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MATERNAL-FETAL MEDICINE

Post-traumatic stress disorder following emergency peripartum hysterectomy

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Abstract
Purpose Our objective was to explore if women who experience emergency peripartum hysterectomy (EPH), a type of severe maternal morbidity, are more likely to screen positive for post-traumatic stress disorder (PTSD) compared to women who did not experience EPH.
Methods Using a retrospective cohort design, women were sampled through online communities. Participants completed online screens for PTSD. Additionally, women provided sociodemographic, obstetric, psychiatric, and psychosocial information. We conducted bivariate and logistic regression analyses, then Monte Carlo simulation and propensity score matching to calculate the risk of screening positive for PTSD after EPH.
Results 74 exposed women (experienced EPH) and 335 non-exposed women (did not experience EPH) completed the survey. EPH survivors were nearly two times more likely to screen positive for PTSD (aOR: 1.90; 95 % CI: 1.57, 2.30), and nearly 2.5 times more likely to screen positive for PTSD at 6 months postpartum compared to women who were not EPH survivors (aOR: 2.46; 95 % CI: 1.92, 3.16).
Conclusion The association of EPH and PTSD was statistically significant, indicating a need for further research, and the potential need for support services for these women following childbirth.

Keywords Maternal morbidity · Emergency hysterectomy · Post-traumatic stress disorder · PTSD · Maternal mental health

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Introduction

As maternal mortality is rare in the developed world, maternal morbidity is considered a more useful key indicator of a population's health status [1]. Emergency peripartum hysterectomy (EPH) is an obstetric procedure performed in a crisis situation as last-resort, life-saving surgery, typically following intractable post-partum hemorrhage [2, 3]. EPH is classified as severe maternal morbidity, or even near-miss maternal mortality, due to the surgical intervention, intubation, blood transfusions, and critical care transfer associated with it [4]. While EPH is rare, with the highest incidence in the United States reported at 2.7 per 1000 deliveries [5, 6], there has been an increase in the prevalence of EPH reported in the US, Canada, and the United Kingdom, a trend most likely attributable to the high/rising cesarean section rates in these countries [7–11].

The few studies that examine mental health sequelae for women who experience EPH analyze postpartum depression (PPD) as the outcome of interest [10, 12–15]. Almost all of these studies measured depression during the EPH hospitalization; only one study examined PPD post-discharge. The latter study observed a prevalence of PPD at

26.7 % [14], which is higher than the expected prevalence of 10–15 % [16–18].

Post-traumatic stress disorder (PTSD) can occur following a traumatic event that involves actual or threatened death, serious injury, or sexual violation. Four categories of symptoms of PTSD include intrusive recollection of the trauma, avoidance, negative cognitions and mood, and hyperarousal [19]. PTSD is associated with childbirth experiences that are considered traumatic [20–22]. EPH may be perceived as traumatic [23, 24] because it is a sudden unexpected event that irrevocably ends childbearing, and involves life-threatening complications and major intervention.

Although scant research has examined the link of childbirth complications to PTSD, one study found that women having two or more maternal complications during childbirth (e.g., retained placenta, hemorrhage or uterine infection) were four times as likely to have symptoms of PTSD subsequently [25]. EPH involves two minimum complications: hemorrhage and a hysterectomy, which may place women at heightened risk for PTSD. Further, a systematic review found that 22 % of intensive care unit (ICU) survivors have clinically significant PTSD [26]. This supports the likelihood that EPH survivors, who are typically admitted to ICU, may develop PTSD. A review of PTSD following severe maternal morbidity found an association of severe pre-eclampsia with PTSD (25), but no research has examined the association of EPH and PTSD. In this study, we intend to fill this gap in knowledge, by evaluating the hypothesis that women who experience EPH have an elevated risk of screening positive for PTSD.

Materials and methods

This retrospective cohort design utilized two groups of women recruited from online communities, one a support group with 240 women who had experienced EPH, and the other a sample from a large online community of mothers with 1.7 million registered users.

The EPH support group population was recruited through mass email announcements sent to the list-serv. Due to the different format of the comparison online community, those members were recruited through announcements on the website. Data collection lasted approximately 3 months. To meet inclusion criteria, participants were 18 years of age or older, and had a surviving infant associated with her most recent labor/delivery. Those who wished to participate completed the informed consent and research survey online. All participants completed the PTSD and depression instruments regarding their current mental status. Because women in these communities vary in time since delivery, we also standardized the time of interest by inquiring about mental health status at 6 months postpartum. Participants whose births occurred over 6 months prior to the time of survey completion were asked to recall their mental health at 6 months postpartum and to complete the PTSD and depression instruments with that time period in mind. Study participants took approximately 30–40 min to complete all components of the instruments.

Sample size calculations were conducted using Stata 9.0 (StataCorp, College Station, TX) for a two group comparison of proportions with 80 % power and a one-sided alpha of 0.05, based on the study hypothesis that women will have a higher risk of screening positive for PTSD. At baseline we selected four unexposed subjects (EPH history) for each exposed subject (no EPH history) selected. Based on our sample size estimation, we required recruitment of at least 51 women from the exposed group and 202 women from the non-exposed group.

Data collection

Prior to the initiation of data collection, approval was obtained from the University of South Florida's Institutional Review Board. All participants electronically signed informed consent forms before accessing the survey and mental health measures. The survey was designed and administered using Checkbox 4.4 (Prezza Technologies, Cambridge, MA). Data analysis was completed using SAS (SAS Institute Inc., Cary, NC, version 9.3).

Instruments and measures

The online survey covered sociodemographic characteristics; obstetric and reproductive history; history of psychological or psychiatric illness; pregnancy, labor and delivery information for the most recent delivery; previous traumatic events (see Table 1 footnotes for definition); and social support (see Table 1 footnotes for definition). This instrument was pilot-tested on both exposed and non-exposed women, and the questions and order were refined based on feedback. All participants received mental health resources online including telephone numbers and websites for support, and those who had screened positive for either depression or PTSD had access to referrals for mental health services via a social worker.

Two established instruments were used to assess depression and PTSD. The Edinburgh Postnatal Depression Scale (EPDS), a 10-item self-report, is the most widely used scale for assessing PPD [27]. A review of validation studies of the EPDS demonstrates good sensitivity and specificity [28]. It has been validated for use with women who are over 1 year post-childbirth [29]. Scores greater

Table 1 Sociodemographic, psychosocial, and obstetric characteristics by emergency peripartum hysterectomy (EPH) status among online respondents, before and after Monte Carlo simulation and propensity score matching[a]

Characteristic	Using original data ($n = 409$)			After Monte Carlo simulation and propensity score matching ($n = 2518$)		
	No EPH *n* (%)	EPH *n* (%)	*p* value	No EPH *n* (%)	EPH *n* (%)	*p* value
Marital status			0.05			1.00
Married or living with partner	310 (92.5 %)	73 (98.7 %)		1198 (95.2 %)	1198 (95.2 %)	
No partner	25 (7.5 %)	1 (1.4 %)		61 (4.8 %)	61 (4.8 %)	
Education			<0.001			0.90
Some college or less	266 (79.4 %)	17 (22.1 %)		573 (45.5 %)	570 (45.3 %)	
At least 4 year college degree	69 (20.6 %)	57 (77.0 %)		686 (54.5 %)	689 (54.7 %)	
Minority			0.36			0.84
Yes	23 (6.9 %)	2 (2.7 %)		64 (5.0 %)	63 (5.0 %)	
No	311 (92.8 %)	72 (97.3 %)		1194 (94.8 %)	1194 (94.8 %)	
Missing	1 (0.3 %)	0 (0.0 %)		1 (0.1 %)	2 (0.2 %)	
Country of residence			<0.001			0.89
USA	324 (96.7 %)	36 (48.7 %)		970 (77.1 %)	973 (77.3 %)	
Other	11 (3.3 %)	38 (51.4 %)		289 (23.0 %)	286 (22.7 %)	
Parity			0.02			0.79
1	115 (34.3 %)	37 (50.0 %)		544 (43.2 %)	559 (44.4 %)	
2+	209 (62.4 %)	35 (47.3 %)		683 (54.2 %)	666 (52.9 %)	
Missing	11 (3.3 %)	2 (2.7 %)		32 (2.5 %)	34 (2.7 %)	
Mode of delivery			<0.001			0.94
Vaginal	223 (66.6 %)	16 (21.6 %)		529 (42.0 %)	520 (41.3 %)	
Cesarean section	101 (30.2 %)	56 (75.7 %)		661 (52.5 %)	669 (53.1 %)	
Missing	11 (3.3 %)	2 (2.7 %)		69 (5.5 %)	70 (5.6 %)	
Previous adverse pregnancy outcome[b]			0.72			0.91
Yes	133 (39.7 %)	26 (35.1 %)		451 (35.8 %)	456 (36.2 %)	
No	191 (57.0 %)	46 (62.2 %)		774 (61.5 %)	766 (60.8 %)	
Missing	11 (3.3 %)	2 (2.7 %)		34 (2.7 %)	37 (2.9 %)	
Pregnancy intention			<0.001			1.00
Intended	197 (58.8 %)	70 (94.6 %)		945 (75.1 %)	946 (75.1 %)	
Unintended	127 (37.9 %)	2 (2.7 %)		242 (19.2 %)	242 (19.2 %)	
Missing	11 (3.3 %)	2 (2.7 %)		72 (5.7 %)	71 (5.6 %)	
Infant in NICU			0.07			0.25
Yes	44 (13.1 %)	17 (23.0 %)		180 (14.3 %)	210 (16.7 %)	
No	279 (83.3 %)	53 (71.6 %)		1031 (81.9 %)	1003 (79.7 %)	
Missing	12 (3.6 %)	4 (5.4 %)		48 (3.8 %)	46 (3.7 %)	
History of mental illness[c]			0.09			0.90
Yes	132 (39.4 %)	22 (29.7 %)		414 (32.9 %)	424 (33.7 %)	
No	195 (58.2 %)	52 (70.3 %)		817 (64.9 %)	806 (64.0 %)	
Missing	8 (2.4 %)	0 (0.0 %)		28 (2.2 %)	29 (2.3 %)	
2 or more previous traumatic events[d]			<0.001			0.67
Yes	152 (45.4 %)	14 (18.9 %)		410 (32.6 %)	431 (34.2 %)	
No	173 (51.6 %)	59 (79.7 %)		832 (66.1 %)	812 (64.5 %)	
Missing	10 (3.0 %)	1 (1.4 %)		17 (1.4 %)	16 (1.3 %)	
Level of social support[e]			0.10			0.88
High	277 (82.7 %)	68 (91.9 %)		1060 (84.2 %)	1069 (84.9 %)	
Low	49 (14.6 %)	6 (8.1 %)		172 (13.7 %)	164 (13.0 %)	
Missing	9 (2.7 %)	0 (0.0 %)		27 (2.1 %)	26 (2.1 %)	

Table 1 continued

	Mean (std error)	Mean (std error)	*p* value	Mean (std error)	Mean (std error)	*p* value
Time since delivery (years)	1.63 (0.14)	3.91 (0.37)	<0.001	2.95 (2.50)	2.86 (2.60)	0.41
Age (years)	28.27 (6.09)	35.19 (5.60)	<0.001	32.41 (5.77)	32.24 (6.06)	0.47
Pain severity, labor and delivery[f]	4.62 (1.96)	4.63 (1.83)	0.95	4.63 (1.92)	4.63 (1.89)	0.98
Pain severity, following delivery[f]	3.60 (1.69)	4.89 (2.12)	<0.001	4.44 (1.73)	4.41 (1.70)	0.63
Maternal length of hospital stay, nights	2.41 (2.13)	7.23 (2.90)	<0.001	5.12 (1.49)	5.14 (1.51)	0.82

[a] Percentages may not add up to 100 % due to rounding error

[b] Previous adverse pregnancy outcome = prior spontaneous abortion, abortion, stillbirth

[c] History of mental illness = any mental illness during last pregnancy or prior to last pregnancy

[d] Traumatic events included but were not limited to the following: combat experience in war; life-threatening accident; fire, floor or natural disaster; witnesses someone being badly injured or killed; raped; or abused or neglected as a child [43]

[e] Adapted from the Pregnancy Risk Assessment Monitoring System survey with 6 yes/no items on different types of social support. High social support scores >3. 3 or less is considered low social support [44]

[f] Pain severity rated on scale where 1 is no pain and 7 is worst pain imaginable

than or equal to 14 were considered a positive screen for depression.

Post-Traumatic Stress Disorder Symptom Scale (PSS) is a self-report instrument comprised of 17 items using a 4 point Likert scale on the three dimensions of PTSD: re-experiencing, avoidance, and arousal. The PSS has demonstrated good test–retest reliability, internal consistency, and concurrent validity [30]. The PSS has been successfully used in evaluation of childbirth as the traumatic event [30]. A total score greater than or equal to 15 was considered a positive screen for PTSD.

Data analysis

We used descriptive analysis to examine the distributions of all variables of interest, and applied Chi-square tests to examine differences in proportions with respect to characteristics of interest between women with EPH versus the comparison group. We also used bivariate analyses to assess relationships between these variables and the outcome measures of PTSD.

We initially performed ordinary logistic procedures to estimate the risk of PTSD among women with EPH using odds ratios. Since these women showed differences in baseline characteristics, we proceeded to match the two groups using the baseline characteristics as matching variables, to control for confounding. A limitation of using the collected raw data was the possibility of generating imprecise estimates as a result of lost power due to the matching. Consequently, we refined our analysis by employing Monte Carlo simulation before propensity score (PS) matching by applying the characteristics (means and covariance matrix) of the original data [31, 32].

Bivariate analyses to identify characteristics associated with PTSD included exposure to EPH, maternal age, marital status, educational level, hours of work per week, minority status, history of previous mental health issues, level of social support, previous traumatic events, parity, previous adverse pregnancies, pregnancy intention, time since delivery, infant admission to neonatal intensive care unit (NICU), pain during labor and delivery, and pain immediately following delivery. Results of the analyses are presented for two distinct outcomes—one for current PTSD (at the time of survey completion) and the other for PTSD at 6 months postpartum, where participants whose birth occurred more than 6 months prior to survey completion were asked to recall back to their mental health at 6 months postpartum.

All variables listed in Table 1 were considered in model-building. Variables that did not contribute significantly to the model were removed. The final logic regression model included EPH, age, social support, trauma history, mental illness history, parity, delivery type, and time since delivery. (Tables provided upon request.) The Hosmer and Lemeshow statistic demonstrated goodness-of-fit for PTSD at time of study completion ($\chi^2 = 5.89$, $df = 8$, $p = 0.66$) and PTSD at 6 months postpartum ($\chi^2 = 3.71$, $df = 8$, $p = 0.88$); therefore we concluded that the data fit both models.

Monte Carlo simulation and propensity score matching

Since some of the variables were categorical, using the polychoric correlation (which assumes that the categorical variables dissect continuous latent variables that are

bivariate normal), means and variance covariance matrix were obtained from the original data and 10,000 observations were simulated from an assumed multivariate distribution. After simulation, the continuous variables were then back-transformed into categorical variables using the cumulative distribution function of the simulated data. At the end of the procedure, there was no difference in the summary statistics between the original and the simulated data.

Recruitment for the study was performed using two different populations; therefore, to attain homogeneity of the study sample, we performed PS matching [33] between the exposed and the unexposed population using the simulated data since it is a mirror image of the original data. All the baseline variables (maternal age, marital status, education level, minority status, country of residence, parity, mode of delivery, previous adverse pregnancy outcomes, pregnancy intention, infant in NICU, history of mental illness, two or more previous traumatic events, level of social support, time since delivery, pain severity, and maternal length of hospital stay) were used to compute the PS by identifying neighborhoods that were identical to each other with respect to the probability of being in the exposed group. Accordingly, for each participant in the exposed group (acting as the dependent variables), we calculated the PS using the logistic regression model with all covariates as the independent variables. Then for each participant from the exposed group, a participant from the unexposed group was selected as a match based on the closest absolute propensity score—the "nearest neighbor" [34]. The selection process was conducted without replacement so that a candidate comparison group member could be matched to only one exposed group member [34, 35]. As expected, the distribution of the covariates between the exposed and unexposed groups was similar after PS matching (Table 1).

After matching, the risk for current PTSD (at the time of survey completion) and PTSD at 6 months postpartum among the exposed group was compared to that of the unexposed group using the generalized estimating equations (GEE). The GENMOD procedure in SAS was used to conduct the final multivariate analysis. All tests of hypothesis were one-tailed (due to the hypothesis that women with EPH history would be at higher risk of PTSD) with a type 1 error rate fixed at 5 %.

Results

A total of 74 exposed (EPH history) and 335 non-exposed (no EPH history) women completed the survey. The exposed group differed in a number of ways from the non-exposed group (Table 1), suggesting key differences in the two sampling frames. To control for these differences, Monte Carlo simulation and PS matching were run, and the characteristics of the exposed and unexposed groups were no longer different (Table 1).

Table 2 provides frequencies for positive screens for PTSD and depression by exposure status, using original data (prior to simulation). We conducted two screens—one to capture PTSD status currently or at the time of survey completion, and the second screen to capture PTSD at 6 months postpartum. The EPH group had a higher prevalence of all psychological outcomes: depression, PTSD, and comorbid PTSD/depression. The prevalence of a positive screen for PTSD, including those who screened positive for PTSD alone and PTSD in conjunction with depression in the exposed group was 40.5 %, a figure almost fivefold greater than in the non-exposed group (8.9 %). Interestingly, women with EPH history who screened positive for depression also screened positive for PTSD. When women recalled their mental health at 6 months postpartum, the prevalence of a positive screen for PTSD was 77.2 % for the exposed group, and 7.1 % for non-exposed.

In the unadjusted model (Table 3), there were increased odds of screening positive for PTSD among the EPH group compared to the non-exposed counterparts, [OR = 6.93 (95 % CI: 3.82, 12.59)]. After controlling for potential confounders, the adjusted OR (aOR) increased more than twofold [15.48 (95 % CI 6.23, 38.46)].

In the unadjusted model (Table 3), there was a remarkable increased odds of screening positive for PTSD at 6 months postpartum among EPH compared to women who did not experience EPH, OR = 43.88 (95 % CI: 20.39, 94.40). In the adjusted model, the odds of screening

Table 2 Frequency of PTSD and depression currently (at time of survey completion) and 6 months postpartum by emergency peripartum hysterectomy status among online respondents

Emergency peripartum hysterectomy		
Outcome	Yes	No
	n (%)	*n* (%)
Current—at time of survey completion	*n* = 74	*n* = 335
PTSD only	18 (24.3 %)	16 (4.8 %)
Depression only	0 (0.0 %)	14 (4.2 %)
Neither	44 (59.5 %)	291 (86.9 %)
Both	12 (16.2 %)	14 (4.2 %)
6 months postpartum	*n* = 70	*n* = 210
PTSD only	6 (8.6 %)	3 (1.4 %)
Depression only	4 (5.7 %)	18 (8.6 %)
Neither	12 (17.1 %)	177 (84.3 %)
Both	48 (68.6 %)	12 (5.7 %)

Table 3 Odds ratios (OR), adjusted odds ratios (aOR), and 95 % confidence intervals (CI) on the association of EPH with PTSD at time of survey completion and at 6 months postpartum before and after Monte Carlo simulation and propensity score matching

	Crude odds ratio (95 % CI)	Adjusted odds ratio (95 % CI)[a]	Adjusted odds ratio (95 % CI) after simulation and propensity score matching[b]
Current PTSD	6.93 (3.82, 12.59)	15.48 (6.23, 38.46)	1.90 (1.57, 2.30)
PTSD 6 months postpartum	43.88 (20.39, 94,40)	55.82 (19.65, 158.60)	2.46 (1.92, 3.16)

[a] Covariates adjusted in the model include maternal age, social support, trauma history, history of mental illness, parity, delivery mode, time since delivery

[b] Covariates adjusted in the model include marital status, education, minority status, country of residence, parity, mode of delivery, previous adverse pregnancy outcomes, pregnancy intention, infant in NICU, history of mental illness, 2 or more previous traumatic events, level of social support, time since delivery, maternal age, pain severity during labor and delivery, pain severity following delivery, maternal length of hospital stay

positive for PTSD at 6 months postpartum was even more striking: aOR = 55.82 (95 % CI: 19.65, 158.60).

Results following simulation and propensity score matching

To validate results, we performed Monte Carlo simulation and PS matching procedures. Out of the 10,000 simulated observations, 1259 were exposed and 8741 unexposed, a 1:7 ratio that reflected our original data. For each exposed subject, one unexposed subject was selected by PS approach as a match, leading to a total sample size of 2518 subjects (1259 exposed + 1259 unexposed) overall. We then proceeded with model construction using GEE. The results showed the odds ratios to be substantially attenuated, although the statistically increased risk of PTSD for EPH survivors remained (Table 3).

Discussion

After validating our initial logistic regression results using simulation and PS matching, the ORs were reduced, but the results still demonstrate that women who experienced EPH were at increased risk of screening positive for PTSD. We found that women were nearly two times as likely to screen positive for PTSD at the time of survey completion, and nearly 2.5 times as likely to screen positive when recalling back to 6 months postpartum. This is supported by findings from prior research studies on PTSD and other life-threatening acute conditions: approximately 12–15 % of patients have PTSD following myocardial infarction [36, 37], and over 20 % of ICU survivors experience PTSD [26].

Given the increasing incidence of EPH, future research is needed, in particular a hospital-based study to limit the self-selected nature of participation in this study. In addition, a prospective study with longer-term follow-up would enable a better estimation of PSTD and/or depression over time. The study of comorbid PTSD and depression after traumatic childbirth is also necessary. Prior research has supported our finding that patients with traumatic experiences experience depression and PTSD together, and not depression alone [38]. One study found an increased risk of depression in people with PTSD, but no increased risk of depression in people without PTSD. This suggests that PTSD may cause depression in trauma victims, or that there is a shared vulnerability for the two disorders [38]. Moreover, although women with comorbid PTSD and depression have more medical issues, worse physical health, and are more likely to attempt suicide than women with depression only [39, 40], the effect of PTSD and comorbid PTSD and depression on the mother–infant bond and child outcomes is not yet known. This is an area deserving further attention.

A strength of this study is the use of statistical methods to control for multiple confounders. Via PS matching, we matched the EPH group with the non-EPH group. Therefore, significant results are due to the exposure and are not influenced by the observable confounders we controlled for. Another strength of this study is the gap in research that this fulfills. Prior to this study, there have been no studies looking at PTSD after EPH.

There are a number of limitations to this study. A major concern is with the generalizability of results. Because sampling took place only in online communities and primarily with women residing in the US, results may not be applicable to women who do not have internet access, do not seek support online, or are not living in the US. In particular, these results may not be representative of EPH survivors or postpartum women in general, as participants elected to join internet groups for support. Therefore, results should be interpreted with caution. Given the lack of publicly available datasets including EPH and mental health, and the length of time to achieve an adequate sample size in a hospital-based study, research utilizing

online communities is a reasonable approach for a preliminary study.

In addition, the mental health sequelae of EPH may not be generalizable to all near-misses—the permanent loss of fertility may render EPH survivors more susceptible to mental health issues [41]. However, research comparing women who experienced severe morbidity versus EPH has shown that both groups have similar levels of postpartum depression, suggesting that women who experience other severe or near-miss complications may also be at-risk for adverse mental health outcomes [14]. Another limitation is that we excluded women who had stillbirths and therefore could have underestimated the prevalence of PTSD, since women who experience traumatic loss such as stillbirth may be at-risk for PTSD.

A further limitation is that women were asked to recall their emotional state at 6 months postpartum, and recall may be different for women who had EPH versus those who did not. Nevertheless, exploring PTSD at 6 months postpartum enabled comparisons between groups at the same time point, and provided an estimate for PTSD in the actual postpartum period.

The clinical implications are that survivors of EPH may be in critical need of psychological services following childbirth. Women who experience EPH should be screened for both depression and PTSD and receive appropriate psychological or psychiatric care. As these mental health reactions may be delayed [42], screens for PTSD and depression should take place at follow-ups and not only at the time of hospitalization. Referrals to therapists or psychiatrists should be provided, regardless of the results of screening, in the event women experience difficulty after discharge from a provider's care. With follow-up visits often completed 6 weeks after delivery, it is clear that there may be a missed opportunity for referrals if patients experience any mental health symptoms for the duration of the postpartum period.

By furthering our understanding of the emotional burden of EPH, the true extent of maternal morbidity can be understood. The burden of EPH is not limited to the duration of the hospital stay. Women who experience EPH and other near-miss maternal events are seen as clinical successes because they survived childbirth, but many may have unmet mental health needs.

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Compliance with ethical standards

Conflict of interest The author declares that there is no actual or potential conflict of interest in relation to this article.

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