Correlation between Tryptophan Daily Intake and Occupational Factors with Stress Outcome Scores among Offshore and Onshore Workers

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ABSTRACT

Introduction. Offshore and onshore workers have a higher risk of psychological stress related to their job. Stress reactions vary depending on the type of stressor, the duration or severity of the stressor, their genetics, their coping styles, and their nutrition. Tryptophan is an essential amino acid precursor of serotonin and melatonin, which have an antidepressant effect and roles in stress perception and management. This study assessed the correlation of daily tryptophan intake and occupational factors with stress outcome scores based on the Indonesian Short Version New Brief Job Stress Questionnaire (SV-NBJSQ) among offshore and onshore workers.

Methods. A cross-sectional study was conducted on 14 offshore workers and 20 onshore workers. Interviews and questionnaires were conducted to obtain demographic data, dietary intake, occupational factors, and stress outcome scores. Tryptophan daily intake was measured through a single 24-hour dietary recall and a one-day-weighted food record. Data of average daily intake for two days were analyzed using the NutriSurvey software based on the food composition table from The United States Department of Agriculture National Nutrient Database for calculating tryptophan intake.

Results. The median (min-max) tryptophan daily intake of offshore workers was 5.5 (1.9–9.9) mg/kg, and 4.5 (1.4–7.5) mg/kg among onshore workers. There was no difference in tryptophan daily intake between offshore and onshore workers (p = 0.064). There was no significant difference between occupational factors except for the shorter tenure of offshore workers (12.5 vs 3, p < 0.001). There was no significant correlation between tryptophan daily intake and each of the stress outcome scores. There was a significant correlation between occupational factors and stress outcome scores among offshore and onshore workers, specifically between workload and fatigue (r = 0.35, p =0.04), workload and depression (r = 0.4, p = 0.02), interpersonal conflict and anxiety (r = 0.47, p = 0.005), role conflict and anxiety (r = 0.47, p = 0.005), as well as between tenure and physical reaction stress (r = -0.42, p = 0.02).

Conclusion. Adequate tryptophan daily intake and high stress outcome scores among offshore and onshore oil and gas workers are observed in this study, and no correlation was found between the two. Similar food sources, homogeneous occupational stressors, the selection bias of the "healthy worker effect" or other factors that were not studied may influence the findings. There is a correlation between occupational factors and stress outcome scores, namely workload and fatigue, workload and depression, interpersonal conflict and anxiety, role conflict and anxiety, and tenure and stress physical reactions.

Keywords: tryptophan intake, job stress, offshore and onshore

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INTRODUCTION

Oil and gas industry workers, especially field workers offshore or onshore, are at risk of stress due to job demands and safety risks.[1,2] Stress can induce reactions in the form of physical and psychological symptoms. Physical symptoms can be musculoskeletal disorders, exhaustion, chronic fatigue syndrome, and hypertension. Psychological reactions can be in the form of changes in vigor, irritability, insomnia, tension, anxiety, and depression.[2-4] Based on research at oil and gas companies in the Middle East, it was found that 15% of workers reported symptoms of anxiety and 18% of workers reported symptoms of depression.[5] About 95% of workers feel stress due to work at moderate to heavy levels.[6] Work stress has a large impact on productivity and the economy. In Europe, the estimated cost of work-related depression is €617 billion per year, which includes costs to employers due to absenteeism and presenteeism, lost productivity, health care costs, and social disability payments.[7]

Psychosocial hazards such as overload, underload, long working hours, and work relationships can cause stress among workers. Work location adds to this issue (including traveling to the location, being away from home, and having to stay on-platform).[8-10] Stress arises when workers feel the job demands are heavier than their abilities.[11] Differences in stress reactions among workers can be caused by the type of stressor, the duration or severity of the stressor, genetics, individual coping styles, and individual nutrition.[12-14]

Nutritional intake plays a role in individual stress management; one of the most important nutrients is tryptophan.[15] This essential amino acid is a large neutral amino acid (LNAA) that plays a role in affecting mental status.[16] Tryptophan is a precursor to the neurotransmitter serotonin and the hormone melatonin,[14] which improve mood, anxiety, depression, and increase sleep efficiency. Low brain serotonin levels are associated with decreased memory and decreased mood.[17] Melatonin as the end-product of tryptophan is important in the regulation of the circadian rhythm, disruption of which is implicated in affective and mood disorders.[18] The daily requirement of tryptophan for an adult is 4 mg/kg body weight (WHO recommendation);[19] Subjects with higher tryptophan intake (> 10 mg/kg of body weight per day) achieved higher positive mood scores, improvement in anxiety, depression, and irritability (compared to those receiving tryptophan intake < 5mg/kg body weight per day).[20]

Typically, upstream oil and gas workers in remote areas, both offshore and onshore, are served meals by company catering. Their daily diet has been estimated to be nutritionally adequate and the quality of the food is guaranteed. However, the amount of their daily tryptophan intake is unknown. It would be interesting to know whether tryptophan levels from the daily intake of offshore and onshore workers are related to their stress outcomes.

The Indonesian short version new brief job stress questionnaire (SV-NBJSQ) measures job stressors and stress outcomes (including stress reactions).[21] In this study, job stressors such as workload, interpersonal conflict, and role conflict are grouped as occupational factors that can affect stress outcomes.

The objective of this study was to determine the correlation between the level of tryptophan daily intake and occupational factors with stress outcome scores based on the Indonesian version of the SV-NBJSQ among offshore and onshore workers.

METHODS

This study included as a part of the baseline phase of an experimental study from the Southeast Asian Ministers of Education Organization (SEAMEO) Regional Center for Food and Nutrition titled "Intervention Strategies to Improve Nutrition and Health of Oil and Gas Worker through Diet Optimization using Linear Programming Approach".

A cross-sectional study was conducted among workers at two oil and gas companies located in East Kalimantan province, Indonesia. Site A is an offshore gas production installation located in the Makassar Strait. Site B is an onshore oil and gas production located beside the Mahakam River, Samarinda. East Kalimantan province was selected because it has a high number of oil and gas production sites. Each company's participation was voluntary, based on the recommendation from the Special Task Force for Upstream Oil and Gas Business Activities Republic of Indonesia.

Participants were recruited through the company's health clinic. The inclusion criteria were:

- male workers age 22 – 54 years and
- have been working at the company for at least a year.

This is because most of the workforce are males in their productive age (between 22 years and 54 years).[22] In one year of work, workers would have experienced all of the company's work and health control programs. Workers who were taking mood stabilizers or antidepressants were excluded.

This study protocol was approved by the Research Ethical Committee at the Faculty of Medicine Universitas Indonesia and Dr. Cipto Mangunkusumo General Hospital (FKUI-RSCM), stated by letter number 182/UN2.F1/ETIK/ PPM.00.02/2020. All participants signed the written informed consent. Data were collected in March 2020. Data collection was carried out by four trained enumerators from March 09, 2020, to March 14, 2020, at the offshore site and from March 16, 2020, to March 18, 2020, at the onshore site.

Respondents' Demographic

Participants answered demographic information (such as age in years, site/unit employed, and education level), smoking habits, and disease history. Examples of sites employed are general maintenance, Health Safety Environment (HSE), production, etc. The level of education was categorized as high school, undergraduate or post-graduate. Participants

were categorized according to Brinkman Index into non-smoker, light smoker (Brinkman index < 200), moderate (Brinkman index 201–600), or heavy smoker (Brinkman index > 600). Body weight was measured using a SECA 878 digital weighing scale that was calibrated to an accuracy of 0.1 kg. Participants' body weight was used as the denominator for total tryptophan intake.

Tryptophan daily intake

Dietary intake was collected using a single 24-hour dietary recall and one-day-weighted food record (WFR). The 24-hour dietary recall was done on the first day using a multiple-pass approach. Portion sizes are estimated using food photograph books. The weighted food record was conducted on the second day, by measuring the participants' food and beverage consumption (including leftovers) on a digital scale at the company restaurant. Food preparation was documented in the company kitchen in cooperation with the head chef and/or nutritionist.

The NutriSurvey software was used to analyze data based on the tryptophan food composition table (FCT) from the United States Department of Agriculture (USDA) National Nutrient Database.[23] Tryptophan daily intake was expressed in mg/kg body weight and is compared against the World Health Organization recommendation (4 mg/kg body weight).

Occupational factors

The Indonesian Short Version New Brief Job Stress Questionnaire (SV-NBJSQ) recorded occupational factors, including tenure (in years), workload, interpersonal conflict, and role conflict. This SV-NBJSQ was translated from Japanese into Indonesian and validated as a job stress screening tool in a previous study. Items were ranked from one to four, with a higher number indicating a better status. Enumerators supervised participants while observing their dispositions.

Stress outcome scores

Stress outcome scores were also measured by the SV-NBJSQ; these include fatigue, anxiety, depression, and stress physical reactions. Items were ranked from one to four, with a higher number indicating the best status.

SPSS software, version 20 was used to analyse the data. Data normality was tested using the Shapiro-Wilk test. Comparison between work location (offshore vs onshore) was conducted for characteristics data, using the Mann-Whitney test for continuous variables (age, tenure, tryptophan daily intake, workload, interpersonal conflict, role conflict, fatigue, anxiety, depression, and stress physical reactions) or Fisher's exact test for categorical variables (work division, level of education and smoking habit). The association between independent variables and dependent variables was assessed using the Spearman correlation test for variables with continuous data and the Kruskal Wallis test for categorical variables. If the p-value was < 0.05, a post hoc test was used to identify which subgroups have a relationship with the dependent variable. Two-tailed statistical test results with P-values < 0.05 were considered statistically significant.

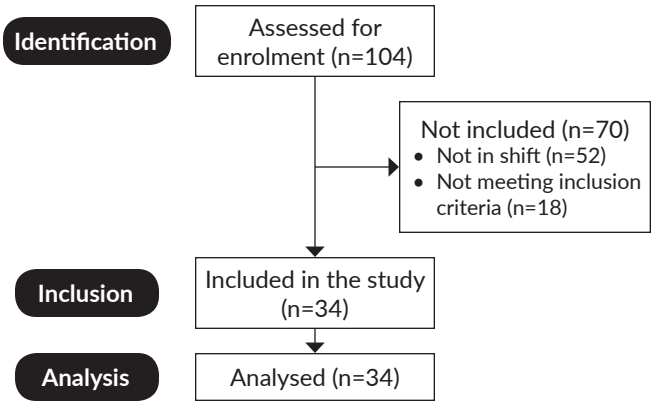

Figure 1. Study enrolment flow chart.

RESULTS

Thirty-four participants (14 offshore, and 20 onshore workers) completed the Indonesian version SV-NBJSQ, basic questionnaire, dietary assessment, and anthropometric measurement. Among 104 eligible workers, 52 were not on shift at the time of the researchers' visit, 17 workers had been on site for less than seven days, and 1 respondent did not fill out the questionnaire (Figure 1). Data collection had to be stopped due to social restrictions related to the COVID-19 outbreak before the minimal sample size of 100 workers was obtained. Despite this, thirty or more samples can be analyzed for statistical significance.

All respondents are married and work 12-hour shifts on 14 consecutive days. Offshore workers had significantly fewer tenure or years of service than onshore workers (P < 0.001). There was no other difference in characteristics between offshore and onshore workers (Table 1).

All workers rated scores ≥ 2.25 for anxiety and depression; some workers scored < 2.25 for fatigue and stress physical reaction (Table 2). There was no significant difference between the stress outcomes scores of offshore and onshore workers. Overall, almost all workers had good mental health status. The worst stress outcome score in this study was fatigue.

There was no association between workers' demographics and stress outcome scores (Table 3).

There was no significant association between workers' tryptophan daily intake and stress outcome scores (Table 4).

Tenure has a negative correlation with stress physical reaction (r = -0.42) (Table 5). Workload and fatigue have a weak Spearman correlation value (r = 0.35). There is a moderate positive correlation between workload and depression scores (r = 0.40), interpersonal conflict and anxiety (r = 0.47), and role conflict and anxiety (r = 0.47).

Table 1. Comparison of the workers' demographics, tryptophan daily intake, and occupational factors based on the work location

	Category/Distribution	Offshore (n = 14)	Onshore (n = 20)	Total (n = 34)	*P* value
Demographic					
Education *(n)*	High school	3	7	10	0.50*
	Undergraduate	8	11	19	
	Postgraduate	3	2	5	
Department *(n)*	General maintenance	2	3	5	0.10*
	HSE	1	7	8	
	Production	9	5	14	
	Others	2	5	7	
Smoking habit *(n)*	Non-smoker	7	13	20	0.67*
	Light smoker	5	6	11	
	Moderate smoker	2	1	3	
Age *(years)*	Median (min-max)	41.8 (30–47)	38.9 (31–47)	39.2 (30–47)	0.68†
Tryptophan daily intake *(mg/kg)*	Median (min-max)	5.5 (1.9–9.9)	4.5 (1.4–7.5)	4.8 (1.4–9.9)	0.06†
Occupational factors					
Tenure *(years)*	Median (min-max)	3 (1–6)	12.5 (1–20)	7.5 (1–20)	<0.001†
Workload	Median (min-max)	2.0 (1.5–4)	2.5 (2–4)	2.5 (1.5–4)	0.14†
Interpersonal conflict	Median (min-max)	3.5 (2–4)	3.7 (2.3–4)	3.7 (2–4)	0.64†
Role conflict	Median (min-max)	3.0 (1–4)	3.0 (1–4)	3.0 (1–4)	0.19†

**Fisher exact test; †Mann-Whitney U test*

Table 2. Comparison of the stress outcomes scores between offshore and onshore workers

	Distribution	Offshore (n = 14)	Onshore (n = 20)	Total (n = 34)	*P* value
Fatigue	Median (min-max)	3.3 (2.7–4)	3.3 (2–4)	3.3 (2–4)	0.38*
Anxiety	Median (min-max)	3.2 (3–4)	3.3 (3–4)	3.3 (3–4)	0.27*
Depression	Median (min-max)	3.8 (3–4)	3.8 (3–4)	3.8 (3–4)	0.63*
Stress physical reactions	Median (min-max)	3.6 (3.3–4)	3.5 (1.2–4)	3.5 (1.2–4)	0.12*

**Mann-Whitney U test*

Table 3. Association between workers' demographics and stress outcomes scores

	Fatigue		Anxiety		Depression		Stress physical reactions	
	Median	*p*	Median	*p*	Median	*p*	Median	*p*
Work location		0.38*		0.27*		0.63*		0.12*
Onshore (20)	3.3 (2–4)		3.3 (3–4)		3.8 (3–4)		3.5 (1.2–4)	
Offshore (14)	3.3 (2.7-4)		3.2 (3–4)		3.8 (3–4)		3.6 (3.3–4)	
Education		0.37†		0.82†		0.53†		0.27†
High school (10)	3.3 (2.7-3.7)		3.3 (3-4)		3.8 (3.5–4)		3.5 (2.7–4)	
Undergraduate (19)	3.3 (3-4)		3.3 (3-4)		3.7 (3- 4)		3.6 (1.2-4)	
Postgraduate (5)	3.3 (2-3.7)		3 (3-4)		3.8 (3.2-4)		3.5 (3.5-3.9)	
Work division		0.22†		0.74†		0.33†		0.15†
General maintenance (5)	3.3 (3–3.7)		3.7 (3–4)		3.8 (3–4)		3.4 (3.3–3.6)	
HSE (8)	3.5 (3–4)		3.3 (3–4)		3.6 (3–4)		3.5 (3.4 4)	
Production (14)	3.3 (2.7–4)		3.3 (3–4)		3.8 (3.5–4)		3.6 (2.7–4)	
Others (7)	3.3 (2–4)		3.0 (3–4)		3.7 (3–4)		3.6 (1.2–4)	
Smoking habit		0.621†		0.312†		0.079†		0.222†
Non-smoker (20)	3.3 (3–4)		3.3 (3–4)		3.7 (3–4)		3.5 (2.9–4)	
Light smoker (11)	3.7 (2–4)		3.7 (3–4)		3.8 (3.2–4)		3.6 (2.7 -4)	
Moderate smoker (3)	3.3 (3–3.7)		3 (3–3.3)		3.7 (3–3.7)		3.8 (1.2–3.8)	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Age *(years)*	0.23	0.08‡	0.23	0.19‡	0.03	0.88‡	-0.04	0.82‡

**Mann-Whitney U test; †Kruskal-Wallis test; ‡Spearman correlation*

Table 4. Correlation between workers' tryptophan daily intake and stress outcome scores

	Fatigue		Anxiety		Depression		Stress physical reactions	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*
***Tryptophan daily intake** (mg/kg)*	-0.12	0.49*	0.02	0.89*	-0.08	0.65*	-0.05	0.77*

**Spearman correlation*

Table 5. Correlation between workers' occupational factors with stress outcome scores

	Fatigue		Anxiety		Depression		Stress physical reactions	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*
***Tenure** (years)*	0.11	0.53*	0.14	0.44*	0.16	0.38*	-0.42†	0.02*
Workload	0.35†	0.04*	0.31	0.08*	0.40†	0.02*	-0.04	0.84*
Interpersonal conflict	0.12	0.51*	0.47†	0.01*	0.32	0.07*	-0.05	0.78*
Role conflict	0.17	0.34*	0.47†	0.01*	0.25	0.16*	-0.09	0.63*

**Spearman correlation; †Statistically significant with p < 0.05*

DISCUSSION

No correlation between tryptophan daily intake and stress outcome scores was found in this study. Occupational factors (tenure, workload, interpersonal conflict, and role conflict) were related to stress outcome scores (fatigue, depression, anxiety, and stress physical reaction). Worker demographics were not associated with stress outcome scores.

Almost all respondents had good physical and mental health status; we cannot, however, conclude that offshore and onshore workers are free from work-related stress. Selection bias may influence our findings since workers have passed physical and mental health checks,[24] and have full autonomy in their choice of workplace.[25,26]

The participants' tryptophan daily intake exceeds the WHO recommended value.[19] Despite this, no significant correlation was found between tryptophan daily intake and stress outcome scores. This may be due to the small sample size or several confounding factors, such as similar food sources, differences in tryptophan absorption, genetics, and individual coping style.[12-14] Other large neutral amino acids (LNAA) not measured (such as tyrosine, phenylalanine, leucine, isoleucine, and valine) may affect tryptophan absorption at the blood-brain barrier through competition.[16]

Tryptophan's role in improving low mood, depression, and anxiety is evident in a hypo-serotonergic state (such as depression or stress). In healthy normo-serotonergic subjects, it has no effect or a negative effect.[27,28] The serotonergic system's sensitivity is likewise affected by genetic, environmental, and psychological factors.[16] In this study, the initial condition of the respondent's serotonergic system was not known.

Like other studies, we found that workload is the main stressor for oil and gas workers.[29,30] More than half stated that the work was hard, even though they were able to complete the task within the allotted time. Workload is found to be weakly associated with fatigue among workers, similarly to rail industry workers.[31] Workload is related to the number of jobs held. The perceived workload of the worker can be conceptualized in different ways, such as the amount or difficulty of work, stamina, ability, or the time a person completes a job.[32]

Workload is also moderately correlated to depression, similar to other studies.[33,34] Workers in the oil and gas industry have difficult work conditions and stressful working schedules.[30] Long work hours, safety hazards (including fire, explosion, blow-out), and accidents (associated with helicopter transport and drilling operations) worsen the workload for oil and gas workers.[35] Workload that exceeds the individual's coping abilities may lead to symptoms of fatigue, difficulty sleeping, poor concentration, and depression.[36]

Interpersonal conflict is moderately correlated with anxiety, up to 2.26 times in other studies.[37] It can manifest as hostility, jealousy, poor communication, or low morale,[38] produce negative emotions such as depression, frustration, low self-esteem, anxiety, and can lead to anger or violence in the workplace.[39]

Role conflict has a moderately significant correlation with anxiety (r = 0.43).[40] This is caused by inconsistent communication or discrepant tasks; the fulfillment of one task will hinder the completion of another.[41] Role conflict can cause stress when the task is given by someone in authority, or when task accomplishment is important to the worker.[40]

Increasing tenure was associated with worse stress physical reactions and mental health.[42] It is theorized that symptoms of stress develop in persons who are overloaded with work and are exposed to interpersonal conflicts for longer.[43]

This study has several limitations. First, this study has a small sample size and lacks power, which could be improved on by larger future studies. Second, participation of oil and gas companies was specially requested, not randomly selected. Third, the tryptophan composition used was borrowed from US data, which may differ from the nutritional content of foodstuffs in Indonesia. Intake of other LNAAs was also not measured, thus we could not calculate the Tryptophan/LNAA ratio. Future studies may consider other amino acids

such as tyrosine, phenylalanine, leucine, isoleucine, and valine. Lastly, a cross-sectional study is a single snapshot and cannot measure the correlation between tryptophan intake and stress response over time.

CONCLUSION

Although offshore and onshore oil and gas workers have adequate tryptophan daily intake and high stress outcome scores, these two were not correlated. There was no difference between offshore and onshore workers. Similar food sources, homogeneous job stressors, and the "healthy worker effect" selection bias may influence the findings in this study.

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Statement of Authorship

All authors contributed in the conceptualization of work, acquisition and analysis of data, drafting and revising, and approved the final version submitted.

Author Disclosure

All authors declared no conflicts of interest

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REFERENCES

1. Mette J, Velasco Garrido M, Harth V, Preisser AM, Mache S. Healthy offshore workforce? A qualitative study on offshore wind employees' occupational strain, health, and coping. BMC Public Health. 2018; 18(1):172.
2. Dias FM, Santos JFDC, Abelha L, Lovisi GM. Occupational stress and professional exhaustion syndrome (burnout) in workers from the petroleum industry: a systematic review. Rev Bras Saúde Ocup. 2016; 41:1-14.
3. Afzainizam N, Embong AM, Yaacob R, Sabina N, Ashgaftaki A, Elsayed M. Job stress among offshore personnel in oil and gas extraction industries. Indian J Sci Technol. 2016; 9(9):1-6.
4. Chen WQ, Yu IT, Wong TW. Impact of occupational stress and other psychosocial factors on musculoskeletal pain among Chinese offshore oil installation workers. Occup Environ Med. 2005; 62(4):251-6.
5. Pavicic Žeželj S, Cvijanovic Peloza O, Mika F, Stamenkovic S, Mahmutovic Vranic S, Šabanagic Hajric S. Anxiety and depression symptoms among gas and oil industry workers. Occup Med (Lond). 2019; 69(1):22-7.
6. Finian OI, Achalu EO, Patrick C. Comparing the effect of occupational stress on oil and gas industry workers in Nigeria with respect to age and gender. EJAS. 2021; 9:536-50
7. International Labour Organization. Workplace stress: A collective challenge. Geneva: ILO Publication; 2016 Apr. 63.
8. Gardner R. Overview and characteristics of some occupational exposures and health risks on offshore oil and gas installations. Ann Occup Hyg. 2003; 47(3):201-10.
9. Witter RZ, Tenney L, Clark S, Newman LS. Occupational exposures in the oil and gas extraction industry: State of the science and research recommendations. Am J Ind Med. 2014; 57(7):847-56.
10. Niven K, McLeod R. Offshore industry: management of health hazards in the upstream petroleum industry. Occup Med (Lond). 2009; 59(5):304-9.
11. Leka S, Griffiths A, Cox T. Work organisation and stress: systematic problem approaches for employers, managers and trade union representatives. Switzerland: World Health Organization; 2003. 33.
12. Scott KA, Melhorn SJ, Sakai RR. Effects of chronic social stress on obesity. Curr Obes Rep. 2012; 1(1):16-25.
13. Glatthaar II. Micronutrients and stress. S Afr Med J. 1999; 89:16-22.
14. Kikuchi AM, Tanabe A, Iwahori Y. A systematic review of the effect of L-tryptophan supplementation on mood and emotional functioning. J Diet Suppl. 2021; 18(3):316-333.
15. Singh K. Nutrient and stress management. J Nutr Food Sci. 2016; 6(4):528.
16. Fernstrom JD. Large neutral amino acids: dietary effects on brain neurochemistry and function. Amino Acids. 2013 Sep; 45(3):419-30.
17. Jenkins TA, Nguyen JC, Polglaze KE, Bertrand PP. Influence of tryptophan and serotonin on mood and cognition with a possible role of the gut-brain axis. Nutrients. 2016 Jan; 8(1):56.
18. Gostner JM, Geisler S, Stonig M, Mair L, Sperner-Unterweger B, Fuchs D. Tryptophan metabolism and related pathways in psychoneuroimmunology: The impact of nutrition and lifestyle. Neuropsychobiology. 2020; 79(1):89-99.
19. Joint WHO/FAO/UNU Expert Consultation. Protein and amino acid requirements in human nutrition. World Health Organ Tech Rep Ser. 2007; (935):1-265. PMID: 18330140.
20. Lindseth G, Helland B, Caspers J. The effects of dietary tryptophan on affective disorders. Arch Psychiatr Nurs. 2015 Apr; 29(2):102-7.
21. Paska da Lopez AAV. Uji validasi dan reliabilitas short version of New Brief Job Stress Questionnaire (NBJSQ) versi bahasa Indonesia sebagai alat penilai stres kerja pada pekerja kantor [Thesis]. Jakarta: Universitas Indonesia; 2019.
22. LAEDC Institute for Applied Economics. The Oil and Gas Industry in California: Its Economic Contrubution and Workforce in 2013. 2015.
23. United State Department of Agriculture. Food data central search results [internet]. 2020. [cited 2020 Dec]. Available from: https://fdc.nal.usda.gov/fdc-app.htm.
24. Mehta RK, Smith A, Williams JP, Camille Peres S, Sasangohar F. Investigating fatigue in offshore drilling workers: a qualitative data analysis of interviews. IISE Trans Occup Ergon Hum Factors. 2019; 7(1):31-42.
25. Gore BF. Workload and fatigue. In: Space safety and human performance. England: Butterworth-Heinemann; 2018. p. 53-85.
26. Parkes KR. Psychosocial aspects of stress, health and safety on North Sea installations. Scand J Work Environ Health. 1998 Oct; 24(5): 321-33.
27. Silber BY, Schmitt JA. Effects of tryptophan loading on human cognition, mood, and sleep. Neurosci Biobehav Rev. 2010 Mar; 34(3):387-407.
28. Markus CR, Firk C, Gerhardt C, Kloek J, Smolders GF. Effect of different tryptophan sources on amino acids availability to the brain and mood in healthy volunteers. Psychopharmacology (Berl). 2008 Nov; 201(1):107-14.
29. Ljoså CH, Tyssen R, Lau B. Mental distress among shift workers in Norwegian offshore petroleum industry--relative influence of individual and psychosocial work factors. Scand J Work Environ Health. 2011; 37(6):551-555.
30. Bresić J, Knezević B, Milosević M, Tomljanović T, Golubić R, Mustajbegović J. Stress and work ability in oil industry workers. Arh Hig Rada Toksikol. 2007 Dec; 58(4):399-405.

31. Smith AP, Smith HN. Workload, fatigue and performance in the rail industry. In: Longo L, Leva M, editors. International symposium on human mental workload: models and applications. Human Workload 2017: Proceedings of the Communications in Computer and Information Science; 2017 Jun 28-30; Dublin, Ireland. Berlin: Springer; 2017. pp. 251-263.
32. Bowling NA, Kirkendall C. Workload: A review of causes, consequences, and potential interventions. In: Houdmont J, Leka S, Sinclair RR, editors. Contemporary occupational health psychology: Global perspectives on research and practice, Vol. 2, 1st ed. New Jersey: Wiley Blackwell; 2012. p. 221–238.
33. Spector PE, Jex SM. Development of four self-report measures of job stressors and strain: interpersonal conflict at work scale, organizational constraints scale, quantitative workload inventory, and physical symptoms inventory. J Occup Health Psychol. 1998 Oct; 3(4):356-367.
34. Ozkan A, Ozdevecioglu M, Kaya Y, Koç FÖ. Effects of mental workloads on depression-anger symptoms and interpersonal sensitivities of accounting professionals. Revista de Contabilidad. 2015; 18(2):194-9.
35. Bjerkan AM. Work and health: a comparison between Norwegian onshore and offshore employees. Work. 2011;40(2):125-42.
36. Melchior M, Caspi A, Milne BJ, Danese A, Poulton R, Moffitt TE. Work stress precipitates depression and anxiety in young, working women and men. Psychological Medicine. 2007; 37(8):1119-29.
37. Lee KH, Ho Chae C, Ouk Kim Y, Seok Son J, Kim JH, Woo Kim C, et al. Anxiety symptoms and occupational stress among young Korean female manufacturing workers. Ann Occup Environ Med. 2015 Nov; 27:24.
38. Gökçe SG, Emhan A, Topuz G, Şimşek M. The analysis of the relationship between job stress, interpersonal conflict, emotion regulation ability and performance: a research in the automotive sector. IJBSS. 2015 Aug; 6(8):201-8.
39. Demsky CA. Interpersonal conflict and employee well-being: the moderating role of recovery experiences [Thesis]. Portland: Portland State University: 2012.
40. Maden-Eyiusta, C. Role conflict, role ambiguity, and proactive behaviors: does flexible role orientation moderate the mediating impact of engagement? Int J Hum Resource Manag. 2019 May; 32(13): 2829-55.
41. Ulleberg P, Rundmo T. Job stress, social support, job satisfaction and absenteeism among offshore oil personnel. Work & Stress. 1997; 11(3):215-28.
42. Chen W-Q, Wong T-W, Yu T-S. Influence of occupational stress on mental health among Chinese off-shore oil workers. Scandinavian J Public Health. 2009;37(7):766-73.
43. Stanetić K, Tešanović G. Influence of age and length of service on the level of stress and burnout syndrome. Medicinski Pregled. 2013; 66(3-4):153-62.