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Climate Change Worry in German University Students: Determinants and Associations with Health-Related Outcomes

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Abstract: Climate change is known to have an impact on human health, including mental health. To better understand this phenomenon, the Climate Change Worry Scale (CCWS), a 10-item questionnaire, was developed to assess climate change worry as a psychological response to climate change. The aim of this study was to validate a German version of the CCWS among university students and to explore potential associations with health outcomes. The CCWS was translated into German and used in an online survey of 1105 university students. We tested the scale's psychometric properties and assessed its associations with sociodemographic characteristics and health outcomes. These included the Somatic Symptom Scale-8, Jenkins Sleep Scale, WHO-5 Well-being Index, and Patient Health Questionnaire 8. All CCWS items loaded on one factor and the items showed high internal consistency. Positive associations were observed between climate change worry and self-reported somatic symptoms, sleep difficulties, mental well-being, and depressive symptoms in multivariate regression models. The German version of the CCWS is a valid tool to measure climate change worry and can be used in future studies. The association between the CCWS and mental health underscores the need to recognize that students perceive climate change as a serious threat.

Keywords: climate change; worry; anxiety; students; university; mental health; Germany

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1. Introduction

There is a strong scientific consensus that climate change is ongoing and poses a serious threat to humankind [1]. Besides the consequences of climate change for the environment (e.g., extreme weather events) [2,3], it has also been shown to have an impact on human health. This does not only apply to the direct health effects of climate change, such as heat deaths [4,5], but also affects mental health, both acute and chronic [6]. Recent studies have shown that people around the world are afraid of climate change and its consequences [7–21]. A scoping review on German studies revealed, for instance, that the majority reported concerns about the consequences of climate change, although these rarely led to clinically significant psychological stress [22]. However, in the international literature, so-called climate anxiety is described as a "clinically significant 'anxious' response" to climate change [7].

To better understand the psychological responses to this ongoing threat, several measures have been established, such as the Climate Anxiety Scale (CAS, [7]) and the Climate Change Worry Scale (CCWS, [8]). The CAS assesses emotional responses to climate

change on two subscales, focusing on functional and cognitive impairment, defining climate anxiety as "anxiety associated with perceptions about climate change, even among people who have not personally experienced any direct impacts" [7]. The CAS was shown to be positively associated with general anxiety and depressive symptoms [11].

The CCWS focuses on proximal worries rather than global impacts. However, research on worry in general has shown that worry is an essential part of generalized anxiety and is associated with poorer mental health [23]. The CCWS items include thoughts about the changes that may occur and the possible effects of these changes [8]. The CCWS was found to be internally consistent and based on a unidimensional measure. Correlations between the CCWS and weather-related measures, as well as stress and anxiety were established [8]. The CCWS was developed in English and has been translated and validated in Italian and Slovenian [9,10]. It showed associations with climate concerns, climate anxiety, pro-environmental behavior, political orientation, anxiety, and stress [9,10]. Climate change worry was more prevalent in females than in males and was associated with self-ratings of being politically liberal [8,9,16]. In addition, perceived worry was associated with higher levels of stress, anxiety, and depressive symptoms [8,10].

Objective

Building on previous findings, this study's objective was to translate the CCWS into German and validate the German version among university students by assessing internal consistency and its factor structure. Furthermore, we aimed to explore whether the CCWS is associated with sociodemographic characteristics as well as different health outcomes, such as somatic symptoms, sleep difficulties, mental well-being, and depressive symptoms. With our findings, we aimed to contribute to and expand the current state of research on climate change worry.

2. Methods

Data were collected from 1105 university students in Germany in March 2024 [24]. The students were recruited through an online panel of an ISO-certified international survey company (https://bilendi.de). The institute is member of the Working Group of German Market and Social Research Institutes (ADM). Data are hosted in the EU on own security servers and data collection and the processing of panelists' personal data are in accordance with the GDPR. The panelists are natural persons (no bots) and can only take part in the survey once. So-called speeders and straightliners were excluded. The survey was optimized for mobile devices. To control for potential differences in response behavior, we had set a quota: in our data collection, 50% of participants used a desktop PC or laptop and 50% used a mobile device. No significant differences in response behavior could be identified.

The market research institute reimbursed participants for their time. Quota sampling was used to represent the existing distribution of university students in Germany based on sex and university type. All participants provided informed consent, and the local ethic commission approved the study (Ethic committee II of the University of Heidelberg, 2019-1123N, 31 January 2019 and 19 October 2020). Plausibility analyses, including checks for consistency, completeness, outliers, distribution, and missing values, were carried out on the dataset. In addition, Cronbach's alpha was calculated for the included item sets.

2.1. Measures

2.1.1. Climate Change Worry Scale

The Climate Change Worry Scale, developed by Stewart (2021) is a tool for assessing proximal worry about climate change [8]. It comprises 10 items on a 5-point scale ranging

from 1 (“never”) to 5 (“always”). The English version of the CCWS was translated into German via a comprehensive forward-backward translation. Original items can be requested from the author. The total score was calculated by summing the scores of all ten items, ranging from 10 to 50, with higher scores indicating increased climate change worries [8].

2.1.2. Somatic Symptom Scale-8 (SSS-8)

The SSS-8 measures self-reported somatic symptom burden on a 5-point Likert scale ranging from 0 (“not at all”) to 4 (“very much”). Its eight items reflect gastrointestinal, pain, fatigue, and cardiopulmonary aspects within the past seven days. It results in a scale that ranges from 0 to 32, with higher scores indicating an increased somatic symptom burden [25]. Cronbach’s alpha was 0.88 in our dataset.

2.1.3. Jenkins Sleep Scale

The Jenkins Sleep Scale is a four-item questionnaire that evaluates the frequency and intensity of sleep difficulties. It covers difficulty falling asleep, awakening throughout the night, trouble remaining asleep, and subjective feelings of sleepiness or fatigue despite receiving an average night’s sleep. All four items were summed to determine the final score, with higher values indicating increased sleep difficulties [26]. Cronbach’s alpha was 0.82.

2.1.4. WHO-5 Well-Being Index (WHO-5)

The World Health Organisation-5 Well-Being Index (WHO-5) is a short self-reported measure of current mental well-being, which consists of five statements rating on a 6-point scale (from 0 “at no time“ to 5 “all of the time”). It results in a scale ranging from 0 to 25, with higher scores indicating enhanced mental well-being [27]. Cronbach’s alpha was 0.90.

2.1.5. Patient Health Questionnaire 8 (PHQ-8)

The PHQ-8 is a measure of depressive disorders that rates eight DSM-IV criteria on a four-point scale between “1” (not at all) and “4” (nearly every day) [28]. The mean score ranged from 1 to 4, with higher scores indicating increased depressive symptoms. Cronbach’s alpha was 0.88.

2.1.6. Sociodemographic and Study-Specific Characteristics

The participants provided information on their sex (female; male), age (in years), type of university (university; university of applied sciences), area of study (humanities; law, economics, and social sciences; mathematics or natural sciences; medicine/health sciences; agricultural, forestry, and nutritional sciences or veterinary medicine; engineering; art, art science; sports; other), and semester (1–2; 3–6; >6). We also asked for migration background (coded as yes; no) [29], side job (yes; no), received funding from Federal Law on support in Education (yes; no) and living situation (alone; with a partner; in a shared apartment; student dormitory; with parents/relatives). In addition, participants were asked to rate their subjective social status based on the MacArthur Scale ranging from one to ten, with one being the poorest and least educated and ten being the wealthiest most educated compared to fellow students [30,31].

2.2. Statistical Analyses

First, we conducted descriptive statistics by calculating the mean values and standard deviations for metric variables and distributions of nominal and categorical variables for the total sample and by sex. *p*-values were based on Chi^2-test and *t*-test, respectively.

Second, we conducted descriptive statistics for the CCWS. In addition, we calculated Cronbach’s alpha to measure the internal consistency of the scale, and an exploratory factor analysis examined whether all items loaded on one factor (the chosen cut-off for

factor loadings was 0.6) indicating that the CCWS is a homogeneous construct. Previous validation studies showed a high Cronbach's alpha (0.95 [8]) and high factor loadings on one factor (0.729–0.896 [8] and 0.75–0.91 [10]).

Third, we analyzed the potential associations between the CCWS and students' individual characteristics using *t*-tests, ANOVA, and Pearson's correlation.

Fourth, we investigated the potential associations between the CCWS and somatic symptoms, sleep, well-being, and depressive symptoms. Beside crude linear models, two adjusted linear regression models were used, one adjusted for sex, age, subjective social status, and migration background, and a second adjusted for type of university, study subject, and semester.

All analyses were performed using IBM SPSS Statistics Version 29 (IBM, Armonk, NY, USA). A predefined *p*-value of 0.05 was considered significant.

3. Results

Because of our quota sampling, approximately half of our sample was female (50.1%) and half male (49.9%). About two-thirds (67.2%) studied at universities, while one-third (32.8%) studied at universities of applied sciences (Table 1). Our sample had an average age of 25.51 (SD: 5.43) years with most students being in their third through sixth semester (40.1%) or upwards (41.8%). The most common areas of study included law, economics, and social sciences (20.7%); engineering (15.9%); and humanities (14.8%). About one-quarter (27.2%) received funding from the Federal Law on Support in Education, 63.9% had a side job, and 18.8% had a migration background. Mean subjective social status based on the MacArthur Scale was 5.90 (SD: 1.94). Most students lived alone (26.1%), with partners (24.9%) or with parents/relatives (25.2%).

The CCWS showed a high internal consistency (Cronbach's alpha = 0.933). Exploratory factor analysis revealed that all items loaded on one factor with at least 0.667 (Kaiser–Meyer–Olkin = 0.948; Bartlett test <0.001). The mean CCWS score was 28.38. Details of the individual CCWS items are shown in Table 2. The highest mean of agreement was found for the item "I worry that outbreaks of severe weather may be the result of a changing climate." (3.34 [1.21]), while the lowest mean was identified for the items "Once I begin to worry about climate change, I find it difficult to stop." (2.46 [1.22]) and "I worry about climate change so much that I feel paralyzed in being able to do anything about it." (2.48 [1.26]).

Participants who received funding from the Federal Law on Support in Education showed higher CCWS scores than those who did not receive funding ($p < 0.001$, Table 3). In addition, higher subjective social status was positively correlated with increased climate change worry (r = 0.092, $p = 0.003$), and students with side jobs had higher CCWS scores than those without side jobs (28.88 vs. 27.69, $p = 0.048$). Regarding students' living situations, climate change worry was higher among students living with a partner, alone, or in a shared apartment than among those living in a student dormitory or with their parents/relatives. Other sociodemographic and study-specific characteristics were not significantly associated with the CCWS score.

Table 1. Sociodemographic characteristics of participants.

Variable	Total		Female		Male		*p*-Value
	n	%/M (SD)	n	%/M (SD)	n	%/M (SD)	
Sex	1105						
Female	554	50.1					
Male	551	49.9					
Age	1089	25.51 (5.43)	549	24.52 (5.36)	540	26.51 (5.33)	<0.001
Type of University	1105		554		551		0.009
University	743	67.2	393	70.9	350	63.5	
University of applied sciences	362	32.8	161	29.1	201	36.5	
Area of study	1105		554		551		<0.001
Humanities	164	14.8	106	19.1	58	10.5	
Law, economics, and social sciences	328	29.7	180	32.5	148	26.9	
Mathematics or natural sciences	162	14.7	70	12.6	92	16.7	
Medicine/health sciences	90	8.1	57	10.3	33	6.0	
Agricultural, forestry, and nutritional sciences or veterinary medicine	25	2.3	11	2.0	14	2.5	
Engineering	176	15.9	38	6.9	138	25.0	
Art or art science	29	2.6	19	3.4	10	1.8	
Sports	24	2.2	7	1.3	17	3.1	
Other	107	9.7	66	11.9	41	7.4	
Semester	1086		548		538		<0.001
1–2	197	18.1	102	18.6	95	17.7	
3–6	435	40.1	186	33.9	249	46.3	
>6	454	41.8	260	47.4	194	36.1	
Migration background	1098		553		545		0.787
Yes	206	18.8	102	18.4	104	19.1	
No	892	81.2	451	81.6	441	80.9	
Side job	1079		543		536		<0.001
Yes	690	63.9	318	58.6	372	69.4	
No	389	36.1	225	41.4	164	30.6	

Table 1. *Cont.*

Variable	Total		Female		Male		*p*-Value
	n	%/M (SD)	n	%/M (SD)	n	%/M (SD)	
Received funding of Federal Law on Support in Education	1085		550		535		<0.001
Yes	295	27.2	122	22.2	173	32.3	
No	790	72.8	428	77.8	362	67.7	
Subjective social status	1105	5.90 (1.94)	554	5.63 (1.90)	551	6.17 (1.94)	<0.001
Living situation	1094		551		543		<0.001
Alone	285	26.1	120	21.8	165	30.4	
With a partner	272	24.9	128	23.2	144	26.5	
In a shared apartment	206	18.8	111	20.1	95	17.5	
Student dormitory	49	4.5	25	4.5	24	4.4	
With parents/relatives	276	25.2	164	29.8	112	20.6	

M = mean, SD = standard deviation, proportion may not round up to 100% due to rounding errors, *p*-value is based on Chi^2-test and *t*-test, respectively.

Table 2. Descriptive statistics of Climate Change Worry Scale items and factor loadings.

Item	Proportion of Agreement (%)					Min, Max	Mean (SD)	Factor Loadings
	Always (5)	Often (4)	Sometimes (3)	Rarely (2)	Never (1)			
1. I worry about climate change more than other people.	9.0	23.1	31.1	22.3	14.5	1, 5	2.90 (1.18)	0.834
2. Thoughts about climate change cause me to have worries about what the future may hold.	10.3	28.6	32.1	18.9	10.1	1, 5	3.10 (1.13)	0.829
3. I tend to seek out information about climate change in the media (e.g., TV, newspapers, internet).	5.4	15.7	28.1	30.8	20.0	1, 5	2.56 (1.13)	0.754
4. I tend to worry when I hear about climate change, even when the effects of climate change may be some time away.	9.3	22.5	33.7	20.1	14.4	1, 5	2.92 (1.17)	0.838

Table 2. *Cont.*

Item	Proportion of Agreement (%)					Min, Max	Mean (SD)	Factor Loadings
	Always (5)	Often (4)	Sometimes (3)	Rarely (2)	Never (1)			
5. I worry that outbreaks of severe weather may be the result of a changing climate.	18.7	30.7	26.3	14.9	9.4	1, 5	3.34 (1.21)	0.667
6. I worry about climate change so much that I feel paralyzed in being able to do anything about it.	6.9	16.3	25.0	21.9	29.9	1, 5	2.48 (1.26)	0.757
7. I worry that I might not be able to cope with climate change.	8.7	20.5	29.0	21.4	20.4	1, 5	2.76 (1.24)	0.810
8. I notice that I have been worrying about climate change.	9.8	23.7	32.2	20.4	13.8	1, 5	2.95 (1.18)	0.856
9. Once I begin to worry about climate change, I find it difficult to stop.	5.8	16.2	24.2	25.4	28.2	1, 5	2.46 (1.22)	0.771
10. I worry about how climate change may affect the people I care about.	8.8	19.8	32.2	23.0	16.2	1, 5	2.82 (1.18)	0.794
CCWS Score						10, 50	28.38 (9.43)	

CCWS = Climate Change Worry Scale, SD = standard deviation, factor loadings based on exploratory factor analysis, CCWS Score = sum of the ten CCWS items.

Table 3. Associations of the Climate Change Worry Scale with sociodemographic characteristics.

Variable	CCWS		*p*-Value
	n	M (SD)/r	
Gender	1037		0.306
Female	516	28.08 (8.90)	
Male	521	28.68 (9.93)	
Age	1029	0.023	0.461
Type of University	1037		0.605
University	696	28.58 (9.50)	
University of applied Sciences	341	27.98 (9.28)	
Area of study	1037		0.273
Humanities	153	29.07 (9.84)	
Law, economics, and social sciences	308	27.15 (9.68)	
Mathematics or natural sciences	157	29.29 (10.20)	
Medicine/health sciences	84	29.46 (8.80)	
Agricultural, forestry, and nutritional sciences or veterinary medicine	22	27.59 (9.38)	
Engineering	165	28.58 (8.85)	
Art or art science	25	29.96 (9.34)	
Sports	24	29.29 (7.27)	
Other	99	28.03 (8.51)	
Semester	1023		0.139
1–2	184	28.60 (9.91)	
3–6	418	28.97 (9.32)	
>6	421	27.70 (9.25)	
Migration background	1034		0.146
Yes	192	27.48 (9.72)	
No	842	28.60 (9.35)	
Side job	1024		0.048
Yes	656	28.88 (9.65)	
No	368	27.69 (8.96)	
Received funding of Federal Law on Support in Education	1022		<0.001
Yes	279	30.28 (9.28)	
No	743	27.59 (9.39)	
Subjective social status	1037	0.090	0.004
Living situation	1031		<0.001
Alone	269	28.62 (9.87)	
With a partner	255	30.11 (9.26)	
In a shared apartment	190	28.60 (8.50)	
Student dormitory	47	25.98 (9.11)	
With parents/relatives	266	26.91 (9.66)	

CCWS = Climate Change Worry Scale, M = mean, SD = standard deviation, r = Pearson's correlation coefficient, *p*-value is based on *t*-test, ANOVA, and Pearson's correlation, respectively.

The CCWS was positively associated with self-reported somatic symptoms, sleep difficulties, mental well-being, and depressive symptoms (Tables 4 and 5, Model I). The associations remained significant after adjusting for sex, age, subjective social status, and immigration background (Model II, Table 5) and type of university, study subject, and semester (Model III, Table 5).

Table 4. Correlation between Climate Change Worry, somatic symptoms, sleep, well-being, and depressive symptoms.

		Climate Change Worry Scale	Somatic Symptom Scale-8	Jenkins Sleep Scale	WHO-5 Well-Being Index	Patient Health Questionnaire 8
Climate Change Worry Scale	Pearson Correlation	1	0.304	0.184	0.112	0.272
	p-Value		<0.001	<0.001	<0.001	<0.001
	n	1037	1035	1035	1035	1031
Somatic Symptom Scale-8	Pearson Correlation	0.304	1	0.642	−0.229	0.685
	p-Value	<0.001		<0.001	<0.001	<0.001
	n	1035	1098	1093	1095	1090
Jenkins Sleep Scale	Pearson Correlation	0.184	0.642	1	−0.312	0.595
	p-Value	<0.001	<0.001		<0.001	<0.001
	n	1035	1093	1095	1093	1088
WHO-5 Well-being Index	Pearson Correlation	0.112	−0.229	−0.312	1	−0.372
	p-Value	<0.001	<0.001	<0.001		<0.001
	n	1035	1095	1093	1098	1089
Patient Health Questionnaire 8	Pearson Correlation	0.272	0.685	0.595	−0.372	1
	p-Value	<0.001	<0.001	<0.001	<0.001	
	n	1031	1090	1088	1089	1091

Table 5. Linear regression models of the Climate Change Worry Scale and health outcomes.

	Model I		Model II		Model III	
	β_{stand}	*p*-Value	β_{stand}	*p*-Value	β_{stand}	*p*-Value
1. Somatic Symptom Scale-8	0.304	<0.001	0.320	<0.001	0.302	<0.001
2. Jenkins Sleep Scale	0.184	<0.001	0.200	<0.001	0.183	<0.001
3. WHO-5 Well-being Index	0.112	<0.001	0.071	0.012	0.092	0.003
4. Patient Health Questionnaire 8	0.272	<0.001	0.295	<0.001	0.271	<0.001

Model I: crude model, only CCWS included. Model II: adjusted for sex, age, subjective social status, and immigration background. Model III: adjusted for type of university, study subject, and semester.

4. Discussion

In this study, we were able to translate the CCWS into German and evaluate its validity and reliability in a nationwide sample of students. Our findings supported the one-dimensional structure also observed in previous studies [8–10], and internal consistency was high, making it appropriate for use in future studies. Furthermore, our study revealed positive associations of climate change worries with self-reported somatic symptoms, sleep difficulties, mental well-being, and depressive symptoms.

Regarding sociodemographic characteristics, we did not find significant differences by sex. Previous studies have found mixed results, with some studies using the CCWS or CAS suggesting that women are more likely to experience worries and anxiety about climate

change [8,12,20,32–34]. However, studies using translated versions of the CCWS in Italian and Slovenian also found no significant differences by sex [9,10]. While the Italian study revealed significant differences between males and females for both climate anxiety scale subscales, they did not find significant differences for the CCWS [9].

Our analysis revealed that students who received funding from the Federal Law on Support in Education and those with side jobs experienced higher levels of climate change worry. This finding suggests a possible financial link because eligibility for funding is dependent on the student's and their family's income remaining below a specified threshold. As such, students receiving this funding are likely to have a lower-income background, which may also increase their likelihood of seeking additional employment. A possible explanation for this finding is that individuals with lower incomes often experience increased levels of general anxiety, which may extend to increased concern about global challenges such as climate change [35,36]. Furthermore, the literature suggests that climate change will have an impact on our economy and the cost of living is expected to increase in the following years, which will be more difficult to compensate for those with lower economic backgrounds [37].

Interestingly, subjective social status measured via the MacArthur scale [30,31] revealed different results: those with a higher subjective social status showed higher levels of climate change worry than those with a lower self-rated social status. Sub-analyses showed no significant association between the subjective social status on the one hand and having side job and funding from the Federal Law on Support in Education on the other hand. This indicates that social status is a complex construct and includes more than just monetary wealth, but further research could help to better understand these findings.

We also found that the living situation was a determinant of climate change concerns. Participants residing with a partner exhibited the highest levels of worry, whereas those living in student dormitories or with their parents reported less worry about climate change. This may be the result of those living with their partner being more future-oriented and likely to be closer to starting a family. Previous studies have shown that climate change can impact individuals' perceptions of their future, with a global survey on climate anxiety showing that 39% of respondents reported being hesitant about having children [38].

Regarding the possible impact on health outcomes, our results show that the CCWS was positively associated with self-reported somatic symptom burden, sleep difficulties, mental well-being, and depressive symptoms. To the best of our knowledge, an association between climate change worry and sleep difficulty has not been previously established. However, a scientifically well-established link between general mental health and the quality of sleep exists [39–41]. Similarly, although we are unaware of any data linking climate change worry to an increased somatic symptom burden, mental health, in general, has been linked to somatic symptoms in numerous studies [42–45]. Given that climate change worry can contribute to overall mental health, it is plausible that it may also be associated with both sleep difficulties and increased somatic symptom burden, as our findings suggest.

When it comes to the relationship between climate change worry and anxiety, on the one hand, and mental well-being and depressive symptoms, on the other hand, our research is in line with previous findings. Although no direct link has been established with the CCWS specifically, the broader literature on climate anxiety and concerns suggests a clear connection to both depressive symptoms and mental well-being [11,12,18,20,21,38,46–49]. Our identified association with the CCWS contributes to the research stage and underscores the validity of the CCWS [8].

Limitations

Our data are based on self-reported responses; thus, we cannot exclude a social desirability bias. Because we only included university students, our data are not representative of the German population. However, our data include a sample of German university students that is representative according to sex and university type based on quota sampling. Our findings serve as a starting point for future research that involves more diverse populations. Because of the cross-sectional study design, no causal associations could be established. Our aim was to use the German version of CCWS for the first time and to identify associations with sociodemographic characteristics and health outcomes. Therefore, no longitudinal data were necessary at this stage of the research.

5. Conclusions

Our German version of the CCWS showed high validity and reliability and is suitable for use in future studies. We could show that climate change worry is prevalent and our findings on the association between climate change worry and somatic symptoms, sleep difficulties, depressive symptoms, and well-being underscore that climate change does not only have direct health effects such as heat deaths.

By contributing to the growing body of literature on climate change worry, our study opens avenues for future research into this emerging field. Since climate change is ongoing and is associated with worries and anxiety, which in turn are associated with several health outcomes, as we could show, it should be quantified how many people suffer from climate change worries and anxiety. Research using the CCWS and the CAS should focus on heterogeneous samples including different age groups, cultures, and levels of education. This could help to identify the extent of mental health support needed by the population.

Unlike general anxiety, which can arise from irrational thoughts and fears [50], climate change worry is based on rational concerns about the future of the planet. Therefore, conventional anxiety therapies, that typically focus on irrational thought patterns, may not be effective [12,46,51]. It is necessary for therapists to recognize climate change worry as a legitimate concern that is not rare but is increasing. Regarding our findings on university students, psychological counseling services on campus should be sensitized to this topic to support students deal with their worries.

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