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The Grieving Heart: The Association Between Hemodynamic Responses to Grief Recall and Prolonged Grief Disorder Symptoms

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Objective: The death of a loved one is among the most stressful life events. Across cultures, grief is associated with increased morbidity and mortality. In addition to psychological distress, grieving includes physical components, such as elevated blood pressure (BP). This study investigated hemodynamic responses to a grief-related interview and the impact of grief severity on cardiovascular reactivity in bereaved individuals 6 to 24 months post-loss.

Methods: Sixty-seven participants (85% females, aged 60 ± 6 years) underwent BP measurements during baseline, after a 5 to 10-minute grief recall task (GR), and during a 10-minute recovery period. Repeated measures ANOVAs compared systolic (SBP) and diastolic BP (DBP) at baseline and 0, 5, and 10 minutes post-GR. ANOVAs were controlled for age, sex, time since loss, and antihypertensive medication. Pairwise comparisons between time points were calculated. Participants meeting prolonged grief disorder (PGD) criteria (n = 6) were descriptively compared with individuals reporting grief severity below the median (n = 32) of the Prolonged Grief-13 questionnaire and to those above the median without PGD (n = 29).

Results: SBP and DBP increased post-GR and remained elevated during the 10-minute recovery [SBP: F(3, 186) = 3.950, p = .009, η^2p = 0.060; DBP: F(3, 186) = 1.923, p = .13, η^2p = 0.030]. Pairwise comparisons revealed significant differences between SBP and DBP at baseline compared with post-GR measurements. Descriptively, the PGD subgroup showed higher baseline values, similarly pronounced reactivity compared with the rest of the sample (contrary to previous findings), and a delayed decline in SBP and DBP, particularly compared with participants with low grief severity.

Conclusions: Findings support the hypothesis that higher PGD symptoms may be linked to a dysregulated hemodynamic stress response. Furthermore, results suggest that the GR is a feasible, transcultural task for eliciting grief-related hemodynamic responses in bereaved individuals up to 2 years post-loss.

Key Words: bereavement, grief, prolonged grief disorder, blood pressure, cardiovascular reactivity

Abbreviations: **ANOVA** = analysis of variance, **BMI** = body mass index, **BP** = blood pressure, **CESD**, = Center for Epidemiological Studies Depression, **DBP** = diastolic pressure, **GR** = grief recall, **ICD** = International Classification of Diseases, **M** = mean, **PG-13** = Prolonged Grief-13 questionnaire, **PGD** = prolonged grief disorder, **SBP** = systolic blood pressure

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INTRODUCTION

Grief is a biopsychosocial phenomenon that is associated with psychophysiological alterations and increased all-cause mortality across cultures.[1] The physical effects of bereavement have been studied for decades and include acute and chronic dysregulation of cardiovascular biomarkers, including blood pressure (BP).[2,3] In addition, grief elicits emotions and thoughts such as sadness, anger, yearning, and rumination.[4] Physiological changes following bereavement may be particularly evident during intense moments of separation distress, manifesting as momentary grief-related emotional experiences, known as "pangs of grief." There is evidence that, for example, greater grief severity is associated with increased rumination, worry, and negative affect, as well as decreased positive affect.[5] To what extent specific grief-related memories are also positively correlated with levels of grief remain a subject of further research.

Both physical and mental dysregulation following a

loss can become chronic, typically considered when lasting for more than 6 months, according to the International Classification of Diseases (ICD-11), termed prolonged grief disorder (PGD).[6] The physical component could manifest as chronic, worsened cardiovascular function, leading to an elevated risk of morbidity and mortality.[4] For example, hemodynamic responses, like large BP changes and delayed recovery after acute stress, have been predictive of cardiovascular disease, such as hypertension.[7,8] Despite this, little is known about the physical response, reactivity, and recovery during pangs of grief in PGD.

The grief recall (GR) task is based on the "separation recall" task, an attachment-related short-term stressor,[9] and has been adapted to elicit grief-relevant emotions. Specifically, it addresses personally relevant and attachment-related memories in the context of grief-related separation distress. To date, the GR task has been used successfully in 2 studies showing a cardiovascular response, for example, an increase in BP.[10,11] In 2023, Palitsky et al[10] were the first to show that higher symptoms of prolonged grief disorder are associated with elevated systolic blood pressure (SBP) reactivity in recent bereavement (<12 mo).

Through ongoing exchange between study teams, the present study was designed to conceptually replicate the study by Palitsky et al[10] and examined changes in systolic and diastolic blood pressure (SBP and DBP) following a grief recall task 6 to 24 months after the death of a loved one in a German sample. We also investigated whether this reactivity and recovery response was associated with grief severity and symptoms of PGD. In consultation with the study team and based on the findings of Palitsky et al,[10] 2 confirmatory hypotheses (H1 and H2) as well as one exploratory hypothesis (H3) were formulated. We hypothesized (H1, confirmatory) that SBP and DBP would be elevated after GR, showing the protocol is a feasible and transculturally applicable task to elicit a grief-related psychophysiological response. We further hypothesized that (H2, confirmatory) higher grief severity would be associated with a more pronounced increase in SBP and DBP, reflecting the relationship between grief severity and the contribution of GR or "pangs of grief" to cardiovascular risk. In an exploratory and descriptive approach, we examined differences in SBP and DBP reactivity (H3a) and recovery (H3b) to GR between participants who met PGD criteria and those who did not. We hypothesized that PGD would be associated with a greater BP reactivity (H3a, higher elevation of SBP and DBP immediately following the GR task) and a delayed recovery within the first 10 minutes afterward (H3b).

METHODS

Participants

The present study was a single-center, cross-sectional, observational study, with a sample size of $N = 67$ participants. Participants were recruited from the general population through a local newspaper article, a local hospice, and grief support groups. Participants between 50 and 70 years old and 6 to 24 months after the death of a close person were included in the study. To avoid potential influences on the comparability of heart rate variability data, exclusion criteria were serious preexisting medical conditions (eg, current cancer disease, severe psychiatric diseases), or the use of systemically active, anticholinergic (eg, tricyclic antidepressants) or immunosuppressive (eg, glucocorticoid) medication. Heart rate variability data are not presented in this paper and have not been published elsewhere. Medical conditions were also used as exclusion criteria to ensure a safe and reliable measurement of stress-related hemodynamic response. Antidepressant medication was not an exclusion criterion, if a stable dose of the antidepressant was taken for at least a month.

Procedures

The ethics committee of Ulm University approved all procedures before recruitment. Potential participants were initially screened through telephone. After obtaining informed consent, a peripheral venous blood sample was taken, and measurements of height and weight were conducted. Subsequently, a single-channel electrocardiogram was applied. All further study procedures took place in a consistently prepared setting in the same low-stimulus interview room at the Clinic for Psychosomatic Medicine and Psychotherapy in Ulm. Initially, the so-called "Cold Face Test"[12] was conducted, during which a cold compress was placed centrally on the participants' foreheads for 2 minutes to examine autonomic reactivity (data not presented). Next, participants completed questionnaires for ~30 minutes. Afterwards, a 10-minute vanilla baseline assessment was presented,[10,13] during which participants were asked to view 10 pairs of nature pictures on a computer monitor. Participants were asked to select the preferred image in each pair. During the nature presentation, participants were alone in a quiet environment and were instructed beforehand to focus only on the images. In the present study, this task aimed to counteract cognitive or emotional preoccupation with the loss. Blood pressure was measured directly before and after the vanilla baseline assessment (time points: baseline 1 and 2) and 5 minutes afterward (time point: baseline 3).

The following semistructured GR interview, which lasted at least 5 but no more than 10 minutes, aimed to emotionally elicit a wave of grief in the present by having participants remember a recent situation when they experienced grief. To make sure that the measured reactivity could be attributed to the experienced grieving situation, the generally worded original interview protocol[9] was minimally modified and also aligned with the procedure in Palitsky et al.[10] Participants were asked to recall a situation since their loss in which they felt alone and abandoned and wished that the deceased person had been there for them (original protocol: "someone had been there for them"). To ensure sufficient intensity of the interview—and thereby elicit a psychophysiological response—participants were asked to select a situation with a stress level of at least 7 (on a scale from 0—not stressful at all to

10—extremely stressful). After recalling the situation, and to maintain emotional engagement, prepared standardized questions were asked if needed, for example, "Do you remember what was on your mind during this painful situation?" For instructions, see Supplemental Digital Content 1 (http://links.lww.com/PSYMED/B129). Blood pressure was taken directly after the GR (time point: post-GR), 5 and 10 minutes afterward (time points: post-GR +5 and post-GR +10). For the supervision of interviewers (V.G. and J.K.) by an experienced psychotherapist (H.G.), temporary audio recordings were used.

Measures

Participants reported age, sex, and loss-specific information, such as relationship to the deceased (parent, spouse, sibling, child) and date of death. Depression severity was assessed using the Center for Epidemiological Studies Depression (CESD-R,[14]). Grief severity and the presence of PGD were assessed using the Prolonged Grief-13 (PG-13) questionnaire.[6,15] The first 2 of the total 13 items of the PG-13 refer to separation distress (eg, longing or intense feelings of grief) and are answered on a 5-point Likert Scale. Item 3 is a yes/no question and captures whether separation distress in item 1 or 2 has persisted for at least 6 months. Items 4 through 12 assess loss-related cognitive, emotional, and behavioral symptoms on a 5-point Likert Scale. Item 13 is again a yes/no question and captures whether there has been functional impairment due to grief. Based on these items, the PG-13 scale can be tabulated in 2 different ways. First, to determine whether PGD is present, as described by Prigerson et al,[6] the criteria include:

- Experiencing bereavement (death of a significant other) and at least 6 months have passed since the death.
- Separation distress: At least one of the questions 1 or 2 must be rated with the highest or second-highest frequency (ie, at least once a day or several times a day).
- Persistence of separation distress covered in 2 for at least 6 months, that is, yes for item 3.
- Experiencing cognitive, emotional, and behavioral symptoms in the context of the loss: that is, the highest or second-highest frequency is indicated at least 5 times in questions 4 to 12.
- Presence of functional impairment, that is, yes for item 13.

Second, to determine the continuous measure of grief severity, sum scores from 11 to 55 were calculated, excluding dichotomous items 3 and 13. A higher sum score reflects higher reported grief severity. Cronbach alpha for the German version[15] of the PG-13 questionnaire was 0.92 in the present study.

Antihypertensive medication was assessed in the initial screening through telephone by asking participants whether they take medication for a "heart disease" or hypertension. In addition, participants were asked if they took any other medication, ensuring no potential antihypertensive treatment was missed. Also, medication was checked at the beginning of the laboratory visit. For analyses, a dichotomous variable was calculated, coded as 0 for no antihypertensive medication and 1 for intake of any antihypertensive medication (eg, beta-blockers, angiotensin-converting-enzyme inhibitors, calcium antagonists, or diuretics).

The measurement of SBP and DBP was carried out using an automated blood pressure device (BoSo-Medicus Control, Bosch & Sohn GmbH & Co. KG) at the 6 above-mentioned time points. The blood pressure measurements were consistently taken in a seated position, at heart level, and on the left upper arm. In addition, study participants were asked to sit quietly, relax, and refrain from speaking during each measurement. If the standard cuff size (22 to 42 cm) did not fit, BP was manually taken using a stethoscope with an appropriate oversized or undersized cuff ($< 5\%$ of the sample). For each measurement, the cuff was newly reapplied. A baseline value for systolic and diastolic blood pressure was calculated as the mean value of the time points baseline 2 and baseline 3. To avoid distracting participants during the grief recall task, no BP measurements were taken during the interview. Consequently, change scores were calculated by subtracting the calculated baseline value from the measurement taken immediately after GR (time point: post-GR).

Analyses

Analyses were conducted using SPSS 28 (IBM). A power analysis ($f = 0.2$; $\alpha = 0.05$/power $= 0.95$) based on the primary endpoint for a larger parent study yielded a result of $N = 84$. However, data collection began in April 2019 and was closed in March 2020 in compliance with government requirements (ie, lockdown) due to the onset of the global COVID-19 pandemic, with a sample size of $N = 67$. Data collection did not reopen. Therefore, power sensitivity analyses in G*Power (Version 3.1.9.7) using the actual sample size of $N = 67$, $\alpha = 0.05$, and power $= 0.8$ were calculated for each model and are reported alongside the results.

To examine general BP response to GR (H1) repeated measures ANOVAs were calculated including the following predefined time points: baseline, post-GR, post-GR +5, and post-GR +10. ANOVAs were adjusted for age, sex, time since death, and antihypertensive medication. Pairwise comparisons were used to examine differences between time points within the model. In line with Palitsky et al[10] paired t tests with bootstrapping (5000 iterations) were performed, comparing baseline and post-GR BP values to provide a descriptive account of the differences without adjustment.

To examine a continuous relationship between grief severity and BP response (H2), linear regression analyses with percentile bootstrapping (5000 iterations) for raw change scores were conducted. To ensure comparability to Palitsky et al,[10] regressions were also performed using residualized change scores. These scores were obtained by regressing post-GR BP measurements onto baseline BP measurements and saving the unstandardized residuals to adjust for baseline BP. Regressions were also adjusted for age, sex, time since death, and antihypertensive medication. The unstandardized regression coefficient B,

derived from bootstrap models, is reported.

For exploratory analyses (H3a and H3b), a categorical variable was created by dividing the sample into 3 groups. After creating a category of participants who met PGD criteria with the first method of PG-13 tabulation, the remaining sample was divided by the median of the PG-13 sum score into 2 groups: one group with scores at or below the median and one group with scores above the median (median = 25). The resulting groups were defined as follows: low grief ($\leq$ median), medium grief ($>$ median), and PGD.

The data that support the findings of the study are available on request from the corresponding author (V.G.) to be reviewed on-site. The data are not publicly available due to privacy reasons.

RESULTS

A total of 153 participants were screened for this study, out of whom 67 met the inclusion criteria and consented to participate. There were no missing values or dropouts for the main outcome variable, blood pressure, throughout the study. Table 1 shows loss-specific information, psychometry, raw values, and changes in BP, as well as sociodemographic and health-related information of the sample.

To examine differences between BP measurements for the entire sample at baseline, immediately after GR and at 5 and 10 minutes of recovery, repeated-measures analyses were performed. Sensitivity analysis in G*power for repeated measures ANOVA based on the actual sample size of $N = 67$ revealed a statistical power of 0.80 assuming an effect size of $f = 0.14$ at $\alpha = 0.05$. For both SBP and DBP, no correction was applied, as sphericity was confirmed (Mauchly tests >0.05). Across the 4 time points, no significant difference was seen for the full sample for DBP [$F(3, 186) = 1.923$, $p = .13$, $\eta^2p = 0.030$, $f = 0.176$]. In contrast, a statistically significant difference for SBP was found across the 4 time points [$F(3, 186) = 3.950$, $p = .009$, $\eta^2p = 0.060$, $f = 0.253$]. However, pairwise comparisons revealed significant differences between systolic and diastolic BP at baseline compared with immediately after GR, 5 minutes post-GR, and baseline compared with 10 minutes post-GR ($p < .05$; see Supplemental Digital Content 2, http://links.lww.com/PSYMED/B130 for pairwise comparisons for SBP and DBP). Thus, the results partially support hypothesis H1, demonstrating that SBP (but not DBP) was elevated after the GR task.

For a descriptive account of the differences without adjustment for age, sex, time since death, and antihypertensive medication, paired t tests with bootstrapping (5000 iterations) were performed, comparing baseline and post-GR measures. A sensitivity analysis using G*Power (paired-samples t test, two-tailed, $\alpha = 0.05$, power = 0.80, $N = 67$) indicated that small to medium effects ($dz = 0.35$) or larger could be reliably detected. Table 2 shows a side-by-side comparison of these tests between the current study and the study by Palitsky et al 2023[10]. The current results show a higher baseline in both SBP and DBP compared with the study by Palitsky et al[10] and a similar magnitude of BP increase and decrease related to the GR. One coinvestigator was involved in both studies, and due to slightly different procedures of measuring BP, we suggest that our 0 min post-GR matches 2 min post-GR in the study by Palitsky et al.[10]

In contrast to Palitsky et al[10] regression analysis in the present study for SBP and DBP revealed no significant association between grief severity and raw changes scores between baseline and post-GR measurements (ΔSBP: $B = -0.014$, $SE = 0.132$, $p = .92$, 95% CI = -0.270 to 0.247 and model $R^2 = -0.039$, $f^2 \approx 0$; ΔDBP: $B = -0.036$, $SE = 0.093$, $p = .69$, 95% CI = -0.216 to 0.157 and model $R^2 = 0.005$, $f^2 = 0.005$). Regression analyses with residualized change scores also revealed no significant associations (ΔSBP_{resid}: $B = 0.140$, $SE = 0.119$, $p = .24$, 95% CI = -0.103 to 0.366 and model $R^2 = -0.040$, $f^2 \approx 0$; ΔDBP_{resid}: $B = 0.082$, $SE = 0.076$, $p = 0.29$, 95% CI = -0.077 to 0.221 and model $R^2 = 0.048$, $f^2 = 0.050$). Therefore, these results do not support hypothesis H2, that higher grief severity would be associated with a more pronounced increase in BP. Again, a sensitivity analysis was conducted using G*Power ($\alpha = 0.05$, power = 0.80, $N = 67$) indicating a minimum detectable effect size of $f^2 = 0.21$.

In an exploratory approach, the sample was divided into 3 groups, as described above, to descriptively compare patterns of reactivity and recovery depending on grief severity (hypotheses H3a and H3b). Figure 1 displays unadjusted means for SBP and DBP over time for each group. It suggests, on a descriptive and exploratory level, that the PGD group shows higher baseline values, a similarly pronounced reactivity, and a delayed recovery in both SBP and DBP following the GR task. Accordingly, these descriptive findings do not support hypothesis H3a (since there is no observable pattern of greater reactivity in the PGD group) but are in line with hypothesis H3b (indicating delayed recovery in the PGD group).

DISCUSSION

The present study investigated changes in SBP and DBP following a laboratory-based grief recall task between 6 and 24 months after the death of a loved one in a German sample and assessed whether these alterations were associated with grief severity and symptoms of prolonged grief disorder. Consistent with prior findings,[10] across the sample, we found an elevation of SBP and DBP after the GR task (H1). However, in contrast to this confirmatory result, our findings do not support a linear relationship between higher baseline grief severity and an elevated response in BP to the GR (H2), across the full spectrum of grief severity. Instead, we found in an exploratory and descriptive approach that only the group of participants who met PGD criteria ($n = 6$) tended to have higher baseline values, a similarly pronounced reactivity as the rest of the sample (in contrast to Palitsky et al[10]), and a delayed decline in both SBP and DBP following the

TABLE 1. Sample Characteristics

Variable Name	Total (n = 67)	Low Grief (n = 32)	Medium Grief (n = 29)	PGD (n = 6)
Age in years	60.33 (5.64)	60.63 (5.25)	60.49 (5.77)	57.97 (7.42)
Months since death	12.77 (5.68)	14.03 (6.07)	11.38 (5.09)	12.76 (5.52)
PG-13	28.40 (9.79)	20.28 (4.11)	33.83 (5.92)	45.5 (4.42)
CESD	37.84 (13.66)	31.31 (10.86)	43.03 (13.8)	47.5 (11.18)
SBP at baseline (mm Hg)	131.22 (17.85)	127.3 (14.84)	133.47 (20.28)	141.25 (16.98)
SBP after GR (mm Hg)	147.79 (21.75)	144.53 (23.6)	149.55 (20.91)	156.67 (12.75)
Raw change in SBP	16.57 (11.88)	17.23 (12.85)	16.09 (11.14)	15.42 (11.79)
DBP at baseline (mm Hg)	86.91 (11.23)	85.2 (11.2)	87.43 (11.38)	93.5 (9.44)
DBP after GR (mm Hg)	93.42 (13.13)	91.28 (12.94)	94.17 (13.8)	101.17 (8.13)
Raw change in DBP	6.51 (6.96)	6.08 (7.05)	6.74 (7.51)	7.67 (3.43)
BMI (kg/m^2)	26.87 (5.59)	26.51 (4.95)	27.6 (6.53)	25.26 (3.74)
	n (%)	n (%)	n (%)	n (%)
Sex, female	57 (85.1)	28 (87.5)	24 (82.8)	5 (83.3)
BP medication, not using	57 (85.1)	27 (84.4)	24 (82.8)	6 (100)
Relationship to deceased				
Spouse/partner	34 (50.7)	11 (34.4)	21 (72.4)	2 (33.3)
Child	10 (14.9)	0 (0)	6 (20.7)	4 (66.7)
Sibling	4 (6)	3 (9.4)	1 (3.4)	0 (0)
Parent	19 (28.4)	18 (56.3)	1 (3.4)	0 (0)
Education				
Post-secondary training	42 (62.7)	16 (50.0)	20 (69.0)	6 (100)
Bachelor's or Master's	18 (26.9)	13 (40.6)	5 (17.2)	0 (0)
Doctorate	3 (4.5)	1 (3.1)	2 (6.9)	0 (0)
Other	4 (6.0)	2 (6.3)	2 (6.9)	0 (0)
Smoking, no	59 (88.1)	29 (90.6)	27 (93.1)	3 (50)
Alcohol				
Never	3 (4.5)	1 (3.1)	2 (6.9)	0 (0)
Monthly basis	24 (35.8)	14 (43.8)	10 (34.5)	0 (0)
Weekly basis	40 (59.7)	17 (53.1)	17 (58.6)	6 (100)
Exercise				
Never	8 (11.9)	4 (12.5)	3 (10.3)	1 (16.7)
< 3x/wk	30 (44.8)	13 (40.6)	15 (51.7)	2 (33.3)
≥ 3x/wk	29 (43.3)	15 (46.9)	11 (37.9)	3 (50)

Data are reported as mean (SD).

PGD = prolonged grief disorder; M = mean; CESD-R = Center for Epidemiologic Studies Depression Scale Revision; SBP = systolic blood pressure; DBP = diastolic blood pressure; GR = grief recall; BMI = body mass index.

Grief groups based on Prolonged Grief-13 questionnaire (PG-13); low grief is ≤ median, n = 32; medium grief is > median, n = 29; and PGD, n = 6.

TABLE 2. Paired t Tests Comparing Baseline and Post-GR BP

Palitsky et al, 2023[10]				Present Study (Goldberg et al)			
Time	**M (SD)**	**M (SE)**	***p***	**Time**	**M (SD)**	**M (SE)**	***P***
Difference From Baseline (SBP in mm Hg)				Difference From Baseline (SBP in mm Hg)			
Baseline	124.32 (15.01)	—	—	Baseline	131.21 (17.85)	—	—
0 min post-GR	145.42 (25.17)	21.10 (2.21)	< .001	—	—	—	—
2 min post-GR	141.11 (21.64)	16.78 (1.81)	< .001	0 min post-GR	147.79 (21.75)	16.57 (1.42)	< .001
4 min post-GR	137.65 (22.12)	13.32 (1.82)	< .001	—	—	—	—
6 min post-GR	135.15 (21.96)	10.82 (1.70)	< .001	5 min post-GR	141.54 (23.50)	10.32 (1.41)	< .001
8 min post-GR	133.16 (20.11)	9.31 (1.54)	< .001	—	—	—	—
10 min post-GR	132.61 (19.40)	8.29 (1.53)	< .001	10 min post-GR	139.72 (23.66)	8.50 (1.44)	< .001
Difference From Baseline (DBP)				Difference From Baseline (DBP)			
Time	M (SD)	M (SE)	*p*	Time	M (SD)	M (SE)	*P*
Baseline	69.05 (8.47)	—	—	Baseline	86.91 (11.23)	—	—
0 min post-GR	77.15 (10.67)	8.10 (1.11)	< .001	0 min post-GR	92.42 (13.13)	6.51 (0.86)	< .001
2 min post-GR	74.72 (10.36)	5.68 (0.96)	< .001	—	—	—	—
4 min post-GR	73.81 (9.51)	4.77 (0.80)	< .001	—	—	—	—
6 min post-GR	72.91 (9.55)	3.86 (0.80)	< .001	5 min post-GR	90.88 (13.46)	3.97 (0.91)	< .001
8 min post-GR	71.56 (9.02)	2.51 (0.66)	< .001	—	—	—	—
10 min post-GR	71.94 (8.30)	2.90 (0.75)	< .001	10 min post-GR	90.30 (14.40)	3.39 (0.89)	< .001

SBP = systolic blood pressure; DBP = diastolic blood pressure; M = mean; GR = grief recall.

Due to slightly different procedures of measuring BP, the 0 min post-GR in the present study corresponds best to the 2 min post-GR in the Palitsky et al. study.[10]

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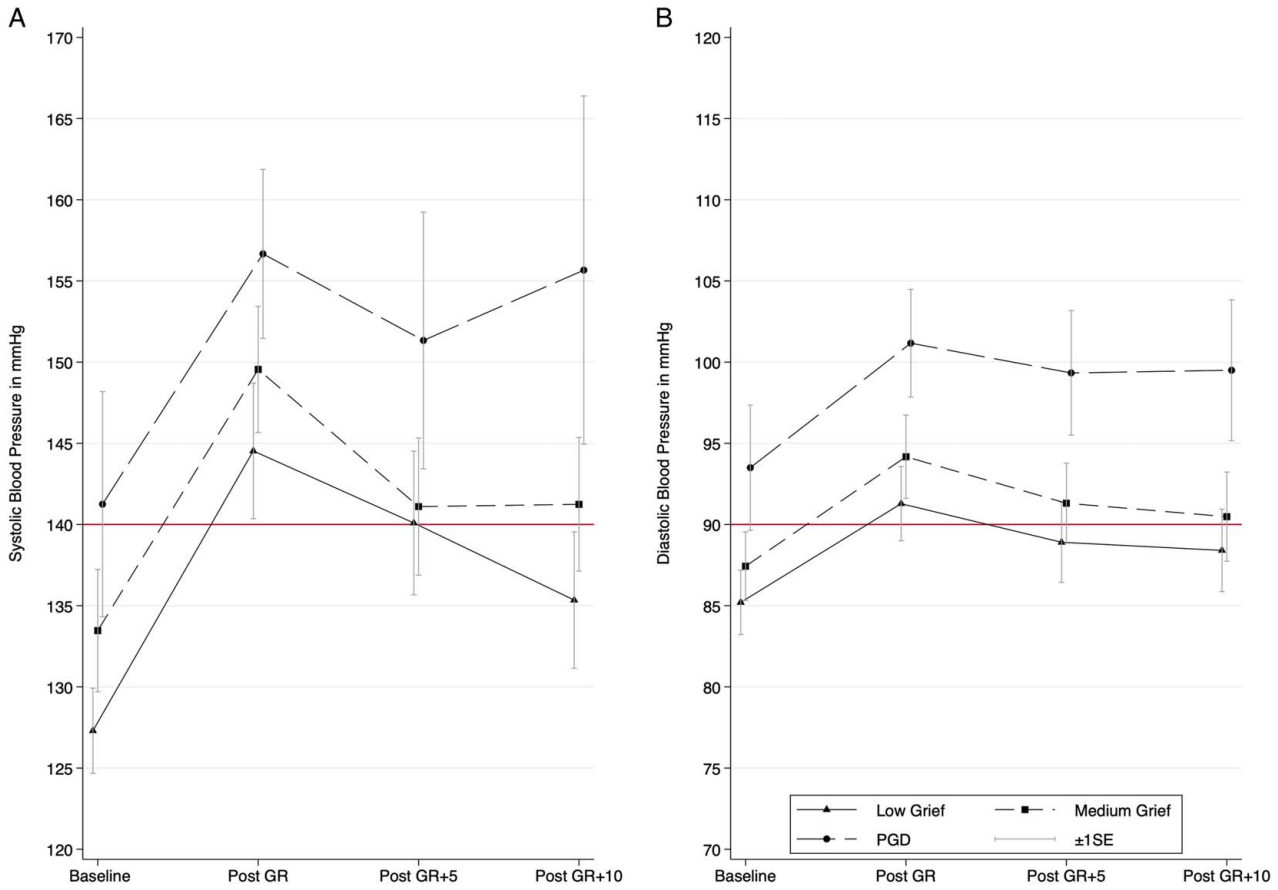

FIGURE 1. Changes in systolic blood pressure (A) and diastolic blood pressure (B) over time. Figure shows unadjusted means. Grief groups based on PG-13 Scale (low grief is ≤ median, $n = 32$; medium grief is > median, $n = 29$; and PGD, $n = 6$). Error bars indicate SEs of the mean. The red line represents clinically relevant elevations in BP. Time in minutes after the grief recall (GR) task. PG-13 = Prolonged Grief-13; PGD = prolonged grief disorder. Color image is available only in online version.

GR (H3a and H3b). To our knowledge, this is the first study to investigate the hemodynamic response to a grief-related stress interview in a bereaved, German sample 6 to 24 months post-loss, reflecting the transition to a prolonged grief reaction.

Although this work conceptually replicates a study by Palitsky et al,[10] there are some important similarities and differences worth noting. First and perhaps most important, the time since loss differed. While Palitsky et al[10] examined bereaved participants within 1 year of loss, our study had a sample that was assessed 6 to 24 months after loss, focusing on chronic alterations following bereavement. Secondly, there were slight differences in procedures of measuring, for example, slight differences in measuring intervals and procedures, leading to the assumption that the first measurement after GR in this study corresponds to the 2-minute measurement.[10] In both studies, the PG-13 questionnaire, utilized to assess PGD symptoms, showed good reliability with Cronbach alpha around 0.9. In addition, the grief recall task appears to be a feasible, transculturally applicable, and safe task to elicit a pang of grief and the associated cardiovascular response.

Prior literature examining BP reactivity suggests, on the one hand, that large BP changes in response to acute stressors may predict hypertension.[8] On the other hand, BP reactivity could be, at least to a certain degree, an adaptive response and even associated with greater subjective well-being.[16] In addition to the measurement of reactivity, recovery has also been studied, showing a relationship between poor recovery from laboratory challenges and cardiovascular disease.[7] Our findings should be seen in the context of this ambiguous and still expanding body of literature. Thus, the present results may partly deviate from Palitsky et al,[10] reflecting a normalization of altered biomarkers due to the longer time of bereavement in the current study. In the present study, most mourners seem to show adequate reactivity, whereas people with PGD seem to exhibit a distinct reactivity, starting from an elevated baseline and with a delayed recovery. These exploratory findings may support the hypothesis of a delayed biopsychological adaptation to loss in PGD.[4]

In addition, it seems to be noteworthy that adaptation to loss is a multifactorial process. For instance, on average, the highest grief severity is associated with child and spouse loss.[17] Other factors and especially health be-

haviors that could influence grief severity and BP reactivity are presented in the sample characteristics (Table 1) on a descriptive level. Further variables, such as relationship quality to the deceased or social support in general could extend this information. The relatively small sample size ruled out the inclusion of these upstream variables in the analyses. It was expected that the measurement of grief severity would reflect the overall disruption of the bereaved.

Bereavement is a period of higher cardiovascular risk and, therefore, should be a time when assessment and follow-up are conducted routinely.[18] Treatment of hypertension should follow guidelines developed for the treatment of hypertension in general and does not necessarily need to be tailored to a bereaved population. However, for the small proportion of bereaved people who develop PGD, this disorder can be effectively treated through evidence-based psychotherapy.[19,20] In addition, progressive muscle relaxation may be added on to other treatment modalities and could improve physiological management of reactivity and recovery in bereavement.[21]

There are several limitations to our study that must be acknowledged. First, the sample size restricts the generalizability of our findings, particularly in subgroup analyses. For example, sex aspects could not be addressed and findings such as the higher risk for men following bereavement[1] could not be confirmed. This limitation may be attributed to the overall healthier male subsample in our study (eg, fewer medications, lower smoking prevalence) and a shorter time since loss compared with the rest of the participants. In addition, overall health variables, cultural differences—which are known to influence grieving processes[22]—and the impact of loss types could not be further investigated due to sample size and ethnic homogeneity of our study population. Larger sample sizes that incorporate greater diversity could help address these limitations and could also increase the likelihood of detecting smaller effects. Nonetheless, it is notable that the proportion of participants with PGD in our sample (9%) aligns with the prevalence reported in a meta-analysis,[23] supporting the plausibility of our findings.

The death of a loved one is rated as the greatest life stressor, and although it may have an impact on mental health functioning, the increased medical risk bereavement poses has long been overlooked. The present study indicates that while most bereaved people have the physiological resilience to absorb the impact of significant loss, those who respond with higher grief severity for a prolonged time period may be those at highest risk for medical consequences.

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Preregistration: This study was pre-registered in the German Clinical Trials Register (DRKS00016597, https://drks.de/search/en/trial/DRKS00016597). As described in the introduction, the hypotheses were formulated after the publication of Palitsky et al.[10], so no analysis plan for the results presented here was included in the study registration.

Data Availability: The data that support the findings of the study are available on request from the corresponding author (V.G.) to be reviewed on-site. The data are not publicly available due to privacy reasons.

Use of AI: Artificial Intelligence was used for translation to a more precise, grammatically correct language.

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