OPEN

Physical Health Consequences of Vicarious Trauma

Prospective Relationship Between Hospital Patient Care Worker Vicarious Trauma Symptoms and Gastrointestinal Disorders

Elisabeth Anne Stelson, PhD, MSW, LSW, MPH, Glorian Sorensen, PhD, MPH, Lisa Berkman, PhD, Sarah Ballou, PhD, Dean Hashimoto, MD, JD, Laura D. Kubzansky, PhD, MPH, and Erika L. Sabbath, ScD, ScM

Objective: Vicarious trauma (VT) is "secondhand" trauma healthcare workers experience when interacting with trauma survivors. The prospective relationship between workers' VT symptoms and physical health has not been studied. **Methods:** Survey data from 775 hospital workers were linked to health insurance expenditures to identify stress-related conditions known as disorders of gut-brain interaction (DGBIs) occurrence within 1-year follow-up. VT symptoms (modeled continuously and categorically) and conditional odds of developing DGBI were assessed with multilevel logistic regression. **Results:** Conditional odds of DGBI increased 4% for every one-point increase in VT symptom score (95% confidence interval, 0.98 to 1.11; $P = 0.17$). Participants with high versus low VT symptoms had 3.40-times the conditional odds of DGBI (95% confidence interval, 1.44 to 8.06; $P = 0.01$). **Conclusion:** Workers with high versus low VT symptoms had significantly higher odds of developing DGBIs, indicating that VT may adversely impact workers' physical health.

Keywords: vicarious trauma, disorders of gut-brain interaction, gastrointestinal disorders, healthcare workers, hospitals, occupational stress, claims data

LEARNING OUTCOMES

- Describe what vicarious trauma is and how workers in healthcare settings may be exposed.
- Examine how vicarious trauma may affect workers physical health in addition to mental health.
- Evaluate how these findings may affect healthcare services and patient care.

Nonphysician hospital workers, such as nurses, medical and nursing assistants, and surgical technicians, represent one of the largest and fastest-growing workforces in the United States, providing critical clinical services to millions of patients every year.[1–3] Although this work can be professionally rewarding, hospital workers navigate fast-paced, stressful environments on a daily basis, frequently interacting with patients, families, and communities who have experienced trauma.[4,5] Responsible for caring for sick and vulnerable patients over the course of long shifts, hospital workers' own mental and physical health can deteriorate from working in these environments.[6–8] These patient-facing workers have high rates of occupational injury, for example, caused by patient lifting, needle sticks, and patient-related violence, as well as emotional strain resulting from caring from sick and dying patients, supporting patients' families, and navigating hierarchical work environments.[6–9] This, in turn, can increase worker turnover and lead to provider shortages.[5,10] As the COVID-19 pandemic revealed, the health of communities relies upon a physically and mentally healthy hospital workforce.[11]

One understudied occupational hazard encountered by hospital workers is vicarious trauma (VT).[12] VT is "secondhand" trauma to which individuals are exposed when working with people who have experienced trauma directly, analogous to secondhand smoking.[13] By virtue of their professional responsibilities, patient-facing hospital workers are frequently exposed to VT when patients and families share their traumatic experiences or when they review documentation of such histories.[14] These VT exposures, which can be specific events or cumulative, have been associated with poor mental health outcomes in this as well as in other healthcare and social service workforces.[13,15–19] A large body of literature has consistently linked trauma exposure with higher risk of adverse physical health outcomes as well as with poorer mental health.[20–22] Considering the biological and behavioral mechanisms by which "firsthand" trauma can affect physical health,[23,24] it is possible that workers' exposure to "secondhand" trauma could produce a similar physical health impact. Because VT occurs in the workplace, it is also

From the Department of Social & Behavioral Sciences, Harvard T.H. Chan School of Public Health, Boston, Massachusetts (E.A.S., G.S., L.B., L.D.K., E.L.S.); Department of Epidemiology, Harvard T. H. Chan School of Public Health, Boston, Massachusetts (E.A.S.); Division of Gastroenterology and Hepatology, Beth Israel Deaconess Medical Center, Boston, Massachusetts (S.B.); Boston College Law School, Newton, Massachusetts (D.H.); and Boston College School of Social Work, Chestnut Hill, Massachusetts (E.L.S.).

ORCID: 0000-0001-5176-2652
ORCID: 0000-0001-6625-7931
ORCID: 0000-0002-6746-1958
ORCID: 0009-0005-8289-4945
ORCID: 0000-0002-4039-2235
ORCID: 0000-0002-7866-7812

L.D.K. and E.L.S. share senior authorship.

Author Contributions: E.A.S.: conceptualization, methodology, formal analysis, visualization, writing—original draft, writing—review and editing, and funding acquisition; G.S.: conceptualization, methodology, writing—review and editing, and funding acquisition; L.B.: conceptualization, methodology, and writing—review and editing; S.B.: conceptualization, methodology, and writing—review and editing; D.H.: resources and project administration; L.D.K.: conceptualization, methodology, writing—review and editing, and supervision; E.L.S.: conceptualization, methodology, writing—review and editing, resources, project administration, funding acquisition, and supervision.

Ethical considerations and disclosures: This study was approved by the Mass General Brigham Institutional Review Board, and all participants provided informed consent to participate in this study.

Funding sources: This study was made possible with support from the National Heart, Lung, and Blood Institute of the National Institutes of Health (5T32HL098048-15), the National Institute for Occupational Safety and Health (5U19OH008861-18), and the Harvard University Lee Kum Sheung Center for Health and Happiness. The funding organizations had no role in the research, writing, or review of the article.

Conflicts of interest: None declared.

Data sharing: Data cannot be made publicly available per agreement with the institutional partner. Contact Erika Sabbath (erika.sabbath@bc.edu) to inquire about access.

AI Statement: AI was not utilized in this study.

Supplemental digital contents are available for this article. Direct URL citation appears in the printed text and is provided in the HTML and PDF versions of this article on the journal's Web site (www.joem.org).

Address correspondence to: Elisabeth Anne Stelson, PhD, MSW, LSW, MPH, 677 Huntington Ave, Boston, MA 02115 (estelson@hsph.harvard.edu).

DOI: 10.1097/JOM.0000000000003432

possible that specific aspects of the work environment may either exacerbate or mitigate the experience of VT. To date, this has been unexplored in the context of physical health outcomes. Identifying factors that may mitigate potential effects of VT on worker health, such as support from supervisors, colleagues, and organizational leadership, could provide insight into strategies for buffering potential adverse effects of VT on physical health. Such evidence is critical in order to understand how healthcare institutions can better protect the health of their staff, increase worker retention—and perhaps by extension—improve patient care.

The Role of Vicarious Trauma in Worker Health

Similar to other psychosocial stress phenomena,[25] VT can be theoretically partitioned into VT exposure and VT symptoms (Fig. 1). A person can experience VT when exposed to the trauma experiences of others, which can occur in the form of a specific secondary exposure event (e.g., a patient describing a traumatic event that happened to them) or accumulated over time as part of working with trauma survivors.[13] There currently is no validated measure of VT exposure per se, and as such, VT research has largely evaluated effects of VT symptoms.[13] VT symptoms, which are sometimes referred to as vicarious traumatization or secondary traumatic stress, capture the adverse psychological response that can occur with VT exposure.[13] This can manifest as emotional (e.g., desire to avoid certain patients), cognitive (e.g., having gaps in memories about patient interactions), and somatic (e.g., rapid heartbeat) symptoms.[26] Such symptoms may or may not meet the clinical diagnosis of posttraumatic stress disorder (PTSD).[26,27] Although a single VT exposure can theoretically trigger VT symptoms, it is more common for workers to be frequently exposed, which may result in VT symptoms.[17] As with other forms of stress and trauma, over time, VT may take a toll, contributing to worse health outcomes among individuals (Fig. 1).[12,13,16,18] For example, in research examining nurses, addiction treatment providers, victims' advocates, and social workers, VT symptoms have been associated with the development of mental health problems, including depression, anxiety, and PTSD, as well as job turnover.[13,15,17,18]

Although VT has increasingly become an occupational health concern for many in the healthcare workforce due to its links with poor mental health and turnover, studies thus far have been limited by small sample sizes, cross-sectional designs, and use of self-reported health measures.[13] Furthermore, no studies to date have investigated the prospective relation between occupational VT symptoms and objective measures of physical health. Lee et al. and Ruiz-Fernández et al. found a significant negative relationship between VT symptoms and participants' self-appraisal of their general health in cross-sectional samples of social workers and nurses, respectively.[16,28] Studies utilizing longitudinal designs with objective measures of health are an important next step to advancing an understanding of the causal relationship between VT symptoms and physical health of workers.

Trauma, Physical Health, and Disorders of Gut-Brain Interaction

Despite limited evidence on the effects of VT symptoms on physical health, numerous studies have found that increased exposure to stress, adversity, and trauma predicts poor physical health.[20,21] With this body of work, researchers have identified multiple pathways by which trauma and stressor exposure may affect physical health, not only via influences on mental health problems, but also via direct biological effects (e.g., activation of the central nervous system mediated through responses by the nervous, endocrine, cardiovascular, and immune systems)[22,23] and via effects on adaptive and maladaptive behaviors[29] and access to material and social resources.[30]

One common physical health problem linked with stress and trauma is a group of chronic gastrointestinal (GI) conditions collectively referred to as disorders of gut-brain interaction (DGBIs).[21,31–34] DGBIs, such as functional heartburn, reflux sensitivity, functional dyspepsia, and irritable bowel syndrome, are conditions thought to be caused by complex, dysregulated interactions of the central nervous system, autonomic nervous system, hypothalamic-pituitary-adrenal axis, and GI system, often triggered by stress.[34,35] DGBI "flares" occur often (sometimes every 3 to 4 weeks[36]), and approximately two-thirds of individuals with symptoms seek medical care annually for the condition.[34] Although many people with DGBIs self-manage symptoms, studies have shown that among individuals with few barriers to accessing healthcare, there is very little difference in symptom severity among individuals who seek medical care compared with those who do not.[37] The burden of DGBIs is substantial, affecting 21% to 40% of the global population at some point in their life,[38] reducing quality of life,[34] and increasing healthcare costs.[34,39] Although exact genetic contribution to DGBIs remains uncertain due to the complicating role of psychiatric disorder heritability, intergenerational trauma, and behavioral modeling,[40,41]studies have shown a strong association between individual's trauma history[21] and occupational stress[31,32] and risk of developing these chronic GI conditions. Moreover, different types of stressors (e.g., home-related stressors and work-related stressors) can be differentially associated with DGBIs.[42]

Given this body of research linking trauma, occupational stress, and DGBIs, examining the relationship between VT symptoms and DGBI can provide insight into potential physical health consequences of occupational VT. From an epidemiological perspective, the nature of DGBIs also lends itself to such investigations. Compared with long etiologic periods of other health conditions linked to stress and trauma (e.g., hypertension), the time lag between a stressor and DGBI development is relatively short.[33,42] This may make it easier for researchers to assess and control for other factors that may confound any observed relationship. DGBIs are also not contagious, an important consideration when studying occupational populations who interact with patients who are sick.[35]

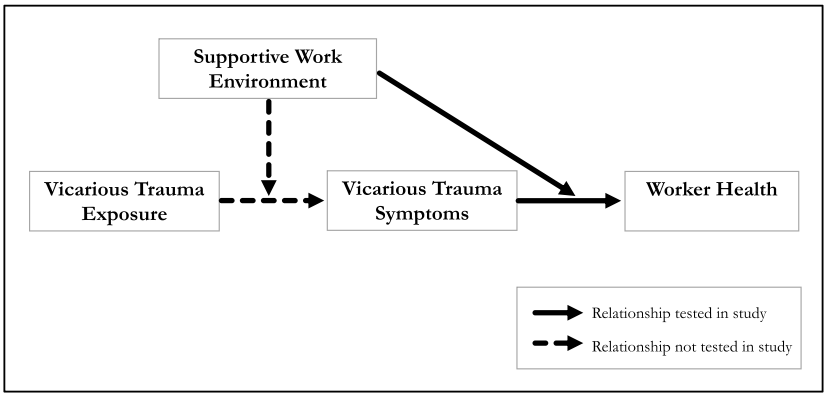

FIGURE 1. Conceptual model describing theorized relationships between vicarious trauma exposure, vicarious trauma symptoms, worker health outcomes, and buffering effects of a supportive work environment.

Supportive Work Environments and Vicarious Trauma Symptoms

Studies suggest that buffering of potentially toxic effects of trauma is possible, with social support at work serving a particularly important buffering role.[43] Studies of healthcare professionals usually consider VT symptoms as an individual issue and do not account for broader occupational environments in which nurses and patient care associates (PCAs) perform their duties.[44,45] However, hospital workers spend their days in settings shaped by important interactions with their coworkers, supervisors, and institutional leaders, and if these interactions are perceived as supportive, organizational environments may buffer the effects of VT symptoms on the health and well-being of workers (Fig. 1). Although not explicitly testing a buffering effect, some VT studies have found greater support at work was inversely associated with VT symptom levels among mental health professionals.[46] These findings align with systematic reviews and meta-analyses that have found organizational interventions in hospitals, such as supportive supervision and shared decision-making, are more likely to be effective in improving staff well-being and reducing absenteeism than interventions that targeted the individual behavior of workers.[47,48] It is important to note that while frequently functioning as a buffer, social support could also theoretically confound the relationship between VT symptoms and DGBIs because it has been found to be separately associated with VT symptoms[46] and DGBIs[32] and may also be activated by VT experiences.[49]

Study Aims

We leveraged data from the Boston Hospital Workers Health Study (BHWHS) to investigate the prospective relationship between VT symptoms of hospital workers and DGBIs identified via health insurance claims data. The cohort comprised nurses and low-wage PCAs, who have high levels of interactions with patients and who are likely to be exposed to VT as a result. We hypothesized that associations between VT symptoms and DGBIs would be similar across the two groups of workers. We also evaluated if supportive work environments may beneficially buffer this relationship. Our primary hypothesis was that higher VT symptoms scores would be positively associated with increased risk of DGBI over a 1-year follow-up period. In a secondary, exploratory hypothesis, we hypothesized that more supportive work environments would reduce the effect of VT symptoms on DGBI.

METHODS

Study Sample

This study utilizes data from the 2018 wave of the BHWHS, an ongoing cohort study of registered nurses and PCAs who work at two large academic hospitals.[50] Details about the cohort structure, composition, and recruitment are available elsewhere.[50,51] In October 2018, a survey of psychosocial working conditions and health, which included a measure of VT, was emailed to 2000 workers (approximately one-third of all nurses and PCAs at the two hospitals) who worked at least 20 hours per week over the 3 months prior to sampling. Overall, the survey had a response rate of 55% (n = 1101 participants). Of these, 44% worked at a unionized hospital with about 800 beds and 56% at a nonunionized hospital with approximately 1000 beds. Participants worked in 91 distinct hospital units across the two hospitals. Survey responses could be linked to institutionally-collected health insurance claims data (date range: January 2017 through December 2019) for the 82% of study participants who participated in the employee health plan. This study was approved by the Mass General Brigham Institutional Review Board.

Our analytic sample was restricted to nurses and PCAs who participated in the 2018 survey, worked in nonmanagement positions, and subscribed to the employee health plan at the time of survey, which allowed us to observe subsequent DGBI claims during the study period (Fig. 2). Managers were excluded because they (1) often have less direct contact with patients and families and (2) are partially responsible for creating the supportive work environment under investigation as a potential VT symptom buffer. We also excluded participants who completed a paper version of the survey (n = 95) because no date of completion was recorded, and therefore the follow-up period (i.e., date of survey completion through December 31, 2019) could not be accurately identified. Participants who did not have employer health insurance plans during the preperiod (i.e., January 1, 2017, through their survey completion date) were included (n = 32, 4% of sample), allowing us to include newer workers, those who may have worked less than full time, and those who may have previously been insured by a family member. Our comparison of the analytic sample to survey participants who were excluded because they were not enrolled in the employee health plan indicated that the two groups were mostly similar, except participants with employee health plans were more likely to be nurses, work more hours per week, and report slightly higher supervisor support (Supplement 1, http://links.lww.com/JOM/B952).

Measures

Exposure

The primary exposure in this analysis was VT symptoms, measured using selected items from the Vicarious Trauma Scale and which defined VT as "the changes that occur in trauma workers as a result of working with trauma survivors… [which is a] cumulative process through which the [worker's] inner experience is negatively transformed through empathetic engagement with the client's trauma material."[52] This concept was originally operationalized as an eight-item scale (range, 0 to 32), with two items assessing broad exposure to VT and six items assessing VT symptoms, and has since demonstrated strong internal consistency among social workers and victims' advocates (α = 0.77 to 0.88).[52–54] However, based on prior work on trauma more generally, which separates exposure to trauma from psychological responses to the experience as depicted in our conceptual model (Fig. 1),[25] the measure has been conceptually criticized for conflating VT exposure with workers' psychological responses as a result of the exposure.[54] In light of this theoretical criticism and because all but five participants endorsed VT exposure on the two exposure-related items, we opted to use only the six items that ask about psychological symptoms occurring in response to VT exposure (e.g., "I find myself distressed by listening to my patients' stories and situations") (Supplements 2, http://links.lww.com/JOM/B952). Of note, we included the five individuals who did not report any VT exposure because (1) the two VT exposure questions were not precise; (2) the ubiquity of VT exposure in hospital settings may make it hard for some participants to identify their exposure; and (3) some of these individuals endorsed VT symptoms, despite not reporting an exposure.

This modified version of the Vicarious Trauma Scale demonstrated strong internal consistency for the full BHWHS sample and when stratified by job, race, sex, age, and hours worked per week (α = 0.84 to 0.88). Concurrent validity was demonstrated in this sample with positive correlation with general measures of psychological distress[55] and burnout[56] also administered in the 2018 BHWHS survey. Discriminant validity was demonstrated by finding no evidence of a correlation with completing the survey on an even or odd day of the month. For the current study, we first used this measure as a continuous variable (score range, 0 to 24). To assess potential nonmonotonic effects, we turned VT symptoms scores into a categorical variable based on three a priori–defined even cut points: low VT symptoms (score range, 0 to 8), medium VT symptoms (score range, 9 to 16), and high VT symptoms (score range, 17 to 24).

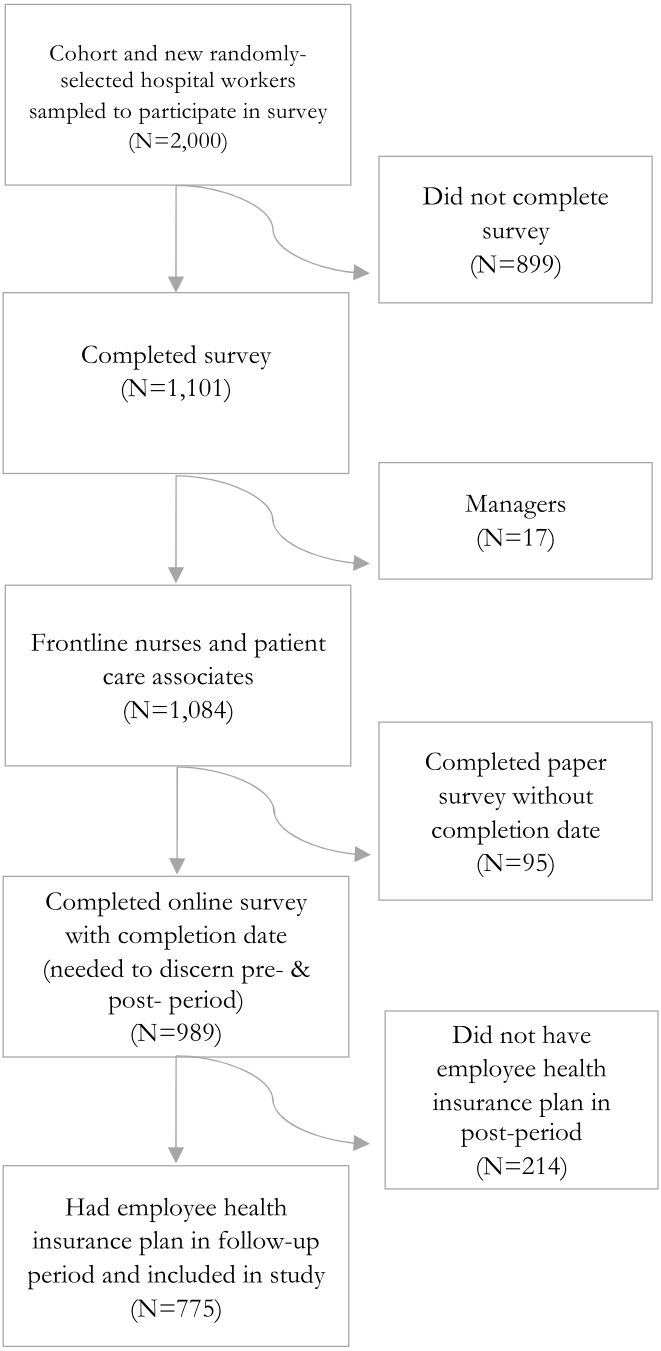

FIGURE 2. Participant recruitment and sampling scheme.

Outcome

Occurrence of one or more DGBIs within the follow-up period was identified using participants' health insurance expenditures, which were linked to survey responses using secure study IDs. DGBIs were defined as claims with *International Classification of Diseases, Tenth Revision* (*ICD-10*) codes relating to functional heartburn, reflux sensitivity, functional dyspepsia, and irritable bowel syndrome that occurred *after* date of survey completion. We identified *ICD-10* codes using criteria from the Rome IV Foundation,[57] previous literature,[39] and in consultation with a DGBI expert. The follow-up period was defined as the time after a participant completed the survey (October 2018 to April 2019) to January 1, 2020.

Supportive Work Environment Variables

A supportive work environment was considered as either an effect modifier or covariate and was operationalized as three separate constructs, each measured by multiple items: supervisor support, coworker support, and people-oriented culture. These three supportive work environment measures have been previously used in occupational health research with healthcare workers.[58,59] Supervisor support and coworker support measures each comprised three Likert-scored items from the Job Content Questionnaire.[60] Supervisor support was measured by (1) "If needed, I can get support and help with my work from my immediate supervisor"; (2) "My supervisor is helpful in getting the job done"; and (3) "My work achievements are appreciated by

my immediate supervisor." In the BHWHS sample, this measure demonstrated strong internal consistency ($\alpha = 0.89$). Coworker support was measured by (1) "If needed, I can get support and help with my work from my coworkers"; (2) "The people I work with are helpful in getting the job done"; and (3) "I have noticed disturbing conflicts between coworkers" (reverse coded). In the BHWHS sample, coworker support demonstrated modest internal consistency ($\alpha = 0.63$). People-oriented culture is a broad measure of cooperation and trust within a work environment that promotes information-sharing and decision-making across job levels and was measured using a four-item Likert subscale from the Employee Self-report Questionnaire, slightly modified for hospital contexts.[61] The items included were (1) "Employees on my home unit are involved in decisions affecting their daily work"; (2) "Working relationships on my home unit are cooperative"; (3) "There is a high level of trust in the employee/employer relationship on my home unit"; and (4) "On my home unit, communications are open and employees feel free to voice concerns and make suggestions." Within the BHWHS sample, this measure demonstrated strong internal consistency ($\alpha = 0.83$).

Covariates

We considered a range of demographic and workplace factors that could potentially confound the relationship between VT symptoms and DGBI, which would not be a "downstream" effect of VT symptoms and would not be collinear with included variables. Since participants completed the survey over several months and therefore had varying amounts of time for a DGBI diagnosis to be observed in the postperiod, we controlled for days between survey completion and January 1, 2020. The mean number of postperiod days was 395. Demographic characteristics included sex, age, and racial/ethnic identity. Due to the limited number of participants who were Latinx/Hispanic, Asian, or multiple races, and because racial/ethnic identity was not a primary variable of interest in this analysis, we collapsed groups and categorized workers as White versus non-White. Structural components of work variables included hospital, job role (nurse vs. PCA), hours worked per week (collapsed to be <40 vs. >40 due to small cell size), shift schedule, and job demands as measured by the Job Content Questionnaire.[62] These demographic and work structure variables were assessed in the 2018 survey. DGBI insurance expenditures from 2017 until the date of each participant's survey completion were also added as a covariate because DGBI insurance costs both indicate whether somebody had a recorded preexisting DGBI diagnosis as well as the approximate baseline severity (with greater costs indicative of greater severity).

Statistical Analysis

Low levels of missingness were observed on the VT symptom measure and covariates (4% to 10%). Given the nature of the outcome data, it was not possible to differentiate missing expenditure data from a participant not having an expenditure. To account for missing survey data, all variables were imputed using the MICE package in R (n = 10 imputations).[63]

We first conducted univariate and bivariate analysis to examine the distribution of all variables, distributions across levels of VT symptoms, and their intercorrelations. We then used multilevel logistic regression with hospital units as random effects to account for clustering within shared work environments to examine the relationship between VT symptoms scores and odds of DGBI occurrence in the follow-up period. We assessed the relationship with a set of three models that progressively adjusted for additional covariates to assess their role in the relationship between VT symptoms and DGBI: model 1 assessed the crude association controlling only for time in the follow-up period; model 2 additionally controlled for demographic characteristics; and model 3 additionally controlled for structural components of work. To evaluate our exploratory hypothesis regarding the role of a supportive work environment in the relationship between VT symptoms and DGBIs, we assessed potential effect modification by each supportive work environment factor by individually adding an interaction term (either supervisor support × VT symptoms, coworker support × VT symptoms, or people-oriented culture × VT symptoms) while controlling for the other two supportive work environment variables. If we found no evidence of effect measure modification, we ran an additional model 4 that also controlled for supportive work environment factors. To identify potential nonmonotonic associations between VT symptoms and DGBI occurrence, we then repeated these analyses modeling VT symptoms as a categorical variable, comparing high and medium levels of VT symptoms to low levels of VT symptoms.

Sensitivity and Post Hoc Analyses

As a planned sensitivity analysis to reduce heterogeneity in the sample, we restricted the sample to only nurses and conducted the same regression analyses described above. As an additional sensitivity analysis, we calculated an e-value for model 4's main effects for the full sample. An e-value represents the minimum strength of association with both an exposure and outcome that an unmeasured confounder would require to either fully attenuate an observed estimate or move the confidence interval (CI) to contain the null.[64] Observing a notable increase in effect size when adding supportive work environment variables as well as the unexpected direction of effect for supervisor support and people-oriented culture, we calculated a variance inflation factor for model 4 as a post hoc analysis. A variance inflation factor can help identify potential issues regarding multicollinearity between variables that might make the model unstable and falsely inflate main effects.[65] As an additional post hoc sensitivity analysis, we restricted the sample to individuals with no baseline DGBI diagnosis and repeated regression analyses with VT symptoms modeled both as a continuous and categorical variable.

RESULTS

Of the 775 participants included in our sample, 679 (88%) were nurses, and 95 (12%) were PCAs (Table 1). The majority of the full sample identified as female (92%) and White (82%) and had at least a baccalaureate degree (70%). Nurses and PCAs significantly differed by all participant characteristics with the exception of people-oriented culture scores. One hundred twenty-five participants (16%) had a diagnosed DGBI prior to filling out the survey, and 75 participants (10%) had a DGBI in the follow-up period.

Distributions of participants with low, medium, and high VT symptoms were relatively consistent across variables, with a little more than half of participants endorsing having experienced a medium level of VT symptoms for each variable (Supplements 3, http://links.lww.com/JOM/B952). Of participants with prior DGBI, 28 (22%) had low VT symptoms, 71 (57%) had medium VT symptoms, and 23 (18%) had high VT symptoms. Among participants with DGBI in the follow-up period, 20 (27%) had low VT symptoms, 39 (52%) had medium VT symptoms, and 16 (21%) had high VT symptoms. Among those with no DGBI in either the preperiod or postperiod, 176 (31%) had low VT symptoms, 340 (59%) had medium VT symptoms, and 61 (11%) had high VT symptoms.

Main Effects: Vicarious Trauma Symptoms and DGBI Occurrence

Across models, continuous VT symptoms were associated with trends toward higher odds of DGBI occurrence, although no estimates reached statistical significance (Table 2). We found no evidence of effect measure modification with the supportive work environment variables (supervisor support, coworker support, and people-oriented culture). In a final model further adjusting simultaneously for elements of a supportive work environment, the odds of having at least one DBGI

TABLE 1. Participant Characteristics by Nurse and PCA Job Roles

Characteristics	Overall (n = 775)	Nurse (n = 680)	PCA (n = 95)	P*
Sex				<0.001
Female	709 (93%)	632 (94%)	78 (84%)	
Male	57 (7%)	42 (6%)	15 (16%)	
Age, y				0.01
<30	216 (28%)	197 (29%)	19 (21%)	
30–39	216 (28%)	198 (29%)	18 (20%)	
40–49	139 (17%)	112 (17%)	18 (20%)	
≥50	203 (27%)	168 (25%)	35 (39%)	
Education				<0.001
High school/GED or less	24 (3%)	0 (0%)	24 (25%)	
Some college	86 (11%)	40 (5.9%)	46 (48%)	
College	538 (70%)	516 (76%)	22 (23%)	
Graduate school	125 (16%)	122 (18%)	3 (3%)	
Racial/ethnic identity				<0.001
White	620 (82%)	596 (89%)	24 (28%)	
African American/Black	79 (10%)	36 (5%)	43 (49%)	
Asian	21 (3%)	17 (3%)	4 (5%)	
Latinx/Hispanic	26 (4%)	12 (2%)	14 (16%)	
Multiple identities/other	10 (1%)	8 (1%)	2 (2%)	
Hospital unit				
Adult ICU	14 (2%)	12 (2%)	2 (2%)	
Adult medical surgical units	365 (47%)	317 (47%)	48 (51%)	
ER	69 (9%)	62 (9%)	7 (7%)	
Float pool	21 (3%)	12 (2%)	9 (10%)	
OB-postpartum	57 (7%)	56 (8%)	1 (1%)	
OR	64 (8%)	47 (7%)	17 (18%)	
Orthopedics	21 (3%)	18 (3%)	3 (3%)	
Pediatric/neonatal ICU	147 (19%)	140 (21%)	7 (7%)	
Pediatric medical surgical units	10 (1%)	9 (1%)	1 (1%)	
Psychiatry	7 (1%)	7 (1%)	0 (0%)	
Hours worked per week				
<29	90 (12%)	83 (12%)	7 (7%)	
30–34	74 (10%)	70 (10%)	4 (4%)	
35–39	405 (52%)	386 (57%)	19 (20%)	
40–44	176 (23%)	120 (18%)	56 (60%)	
≥45	28 (3%)	20 (3%)	8 (9%)	
Usual shift				<0.001
Day	272 (35%)	230 (34%)	42 (44%)	
Evening	43 (6%)	26 (4%)	17 (18%)	
Night	169 (22%)	152 (22%)	17 (18%)	
Rotating	289 (37%)	270 (40%)	19 (20%)	
DGBI in postperiod				0.07
No DGBI	694 (90%)	614 (90%)	80 (84%)	
DGBI	81 (10%)	66 (10%)	15 (16%)	
Vicarious trauma symptoms (0–24)	11.20 (4.90)	11.6 (4.70)	8.40 (5.10)	<0.001
Job demands (0–24)	16.73 (2.78)	17.03 (2.51)	14.58 (3.57)	<0.001
Supervisor support (0–12)	8.42 (2.92)	8.29 (2.88)	9.36 (3.01)	<0.001
Coworker support (0–12)	8.18 (2.42)	8.24 (2.27)	7.74 (3.29)	0.49
People oriented culture (0–16)	11.00 (2.80)	11.0 (2.80)	10.50 (2.90)	0.07

Values are presented as n (%) or mean (standard deviation).

*Fisher exact test, Pearson χ^2 test, Wilcoxon rank sum test.

PCA, patient care associate; ICU, intensive care unit; DGBI, disorders of gut-brain interaction; ER, emergency room; OB, obstetrics.

in the follow-up period increased 4% for every one-point increase in VT symptoms score (95% CI, 0.98, 1.11; $P = 0.17$).

When comparing high or medium levels of VT symptoms versus low levels, the odds of having DGBI nearly doubled for participants with high VT symptom levels when progressively controlling for demographics, baseline DGBI, and work structure, and this result trended toward significance (Table 3). Again, we found no evidence of effect modification by supportive work environment. After further adjusting simultaneously for elements of a supportive work environment, the conditional odds of developing DGBI for participants with high VT symptoms was 3.40 times higher (95% CI, 1.44 to 8.06; $P = 0.01$) compared with participants with low levels.

Sensitivity and Post Hoc Analyses

When restricted to be a more homogenous sample of nurses and progressively controlling for demographics, baseline DGBI, work structure, and—after finding no evidence of effect modification—supportive work environment, we observed a similar relationship between VT symptoms (modeled both continuously and categorically) and

TABLE 2. Prospective Relationship Between VT Symptoms Score and DGBI Occurrence With Full Sample (n = 775)

	Model 1			Model 2			Model 3			Model 4		
Characteristics	**OR**	**95% CI**	***P***	**OR**	**95% CI**	***P***	**OR**	**95% CI**	***P***	**OR**	**95% CI**	***P***
VT symptoms	1.01	0.96, 1.06	0.77	1.01	0.96, 1.07	0.74	1.01	0.96, 1.07	0.66	1.04	0.98, 1.11	0.17
Days in follow-up period	0.95	0.63, 1.44	0.81	0.90	0.59, 1.37	0.62	0.90	0.58, 1.38	0.63	0.96	0.62, 1.49	0.86
Age (ref: <30)				1.60	0.83, 3.07	0.16	1.62	0.82, 3.21	0.17	1.70	0.84, 3.44	0.14
30–39												
40–49				1.17	0.52, 2.63	0.70	1.19	0.51, 2.80	0.69	1.33	0.56, 3.18	0.52
≥50				0.99	0.46, 2.12	0.98	0.91	0.41, 2.06	0.83	1.10	0.47, 2.50	0.54
Sex (ref: male)				1.17	0.40, 3.44	0.78	1.52	0.50, 4.65	0.47	1.43	0.46, 4.58	0.40
Female												
Race (ref: White)				1.21	0.48, 3.03	0.69	1.80	0.64, 5.11	0.27	1.54	0.56, 4.23	0.40
Non-White												
Baseline DGBI costs				1.00	1.00, 1.00	0.03	1.00	1.00,1.00	0.02	1.00	1.00, 1.00	0.03
Hospital (ref: smaller, unionized)							0.69	0.38, 1.25	0.22	0.70	0.39, 1.26	0.23
Larger, non-unionized												
Hours per week (ref: <40)							1.78	0.92, 3.46	0.09	1.64	0.84, 3.19	0.15
>40												
Usual shift (ref: day)							1.31	0.68, 2.52	0.43	1.49	0.76, 2.92	0.25
Evening/night												
Rotating							0.99	0.50, 2.01	0.98	1.05	0.45, 2.15	0.89
Job role (ref: nurse)							1.44	0.55, 3.78	0.46	1.21	0.90, 3.21	0.70
PCA												
Job demands							1.05	0.95, 1.16	0.37	1.01	0.91, 1.12	0.91
Supervisor support										1.11	0.98, 1.26	0.10
Coworker support										0.94	0.82, 1.08	0.39
People-oriented culture										1.09	0.95, 1.25	0.20

VT, vicarious trauma (score range, 0–24); DGBI, disorders of gut-brain interaction; OR, odds ratio; CI, confidence interval; ref, reference group; PCA, patient care associate.

DGBI as with the full sample (Supplements 4 and 5, http://links.lww.com/JOM/B952). Next, we calculated an e-value for model 4 for when VT symptoms were modeled as continuous and categorical variables with the full sample. When VT symptoms were modeled as continuous, we found that an unmeasured confounder would need to be associated with both VT symptoms and DGBI by an odds ratio (OR) of at

TABLE 3. Prospective Relationship Between Levels of VT Symptoms and DGBI Occurrence With Full Sample (n = 775)

	Model 1			Model 2			Model 3			Model 4		
Characteristics	**OR**	**95% CI**	***P***	**OR**	**95% CI**	***P***	**OR**	**95% CI**	***P***	**OR**	**95% CI**	***P***
VT symptoms (reference: low)	0.96	0.54, 1.70	0.89	0.97	0.52, 1.81	0.93	0.95	0.50, 1.81	0.89	1.18	0.61, 2.30	0.62
Medium												
High	1.91	0.92, 3.97	0.08	1.94	0.89, 4.21	0.09	2.07	0.94, 4.62	0.07	3.40	1.44, 8.06	0.01
Days in follow-up period	0.99	0.66, 1.50	0.97	0.93	0.61, 1.42	0.74	0.94	0.61, 1.45	0.78	1.00	0.64, 1.54	0.99
Age (ref: <30)				1.60	0.83, 3.07	0.16	1.62	0.82, 3.20	0.17	1.72	0.85, 3.46	0.13
30–39												
40–49				1.12	0.50, 2.49	0.79	1.12	0.48, 2.62	0.79	1.31	0.55, 3.11	0.54
≥50				0.98	0.46, 2.10	0.97	0.91	0.40, 2.04	0.81	1.09	0.47, 2.49	0.84
Sex (ref: male)				1.17	0.40, 3.43	0.77	1.56	0.51, 4.78	0.43	1.50	0.48, 4.71	0.48
Female												
Race (ref: White)				1.18	0.47, 2.95	0.72	1.83	0.64, 5.19	0.26	1.60	0.58, 4.40	0.36
Non-White												
Baseline DGBI costs				1.00	1.00, 1.00	0.01	1.00	1.00, 1.00	0.01	1.00	1.00, 1.00	0.01
Hospital (ref: smaller, unionized)							0.70	0.39, 1.25	0.23	0.70	0.40, 1.23	0.21
Larger, non-unionized												
Hours per week (ref: <40)							1.84	0.95, 3.56	0.07	1.67	0.88, 3.18	0.12
>40												
Usual shift (ref: day)							1.38	0.71, 2.67	0.34	1.61	0.82, 3.16	0.16
Evening/night												
Rotating							0.99	0.49, 1.90	0.97	1.07	0.54, 2.14	0.84
Job role (ref: nurse)							1.43	0.55, 2.77	0.46	0.99	0.44, 3,09	0.76
PCA												
Job demands							1.04	0.95, 1.15	0.39	1.13	0.89, 1.10	0.91
Supervisor support										1.13	1.00, 1.28	0.06
Coworker support										0.94	0.82, 1.09	0.42
People-oriented culture										1.10	0.96, 1.26	0.17

VT, vicarious trauma (low: 0–8 points, medium: 9–16 points, high: 17–24 points); DGBI, disorders of gut-brain interaction; OR, odds ratio; CI, confidence interval; ref, reference group; PCA, patient care associate.

least 1.28 in order to fully attenuate the observed association between VT symptoms and DGBI. As this result was not statistically significant, no additional unmeasured confounding would be required to move the CI to contain the null. However, when VT symptoms were modeled categorically, an unmeasured confounder would require an OR of 6.38 to fully attenuate the results. To move the CI to include the null (lower bound of 95% CI), an unmeasured confounder associated with both VT symptoms and DGBI would require an OR of 2.21.

Across analyses, when supportive work environment variables were included in model 4 (Tables 2-3, Supplements 4 to 5, http://links.lww.com/JOM/B952), the association between VT symptoms and DGBIs increased, especially when VT symptoms were modeled as a categorical variable. It is also worth noting that higher levels of supervisor support and people-oriented culture were associated with increased odds of a new DGBI claim in these models, and the direction of this effect was unexpected. For example, when adjusting for categorical VT symptoms with the full sample, the conditional odds of DGBI increased 13% for every one-point increase in supervisor support (95% CI, 1.00 to 1.28; $P = 0.06$) and 10% for every one-point increase in people-oriented culture (95% CI, 0.96 to 1.26; $P = 0.17$) (Table 3). In light of these findings, we conducted additional analyses to identify if supervisor support and people-oriented culture functioned as suppressor variables. We first reviewed bivariate analyses, which indicated that VT symptoms were positively correlated with DGBI occurrence, but this correlation was relatively weak ($r = 0.02$). A stronger, negative correlation was observed between VT symptoms and supervisor support ($r = -0.34$), coworker support ($r = -0.28$), and people-oriented culture ($r = -0.27$). Supervisor support ($r = 0.05$) and people-oriented culture ($r = 0.02$) were weakly positively associated with DGBI occurrence, whereas coworker support had no substantive correlation with DGBIs. As a second step, we calculated variance inflation factors for the fully adjusted models that included supportive work environment variables. The variance inflation factors for covariates ranged from 1.06 to 1.90 and 1.06 to 1.91 when modeling VT symptoms continuously and categorically respectively, indicating minimal multicollinearity. Thus, it appears that supervisor support and people-oriented culture effectively mask the relationship between VT symptoms and DGBI, and by including them in the model, the strength of the relationship between VT symptoms and DGBI can be more clearly observed.

As a final post hoc analysis, we restricted the sample to participants without baseline DGBI diagnosis (n = 650) and reran our increasingly adjusted set of regression analyses (Table 4). In the fully adjusted model, we again observed similar relationships between continuous VT symptoms and DGBI in the follow-up period (OR, 1.05; 95% CI, 0.97 to 1.13; $P = 0.24$) and when comparing a high level of VT symptoms to low (OR, 4.16; 95% CI, 1.57 to 11.60; $P = 0.005$). Associations were also stronger in the fourth model when supportive work environment covariates were added.

DISCUSSION

In this study, we investigated the prospective relationship between VT symptoms with DGBI occurrence in health claims data over an approximately 1-year period among nurses and PCAs at two large urban hospitals. To our knowledge, this is the first study to assess the prospective relationship between VT and workers' physical health outcomes. Previous studies have found VT symptoms to be significantly associated with worker mental health problems, namely, depression, anxiety, and PTSD.[13,17,18] Two cross-sectional studies have found significant associations between VT symptoms and self-appraised general health.[16,28] This study adds to the growing body of literature investigating how occupational VT affects the health of helping professionals, such as nurses and PCAs, by expanding this line of inquiry to assess prospectively how VT symptoms may adversely affect workers' GI health.

Although we observed a somewhat weak effect of VT symptoms on DGBI when VT symptoms were modeled continuously, when considering VT symptoms as a categorical variable, the conditional odds of developing a DGBI in the follow-up period were 3.40 times higher for participants with high levels of VT symptoms compared with participants with low levels. Such findings may suggest the association of VT symptoms with subsequently occurring DGBI is likely not monotonic, whereby high levels of VT symptoms may be particularly toxic to workers compared with low levels. These results were robust to a number of sensitivity analyses (Fig. 3), including when restricted to only nurses and among participants without a documented baseline DGBI, the latter indicating VT symptoms may have similar effects on DGBI across the workforce and not only individuals who may be more susceptible. Although CIs were wide due to few participants with high VT symptom levels having DGBIs (ie, a rare outcome), e-value calculations indicated that a substantial amount of unmeasured confounding would be required to fully attenuate these results. Thus, this analysis suggests the effects of VT may have a "long arm"; VT symptoms appear to adversely affect not only the mental health of professionals who work with trauma survivors as previous studies have demonstrated, but also their physical health.

Understanding the Role of Supportive Work Environments: Potential Suppressor Effects

In this study, we did not observe evidence of effect modification by any of the supportive work environment elements (supervisor support, coworker support, or people-oriented culture). Because identification of effect measure modification often requires higher statistical power than that required for main effects[66] and considering the theoretical likelihood based on stress and trauma literature,[50] it is possible that elements of a supportive work environment do effectively modify this relationship. Future studies with sufficient statistical power should continue to evaluate these relationships.

That said, supervisor support and people-oriented culture acted as suppressors in the relationship between VT symptoms and DGBIs in the current study, and without their inclusion in the models, this relationship was partially masked.[65] Social support suppressor effects are not rare in studies investigating the relationship between stress and health and can indicate how individuals' appraisal of available social support can positively and uniformly increase when faced with stressors.[50] Thus, including supervisor support and people-oriented culture may enhance accuracy and help to identify the true magnitude of the relationship between VT symptoms and DGBIs, and this may be true for other health outcomes, as well.

It is worth noting that in the fully adjusted models, the correlation between increased supervisor support and odds of DGBI trended toward significance. This seemingly counterintuitive direction may be explained by previous studies finding that employees who work in more supportive environments have increased healthcare utilization, likely due to increased workplace flexibility and encouragement to attend to personal health needs.[67,68] In this analysis, a participant was identified as having the outcome of interest (a DGBI) only if they had received medical care for that diagnosis, because the outcome was identified using insurance data. Therefore, workers with supportive supervisors may be more likely to receive a DGBI diagnosis compared with workers with comparable DGBI issues, but whose less supportive supervisors acted as a barrier to receiving care.

Study Strengths, Limitations, and Considerations

As a novel exploration of the relationship between occupational VT symptoms and common GI disorders, this study has several strengths. To date, most research on health effects of VT symptoms have focused on mental health and on general physical health assessed via self-report measured at the same time as VT symptoms. Such associations may be subject to concerns about reporting bias and reverse

TABLE 4. Relationship between VT Symptoms Scores and Levels With DGBI Occurrence Among Participants Without History of DGBI (n = 650)

	VT Symptoms Modeled Continuously				VT Symptoms Modeled Categorically		
Characteristics	**OR**	**95% CI**	***P***		**OR**	**95% CI**	***P***
VT symptoms	1.05	0.97, 1.13	0.24	VT symptoms (reference: low)			
				Medium	1.01	0.46, 2.24	0.98
				High	4.16	1.53, 11.35	0.005
Days in follow-up period	1.07	0.61, 1.82	0.85		1.11	0.65, 1.91	0.70
Age (ref: <30)							
30–39	1.69	0.71, 4.03	0.24		1.80	0.76, 4.28	0.18
40–49	1.65	0.58, 4.67	0.34		1.74	0.62, 4.91	0.29
≥50	1.41	0.51, 3.69	0.54		1.42	0.54, 3.76	0.48
Sex (ref: male)							
Female	2.24	0.46, 10.55	0.32		2.38	0.51, 11.05	0.27
Race (ref: White)							
Non-White	0.92	0.00, Inf	1.00		2.34	0.00, Inf.	0.95
Hospital (ref: smaller, unionized)							
Larger, non-unionized	0.81	0.38, 1.69	0.56		0.81	0.40, 1.63	0.55
Hours worked per week (ref: <40)							
>40	1.07	0.45, 2.44	0.91		1.10	0.48, 2.52	0.82
Usual shift (ref: day)							
Evening/night	1.81	0.82, 3.93	0.14		2.01	0.92, 4.38	0.08
Rotating	0.95	0.41, 2.36	0.97		1.02	0.43, 2.40	0.97
Job role (ref: nurse)							
PCA	1.25	0.40, 3.95	0.70		1.18	0.38, 3.65	0.77
Job demands	0.97	0.86, 1.10	0.65		0.95	0.84, 1.08	0.43
Supervisor support	1.11	0.95, 1.8	0.18		1.12	0.96, 1.29	0.14
Coworker support	0.83	0.75, 1.04	0.14		0.88	0.75, 1.04	0.14
People-oriented culture	1.08	0.92, 1.26	0.34		1.10	0.94, 1.28	0.24

VT, vicarious trauma (score range: 0–24, low VT: 0–8 points, medium VT: 9–16 points, high VT: 17–24 points); DGBI, disorders of gut-brain interaction; OR, odds ratio; CI, confidence interval; ref, reference group; PCA, patient care associate.

causation. In contrast, we measured DGBIs using workers' health claims data, providing an objective health indicator. DGBIs were also measured prospectively with respect to assessment of VT symptoms, allowing us to preserve the temporal relationship between VT symptoms and DGBI occurrence, thereby mitigating concerns about reverse causation. In addition, VT symptoms were assessed within a survey that contained a wide array of other structural and psychosocial work factors, allowing us to control for many potential confounders in our analysis.

That said, it is important to acknowledge several limitations of the data. First, VT symptoms were estimated using a brief six-item measure. While the measure appears psychometrically strong in this

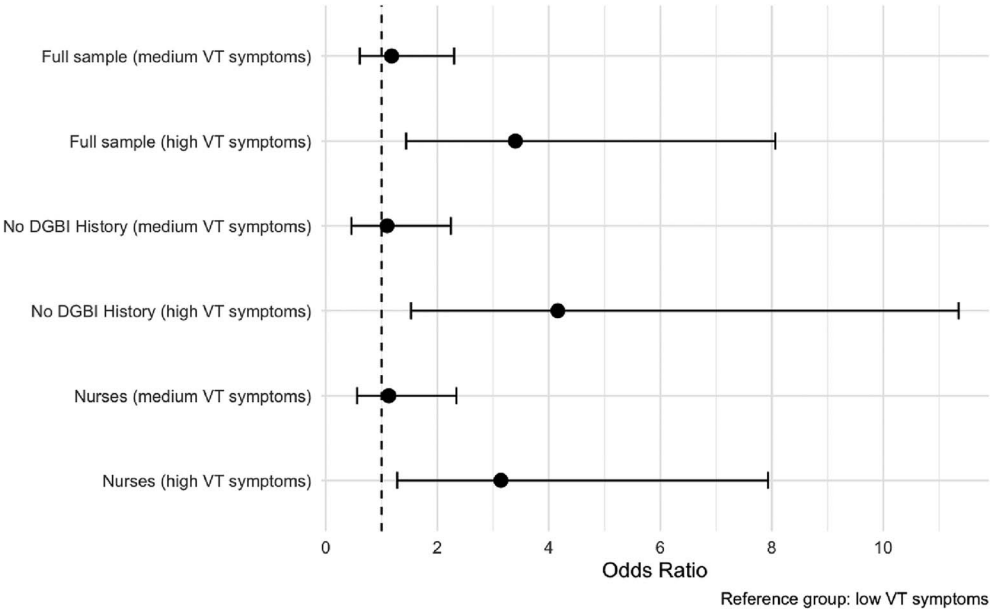

FIGURE 3. Comparison of the relationship between vicarious trauma (VT) symptoms and disorders of gut-brain interaction across samples (conditional odds ratios and confidence intervals).

sample, we did observe potential ceiling effects indicated by the left skew of score distribution. Thus, an instrument with greater scale range and question detail may yield more accurate estimates. Relatedly, the VT symptom categorical variable was based on three a priori–defined even cut points; future research should consider validating these cut points. Second, our data did not allow us to control for job tenure or past personal trauma, which may have confounded the observed relationship. That said, we were able to adjust for a number of other important demographic and work-related variables. In addition, our e-value calculations indicate that a potential confounder would require an OR of 6.38 to fully attenuate the observed relationship—an OR that is substantially higher than any other point estimate in the models. Third, our sample of hospital workers was predominately White and female. Although this demographic makeup may be similar to the US nursing workforce,[69] it does limit generalizability to other workers. Fourth, our sample also comprised individuals who subscribed to one of the healthcare plans provided by the hospital employer in the follow-up period, and we excluded workers who received their insurance elsewhere and who may therefore be a slightly different population. Additionally, not all participants subscribed to the health plans for all or part of the presurvey period. Nonetheless, we were able to control for documented DGBIs for most individuals who did have a health plan all or part of the time before survey administration (96% of sample).

It is also important to note that DGBIs were assessed using *ICD-10* codes in workers' health expenditure data. Many DGBIs are never documented in health claims data as individuals self-treat with over-the-counter medicines (especially if they experience only mild symptoms),[37] which these data cannot capture. Workers must also take the time to visit a doctor in order to receive a diagnosis. Thus, our estimate of DGBIs in both the preperiod and postperiod is likely an undercount of the true occurrence in this sample, which was comparatively less than other population assessments.[38] Notwithstanding, previous research indicates that among populations with greater access to healthcare services (such as insured hospital workers in this study), there is no difference in DGBIs between those who seek medical care and those who do not, minimizing the potential effect of confounding.[37] In addition, DGBI "flares" usually occur every few weeks, and most of these patients receive care annually, and as such, an individual who seeks DGBI medical care would likely have done so in the 1.5- to 2-year preperiod for which we were able to adjust for the vast majority of participants.[34,36] Lastly, it is also important to recognize the likely impact of the healthy worker survivor effect on this sample. That is, workers with high levels of VT or higher rates of DGBIs may be more likely to leave their jobs than workers with lower levels. This selection bias, if present, could attenuate associations, suggesting that our observed associations may be a conservative estimate of the effect.[70]

Considering Vicarious Trauma and Worker Health in Healthcare Organizations

Given the relationship we observed between VT symptoms and GI health in this study, coupled with earlier studies indicating VT symptoms increase symptoms of poor mental health, job dissatisfaction, and turnover among workers,[13,15,18] we believe healthcare organization would benefit from identifying ways to either reduce workers' VT exposure or mitigate symptoms. This is likely beneficial not only for workers, but also for patients. Hospital workers' mental and physical health challenges can contribute to absence and workforce turnover, which in turn can drive job vacancies and workforce shortages,[5,10,11,71,72] which can be quite costly to organizations.[73] In recognition of the integral role worker health and well-being plays in healthcare delivery, the Institute of Medicine has amended its "Triple Aim" of improving patient experiences, advancing population health, and reducing healthcare cost to also prioritize healthcare worker well-being as part of a new "Quadruple Aim."[74]

Reducing VT exposure or addressing symptoms can theoretically be done in two ways. One strategy is to encourage workers to practice individual-level interventions, such as mindfulness.[46] Although this may be effective in reducing VT symptoms for certain individuals, workers do not always have control of their shifts, breaks, and spaces needed for this practice. In addition, this approach is likely to engage the few motivated individuals willing to engage in such interventions, but miss many workers impacted by VT symptoms. A second approach involves developing organizational interventions, and such "upstream" interventions hold the potential to reach a larger proportion of the workers.[48,49] Specific evidence-based VT organizational interventions are lacking and require future intervention research.[46] However, effective interventions to build trust and worker voice in interpersonal supervisory and coworker relationships and within larger organizational cultures—key features of supportive work environments—do exist and may be effective in reducing the effects of VT.[47,75–78] Dedicated time and spaces for structured trauma debriefing with trained trauma facilitators—established interventions for direct trauma—may also reduce the effects of secondary trauma.[78] Interventions that decrease "dose" of exposure, such as with shift rotation, may also be effective.[79]

CONCLUSION

By virtue of their work with patients, families, and communities who have experienced trauma, hospital workers are at risk for VT, which has been shown to adversely affect worker mental health, performance, turnover, and, in this study, development of common GI disorders, such as DGBIs. Findings from this study indicate that individuals experiencing high levels of VT symptoms had significantly increased odds of developing common GI disorders, such as gastroesophageal reflux disease, function dyspepsia, and irritable bowel syndrome, compared with those with low levels. The relationship between VT symptoms and these GI outcomes was partially masked by elements of a supportive work environment, indicating that accounting for the environments in which workers spend their time is critical for investigating the relationship between VT and health. Considering the prevalence of VT in hospital work environments, the prevalence of DGBIs, and the likely costs to employers associated with these conditions, healthcare organizations should consider testing organizational interventions to reduce VT exposure, such as shift rotation, or mitigate its effects, such as dedicated time and spaces for structured trauma debriefing and developing policies and practices that foster worker voice and interpersonal support.

ACKNOWLEDGMENTS

The authors thank those who participated in the 2018 BHWHS worker survey.

REFERENCES

1. Bureau of Labor Statistics. *Occupational Outlook Handbook, Medical Assistants*. US Department of Labor; 2020: Accessed November 17, 2020. Available at: https://www.bls.gov/ooh/healthcare/registered-nurses.htm.
2. Bureau of Labor Statistics. *Occupational Outlook Handbook, Nursing Assistants and Orderlies*. US Department of Labor; 2020: Accessed November 17, 2020. Available at: https://www.bls.gov/ooh/healthcare/registered-nurses.htm.
3. Bureau of Labor Statistics. *Occupational Outlook Handbook, Registered Nurses*. US Department of Labor; 2020: Accessed November 17, 2020. Available at: https://www.bls.gov/ooh/healthcare/registered-nurses.htm.
4. American Nurses Association. What is nursing. 2023. Accessed January 24, 2023. Available at: https://www.nursingworld.org/practice-policy/workforce/what-is-nursing/.
5. Engström M, Mårtensson G, Pålsson Y, Strömberg A. What relationships can be found between nurses' working life and turnover? A mixed-methods approach. *J Nurs Manag* 2022;30:288–297.
6. Hopcia K, Dennerlein JT, Hashimoto D, Orechia T, Sorensen G. Occupational injuries for consecutive and cumulative shifts among hospital registered nurses and patient care associates: a case-control study. *Workplace Health Saf* 2012; 60:437–444.

7. Harris R, Sims S, Parr J, Davies N. Impact of 12h shift patterns in nursing: a scoping review. *Int J Nurs Stud* 2015;52:605–634.
8. Hall LH, Johnson J, Watt I, Tsipa A, O'Connor DB. Healthcare staff wellbeing, burnout, and patient safety: a systematic review. *PLoS One* 2016;11:e0159015.
9. Liu J, Gan Y, Jiang H, et al. Prevalence of workplace violence against healthcare workers: a systematic review and meta-analysis. *Occup Environ Med* 2019;76: 927–937.
10. Ki J, Choi-Kwon S. Health problems, turnover intention, and actual turnover among shift work female nurses: analyzing data from a prospective longitudinal study. *PLoS One* 2022;17:e0270958.
11. Lavoie-Tremblay M, Gélinas C, Aubé T, et al. Influence of caring for COVID-19 patients on nurse's turnover, work satisfaction and quality of care. *J Nurs Manag* 2022;30:33–43.
12. Isobel S, Thomas M. Vicarious trauma and nursing: an integrative review. *Int J Ment Health Nurs* 2022;31:247–259.
13. Molnar BE, Sprang G, Killian KD, Gottfried R, Emery V, Bride B. Advancing science and practice for vicarious traumatization/secondary traumatic stress: a research agenda. *Dent Traumatol* 2017;23:129–142.
14. Beck CT, Gable RK. A mixed methods study of secondary traumatic stress in labor and delivery nurses. *J Obstet Gynecol Neonatal Nurs* 2012;41:747–760.
15. Bride B, Kintzle S. Secondary traumatic stress, job satisfaction, and occupational commitment in substance abuse counselors. *Dent Traumatol* 2011;17:22–28.
16. Lee JJ, Gottfried R, Bride B. Exposure to client trauma, secondary traumatic stress, and the health of clinical social workers: a mediation analysis. *Clin Soc Work J* 2018;46:228–235.
17. Ludick M, Figley CR. Toward a mechanism for secondary trauma induction and reduction: reimagining a theory of secondary traumatic stress. *Dent Traumatol* 2017;23:112–123.
18. Molnar BE, Meeker SA, Manners K, et al. Vicarious traumatization among child welfare and child protection professionals: a systematic review. *Child Abuse Negl* 2020;110:104679.
19. Velasco J, Sanmartín FJ, Gálvez-Lara M, Cuadrado F, Moriana JA. Psychological effects of professional exposure to trauma and human suffering: systematic review and meta-analysis. *Trauma Violence Abuse* 2023;24:1656–1676.
20. Hughes K, Bellis MA, Hardcastle KA, et al. The effect of multiple adverse childhood experiences on health: a systematic review and meta-analysis. *Lancet Public Health* 2017;2:e356–e366.
21. Pacella ML, Hruska B, Delahanty DL. The physical health consequences of PTSD and PTSD symptoms: a meta-analytic review. *J Anxiety Disord* 2013; 27:33–46.
22. Brotman DJ, Golden SH, Wittstein IS. The cardiovascular toll of stress. *Lancet* 2007;370:1089–1100.
23. Godbout JP, Glaser R. Stress-induced immune dysregulation: implications for wound healing, infectious disease and cancer. *J Neuroimmune Pharmacol* 2006;1:421–427.
24. Sowder KL, Knight LA, Fishalow J. Trauma exposure and health: a review of outcomes and pathways. *J Aggress Maltreat Trauma* 2018;27:1041–1059.
25. Cohen S, Kessler RC, Gordon LU. Strategies for measuring stress in studies of psychiatric and physical disorders. In: Cohen S, Kessler RC, Gordon LU, eds. *Measuring Stress: A Guide of Health and Social Sciences*. New York, NY: Oxford University Press; 1995:3–26.
26. Bride B, Robinson M, Yegidis B, Figley C. Development and validation of the Secondary Traumatic Stress Scale. *Res Soc Work Pract* 2004;14:27–35.
27. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 5th ed. Washington DC: American Psychiatric Association; 2013.
28. Ruiz-Fernández MD, Ortega-Galán ÁM, Fernández-Sola C, Hernández-Padilla JM, Granero-Molina J, Ramos-Pichardo JD. Occupational factors associated with health-related quality of life in nursing professionals: a multi-centre study. *Int J Environ Res Public Health* 2020;17:982.
29. Wills TA, Sandy JM, Yaeger AM. Stress and smoking in adolescence: a test of directional hypotheses. *Health Psychol* 2002;21:122–130.
30. Macleod J, Davey Smith G. Psychosocial factors and public health: a suitable case for treatment? *J Epidemiol Community Health* 2003;57:565–570.
31. Huerta-Franco MR, Vargas-Luna M, Tienda P, Delgadillo-Holtfort I, Balleza-Ordaz M, Flores-Hernandez C. Effects of occupational stress on the gastrointestinal tract. *World J Gastrointest Pathophysiol* 2013;4:108–118.
32. Nam Y, Kwon SC, Lee YJ, Jang EC, Ahn SH. Relationship between job stress and functional dyspepsia in display manufacturing sector workers: a cross-sectional study. *Ann Occup Environ Med* 2018;30:62.
33. Chang L. The role of stress on physiologic responses and clinical symptoms in irritable bowel syndrome. *Gastroenterology* 2011;140:761–765.e5.
34. Black CJ, Drossman DA, Talley NJ, Ruddy J, Ford AC. Functional gastrointestinal disorders: advances in understanding and management. *Lancet* 2020;396:1664–1674.
35. Ballou S, Feingold JH. Stress, resilience, and the brain-gut axis: why is psychogastroenterology important for all digestive disorders? *Gastroenterol Clin North Am* 2022;51:697–709.
36. Palsson OS, Baggish J, Whitehead WE. Episodic nature of symptoms in irritable bowel syndrome. *Am J Gastroenterol* 2014;109:1450–1460.
37. Chang S, Jones M. Consulters and nonconsulters in irritable bowel syndrome: what makes an IBS patient a patient? *Pract Gastroenterol* 2003;27:15–26.
38. Sperber AD, Bangdiwala SI, Drossman DA, et al. Worldwide prevalence and burden of functional gastrointestinal disorders, results of Rome Foundation Global Study. *Gastroenterology* 2021;160:99–114.e3.
39. Joish VN, Donaldson G, Stockdale W, et al. The economic impact of GERD and PUD: examination of direct and indirect costs using a large integrated employer claims database. *Curr Med Res Opin* 2005;21:535–543.
40. Makker J, Chilimuri S, Bella J. Genetic epidemiology of irritable bowel syndrome. *World J Gastroenterol* 2015;21:11353–11361.
41. Lembo A, Zaman M, Jones M, Talley NJ. Influence of genetics on irritable bowel syndrome, gastro-oesophageal reflux and dyspepsia: a twin study. *Aliment Pharmacol Ther* 2007;25:1343–1350.
42. Zhong L, Liang Y, Chu H, et al. Potential risk factors of disorders of gut-brain interaction in undergraduates and postgraduates: partially mediated by life stress and lifestyle. *Dig Dis* 2024;42:391–398.
43. Koenen KC, Sumner JA, Gilsanz P, et al. Post-traumatic stress disorder and cardiometabolic disease: improving causal inference to inform practice. *Psychol Med* 2017;47:209–225.
44. Ditzen B, Heinrichs M. Psychobiology of social support: the social dimension of stress buffering. *Restor Neurol Neurosci* 2014;32:149–162.
45. Molina-Praena J, Ramirez-Baena L, Gómez-Urquiza JL, Cañadas GR, de la Fuente EI, Cañadas-de la Fuente GA. Levels of burnout and risk factors in medical area nurses: a meta-analytic study. *Int J Environ Res Public Health* 2018;15:2800.
46. Kim J, Chesworth B, Franchino-Olsen H, Macy RJ. A scoping review of vicarious trauma interventions for service providers working with people who have experienced traumatic events [published online March 9, 2021]. *Trauma Violence Abuse* 2022;23:1437–1460.
47. Sutton L, Rowe S, Hammerton G, Billings J. The contribution of organisational factors to vicarious trauma in mental health professionals: a systematic review and narrative synthesis. *Eur J Psychotraumatol* 2022;13:2022278.
48. Barrientos-Trigo S, Vega-Vázquez L, de Diego-Cordero R, Badanta-Romero B, Porcel-Gálvez AM. Interventions to improve working conditions of nursing staff in acute care hospitals: scoping review. *J Nurs Manag* 2018;26:94–107.
49. De Simone S, Vargas M, Servillo G. Organizational strategies to reduce physician burnout: a systematic review and meta-analysis. *Aging Clin Exp Res* 2021;33:883–894.
50. Wheaton B. Models for the stress-buffering functions of coping resources. *J Health Soc Behav* 1985;26:352–364.
51. Sabbath EL, Hashimoto D, Boden LI, et al. Cohort profile: the Boston Hospital Workers Health Study (BHWHS). *Int J Epidemiol* 2018;47:1739–1740g.
52. Sabbath EL, Pan Y, McTernan ML, et al. Adding injury to insult: unfair treatment at work and occupational injury among hospital patient-care workers [published online May 13, 2024]. *Am J Ind Med* 2024;67:667–676.
53. Vrklevski LP, Franklin J. Vicarious trauma: the impact on solicitors of exposure to traumatic material. *Dent Traumatol* 2008;14:106–118.
54. Benuto L, Singer J, Cummings C, Ahrendt A. The vicarious trauma scale: confirmatory factor analysis and psychometric properties with a sample of victim advocates. *Health Soc Care Community* 2018;26:564–571.
55. Aparicio E, Michalopoulos LM, Unick GJ. An examination of the psychometric properties of the vicarious trauma scale in a sample of licensed social workers. *Health Soc Work* 2013;38:199–206.
56. Kessler RC, Andrews G, Colpe LJ, et al. Short screening scales to monitor population prevalences and trends in non-specific psychological distress. *Psychol Med* 2002;32:959–976.
57. West CP, Dyrbye LN, Satele DV, Sloan JA, Shanafelt TD. Concurrent validity of single-item measures of emotional exhaustion and depersonalization in burnout assessment. *J Gen Intern Med* 2012;27:1445–1452.
58. Drossman DA, Tack J. Rome Foundation clinical diagnostic criteria for disorders of gut-brain interaction. *Gastroenterology* 2022;162:675–679.
59. López Gómez MA, Sabbath E, Boden L, et al. Organizational and psychosocial working conditions and their relationship with mental health outcomes in patient-care workers. *J Occup Environ Med* 2019;61:e480–e485.
60. Maglalang DD, Katigbak C, Gómez MAL, et al. Workplace discrimination and short sleep among healthcare workers: the buffering effect of people-oriented culture. *J Occup Environ Med* 2021;63:857–864.
61. Amick BC, Habeck RV, Hunt A, et al. Measuring the impact of organizational behaviors on work disability prevention and management [published online 2000]. *J Occup Rehabil*.
62. Karasek R, Brisson C, Kawakami N, Houtman I, Bongers P, Amick B. The Job Content Questionnaire (JCQ): an instrument for internationally comparative assessments of psychosocial job characteristics. *J Occup Health Psychol* 1998;3:322–355.

63. Buuren SV, Groothuis-Oudshoorn K. mice: Multivariate imputation by chained equations in R. *J Stat Soft* 2011;45. doi:10.18637/jss.v045.i03
64. VanderWeele TJ, Ding P. Sensitivity analysis in observational research: introducing the e-value. *Ann Intern Med* 2017;167:268–274.
65. Akinwande MO, Dikko HG, Samson A. Variance inflation factor: as a condition for the inclusion of suppressor variable(s) in regression analysis. *OJS* 2015;05: 754–767.
66. Greenland S. Basic problems in interaction assessment. *Environ Health Perspect* 1993;101 Suppl 4(Suppl 4):59–66.
67. Butler AB, Grzywacz JG, Ettner SL, Liu B. Workplace flexibility, self-reported health, and health care utilization. *Work Stress* 2009;23:45–59.
68. Sabbath EL, Sparer EH, Boden LI, et al. Preventive care utilization: association with individual- and workgroup-level policy and practice perceptions. *Prev Med* 2018;111:235–240.
69. Bureau of Labor Statistics. *Labor Force Characteristics by Race and Ethnicity.*; 2019. Accessed September 13, 2020. Available at: https://www.bls.gov/opub/reports/race-and-ethnicity/2018/pdf/home.pdf.
70. Li CY, Sung FC. A review of the healthy worker effect in occupational epidemiology. *Occup Med* 1999;49:225–229.
71. NSI Nursing Solutions, Inc. *2022 NSI National Health Care Retention & RN Staffing Report*. 2022. Accessed March 14, 2022. Available at: https://www.nsinursingsolutions.com/Documents/Library/NSI_National_Health_Care_Retention_Report.pdf.
72. Brewer CS, Kovner CT, Greene W, Tukov-Shuser M, Djukic M. Predictors of actual turnover in a national sample of newly licensed registered nurses employed in hospitals. *J Adv Nurs* 2012;68:521–538.
73. Jones C, Gates M. The costs and benefits of nurse turnover: a business case for nurse retention. *Online J Issues Nurs* 2007;12. doi:10.3912/OJIN.Vol12No03Man04.
74. Bodenheimer T, Sinsky C. From Triple to Quadruple Aim: care of the patient requires care of the provider. *Ann Fam Med* 2014;12:573–576.
75. Choi GY. Organizational impacts on the secondary traumatic stress of social workers assisting family violence or sexual assault survivors. *Adm Soc Work* 2011;35:225–242.
76. Slattery SM, Goodman LA. Secondary traumatic stress among domestic violence advocates: workplace risk and protective factors. *Violence Against Women* 2009;15:1358–1379.
77. McLellan DL, Moore W, Nagler E, Sorensen G. *Implementing an Integrated Approach: Weaving Employee Health, Safety, and Well-Being Into the Fabric of Your Organization*. Harvard Center for Work, Health, and Wellbeing; 2017: Available at: http://www.centerforworkhealth.sph.harvard.edu/sites/default/files/10.12.17_Guidelines_Screen_post.pdf. Accessed April 20, 2024.
78. Fricke J, Siddique SM, Douma C, et al. Workplace violence in healthcare settings: a scoping review of guidelines and systematic reviews. *Trauma Violence Abuse* 2023;24:3363–3383.
79. Pryce J, Albertsen K, Nielsen K. Evaluation of an open-Rota system in a Danish psychiatric hospital: a mechanism for improving job satisfaction and work-life balance. *J Nurs Manag* 2006;14:282–288.

