. In order to better characterize VC fatigue, it is of importance not only to investigate associations with age, gender and personality (as has been done earlier and will be revisited). Besides, it is crucial to shed light on relevant psychopathological constructs co-occurring with VC fatigue. In the present survey study, based on data from $N = 311$ participants recruited via the Internet we investigated the associations between VC fatigue, burnout and depression, and we specifically took the personality trait neuroticism as potential predisposing variable into account. These four constructs were robustly positively associated with each other. Moreover, mediation analyses revealed that the positive associations between neuroticism and burnout/depression might in parts be mediated by VC fatigue. However, future studies are needed to disentangle cause and effect between the aforementioned variables. The present study, to our knowledge, is among the first to reveal associations between VC fatigue and psychopathologies. Moreover, in this paper we present a German version of the Zoom Exhaustion & Fatigue scale (ZEF) by Fauville and colleagues.

1. Introduction

Since the outbreak of the COVID-19 pandemic and the need for physical distancing, humans have increasingly relied on electronic communication tools, predominantly videoconferencing as this mode closely resembles face-to-face communication. Unsurprisingly, the number of videoconference users dramatically increased in the beginning of the pandemic. In April 2020, shortly after the outbreak of COVID-19, around 300 million individuals met daily via the Zoom platform. This number is especially impressive considering that before the pandemic only 10 million users met daily via Zoom (Vailshery, 2022). Zoom represents a prominent, but not the only videoconference platform available (others are WebEx, Teams, etc.).

Undoubtedly, videoconferencing tools are helpful, because they enable humans to communicate across far distances in a (more or less) direct way at low cost. As a consequence of the availability of videoconferencing, people and companies have been able to maintain

communication during COVID-19 induced lockdowns, thereby helping economies (e.g., via home office) and societies (e.g., via home schooling) to continue functioning. However, more and more researchers have begun to investigate potential negative side effects, including VC fatigue, recently.

According to Fauville et al. (2021b) VC fatigue is a construct being built upon facets such as general fatigue, social fatigue, emotional fatigue, visual fatigue and motivational fatigue. Visual fatigue touches upon tired eyes after videoconferences, social fatigue describes not wanting to see someone after the videoconferences, motivation fatigue includes not having energy to do more work after the videoconferences and emotional fatigue comprises being emotionally exhausted after participation in videoconferences. Females tend to be more prone to suffer from VC fatigue than males, and younger people tend to be more fatigued than older people (Fauville et al., 2021a). From the perspective of personality psychology, neuroticism presents the domain being most strongly linked to VC fatigue out of the Big Five domains (in this work an

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inverse association between VC fatigue and emotional stability: Fauville et al., 2021a). Potential causes for VC fatigue have been put forward by several researchers (for a recent overview, see Döring et al., 2022). Bailenson (2021), for example, identified mirror anxiety as an important cause, hence monitoring one's own appearance in the online-conference could result in VC fatigue (see also facial appearance dissatisfaction; Ratan et al., 2022). Also factors such as hypergaze (being constantly stared at), reduced mobility due to trying to stay in front of the computer screen and cognitive overload by trying to understand non-verbal signals from the interaction partners can contribute to VC fatigue. The latter, non-verbal signals, are harder to detect in videoconferences than in face-to-face settings. For an empirical test of these theoretical explanations see a recent work by Fauville et al. (2021a).

Although the VC fatigue literature is growing (Bennett et al., 2021; Oducado et al., 2021; Riedl, 2022), to our knowledge, links of VC fatigue to other psychiatric symptoms have not yet been studied (or we are among the first to do this). As videoconferences are often used in the business setting, the present study links VC fatigue to burnout tendencies. Burnout describes a state of emotional exhaustion, depersonalization and productivity loss at work (Maslach et al., 1997). If persons attend many videoconferences a day, with few and short breaks in between them, this might lead not only to VC fatigue, but also to burnout tendencies. Given the overlap between burnout and depression (Plieger et al., 2015), the present study also administered a short measure to screen for depression tendencies to better understand how strong the constructs of VC fatigue, burnout and depression would overlap. Importantly, the present research includes a German version of the Zoom Exhaustion & Fatigue scale (ZEF) (for the English original see: Fauville et al., 2021b). Thus, we also aimed at validating this German version by re-investigating its links to age, gender and personality. Regarding personality, Fauville et al. (2021a) showed that higher neuroticism is linked to higher VC fatigue. It is well known that neuroticism in general is linked to negative affect and depressive tendencies (Saklofske et al., 1995), as well as to stress, exhaustion and fatigue during human interaction with digital technologies (e.g. Ayyagari et al., 2011; Krishnan, 2017; Riedl, 2013). Therefore, we expect the link between neuroticism and burnout/depression to be mediated by VC fatigue. Although we do not have longitudinal data, one causal mechanism could be the following: Neuroticism – a stable personality trait – makes a person more prone to experience negative affect and develop a psychopathology. Such negative affect might be triggered in individuals with higher scores in neuroticism, in particular by long and inappropriate use of videoconferencing tools (e.g., Fauville et al., 2021a), resulting in VC fatigue and this variable then being a mediator leading to burnout and depression.

2. Methods

2.1. Sample and procedure

The current work is part of a larger project that was preregistered (<https://osf.io/c4rw2>) as a study investigating the interplay between Internet use disorders, aspects of videoconferencing, personality traits, depression and burnout. As Internet use disorders, social phobia and autistic traits are investigated in another project (being separately preregistered), we will not go into detail regarding these variables. Eligible participants were at least 18 years old, German-language speakers, and provided informed electronic consent prior to taking part in the study. The survey website was promoted by students, via social media, and other media appearances by the researchers in the time between May 2021 and March 2022. The research project was approved by the local ethics committee at Ulm University, Ulm, Germany.

The present work focuses on a part of this larger project, namely the associations between neuroticism, videoconferencing-fatigue, depression and burnout. The survey participants were recruited within German-speaking videoconferencing tool users (everyone could

participate in the study, but those not using videoconferences were filtered out). In total, there were 315 responses to the survey. However, after eligibility checks (age 18+, valid consent, using videoconferencing tools) and careless response pattern analysis (individuals with 15 or more of the same responses in a row to the (Mini-) International Personality Item Pool (IPIP) inventory were defined as careless responders), the effective sample consisted of $N = 311$ participants (197 female, 112 male, 2 diverse; age $M = 29.40$, $SD = 11.22$). Among the effective sample, the distribution of participants by the highest obtained education level by the time of the survey was: 171 participants (55%) reported having a higher educational degree (university - including university of applied science - degree), 139 participants (45%) had completed secondary education, and one person reported not having graduated from a school. Altogether, 89 participants (29%) reported being university students at the time of the survey. Most of the participants, 171 (55%), reported being from Germany, 86 participants (28%) were from Austria, 7 participants (2%) were from another country and 47 participants (15%) had missing data in this question. Zoom was the most popular videoconferencing (VC) tool used (272 participants; 87%), followed by Microsoft Teams (198; 64%), Skype (151, 49%), Cisco WebEx (138; 44%), Big Blue Button (91; 29%), FaceTime (89; 29%), Jitsi (44; 14%), GoTo (38; 12%), and 72 participants (23%) reported (also) using a VC tool not listed here. Of note, the participants could choose several tools, i.e., VC tools were not mutually exclusive. Please note that %-numbers in this section are rounded.

2.2. Questionnaires

The Big Five of Personality were assessed by applying the German version of the Mini-IPIP with the original English version presented in Donnellan et al. (2006). The personality dimensions are called Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Intellect/Imagination. Each dimension is assessed with four items. Items are answered on a five-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree. The present German version was retrieved from the website of the International Personality Item Pool: <https://ipip.org/German100-ItemBig-FiveFactorMarkers.htm>. In the present work, we only worked with the neuroticism items; since each subscale also contains reverse-coded items, we first reversed the values to be consistent with the general scale score direction (e.g., higher scores depict higher levels of neuroticism). The neuroticism subscale showed acceptable internal reliability ($\alpha = .74$, McDonald's $\omega_{total} = .75$).

For the present research all participants filled in the German version of Zoom Exhaustion & Fatigue Scale (ZEF; original in English by Fauville et al., 2021b), which was forward and back translated by two bilingual (German/English) speaking psychologists. The German items are presented in the supplementary material and on the Open Science Framework project website. The ZEF scale assesses VC fatigue on a 15-item scale with the following answer format (13 items: 1 = not at all, 2 = slightly, 3 = moderately, 4 = very, 5 = extremely; 2 items with 1 = never to 5 = always). Higher scores indicate higher VC fatigue. The scale includes multiple dimensions of VC fatigue (i.e., general fatigue, visual fatigue, social fatigue, motivational fatigue, emotional fatigue), which form a higher-order factor of VC fatigue (Fauville et al., 2021b). Typically, therefore, the item scores are summed to form one total index of VC-fatigue. The internal consistency of the scale in the present sample was good, Cronbach's $\alpha = .93$, McDonald's $\omega_{hierarchical} = .80$, and $\omega_{total} = .95$.

Because data collection was implemented during the COVID-pandemic, we also applied the German version of the Fear of COVID-19 scale (FCV-19S) with seven items (Sanwald et al., 2022) as a control variable; the original version can be found here (Ahorsu et al., 2020). The scale items are answered on a five-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree. Higher scores indicate higher Fear of COVID-19. The internal consistency for the FCV-19S was acceptable ($\alpha = .78$, $\omega_{total} = .79$).

To gain insights into depressive tendencies, the German version of the PHQ-9 scale (original by Kroenke et al., 2001) was administered. Due to ethical restrictions, the suicide item was not used (hence the scale is called PHQ-8). Therefore, the administered scale consisted of eight items, which are answered on a four-point Likert scale with 0 = not at all, 1 = several days, 2 = more than half the days, and 3 = nearly every day. Higher scores indicate higher depressive tendencies. Cronbach's $\alpha = .86$ and $\omega_{\text{total}} = .90$, indicating good internal consistency.

Individual differences in burnout tendencies were assessed with a German version of the Maslach Burnout Inventory-General Survey (MBI-GS) as administered in a work on burnout/depression and Internet use disorder (Peterka-Bonetta et al., 2019). For the present research we relied on the MBI-GS consisting of 16 items being answered on a seven-point Likert scale ranging from 1 = very mild, barely noticeable to 7 = major, very strong. The scale consists of three subscales: emotional exhaustion ($\alpha = .87$, $\omega_{\text{total}} = .87$), cynicism ($\alpha = .81$, $\omega_{\text{total}} = .82$), and professional efficacy ($\alpha = .81$, $\omega_{\text{total}} = .81$; reverse-coded). To compute the burnout score, we first ran a confirmatory factor analysis (CFA) on the scale, modeling general burnout as a higher-order factor from the sub-factors. All item-level data were treated as ordinal; we used the mean and variance adjusted weighted least squares (WLSMV) estimation. Because the CFA showed a satisfactory model fit (Hooper et al., 2007; Kline, 2016; MacCallum et al., 1996), WLSMV $\chi^2(101, N = 311) = 596.731, p < .001$, CFI = .926, TLI = .913, RMSEA = .126 (90% CI: .116 to .136), with factor loadings in the range of .463 to .899, we computed the summed burnout score. Of note, the internal reliability statistics for the unidimensional burnout scale were also acceptable, $\alpha = .89$, $\omega_{\text{hierarchical}} = .65$, and $\omega_{\text{total}} = .92$. For further test statistics also on the other questionnaires see the supplementary material.

2.3. Analysis

The data analysis was conducted in R v4.1.3 (R Core Team, 2021). The package psych v2.2.3 (Revelle, 2021) was used for computing internal consistency statistics (Cronbach's α and McDonald's ω_{total} and $\omega_{\text{hierarchical}}$), Pearson correlation coefficients (p-values adjusted with Holm's method), Cohen's d (group difference effect sizes), and the mediation model results. Additionally, we used non-parametric Mann-Whitney U-Tests (for comparing two groups, e.g., student status) and Kruskal-Wallis test (for comparing differences between the three gender groups) to assess for group differences in the VC fatigue scale, as also specified in the pre-registration.

The mediation models included neuroticism as the predictor, the

mediator was the VC-fatigue score, and relevant covariates (Fear of COVID-19, gender, student status, and age) were also included. In Model 1, the outcome variable was the PHQ-8 score (depression), whereas in Model 2 the outcome variable was the MBI-GS score (burnout). The standard errors of indirect effects were bootstrapped over 5000 samples. The general model form is depicted in Fig. 1.

3. Results

3.1. Descriptive statistics and correlations

The descriptive statistics and correlation analysis results are presented in Table 1.

Table 1 shows that all variables (except age) were positively correlated with each other. VC fatigue had a small-to-medium correlation with fear of COVID-19, a medium-sized association with neuroticism, and a strong correlation with depression and burnout. Depression had a strong association with neuroticism and burnout, the association of depression with fear of COVID-19 yielded a medium-sized relationship strength. Burnout had a small-to-medium sized correlation with fear of COVID-19, and a medium-sized association with neuroticism. Finally, age was negatively (with small effects) correlated with almost all variables (except for fear of COVID-19 for which the correlation was not significant).

Additional tests to assess gender differences in VC fatigue were computed. The results of Kruskal-Wallis test showed that there were gender differences in the VC fatigue scale, $\chi^2(2) = 16.516, p < .001$. Subsequent pairwise comparisons (Mann-Whitney U-Tests) revealed the only significant difference between females and males: Female study participants ($M = 38.27, SD = 10.95$) reported higher VC fatigue than male respondents ($M = 33.58, SD = 12.12$), $W = 8146, p < .001, |d| = .41, |r| = .19$. Participants who were enrolled as university students at the time of the survey ($M = 39.80, SD = 11.38$) had higher scores in VC fatigue than participants not enrolled as students ($M = 35.39, SD = 11.49$), $W = 11906, p = .005, |d| = .39, |r| = .17$.

3.2. Mediation analyses

In order to test the indirect effects of VC fatigue in the relationships between neuroticism and depression (Model 1) and burnout (Model 2), we ran two mediation models. Fear of COVID-19, gender (1 = male, 0 = female/diverse), student status, and age were included as a covariates in both models. The results of these analyses are presented in Table 2.

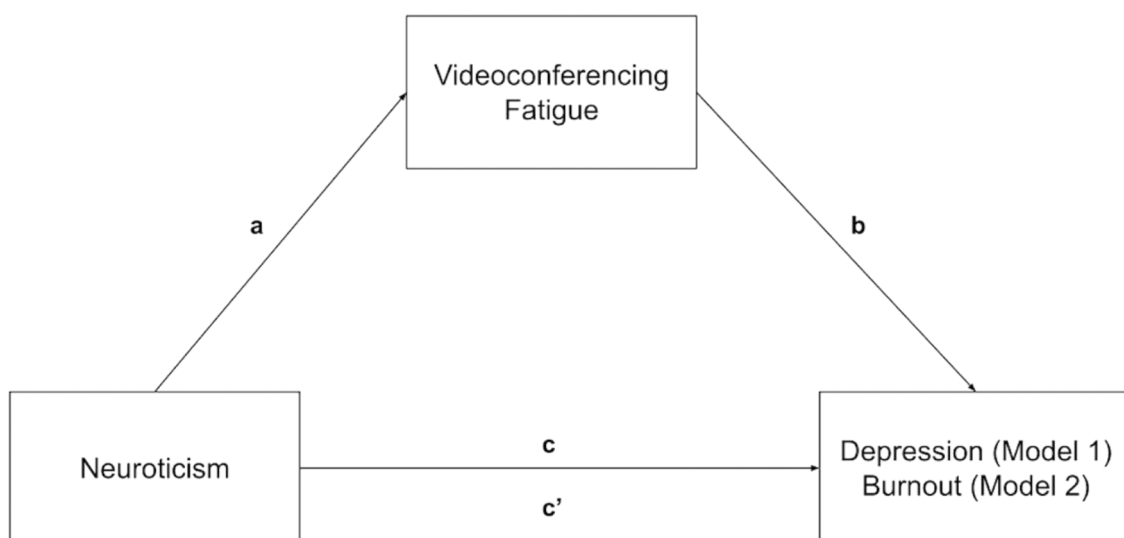


Fig. 1. The mediation model. a, b, and c' are direct effects, whereas c is the total effect (direct effect + indirect effect) from Neuroticism to depression (Model 1) or burnout (Model 2). Fear of COVID-19, gender, student status, and age are included as covariates.

Table 1
Descriptive statistics and correlation analysis results (N = 311).

	Descriptive Statistics				Correlations				
	M	SD	Min	Max	1	2	3	4	5
1. Neuroticism (IPIP-20)	10.84	3.37	4	20	-				
2. ZEF (Videoconference Fatigue)	36.65	11.61	15	75	.395***	-			
3. FCV-19S (Fear of COVID-19)	12.15	4.11	7	28	.350***	.262***	-		
4. PHQ-8, (Depression)	7.71	4.89	0	24	.512***	.588***	.363***	-	
5. MBI-GS (Burnout)	53.57	16.07	17	97	.431***	.511***	.261***	.626***	-
6. Age	29.40	11.22	18	74	-.149**	-.155**	-.072	-.238***	-.210***

Notes. IPIP-20: International Personality Item Pool-20 Inventory, ZEF: Zoom Exhaustion & Fatigue Scale, FCV-19S: Fear of COVID-19 scale (short), PHQ-8: Patient Health Questionnaire 8, MBI-GS: Maslach Burnout Inventory – General Survey. Pearson correlation coefficients are presented (p-values adjusted with Holm’s method). Sum scores are presented for the questionnaires. * $p < .05$, ** $p < .01$, *** $p < .001$. M = Mean, SD = Standard Deviation, Min: Observed Minimum, Max: Observed Maximum.

Table 2
Results of mediation analyses.

	Mediation model statistics			
	Outcome: Depression			
	β	SE	t (df)	95% CI for ab
Direct effect (a)	.311	.057	5.417*** (305)	-
Direct effect (b)	.425	.046	9.230*** (304)	-
Direct effect (c')	.292	.050	5.821*** (304)	-
Total effect (c)	.425	.052	8.143*** (305)	-
Indirect effect (ab)	.130	.025	-	[.083; .180]
Model statistics	R	R-squared	F	df
	.60	.36	84.90***	2; 304
	Outcome: Burnout			
	β	SE	t (df)	95% CI for ab
Direct effect (a)	.311	.057	5.417*** (305)	-
Direct effect (b)	.393	.050	7.816*** (304)	-
Direct effect (c')	.288	.055	5.253*** (304)	-
Total effect (c)	.410	.055	7.441*** (305)	-
Indirect effect (ab)	.116	.025	-	[.070; .167]
Model statistics	R	R-squared	F	df
	.54	.30	63.68***	2; 304

Notes. Standardized coefficients are displayed. Standard errors of indirect effects are bootstrapped over 5,000 samples. Averaged bootstrapped indirect effects (ab) are displayed. *** $p < .001$.

Table 2 shows that the results in both models were quite similar. Specifically, in both models the direct as well as indirect effects were positive and statistically significant. This means that both models include partial mediation effects. It was also observed that in Model 1 (depression as outcome), the indirect effect was somewhat higher (.130) than the indirect effect (.116) in Model 2 (burnout as outcome). The direct effect of VC fatigue was also higher in Model 1 than in Model 2. Finally, the models explained 36% (Model 1) and 30% (Model 2) of the outcome variables’ variance – indicating that a large part of variance is not explained by the potential effects of neuroticism and VC fatigue.

As we deal with cross-sectional data and no causality can be inferred, we also present the data for an alternative model, where we have neuroticism as a predictor variable, VC fatigue as the outcome variable and either depression/burnout as mediator in the supplementary material.

4. Discussion

The present study contributes to research on VC fatigue in several ways. First of all, we provide a German version of the ZEF scale to be used by others in future research (see supplementary material, OSF link: <https://osf.io/c4rw2>). This version of the ZEF was validated in the present work by the investigation of its associations with

sociodemographic variables and neuroticism. Similar to findings in the existing literature (Fauville et al., 2021a), females exhibited higher VC fatigue scores than males, younger participants were more prone to experience VC fatigue than older people and higher neuroticism was linked to higher VC fatigue. This consistency of correlations across studies underlines the validity of the translation, as do the high internal consistencies found in the present work.

Next, the main research aim of the present work was to establish if higher VC fatigue tendencies are positively linked to depressive and burnout tendencies. We confirmed the positive relationships. Even though causal conclusions are not possible based on cross-sectional survey data, it is plausible that neuroticism, as a personality variable which is rather stable over time (for a recent more detailed view see the work by Wright and Jackson (2022)), marks the beginning of the causal chain. People scoring higher on neuroticism have a higher probability of experiencing negative affect and of developing a psychopathology (Lahey, 2009). Importantly, the situation-specific development of negative affect might also be influenced by the perception of VC fatigue, which, in turn, might affect psychopathological tendencies such as depression and burnout. This theorizing is consistent with our conceptual model in Fig. 1 which indicates that depression and burnout are partly affected by the mediation path of neuroticism via VC fatigue and not only directly by the personality trait neuroticism. In fact, our mediation models showed that the associations between neuroticism and depression/burnout (two models) were partly mediated by VC fatigue. However, an alternative way to causally interpret the data is that VC fatigue could result in higher negative affect (= neuroticism) scores, which, in turn, lead to burnout and depression. Moreover, it is not clear if, for instance, feeling of burnout leads to higher VC fatigue, or if burnout is a result of too many videoconference attendances which come along with fatigue. Regarding the latter, we present alternative models in the supplementary material with VC fatigue being the outcome variable, neuroticism still being the predictor and depression or burnout the mediator. These models led to partial or fully mediated mediation models. Because only experimental and in parts longitudinal studies are suitable to provide answers to the causal chain, we make a call for corresponding future studies (see also interesting relevant literature on analysis of mediation effects: Cai et al., 2022; Cole and Maxwell, 2003; O’Laughlin et al., 2018). Beyond this limitation, we stress that the present work is confined to German speaking participants. Hence, the associations observed here need to be replicated also in other cultures before more definitive conclusions can be made. We also mention that some relevant job-related stress variables impacting also on burnout/depression or videoconference variables might exist, which have not been controlled for. Finally, the fact that our data are self-reports comes along with usual challenges such as answering in a socially desirable manner or a lack of introspection. Hence, future

research should also consider use of neurophysiological measurement in the study of VC fatigue. As an example, electroencephalography (EEG) research analyzing people's P300 amplitude after participating in many videoconferencing sessions or one very long session could reveal smaller amplitudes if compared to baseline conditions, which is typically interpreted as a neurophysiological sign of fatigue or depletion of cognitive resources (e.g., Trimmel and Huber, 1998). It will be rewarding to see what insights future research will reveal.

Author Statement

C.M. and C.S. planned and designed the present study. C.M. and R.R. carried out the data collection. C.M. drafted the first version of the manuscript, whereas D.R. ran statistical analysis, which were independently checked by C.S. All authors worked over the paper and approved upon the final version.

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Declaration of Competing Interest

All authors report no conflict of interest. However, for reasons of transparency Dr. Montag mentions that he has received (to Ulm University and earlier University of Bonn) grants from agencies such as the German Research Foundation (DFG). Dr. Montag has performed grant reviews for several agencies; has edited journal sections and articles; has given academic lectures in clinical or scientific venues or companies; and has generated books or book chapters for publishers of mental health texts. For some of these activities he received royalties, but never from gaming or social media companies. Dr. Montag mentions that he was part of a discussion circle (Digitalität und Verantwortung: <https://about.fb.com/de/news/h/gespraechskreis-digitalitaet-und-verantwortung/>) debating ethical questions linked to social media, digitalization and society/democracy at Meta. In this context, he received no salary for his activities. Finally, he mentions that he currently functions as independent scientist on the scientific advisory board of the Nymphenburg group (Munich, Germany). This activity is financially compensated. Moreover, he is on the scientific advisory board of Applied Cognition (Redwood City, CA, USA), an activity which is also compensated.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:[10.1016/j.jadr.2022.100409](https://doi.org/10.1016/j.jadr.2022.100409).

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