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Determinants of Depression and Anxiety in U.S. Mariners during the COVID-19 Pandemic

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Abstract

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Objective: This study characterizes determinants of depression and anxiety among U.S. Mariners during the COVID-19 pandemic and identifies areas for intervention on these outcomes.

Methods: We developed a cross-sectional online survey assessing mental health, barriers to accessing mental health care, concerns, worries, and experiences when sailing during the pandemic, job satisfaction, and safety climate for U.S. Mariners. We measured depression using the Patient Health Questionnaire-2 (PHQ-2) and anxiety using the Generalized Anxiety Disorder-2 (GAD-2) scale. A score of 3 or greater indicated a diagnosis was likely for both scales. Differences in GAD-2 and PHQ-2 scores were investigated between groups defined by gender, race/ethnicity, age, industry, and credential, and logistic regression models were

developed to investigate factors related to depression and anxiety. Barriers to access mental health care were also collated.

Results: The survey was completed by n=1,384 U.S. Coast Guard-credentialed mariners who had sailed during the COVID-19 pandemic. Of the respondents who choose to identify, 89% identified as male, 82% identified as white, and 87% were between the ages of 25 - 65. The prevalence of likely depression and anxiety were 20.7% and 22.7%, respectively, among survey respondents. Mariners with depression symptoms were more likely to experience adverse events on the vessel (OR 1.64, [CI: 1.25, 2.15]), report lower well-being (OR 0.30, [CI: 0.22, 0.40]), and had more concerns about COVID-19 (OR 1.47, [CI: 1.11, 1.96]). While mariners with anxiety symptoms were more likely to be young (OR 0.84, [CI: 0.74, 0.96]), hold concerns about COVID-19 (OR 2.01, [CI: 1.52, 2.67]), experience less support on the vessel (OR 0.66, [CI: 0.45, 0.97]), and reported lower well-being (OR 0.28, [CI: 0.20, 0.37]). Mariners reported many barriers to accessing mental health care when on a vessel, mariners with the depressed and anxiety symptoms groups identifying more barriers.

Conclusions: Pandemic impacts faced by U.S. Mariners led to an increased mental health burden (increased prevalence of depression and anxiety symptoms) coupled with decreased mental healthcare access on the vessel. Going forward, steps must be taken to decrease barriers to accessing mental health care for mariners.

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Chapter 1. INTRODUCTION

United States (U.S.) Mariners play a vital role in transporting goods and people throughout the U.S. and worldwide. In many cases, seafarers' mental health continues to be very poor and often results in fatalities[1]. During the COVID-19 pandemic, the maritime industry was deemed essential and U.S. Mariners could not work from home[2], which could increase their risk of exposure to SARS-CoV-2[3] and experience mental health impacts due to the added stress of working during the pandemic and changes to workplace practices and protocols.

There is growing recognition of the critical role that occupation plays in mental health, and U.S. Mariners have unique workplace characteristics that could increase their susceptibility to adverse mental health outcomes, even when a pandemic is not impacting their work environment. McVeigh et al. found that depression, anxiety, suicide, and alcohol or drug dependence are recognized health problems within the maritime sector[2]. Previous occupational health research among U.S. Mariners has investigated causes for mental health susceptibility, including company culture, social isolation, violence at work, job dissatisfaction, and extended tours[4]. In a pre-COVID-19 study of international seafarers (which included U.S.-based Mariners), 16% of seafarers had a Patient Health Questionnaire (PHQ-9) score indicating depression was likely and anxiety symptoms by Generalized Anxiety Disorder (GAD-7) score indicating generalized anxiety disorder was likely were highly correlated with depressive symptoms[3]. Although a plethora of research characterizing the mental health impact on international mariners is published, there is a void of research characterizing mental health impacts on U.S. Mariners during COVID-19.

There is limited research investigating the direct relationship between psychosocial stressors and adverse mental health outcomes among U.S. Mariners. No study has examined how the

COVID-19 pandemic has impacted this essential industry, yet the COVID-19 pandemic affected the work environment of mariners in many ways. In the "State of the U.S. Maritime Industry: Impacts of the COVID-19 Pandemic" Congressional Hearing, mariners and representatives from the maritime industry engaged in international trade reported facing lockdowns, mandatory quarantines, and travel and port restrictions imposed by governments around the world[5]. These circumstances created issues restricting crew changes and repatriation of seafarers, raising humanitarian concerns regarding the mental and physical safety of mariners stuck onboard vessels[5]. The abandonment of seafarers internationally also arose during the pandemic[5], and many mariners experienced long periods of time on vessels without access to shore leave or the ability to get home.

The International Seafarer group, the Mission to Seafarers, takes quarterly pulse surveys of mariners worldwide to assess job satisfaction and well-being measures. According to the mission's Seafarer Happiness Index, a global survey designed to track seafarers' welfare needs and feelings about life at sea, overall international seafarer satisfaction levels at sea have dropped to 6.32 out of 10 — a decrease of more than 5% from the figure recorded at this time last year (6.69)[6]. The recent Seafarers Happiness Index (SHI) continues to show an alarming trend in SHI, 6.69 (1st Quarter 2019), 6.41 (3rd Quarter 2021), and 5.85 (1st Quarter 2022), raising concerns around the mental well-being of mariners[6]. However, these surveys may not be representative of U.S. Mariners and the specific impacts they may face while aboard a vessel.

Here, we investigate factors related to depression and anxiety in a survey of 1,384 Coast Guard credentialed U.S. Mariners who actively sailed during the COVID-19 pandemic. This study aims to characterize and understand determinants of depression and anxiety among U.S. Mariners and identify areas for intervention to improve these outcomes during public health emergencies

and beyond. This study adds to the growing body of literature characterizing the impact of COVID-19 on essential workers and how workplace determinants influence worker mental health[7-12]. Our study is the first to investigate how job stressors and experiences specific to COVID-19 impacted depression and anxiety in U.S. Mariners and investigate barriers to mariners accessing mental health care. The work summarized here is essential to identify ways to support mariners' overall health and well-being and will increase our body of knowledge related to how the workplace can influence mental health and well-being.

Chapter 2. METHODS

This study involved collaboration between University of Washington researchers, the U.S. Committee on the Marine Transportation System (CMTS) COVID-19 Working Group, the U.S. Department of Transportation Maritime Administration (MARAD), and the Ship Operations Cooperative Program (SOCP). The University of Washington Human Subjects Division determined this project to be exempt from review, as researchers were collecting no identifying information STUDY00012073.

2.1 STUDY POPULATION AND SETTING

Research participants were 1,589 U.S. Mariners that completed the online survey during the COVID-19 pandemic. Participants (1,384) who actively sailed during the pandemic were included in the data analysis. Individuals that were not U.S. Mariners, U.S. citizens, or permanent residents who work on U.S. vessels were excluded from completing the online survey. A mariner is defined as one who operates or navigates a seagoing vessel, for the purposes of this study, individuals who have sailed within the maritime industry were considered mariners. Our target population were mariner’s representative of the maritime industry. The online survey was open for a six-month

period and based within the United States. Participation to complete the survey was strictly voluntary, there was no active recruitment for participants. However, the survey was actively promoted by the stakeholders below.

2.2 SURVEY DEVELOPMENT AND METRICS COLLECTED

A web-based survey was developed in REDCap[13,14]. The survey was created with input from the U.S. Committee on the Marine Transportation System (CMTS) COVID-19 Working Group (C-19 WG), CDC/NIOSH, and the Ship Operations Cooperative Program (SOCP) to ensure its applicability to the intended audience. The electronic survey was designed to take 10-minutes to complete. The survey was open to all U.S. Mariners for six months, from Jan 25, 2021 through Jul 31, 2021. If respondents were U.S. citizens or permanent residents, a merchant mariner who worked on a U.S. vessel and had actively sailed at some point during the COVID-19 pandemic, they were included in this survey sample. Merchant mariners who did not meet those criteria were excluded from the survey. A total of 1,686 completed the survey, while 1,589 U.S. Mariners met the inclusion criteria, only 1,384 actively sailed during the pandemic and were included in the data analysis.

The survey used validated scales to assess five mental health outcomes: perceived stress ([PSS-4] scale[15]), suicidal ideation (single question from PHQ-9) scale[16], post-traumatic stress disorder (PTSD), depression (assessed via the Patient Health Questionnaire-2 [PHQ-2] scale[17]), and generalized anxiety disorder (assessed via the General Anxiety Disorder-2 Questionnaire [GAD-2] scale[18]). The survey also addressed additional questions about job satisfaction, barriers to accessing mental health care when ashore and on a vessel, general health and well-being, and safety climate aboard a ship. We created a conceptual model (Figure 2.1) consisting of the

outcomes of interest and exposures related to those outcomes in the literature to guide our analysis. Depression and anxiety are the outcomes of interest in this manuscript.

This conceptual model builds on previous theoretical frameworks. A literature review on conceptual models of depression and anxiety shows a unidirectional relationship between the outcomes of interest (depression and anxiety), job stressors (vessel concerns, vessel experiences, mariner impacts, and time without shore leave)[19], and safety climate (mental health communication, management support, and vessel support safety culture)[19]. It is well documented that psychosocial safety climate and positive organizational behaviors buffer the effects of job demands on depression[20]. Survey questions about mental health communication, management support, and vessel support addressed safety culture climate. Our conceptual model also includes intermediate factors (general health/well-being and job satisfaction), which can be influenced by distal expsoures[9,21,22] and can, in turn, influence depression and anxiety[9,21,22] in a bidirectional relationship.

The survey used two questions to evaluate PHQ-2 at the survey response time. These two questions asked respondents to rate how they have been bothered by things using a four-point Likert scale (0=not at all, 1=several days, 2=more than half the days, 3=nearly every day). Questions asked respondents if they had little interest or pleasure in doing things and if they were feeling down, depressed, or hopeless at the time of response. Raw scores for the two questions were added together for a composite score for major depressive disorder; scores $\geq$ 3 indicated major depressive disorder is likely[17,23] and used as a cut-off score in subsequent analyses.

The survey also used two questions to evaluate GAD-2 during survey response. These two questions asked respondents to rate how they have been bothered by things using a four-point Likert scale (0=not at all, 1=several days, 2=more than half the days, 3=nearly every day).

Questions asked respondents if they felt nervous, anxious, or on edge and not being able to stop or control worrying at the time of response. Raw scores for the two questions were added together for a composite score of generalized anxiety disorder; scores ≥ 3 indicated generalized anxiety disorder is likely11 and used as a cut-off score in subsequent analyses.

The survey used three questions to evaluate general health and well-being during survey response. These three questions asked respondents to rate their current overall health status using a five-point Likert scale (0=poor, 1=fair, 2=good, 3=very good, 4=excellent). Questions asked respondents to rate their overall physical health, mental health, and sleep quality at the time of response. Raw scores for all three questions were averaged as a composite well-being score; higher scores indicated better overall well-being. When combining the three questions, the well-being score had a Cronbach's alpha (Cα) of 0.78 (CI: 0.76, 0.80), indicating acceptable reliability and congruence between the measures[24,25].

The survey used three questions to evaluate job satisfaction in the survey response, adapted from Spector's 36-question Job Satisfaction Scale[26]. Job satisfaction questions asked respondents to rate the following three questions: "do you like the people you work with, do you like doing the things you do at work, do you get enough time to relax and recharge when on the vessel" using a four-point Likert scale (0=strongly disagree, 1=disagree, 2=agree, 3=strongly agree). Raw scores for all three questions were averaged for a composite job satisfaction score; lower scores indicated less job satisfaction. When combining the three questions, the overall job satisfaction had a Cronbach's alpha (Cα) of 0.67 (CI: 0.64, 0.70), indicating questionable reliability between the measures[24,25].

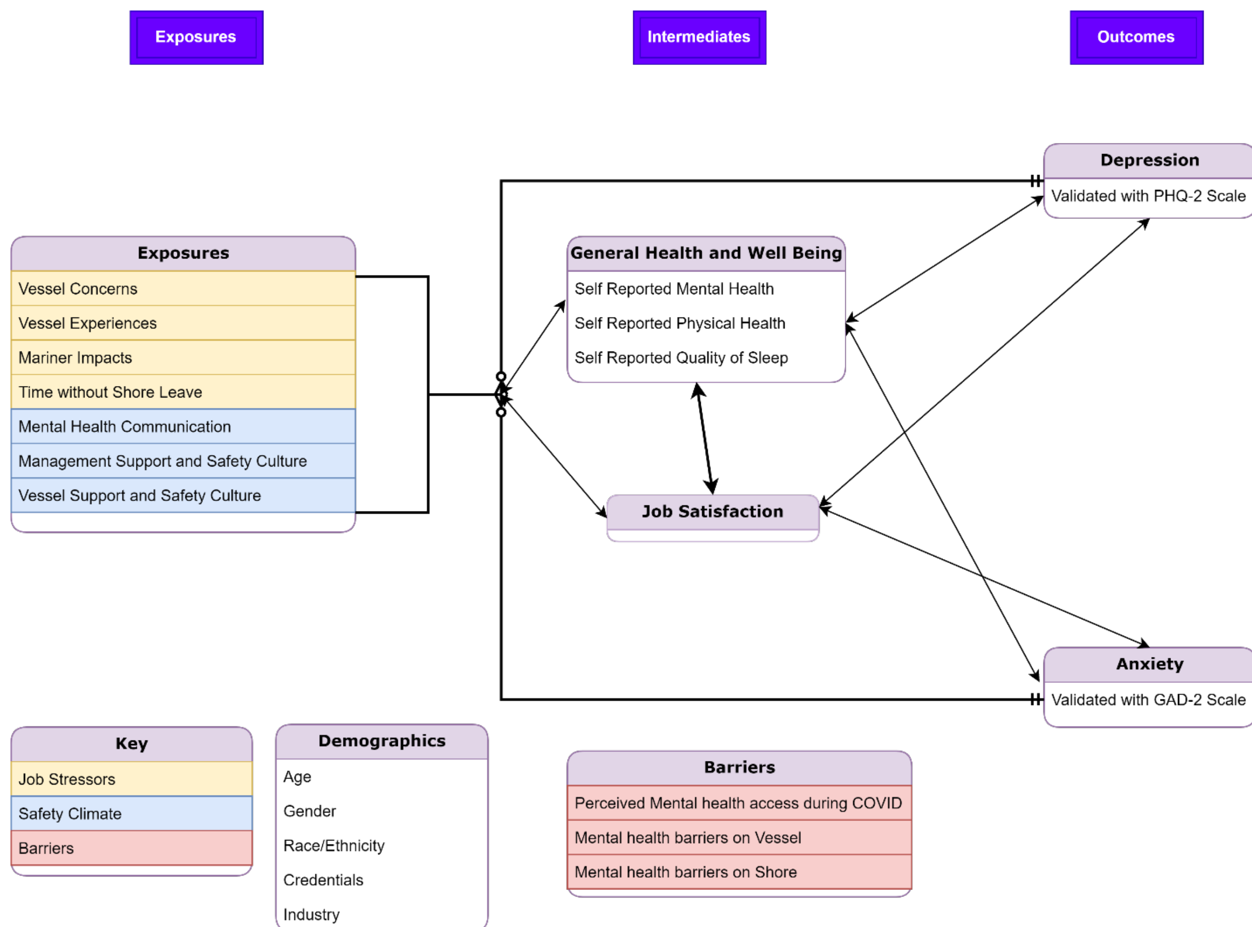


Figure 2.1. Conceptual model of the exposures and outcomes assessed in this study. An arrow indicates that a direct relationship is expected between the variables or groups of variables. Double vertical lines indicate the outcome. Demographics and barriers can potentially impact the exposures and outcomes presented in this conceptual model.

Questions on job stressors during COVID-19 were assessed. We assessed which concerns mariners had sailing during COVID-19, their experiences sailing during COVID-19, the impacts the mariners had on their contracts during COVID-19, and the longest time they were on a ship without shore leave during COVID-19. A composite vessel concerns score was developed by averaging raw scores of responses to seven questions asking respondents how often they have been concerned about: being away from family, mariner contract length, money, lack of work, a family member getting COVID-19 while being away, themself getting COVID-19 while at sea or ashore,

and extra work on board if there is a COVID-19 case on their vessel. All seven questions were scored on a 5-point frequency scale (0=never, 1=almost never, 2=sometimes, 3=fairly often, 4=very often), and incomplete responses were excluded from the analysis. A higher score indicated more concerns when they were sailing. When combining the seven questions, the overall job stressors had a Cronbach's alpha (Cα) = 0.74 with a 95% CI: 0.71, 0.77, indicating questionable reliability between the measures[24,25].

Vessel experiences were evaluated by averaging raw scores of responses to seven questions asking respondents how often they experienced: no or inadequate access to the internet, no cell phone or inadequate cell phone service, being restricted in their ability to join or rejoin their family, having feelings of isolation on board, having to quarantine due to potential exposure to COVID-19, being denied shore leave when in port, and being unable to join a vessel due to interruption of normal crew changes. All seven questions were scored on a 5-point frequency scale (0=never, 1=almost never, 2=sometimes, 3=fairly often, 4=very often), and incomplete responses were excluded from the analysis. A higher score indicated they experienced more negative experiences while sailing. When combining the seven questions, the overall vessel experiences had a Cronbach's alpha (Cα) = 0.86 with a 95% CI: 0.85, 0.87, indicating questionable reliability between the measures[24,25].

Mariner impacts were evaluated as a total number of impacts the respondent selected having experienced, from seven options: personnel have been infected with COVID-19, port calls have been affected, cargo onload/offload affected, shore leave has been canceled, shore medical visits have been impacted, contract extended voluntarily, contract extended involuntarily, or limited ability to get on or off the vessel. The total number of impacts is reported as a 0 to 7 score, and a higher score indicates that mariners had more consequences.

Time without shore leave question "since Mar 1, 2020 what is the longest time they have been onboard a vessel continuously, without shore leave" was scored on a four-point frequency scale (0=less than 2-months, 1=2 – 4-months, 2=4 – 6-months, 3=more than 6-months), a higher score indicates mariners' that experienced a longer continuous voyage without shore leave during the pandemic.

A composite vessel support scale was developed from three statements which respondents rated their agreement with: if I am feeling sad or stressed, there is usually someone on the vessel I can talk to, senior vessel officers encourage the crew to get mental health help, and senior vessel officers generally encourage employees to work following safety rules. All three questions were scored on a 4-point agreement scale (0=strongly disagree, 1=disagree, 2=agree, 3=strongly agree), and incomplete responses were excluded from the analysis. When combining the three questions, the vessel support score had a Cronbach's alpha (Cα) = 0.67 with a 95% CI: 0.64, 0.70, indicating questionable reliability between the measures[24,25].

A management support scale was developed by averaging raw scores of responses to two statements respondents rated their agreement with: does management generally encourage employees to work following safety rules and does management at their organization encourage the crew to get mental health help. Both questions were scored on a 4-point agreement scale (0=strongly disagree, 1=disagree, 2=agree, 3=strongly agree), and incomplete responses were excluded from the analysis. When combining the two questions, the management support score had a Cronbach's alpha (Cα) = 0.74 with a 95% CI: 0.71, 0.77, indicating questionable reliability between the measures[24,25].

Other questions were asked on concerns over COVID-19 on a vessel (testing protocol, exposure/infection quarantine/isolation protocol, and interest in crew COVID-19 vaccination),

mental health outcomes (suicidal ideations, PTSD, and perceived stress), and mental health due to serving in a time of National Need during COVID-19 (length of tour served and if they would serve that length of a tour during/after COVID-19, minimum length of shore break they would accept, and whether or not they would serve in the specific industry again). Additional variables collected on the survey are not discussed in this work.

Demographic data were also collected, including age, gender, and race/ethnicity. Age was categorized into seven groups; 18 – 24, 25 – 34, 35 – 44, 45 – 54, 55 – 64, 65+, and prefer not to answer. Gender was categorized into three groups; male, female, and prefer not to answer. Race/ethnicity of seven groups; American Indian or Alaska Native, Asian, Black or African, Hispanic/Latinx or Spanish origin, Middle Eastern or North African, Native Hawaiian or other Pacific Islander, White, Race/ethnicity or origin not listed, and a prefer not to answer.

Credentials were combined into four groups based on cadet/pilot, licensed deck/engineer officer, unlicensed deck/engineer, and others. The cadet/pilot group comprises cadets (maritime students) and pilots (navigational experts who maneuver ships through dangerous or congested waters). The licensed deck/engineer officer group includes licensed deck officers of both limited and unlimited tonnage or waters and licensed engineer officers, both limited and unlimited horsepower. The unlicensed deck/engineer group comprises both limited tonnage or waters or horsepower and unlimited tonnage or waters or horsepower—respondents who selected 'other' as their credentials were considered a fourth group.

The industry was combined into five groups: oceangoing cargo vessels, inland and coastal vessels/workboats, passenger vessels, and government/public vessels. The oceangoing cargo vessels group comprises container shipping, oceangoing tankers or gas carriers, and dry bulk carriers. The inland and coastal vessels/workboats group comprises offshore support vessels,

offshore drilling vessels or rigs, tugs, towboats & barges, and fishing vessels. The passenger vessels group is composed of cruise, ferry, and passenger vessels. At the same time, the government/public vessels group is formed of Navy/Coast Guard & government ships, boats and/or barges. The final group is comprised of respondents who selected 'other' as their industry and were considered the fifth group.

Questions on mental health access, barriers, and safety climate were also included in the survey. Respondents were asked if they felt like they would be able to reasonably continue or start mental health care while on a vessel and when at home if they wanted to. Respondents who indicated they could not reasonably continue or start mental health care were asked to select which barriers they thought would prevent them from starting or continuing mental health care on a vessel or at home. For mariners who were currently receiving mental health care either at home or onboard a ship, questions were asked about any barriers they faced in receiving mental health care.

The survey was promoted by CMTS C-19 WG, CDC/NIOSH, and SOCP members. The CMTS is a committee responsible for assessing the adequacy of the marine transportation system, promoting the integration of the MTS with other modes of transportation, and coordinating with stakeholders in making recommendations regarding federal policies. The SOCP is a 501(c)6 nonprofit and nonpartisan member-driven organization of industry leaders to promote and improve the maritime industry through collaboration, facilitation, recommendation, and innovation[5]. During the pandemic, the C-19 WG was instrumental in identifying physical and mental challenges faced by mariners and recommending policy changes[5].

2.3 Survey data analysis

Raw data were downloaded from REDCap[14]. Questions were scored and combined to create scales, as explained above. When questions were combined into a scale, some were reverse coded to

ensure all questions were either in the affirmative or negative to ease interpretation of the scale and results. Descriptive statistics and analysis of variance (ANOVA) were used to characterize and look at differences in PHQ-2 and GAD-2 scores between groups defined by demographics, industry, and credentials.

Logistic regression models were developed for the outcomes of depression and anxiety, which were guided by the conceptual model shown in Figure 2.1. They included the following variables: job stressors (vessel concerns, vessel experiences, mariner impacts, time w/o shore leave), safety climate (mental health communication, management support and safety culture, vessel support and safety culture), job satisfaction, general health & well-being (combined mental, physical, sleep quality), and physical health as predictors. Demographic data (age, gender, credentials, and industry) were also included in each model. Race/ethnicity was not included in the models due to the homogeneity of responses in this population.

The logistic regression models did not include mental health access and mental health barriers because these questions were not asked of all survey respondents. However, bar charts were developed which show the percent of respondents who selected each barrier to mental health care access by mental health status at home and sea. Statistical significance was defined as a $p \leq 0.05$.

All data analysis was completed in R Studio version 2022.02.0 build 443[14].

Chapter 3. RESULTS

Table 1. (**Error! Bookmark not defined.**) summarizes the demographics of the survey respondents. U.S. Mariners who responded to the survey predominantly identified as male (89%), white (82%), and (87%) were between the ages of 22 – 65. Sixteen percent belong to the

oceangoing cargo vessels industry, and 64% of respondents serve as licensed deck/engineer officers.

		n (%)	(%)
Age (years)	18 – 24	60	3.8%
	25 – 34	254	16.0%
	35 – 44	254	16.0%
	45 – 54	204	12.8%
	55 – 64	290	18.3%
	65+	83	5.2%
	Prefer not to answer	444	27.9%
Gender	Male	1001	63.0%
	Female	125	7.9%
	Prefer not to answer	463	29.1%
Maritime Industry	Inland Waterways	110	6.9%
	Harbor Tugs	71	4.5%
	Ferries & Passenger vessels	104	6.5%
	Pilotage	24	1.5%
	Dredging and Marine Construction	35	2.2%
	Great Lakes	46	2.9%
	Coastwise -- Jones Act	200	12.6%
	Offshore Energy Support	77	4.8%
	Ocean -- Jones Act (US to Hawaii/Guam/Alaska/Puerto Rico)	97	6.1%
	Ocean -- International (Commercial Vessel)	250	15.7%
	Military Sealift Command (MSC) Vessel	245	15.4%
	Maritime Administration (MARAD) Ready Reserve	97	6.1%
	NOAA vessel	50	3.1%
	US Army Corps of Engineers vessel	16	1.0%
	Other maritime industry	167	10.5%
Position	Cadet/Pilot	91	5.7%
	Licensed deck/engineer officer	1021	64.3%
	Unlicensed deck/engineer	260	16.4%
	Other position	217	13.7%
Race/Ethnicity	American Indian or Alaska Native	33	2.1%
	Asian	41	2.6%
	Black or African	41	2.6%
	Hispanic, Latinx, Spanish origin	45	2.8%
	Native Hawaiian or other Pacific Islander	19	1.2%
	White	948	59.7%
	Other race/ethnicity	24	1.5%
	Prefer not to answer	438	27.6%

3.1 DESCRIPTIVE RESULTS

Table 2. (**Error! Bookmark not defined.**) shows results of the Analysis of Variance (ANOVA), outlining the distribution of outcomes of interest within demographics, industry, and credentials.

	Depression n = 1312 (1.65)					Anxiety n = 1318 (1.74)				
Group	**n**	**Mean PHQ-2 Score**	**(SD)**	**(%) high**	***p****	**n**	**Mean GAD-2 Score**	**(SD)**	**(%) high**	***p****
Age										
18 – 24	50	1.46	(1.42)	22%	**<0.001**	51	1.59	(1.79)	29%	**<0.001**
25 – 34	241	1.90	(1.76)	28%		241	2.10	(1.88)	37%	
35 – 44	228	1.66	(1.76)	24%		230	1.73	(1.79)	25%	
45 – 54	193	1.38	(1.69)	18%		193	1.41	(1.66)	20%	
55 – 64	250	1.26	(1.60)	17%		251	1.10	(1.54)	12%	
65+	101	0.93	(1.26)	13%		102	1.15	(1.66)	16%	
Gender										
Male	907	1.48	(1.68)	21%	0.312	912	1.47	(1.72)	22%	0.186
Female	104	1.67	(1.78)	20%		105	2.17	(1.82)	33%	
Prefer not to answer	52	1.23	(1.47)	21%		47	1.47	(1.93)	23%	
Race/Ethnicity										
American Indian or Alaska Native	24	1.53	(1.48)	33%	0.077	32	1.28	(1.85)	13%	0.306
Asian	38	1.87	(2.03)	34%		38	1.55	(2.02	24%	
Black or African	32	1.63	(1.93)	22%		33	1.42	(1.70)	21%	
Hispanic, Latinx, Spanish origin	40	1.58	(1.66)	25%		41	1.56	(1.92)	22%	
Native Hawaiian or other Pacific Islander	18	1.56	(1.50)	22%		18	1.72	(1.96)	33%	
White	854	1.50	(1.67)	20%		858	1.59	(1.75)	24%	
Prefer not to answer	116	1.31	(1.62)	23%		116	1.28	(1.69)	19%	
Maritime Industry (vessel type)										
Oceangoing cargo vessels	269	1.44	(1.66)	20%	**0.016**	269	1.46	(1.71)	20%	0.151
Inland and coastal cargo vessels/workboats	421	1.28	(1.57)	17%		421	1.47	(1.68)	17%	
Passenger vessels	78	1.31	(1.49)	17%		78	1.24	(1.63)	17%	
Government/public vessels	330	1.78	(1.73)	27%		330	1.71	(1.80)	27%	
Other vessels	86	1.37	(1.73)	16%		86	1.50	(1.89)	16%	
Credentials (Position)										
Cadet/Pilot	56	1.20	(1.49)	16%	0.931	58	1.57	(1.63)	28%	0.364
Licensed deck/engineer officer	817	1.49	(1.64)	20%		817	1.55	(1.72)	22%	
Unlicensed deck/engineer	193	1.42	(1.72)	21%		195	1.41	(1.78)	23%	
Other credentials	116	1.41	(1.66)	20%		118	1.46	(1.79)	21%	
All Respondents	**1312**	**1.46**	**(1.65)**	**21%**		**1318**	**1.52**	**(1.73)**	**23%**	

Considering all respondents (n=1,384), the mean PHQ-2 score was 1.46 (SD: 1.65), and GAD-2 score was 1.52 (SD: 1.74). Mean PHQ-2 and GAD-2 scores differed significantly by age category

(*p*<0.001), with individuals in the age group 25-34 (n=241) having the highest PHQ-2 and GAD-2 scores (1.90 and 2.10, respectively). PHQ-2 and GAD-2 scores tended to decrease with age. Female respondents (n=104) had higher PHQ-2 and GAD-2 scores than male respondents (n=907), though this did not reach the level of statistical significance. Differences in PHQ-2 and GAD-2 were present by race/ethnicity as well, with respondents of Asian race (n=38) having the highest PHQ-9 mean (1.87, SD: 2.03), and respondents of Native Hawaiian or other Pacific Islander (n=18) having the highest GAD-2 mean (1.72, SD: 1.96). However, these differences were not statistically significant.

When looking by maritime industry, respondents in the government/public vessels category (n=330) had the highest PHQ-2 and GAD-2 scores, with means of 1.78 (SD: 1.73) and 1.71 (SD: 1.80), respectively. Both PHQ-2 and GAD-2 scores were significantly different between groups defined by industry, based on the ANOVA. By position, unlicensed deck/engineers (n=193) had the highest PHQ-2 score (mean: 1.42, SD: 1.72), and cadet/pilots had the highest GAD-2 score (mean:1.57, SD: 1.63), though differences by position were not significant.

Table 3. (**Error! Bookmark not defined.**) presents descriptive statistics for the outcomes of interest and predictors included in the logistic regression models. There were 271 (20.7%) of the respondents who answered the PHQ-2 questions and had PHQ scores $\geq$ 3 indicating major depressive disorder is likely, and there were 299 (22.7%) of the respondents who answered the GAD-2 questions and had GAD-2 scores $\geq$ 3 indicating generalized anxiety disorder is likely.

Being away from family and feeling concerned about a family member getting COVID were, on average, what concerned mariners the most frequently when they were aboard a vessel (mean frequency scores: 2.42, SD: 1.22, and 2.26 SD: 1.27, respectively). Respondents' most frequently experienced events were denial of shore leave when in port due to COVID-19 (mean frequency

score: 2.33, SD: 1.60) and having no access or inadequate access to the internet on a vessel (mean frequency score: 1.99, SD: 1.38). 62% of respondents had restricted ability to get on or off the vessel, 56% of respondents stated that their shore leave was cancelled, and 48% stated port calls have been affected (Table 3). 47% of respondents were on a vessel for less than 2 months without access to shore leave, while 17% of respondents were on a vessel for 4-6 months without access to shore leave. 34% of respondents indicated they had received some mental health information from their company during the COVID-19 pandemic, while 54% of respondents indicated they had not received any mental health information from their company.

Most respondents agreed that vessel senior officers and company management generally encourage employees to work according to safety rules, including COVID protocols (mean agreement scores of 3.26, SD: 0.73 and 3.13, SD: 0.81, respectively). Most respondents agreed they like doing the things they do at work (mean agreement score:3.24, SD: 0.61).

11% of respondents rated their current overall physical health excellent, 16% rated their current overall mental health excellent, and 7% rated their current overall sleep quality excellent. Figures 1 & 2 (**Error! Bookmark not defined.&Error! Bookmark not defined.**) show perceived barriers to accessing mental health care seaboard a vessel by PHQ-2 and GAD-2 scores as low (<3), high (≥3), and all respondents, respectively.

Similar barriers were reported while at sea when stratifying by PHQ-2 or GAD-2 status. 61% (n=165) of respondents with PHQ-2 scores indicating depression, and 62% (n=185) of respondents with GAD-2 scores indicating anxiety reported a lack of internet/phone access as a barrier to accessing mental health care aboard a vessel. 57% (n=154) of respondents with PHQ-2 scores indicating depression and 63% (n=188) of respondents with GAD-2 scores indicating anxiety reported there is no privacy on board to talk to someone as a barrier to accessing mental health

care aboard a vessel. 48% of all PHQ-2 (n=630) and GAD-2 (n=633) respondents reported that they would be concerned about their United States Coast Guard (USCG) credentials as a barrier to accessing mental health care aboard a vessel.

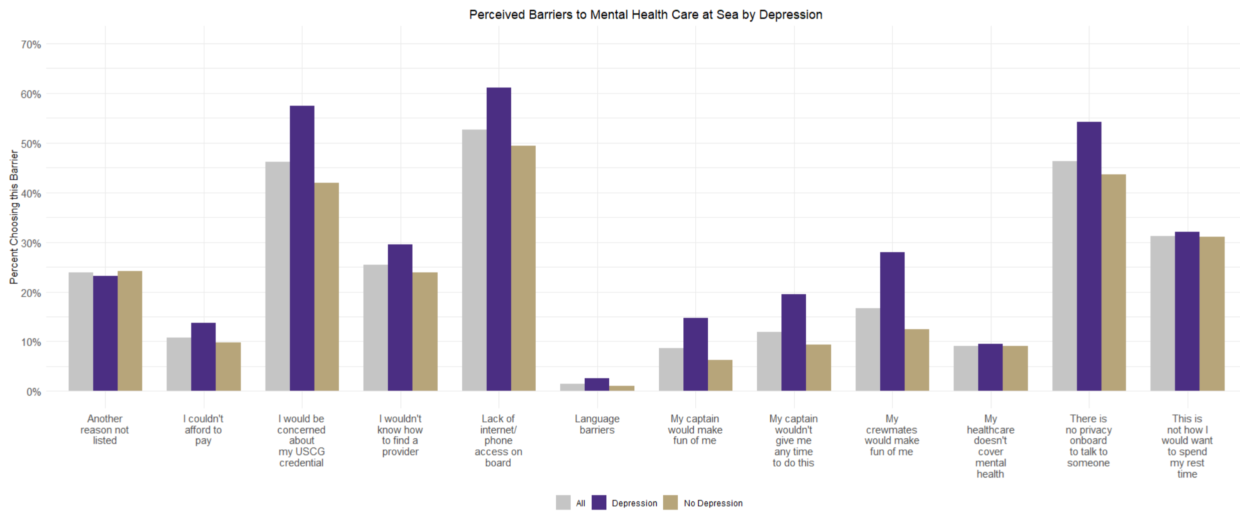


Figure 3.1. Perceived barriers to mental health care at sea by self-reported depression status.

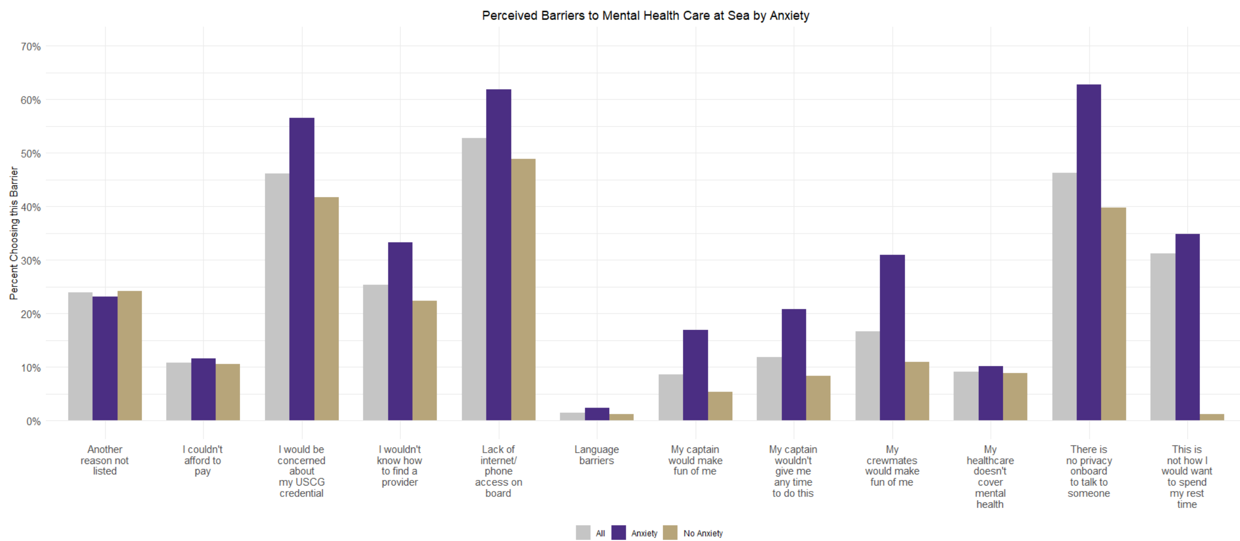


Figure 3.2. Perceived barriers to mental health care at sea by self-reported anxiety status .

Figures 3 & 4 (**Error! Bookmark not defined.&Error! Bookmark not defined.**) perceived barriers to accessing mental health care at home by PHQ-2 and GAD-2 score, respectively. Similar

barriers were reported at home when stratifying by PHQ-2 or GAD-2 status. In contrast to perceived barriers at sea, at home, 19% (n=52) of respondents with PHQ-2 scores indicating depression and 23% (n=69) of respondents with GAD-2 scores indicating anxiety reported they would be concerned about their USCG credentials as a barrier to accessing mental health care at home is seen as the most concerning barrier. 15% (n=41) of respondents with PHQ-2 scores indicating depression and 12% (n=36) of respondents with GAD-2 scores indicating anxiety reported they couldn't afford to pay for care as a barrier to accessing mental health care at home. 17% of all PHQ-2 (n=223) and GAD-2 (n=224) respondents reported concerns regarding their USCG credentials as the most concerning barrier to accessing mental health care at home.

3.2 REGRESSION MODELS

Logistic Regression model results for depression and anxiety are presented in Table 4. (**Error! Bookmark not defined.**). Results from the depression model found that increased vessel concerns and vessel experiences scores significantly increased the odds of major depressive disorder being likely (OR 1.47, [CI: 1.11, 1.96] and OR 1.64, [CI: 1.25, 2.15]), respectively. Increased overall well-being now was a protective factor associated with decreased odds of likely major depressive disorder (OR: 0.30, [CI: 0.22, 0.40]). This model explained 20.7% of the variance in mariners with depression symptoms.

Results from the anxiety regression found that increased vessel concerns and decreased physical activity during the pandemic significantly increased the odds of generalized anxiety disorder being likely (OR 2.01, [CI: 1.52, 2.67]; and OR 1.29, [CI: 1.07, 1.55]), respectively. Increased overall wellbeing, positions of licensed deck or engineer officers, vessel support, and age scores were protective factors associated with decreased odds of generalized anxiety disorder (OR: 0.28 [CI: 0.20, 0.37]; OR: 0.34 [CI: 0.15, 0.78]; OR: 0.66 [CI: 0.45, 0.97], OR: 0.84 [CI:

0.74, 0.96], respectively). This model explained 22.7% of the variance in mariners with anxiety symptoms.

Table 4. Logistic regression analyses for mental health outcomes of interest.

	Depression		Anxiety	
Predictors	OR	95% CI	OR	95% CI
Age	1.05	0.92, 1.19	**0.84***	0.74, 0.96
Gender (male vs. other)	0.84	0.66, 1.05	1.17	0.95, 1.42
Cadet/Pilot	---	---	---	---
Licensed deck or engineer officer	0.59	0.24, 1.57	**0.34***	0.15, 0.78
Unlicensed deck or engineer	0.74	0.27, 2.15	0.45	0.18, 1.12
Other type of position	0.66	0.22, 2.10	0.45	0.16, 1.24
Oceangoing vessel cargo	---	---	---	---
Inland/coastal operations/workboats	1.18	0.69, 2.00	1.17	0.70, 1.97
Passenger vessel operations	1.67	0.69, 3.90	1.01	0.41, 2.35
Government/public vessel operations	1.59	0.97, 2.61	1.37	0.84, 2.25
Other type of vessel	0.93	0.39, 2.09	1.00	0.43, 2.18
Vessel concerns	**1.47***	1.11, 1.96	**2.01***	1.52, 2.67
Vessel experiences	**1.64***	1.25, 2.15	1.17	0.90, 1.52
Mariner impacts	1.03	0.92, 1.16	1.03	0.92, 1.15
Time without shore leave	0.99	0.79, 1.24	0.83	0.66, 1.04
Mental health communication	1.07	0.81, 1.41	1.06	0.81, 1.39
Vessel support and safety culture	0.72	0.49, 1.06	**0.66***	0.45, 0.97
Management support and safety culture	1.02	0.75, 1.38	1.01	0.76, 1.36
Job satisfaction	1.04	0.69, 1.55	0.94	0.63, 1.40
Overall wellbeing now	**0.30***	0.22, 0.40	**0.28***	0.20, 0.37
Physical activity during the pandemic	1.04	0.87, 1.26	**1.29***	1.07, 1.55

Models for depression and anxiety were assessed using logistic regression.
--- indicates reference group
**Indicates p-value ≤ 0.05*

Chapter 4. DISCUSSION

U.S. Mariners are essential workers who, during the COVID-19 pandemic, were exposed to increased mental health risk (prevalence of positive depression and anxiety screens 20.7% and 22.7%, respectively). In a survey of n=233 U.S.-based vessel masters and pilots before the COVID-19 pandemic, 16% were found to have a score indicating depression, assessed from the

longer-version PHQ-9[1]. While our sample differed from the previous sample, these findings suggest that depression was notable before the COVID-19 pandemic and increased during the COVID-19 pandemic[8,27].

The mental health of U.S. Mariners during COVID-19 is a crucial consideration for occupational and public health because commercial shipping is vital for maintaining global supply chains[27]. A systematic review and meta-analysis of 485 studies with a combined sample size of 267,995 individuals found job satisfaction was strongly associated with mental/psychological problems and burnout[22]. Organizations should include the development of stress management policies to identify and eradicate U.S. mariner work practices that cause most job dissatisfaction as part of any exercise aimed at improving employee health[22]. In a survey of 233 U.S. Mariners, mariners with depressive symptoms were disproportionally more likely to report a work injury in the past year; 50% of mariners with depressive symptoms reported a work injury compared to 15% of mariners without any depressive symptoms[3].

In an international survey, depression, anxiety, and suicidal ideation were associated with an increased likelihood of injury and illness while working onboard the vessel[4], and seafarer depression, anxiety, and suicidal ideation were associated with an increased likelihood of planning to leave work as a seafarer in the next 6-months[4]. Work environmental factors such as job demands comprise pressure from contractors/customers/time, working hours, ship department, job title, voyage episodes, period of seafaring, noise, and vibration[28] can lead to increased stress. Job resources, including instrumental support, team cohesion, shipboard caring, and effort-reward imbalance[28] can be protective against depression and anxiety. Additionally, a Danish study showed that leisure-time physical activity was associated with higher perceived energy, and for men, also with lower perceived stress in high-risk jobs[29].

Our multivariable logistic regression analysis showed that U.S. Mariners who had more vessel concerns (e.g., lack of internet/phone access, lack of privacy to communicate concerns with someone, and concerns about their USCG credentials being negatively impacted if they sought mental health care). Also had an increased number of adverse vessel experiences (e.g., limited ability to get on or off the vessel, shore leave was canceled, and port calls have been affected) were significantly more likely to have increased odds of depression. Similarly, the regression analysis showed that anxiety in U.S. Mariners was more likely in respondents who had more vessel concerns (e.g., lack of internet/phone access, lack of privacy to communicate concerns with someone, and concerns about their USCG credentials being negatively impacted if they sought mental health care) and less physical activity (e.g., 2 or less days per week). These findings are consistent with previous research in other occupations showing relationships between exposure experiences and mental health[2,29].

In our study, we explored barriers mariners face when accessing mental health care, both at home and at sea. Regardless of their mental health status, respondents most reported concern about losing their U.S. Coast Guard mariner credentials as a barrier to accessing mental health care, both at home and at sea. While the U.S. Coast Guard released updated guidance to address this concern due to initial results of the survey, the longstanding culture of the maritime industry and U.S Coast Guard may continue to dissuade mariners from seeking mental health care, even if their credentials would not be at risk[30]. Continuing to promote a culture of mental health care access from vessel owners, ship captains, and credentialing agencies is essential.

54% (n=712) of all respondents reported the lack of internet/phone access on board vessel as a barrier to accessing mental health care (146 depressed, 161 anxious), and 50% (n=659) of respondents indicated the lack of privacy on board a vessel (136 depressed, 150 anxious) is a

barrier to accessing mental health care at sea. When appropriate, increasing access to phone and internet for mariners while they are at sea could have positive impacts on mental health if it allows mariners to access telehealth for mental health care[31]. Mariners who screened for depression and anxiety (12 - 15%, respectively) also indicated they didn't think they could afford mental health care or didn't know how to find an appropriate mental healthcare provider, which are both barriers that could be removed with increased communication from employers, mental health care availability for mariners, and resources for finding a provider. Given that 54% (n=610) of respondents indicated they didn't receive any communication from the organization they work for regarding mental health during the pandemic (with an additional 13% [n=113] unsure of whether they received any communication), increasing appropriate communication around mental health could be an essential point of intervention for employers of mariners.

Of note, mariners with a PHQ-2 score indicating depression was likely or a GAD-2 score indicating anxiety was likely were more likely to report barriers to access mental health care than mariners without depression or anxiety. This means that the mariners who needed the mental health care the most were more likely experience real or perceived barriers making it challenging for them to obtain mental health care. This is concerning from an occupational health perspective because poor mental health can negatively affect employee job performance and productivity4, engagement with one's work[28], communication with coworkers[32], and physical capability and daily functioning[29]. Mental illnesses such as depression are associated with higher rates of disability and unemployment[33].

Two critical factors related to mental health and psychological issues can be categorized as individual and work environmental factors[28]. Individual factors affected by COVID-19 that contributed to increased risk of a mental health outcome were vessel concerns (money concerns,

being away from family, and fears of oneself getting COVID while at sea or ashore); vessel experiences (being denied shore leave and unable to rejoin family) and reported vessel impacts (working with personnel infected with COVID, and shore medical visits negatively impacted). Systemic work environmental factors affected by COVID-19 that contributed to increased risk of a mental health outcome were vessel concerns (mariner contract length, lack of work, and extra work on board if there was a positive COVID case on a vessel), vessel experiences (having to quarantine due to potential COVID exposure and being unable to join a vessel due to interruption of regular crew changes), and reported vessel impacts (port calls been affected, cargo onload/offload been affected, and mariner contract being involuntarily extended). While individual and work environmental factors such as experience, age, and vessel support were protective against developing mental health outcomes, similar results of prior study[34].

Previous investigations of psychosocial safety climate have shown a benefit to decreasing the prevalence of mental health amongst workers[20]. When senior managers and supervisors value workers' psychosocial safety, which is reflected in how an organization communicates its view of mental health, then the organization's PSC can buffer the effects of job demands on individual workers' depression[20]. The majority of respondents (57%), with or without a mental health outcome, were concerned about the impact on their USCG credentials if they admitted/sought mental health care to their organization. Psychosocial safety climate is a facet-specific component of organizational climate. It refers to shared perceptions regarding policies, practices, and procedures reflected in organizational communication concerning the value of employees' psychosocial health and safety in the workplace[20]. Combined, the workforce makes up 63% of medical and behavioral health care services cost[35]. By addressing mental health issues in the

workplace, employers can reduce health care costs for their businesses and employees up to $67.8 billion a year[33], a decrease in work days lost, and increase productivity.

Workplace health promotion programs have proven successful, especially when they combine mental and physical health interventions[20,33]. In line with the health-oriented leadership (HoL) concept, the previous studies[20,28,32,33] showed that leaders showing care for the health of their employees is positively related to employees' affective organizational commitment, job satisfaction, and performance, as well as negatively to employees' depression, burnout, health complaints, and strain[34]. Promoting health-oriented leadership by vessel captains and by company management could have positive impacts on mariner job satisfaction[22], decrease feelings of isolation[10,36], and increase feelings of social support[36], which could all improve job performance and productivity, employee engagement with one's work, leading to decreased rates of disability and unemployment[3].

4.1 LIMITATIONS

This study aimed to address an area that has often been discussed in the literature on mental health in international seafarers, but to our knowledge not been done on U.S. mariners during the COVID-19 pandemic. The survey was developed and promoted in a collaborative effort with CMTS C-19 WG, NIOSH, and the SOCP members, to characterize the mental health of mariners which could lead to, sampling bias. Participants who choose to complete the voluntary survey could have a prior mental health history or diagnosis. While those without any mental health challenges choosing to not participate in the survey or mariners who were out at sea during the duration of the survey may not have had the opportunity to take the survey leading to a higher sampling probability of self-reported mental health symptoms decreasing the generalizability of our results outside of the sampled population. However, in general, mariners exhibited a higher prevalence of

mental health outcomes than the general population prior to the pandemic, and rates were comparable to those experienced by healthcare workers and other essential workers during the pandemic, and long haul truckers and offshore gas/oil rig workers before the pandemic[37].

Another limitation is acquiescence response bias. The length of the survey being 10-minutes could've led to survey fatigue, participants lack the motivation to engage with the entire survey, or due to the sensitive nature of the survey participants were more reserved where they ended the survey short. In attempt to mitigate acquiescence response bias we formulated the survey questions to be easily interpretated by the respondents and to correspond more closely with mental health access and outcomes. Out of the 1,384 respondents who sailed during the pandemic, there was < 5% of respondents that did not complete the entire survey.

The design of this study was cross-sectional in nature and therefore only reflects mental health sentiments during COVID-19 pandemic at the time of the sample. The needs identified within our survey could change over time and may only be applicable during the COVID-19 pandemic. However, despite the timing of our survey, our results mirror similar results in previous research on international seafarers[27] and national mariner reports[3] suggestive that our results may be representative of the U.S. maritime industry.

Our study sample was homogenous where the white race was predominantly represented. The U.S. maritime industry is predominantly made up of the white race and the results could be considered representative. However, of the 19% (n=268) non-white survey participants 2% (n=62) had mean PHQ-2 and GAD-2 scores greater than the sample mean that could've been statistically significant with a larger non-white participant. The 43% (n=116) prefer not to answer race/ethnicity group could've been composed of white or of minority populations, who have a

negative stigma associated with mental health[10,19,36], therefore not selecting their ethnicity and find safety in being anonymous.

4.2 STRENGTHS AND FUTURE CONSIDERATIONS

Despite the limitations of our study, a great length of measures and steps were taken to ensure internal and external validity and generalizability. The survey was developed and promoted in a collaborative effort with CMTS C-19 WG, NIOSH, and the SOCP members, to characterize the mental health of mariners. The promotion efforts led to a large study sample; 1,384 respondents increased the power of our study.

Strict data version control and verification of analysis codes amongst research team helped reduce measurement errors. Missing data and results for groups less than 10-responses were mitigated by omitting them from the report and were not used for data analysis to minimize reducing the statistical power of the study and minimize biased estimates, leading to invalid conclusions.

Another strength is this study used the PHQ-2 and GAD-2 instead of the longer PHQ-9 and GAD-7 for depression and anxiety, respectively. The shorter questionnaires have high sensitivities (97% and 86%, respectively), leading to fewer false negative results, and thus fewer cases are missed[18,23]. By capturing most U.S. Mariner mental health cases, we were able to better characterize the mental health prevalence of the U.S. maritime industry during the COVID-19 pandemic. This could lead to improved generalizability within the U.S. maritime industry.

Interesting areas for further research could consider diversifying the sample to better characterize the mental health of minority U.S. mariners. Additionally, conducting a longitudinal study to better characterize the mental health of U.S. Mariners, determine variable patterns over time, help with developing mental health trends, and are more powerful than a cross-sectional

study. Due to the scarcity of research on mental health of U.S. Mariners and reduction of health risks in this essential workforce, this would be an interesting area for further exploration.

Chapter 5. CONCLUSIONS

During the COVID-19 pandemic, the job characteristics of U.S. Mariners places them at increased risk of developing depression symptoms and anxiety symptoms due to changes in work protocols, negative work experiences such as long periods at sea without shore leave, and limited contact with home. Many of these workplace factors were present prior to the pandemic and have been neglected. We found a notable proportion of survey respondents to likely have depression and/or anxiety symptoms. But this is negative trend does not have to continue to promulgate, it can be slowed down and eventually reversed. Identified areas of intervention for the maritime industry, include increasing mental health surveillance, increasing communication, and training around mental health, and increasing access to mental health care, particularly at sea.

The highest rates of depression and anxiety symptoms were reported in non-white and female U.S. Mariners, respectively. While females and minority U.S. Mariners represented a small proportion of our sample, the mental health needs and organizational culture must be prioritized to increase diversity within the maritime industry and progress towards occupational equity.

Given the vital role that mariners play in transporting goods, mariner mental health and well-being is important for not only the U.S. economy but also for public health, transportation safety, and economic reasons. Our goal is to inform the maritime industry of the current mental health status of the force based on our results to catalyze the maritime industry in improving U.S. Mariner mental health and well-being with simple interventions. As well as, positively impacting the

occupational health and worker well-being, that could lead to a decreased prevalence of depression and anxiety symptoms in this population.

APPENDIX A

Table 1: Characteristics of survey respondents

		n (%)	(%)
Age (years)	18 – 24	60	3.8%
	25 – 34	254	16.0%
	35 – 44	254	16.0%
	45 – 54	204	12.8%
	55 – 64	290	18.3%
	65+	83	5.2%
	Prefer not to answer	444	27.9%
Gender	Male	1001	63.0%
	Female	125	7.9%
	Prefer not to answer	463	29.1%
Maritime Industry	Inland Waterways	110	6.9%
	Harbor Tugs	71	4.5%
	Ferries & Passenger vessels	104	6.5%
	Pilotage	24	1.5%
	Dredging and Marine Construction	35	2.2%
	Great Lakes	46	2.9%
	Coastwise -- Jones Act	200	12.6%
	Offshore Energy Support	77	4.8%
	Ocean -- Jones Act (US to Hawaii/Guam/Alaska/Puerto Rico)	97	6.1%
	Ocean -- International (Commercial Vessel)	250	15.7%
	Military Sealift Command (MSC) Vessel	245	15.4%
	Maritime Administration (MARAD) Ready Reserve	97	6.1%
	NOAA vessel	50	3.1%
	US Army Corps of Engineers vessel	16	1.0%
	Other maritime industry	167	10.5%
Position	Cadet/Pilot	91	5.7%
	Licensed deck/engineer officer	1021	64.3%
	Unlicensed deck/engineer	260	16.4%
	Other position	217	13.7%
Race/Ethnicity	American Indian or Alaska Native	33	2.1%
	Asian	41	2.6%
	Black or African	41	2.6%
	Hispanic, Latinx, Spanish origin	45	2.8%
	Native Hawaiian or other Pacific Islander	19	1.2%
	White	948	59.7%
	Other race/ethnicity	24	1.5%
	Prefer not to answer	438	27.6%

APPENDIX B

Table 2: ANOVA of Outcomes of Interest and Demographics

Group	Depression n = 1312 (1.65)					Anxiety n = 1318 (1.74)				
	n	Mean PHQ-2 Score	(SD)	(%) high	*p**	n	Mean GAD-2 Score	(SD)	(%) high	*p**
Age										
18 – 24	50	1.46	(1.42)	22%	**<0.001**	51	1.59	(1.79)	29%	**<0.001**
25 – 34	241	1.90	(1.76)	28%		241	2.10	(1.88)	37%	
35 – 44	228	1.66	(1.76)	24%		230	1.73	(1.79)	25%	
45 – 54	193	1.38	(1.69)	18%		193	1.41	(1.66)	20%	
55 – 64	250	1.26	(1.60)	17%		251	1.10	(1.54)	12%	
65+	101	0.93	(1.26)	13%		102	1.15	(1.66)	16%	
Gender										
Male	907	1.48	(1.68)	21%	0.312	912	1.47	(1.72)	22%	0.186
Female	104	1.67	(1.78)	20%		105	2.17	(1.82)	33%	
Prefer not to answer	52	1.23	(1.47)	21%		47	1.47	(1.93)	23%	
Race/Ethnicity										
American Indian or Alaska Native	24	1.53	(1.48)	33%	0.077	32	1.28	(1.85)	13%	0.306
Asian	38	1.87	(2.03)	34%		38	1.55	(2.02	24%	
Black or African	32	1.63	(1.93)	22%		33	1.42	(1.70)	21%	
Hispanic, Latinx, Spanish origin	40	1.58	(1.66)	25%		41	1.56	(1.92)	22%	
Native Hawaiian or other Pacific Islander	18	1.56	(1.50)	22%		18	1.72	(1.96)	33%	
White	854	1.50	(1.67)	20%		858	1.59	(1.75)	24%	
Prefer not to answer	116	1.31	(1.62)	23%		116	1.28	(1.69)	19%	
Maritime Industry (vessel type)										
Oceangoing cargo vessels	269	1.44	(1.66)	20%	**0.016**	269	1.46	(1.71)	20%	0.151
Inland and coastal cargo vessels/workboats	421	1.28	(1.57)	17%		421	1.47	(1.68)	17%	
Passenger vessels	78	1.31	(1.49)	17%		78	1.24	(1.63)	17%	
Government/public vessels	330	1.78	(1.73)	27%		330	1.71	(1.80)	27%	
Other vessels	86	1.37	(1.73)	16%		86	1.50	(1.89)	16%	
Credentials (Position)										
Cadet/Pilot	56	1.20	(1.49)	16%	0.931	58	1.57	(1.63)	28%	0.364
Licensed deck/engineer officer	817	1.49	(1.64)	20%		817	1.55	(1.72)	22%	
Unlicensed deck/engineer	193	1.42	(1.72)	21%		195	1.41	(1.78)	23%	
Other credentials	116	1.41	(1.66)	20%		118	1.46	(1.79)	21%	
All Respondents	**1312**	**1.46**	**(1.65)**	**21%**		**1318**	**1.52**	**(1.73)**	**23%**	

APPENDIX C

Table 3: Outcomes of interest and predictors	n	(%)	Mean	(S.D.)
Overall depression *(PHQ-2: 0 = not at all, 1 = several days, 2 = more than half the days, 3 = nearly everyday*)	1312	82.6%	1.46	(1.65)
Little interest or pleasure in doing things			0.77	(0.91)
Feeling down, depressed, or hopeless			0.69	(0.86)
Distribution of depression scores				
Major depressive disorder likely (≥3)	271	20.7%		
Major depressive disorder unlikely (<3)	1041	79.3%		
Missing	369	23.2%		
Overall anxiety *(GAD-2: 0 = not at all, 1 = several days, 2 = more than half the days, 3 = nearly everyday)*	1318	82.9%	1.52	(1.73)
Feeling nervous, anxious, or on edge			0.86	(0.94)
Not being able to stop or control worrying			0.66	(0.89)
Distribution of anxiety scores				
Generalized anxiety disorder likely (≥3)	299	22.7%		
Generalized anxiety disorder unlikely (<3)	1019	77.3%		
Vessel conerns^ - total average *(0 = never, 1 = almost never, 2 = sometimes, 3 = fairly often, 4 = very often) Since Mar 1, 2020 how often have you been concerned about the things below when on a vessel?*			1.92	(0.84)
Being away from family				
Mariner contract length			2.42	(1.22)
Money			1.82	(1.40)
Lack of work			1.93	(1.26)
A family member getting COVID while I am away			1.59	(1.31)
Myself getting COVID while at sea or ashore			2.26	(1.27)
Extra work onboard if there is a COVID case on my vessel			1.83	(1.28)
			1.60	(1.30)
Vessel experiences^ - total average *(0 = never, 1 = almost never, 2 = sometimes, 3 = fairly often, 4 = very often) Since Mar 1, 2020, how often have you experienced the things listed below?* Having no access or inadequate access to internet on a vessel			1.84	(1.03)
Having no cell phone or inadequate cell phone service while in port, harbors, and inland waterways			1.99	(1.38)

Being restricted in my ability to join or rejoin my family			1.71	(1.31)
Having feelings of isolation aboard			1.97	(1.38)
Having to quarantine due to a potential exposure to COVID			1.83	(1.37)
Being denied shore leave when in port due to the COVID			1.50	(1.30)
Being unable to join a vessel due to interruption of normal crew changes during COVID			2.33	(1.60)
			1.56	(1.40)
Mariner Impacts^ - total sum (check all that apply) *How has your vessel or your mariner contract been impacted by the COVID pandemic since Mar 1, 2020?*	1234			
Personnel have been infected with COVID	346	10.2%		
Port calls have been affected	535	15.7%		
Cargo onload/off load has been affected	270	7.9%		
Shore leave has been cancelled	635	18.7%		
Shore medical visits have been impacted	291	8.6%		
My mariner contract has been extended voluntarily	94	2.8%		
My mariner contract has been extended involuntarily	326	9.6%		
I've had restricted ability to get on or off the vessel	699	20.6%		
My vessel or mariner contract has not been impacted due to COVID	202	5.9%		
Time without shore leave (1 = less than 2 months, 2 = 2 to 4 months, 3 = 4 to 6 months, 4 = more than 6 months) *Since Mar 1, 2020 what is the longest you have beenonboard a vessel continuously, without shore leave?*				
Less than 2 months	580	46.6%		
2 to 4 months	362	29.1%		
4 to 6 months	208	16.7%		
More than 6 months	94	7.6%		
Mental health communication (0 = No, 1 = Yes, 2 = I am not sure) *During the COVID-19 pandemic (since Mar 1, 2020) have you received any information from the company you work for related to mental health?*				
No	610	53.6%		

Yes	384	33.8%		
I am not sure	143	12.6%		
Vessel support and safety culture^* - total average *(1 = strongly disagree, 2= disagree, 3 = agree, 4 = strongly agree)*				
What is the safety climate like both shoreside and onboard?				
If I am feeling stressed or sad, there is usually someone on the vessel I can talk to			2.80	(0.66)
Vessel senior officers encourage the crew to get mental health help if needed			2.42	(0.89)
Vessel senior officers generally encourage employees to work in accordance with safety rules, including COVID protocols			2.71	(0.89)
			3.26	(0.73)
Management support and safety culture^* - total average *(1 = strongly disagree, 2= disagree, 3 = agree, 4 = strongly agree)*				
What is the safety climate like both shoreside and onboard?			2.88	(0.78)
Company management encourages the crew to get mental health help if needed				
Company management generally encourages employees to work in accordance with safety rules, including COVID protocols			2.63	(0.93)
			3.13	(0.81)
Job satisfaction^* - total average *(1 = strongly disagree, 2= disagree, 3 = agree, 4 = strongly agree)*				
The following questions are about your job satisfaction?			3.01	(0.54)
I like the people I work with				
I like doing the things I do at work			3.16	(0.63)
I get enough time to relax and recharge when on the vessel			3.24	(0.61)
			2.63	(0.84)
General health and well being^¶ - total average *(1 = excellent, 2 = very good, 3 = good, 4 = fair, 5 = poor)*				
The following are general questions about your physical and mental health, including questions about your sleep habits.			2.86	(0.89)
In general, how would you rate your overall physical health now?				

Excellent	146	11.0%
Very Good	438	34.0%
Good	480	38.0%
Fair	185	15.0%
Poor	25	2.0%
In general, how would you rate your overall mental health now?		
Excellent	206	16.0%
Very Good	384	30.0%
Good	366	29.0%
Fair	250	20.0%
Poor	62	5.0%
In general, how would you rate your overall sleep quality now?		
Excellent	94	7.0%
Very Good	243	19.0%
Good	350	28.0%
Fair	391	31.0%
Poor	186	15.0%
Mental Health* *(1 = much worse, 2 = somewhat worse, 3 = the same, 4 = somewhat better, 5 = much better)* *Compared to before the COVID pandemic (before Mar 1, 2020) how would you rate your mental health now?*		
Much worse	123	10.0%
Somewhat worse	498	39.0%
The same	544	42.0%
Somewhat better	70	5.0%
Much better	55	4.0%
Physical Activity* *(1 = no days, 2 = 1-2 days, 3 = 3-4 days, 4 = 5 or more days)* *In a typical week, how many days do you get at least 30minutes of physical activity, outside of work activities?*		
No days	217	17.0%
1 - 2 days	359	28.0%
3 - 4 days	338	26.0%
5 or more days	376	29.0%
Sleep Change* *(1 = much worse, 2 = somewhat worse, 3 = the same, 4 = somewhat better, 5 = much better)*		

Compared to before the COVID pandemic (before Mar 1, 2020) how would you rate your sleep quality now?

Much worse	102	8.0%
Somewhat worse	360	28.0%
The same	737	57.0%
Somewhat better	62	5.0%
Much better	29	2.0%

^ Indicates items that were combined using Cronbach's Alpha
* Indicates items where a higher score is better for perceived mental health or well-being
¶ Indicates items with reverse coding

APPENDIX D

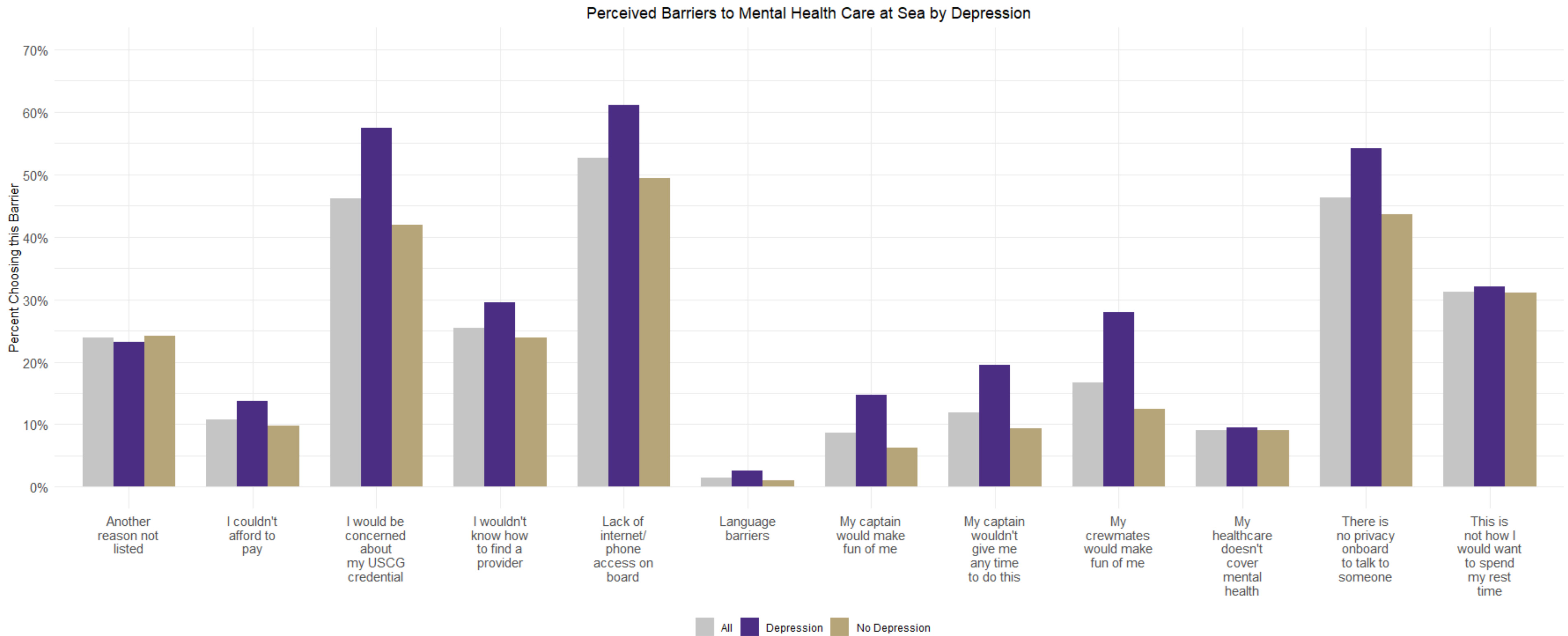
Table 4. Logistic regression analyses for mental health outcomes of interest

	Depression		Anxiety	
Predictors	OR	95% CI	OR	95% CI
Age	1.05	0.92, 1.19	**0.84***	0.74, 0.96
Gender (male vs. other)	0.84	0.66, 1.05	1.17	0.95, 1.42
Cadet/Pilot	---	---	---	---
Licensed deck or engineer officer	0.59	0.24, 1.57	**0.34***	0.15, 0.78
Unlicensed deck or engineer	0.74	0.27, 2.15	0.45	0.18, 1.12
Other type of position	0.66	0.22, 2.10	0.45	0.16, 1.24
Oceangoing vessel cargo	---	---	---	---
Inland/coastal operations/workboats	1.18	0.69, 2.00	1.17	0.70, 1.97
Passenger vessel operations	1.67	0.69, 3.90	1.01	0.41, 2.35
Government/public vessel operations	1.59	0.97, 2.61	1.37	0.84, 2.25
Other type of vessel	0.93	0.39, 2.09	1.00	0.43, 2.18
Vessel concerns	**1.47***	1.11, 1.96	**2.01***	1.52, 2.67
Vessel experiences	**1.64***	1.25, 2.15	1.17	0.90, 1.52
Mariner impacts	1.03	0.92, 1.16	1.03	0.92, 1.15
Time without shore leave	0.99	0.79, 1.24	0.83	0.66, 1.04
Mental health communication	1.07	0.81, 1.41	1.06	0.81, 1.39
Vessel support and safety culture	0.72	0.49, 1.06	**0.66***	0.45, 0.97
Management support and safety culture	1.02	0.75, 1.38	1.01	0.76, 1.36
Job satisfaction	1.04	0.69, 1.55	0.94	0.63, 1.40
Overall wellbeing now	**0.30***	0.22, 0.40	**0.28***	0.20, 0.37
Physical activity during the pandemic	1.04	0.87, 1.26	**1.29***	1.07, 1.55

Models for depression and anxiety were assessed using logistic regression.
--- indicates reference group
**Indicates p-value ≤ 0.05*

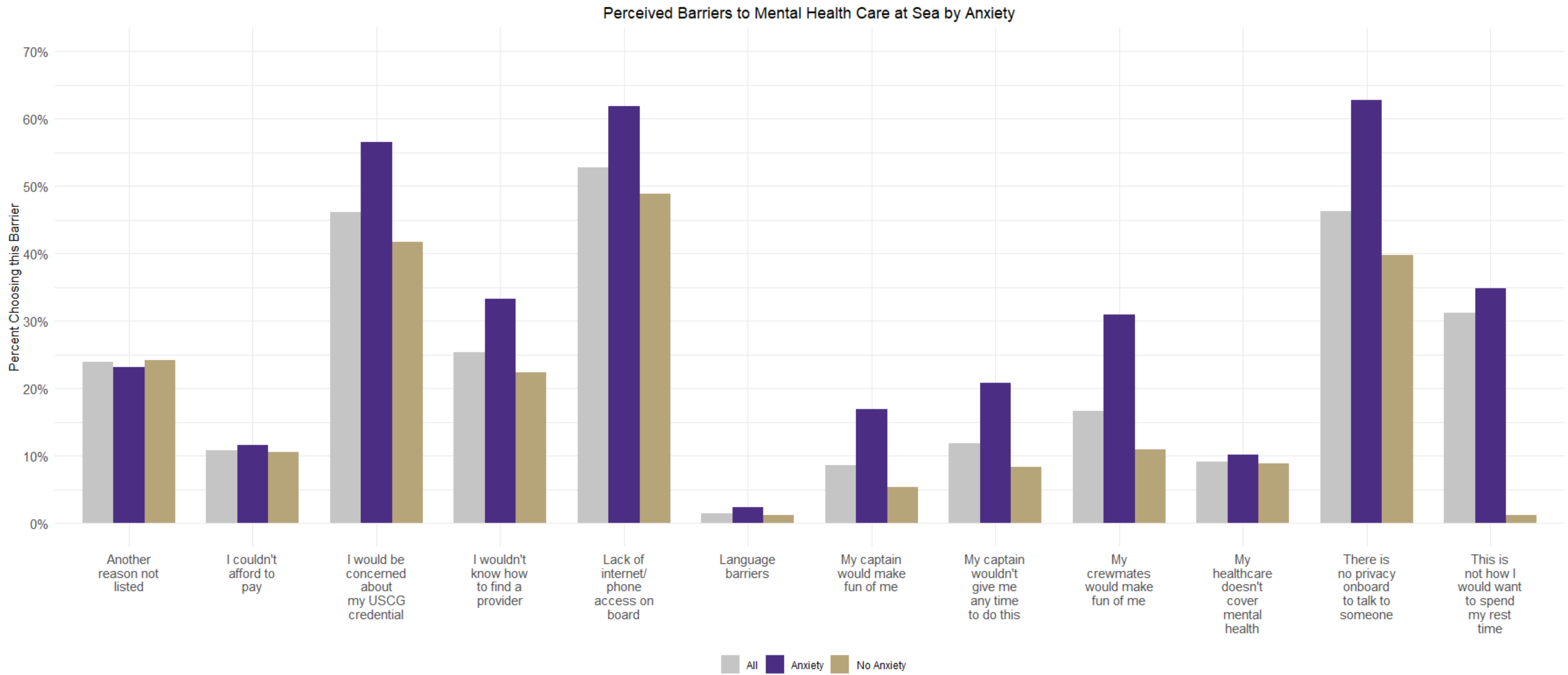
APPENDIX E

Figure 3.1. Perceived Barriers to Mental Health Care at Sea by Depression



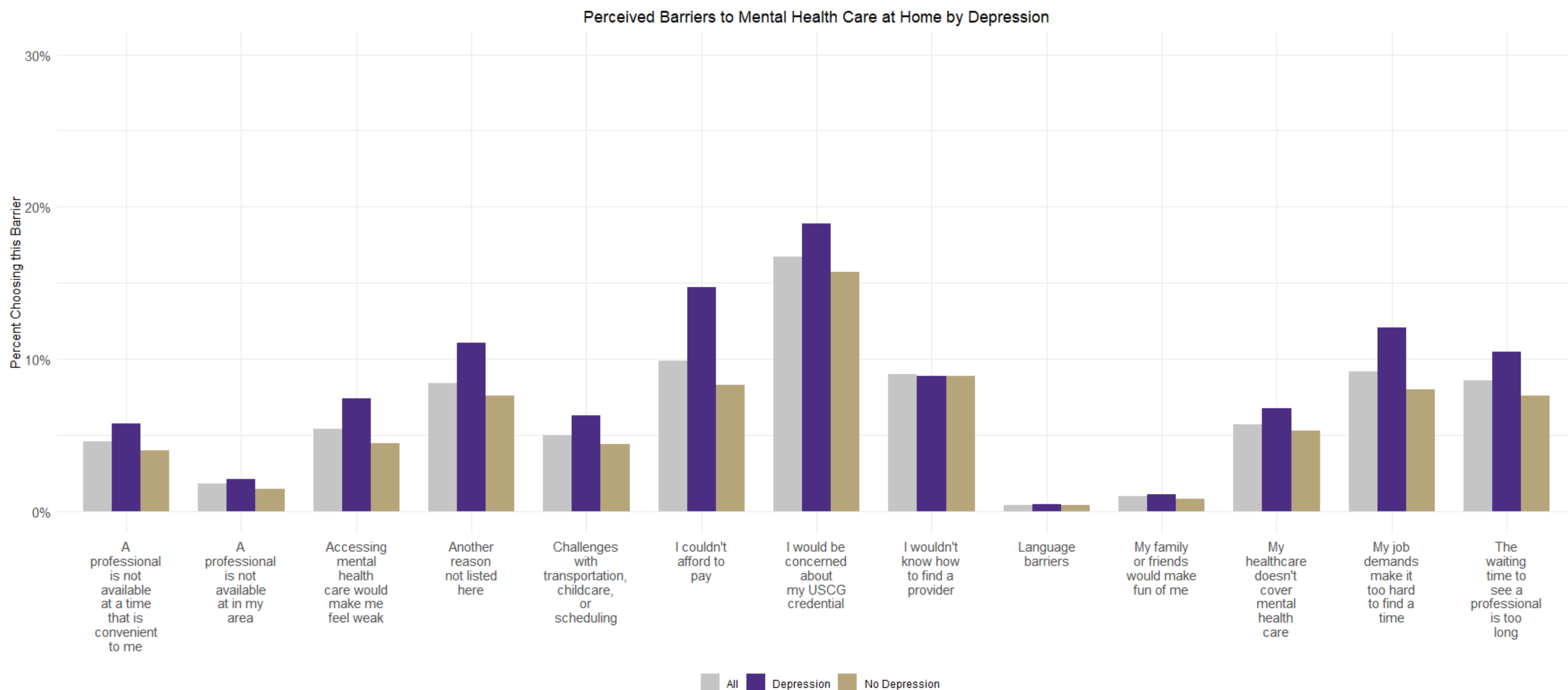
APPENDIX F

Figure 3.2. Perceived Barriers to Mental Health Care at Sea by Anxiety



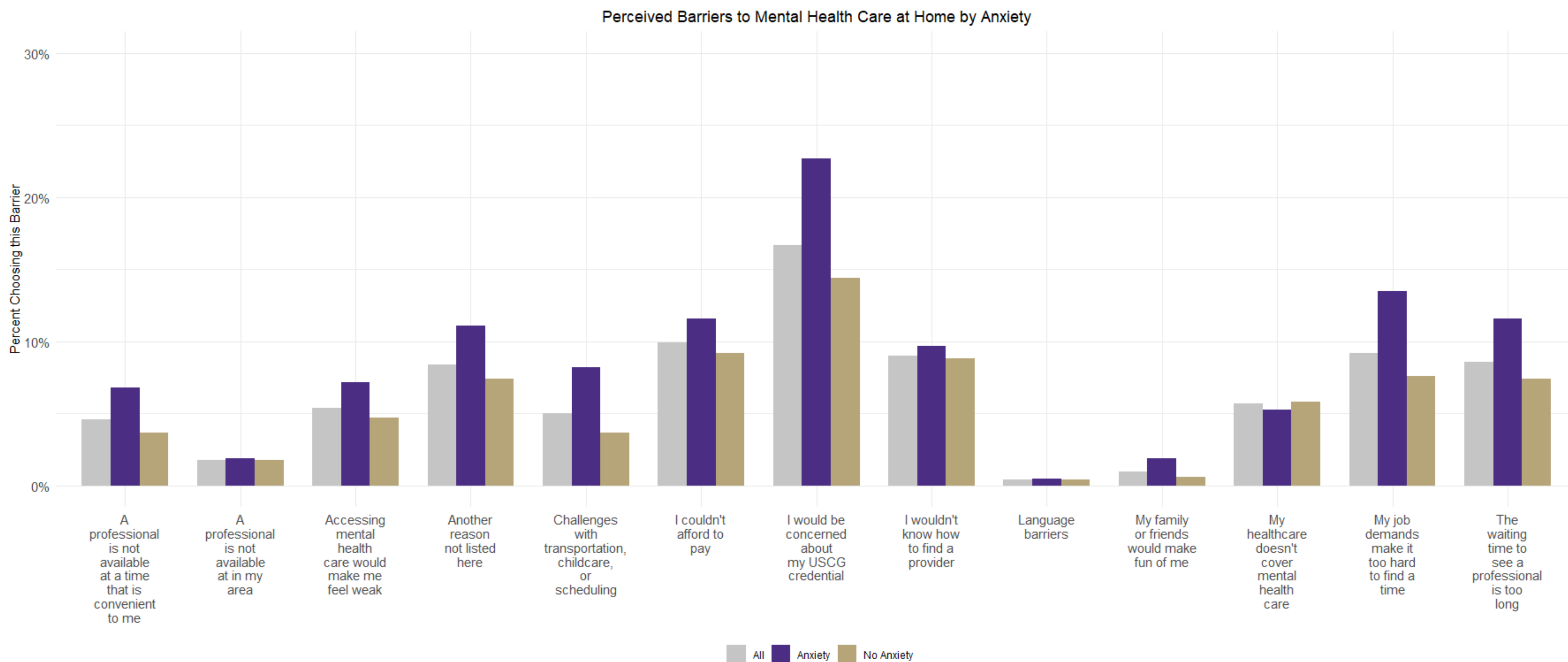
APPENDIX G

Figure 3.3. Perceived Barriers to Mental Health Care at Home by Depression



APPENDIX H

Figure 3.4. Perceived Barriers to Mental Health Care at Home by Anxiety



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