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ORIGINAL ARTICLE

Anemia status and its related factors among Indonesian workers: Hemoglobin surveys in three different workplaces

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Abstract

This study aims to explore risk factors of low hemoglobin status (anemia) among workers in three different workplaces in Indonesia. Cross-sectional study design was applied to screen hemoglobin value by using a multiwave pulse total-hemoglobinometer Masimo® and obtain socio-demographic characteristics using a questionnaire. Three workplaces were purposively selected to have total population eligible for this study. Health safety protocol was applied both for the subjects and researchers as COVID19 prevention. Statistical analyses were used accordingly to find potential risk factor(s) of anemia among workers. A total of 2386 eligible subjects with mean age of 36.8 ± 9.2 years participated in this study consisted of mainly male workers (85.3%), mostly married (79.0%), never smoke (55.8%) and working in shift (68.7%). Mean of hemoglobin value was 14.2 ± 1.2 mg/dL with anemia prevalence of 9.9%. Risk factor of anemia among workers were female-gender, non-marriage status, never smoking and no-work shift. However, the potential determinant for anemia among workers was female-gender, in which the prevalence of anemia was 24.6% as compared to 7.4% in male-gender. Keep providing free meal in the workplace canteen is a must, but there is a need to provide iron and vitamin C-fortified food and/or iron and vitamin C supplement especially for female workers.

Keywords anemia, iron intake, Masimo®, workers

Introduction

Anemia, especially iron deficiency anemia, is a worldwide public health problem for its alarmingly high prevalence, including in Indonesia. Besides pregnant women and children, there are also significant deleterious consequences of iron deficiency with or without anemia (i.e. as the most severe form of iron deficiency) among workers in relation to their physical working capacity.[1] It is well-known that iron plays an essential role in oxidative energy production, in which it will affect aerobic capacity, endurance capacity, energy efficiency, muscle and brain activities, and finally economic productivity.

As one of developing countries, Indonesia must compete globally in industrial production. This will result in the numbers of worker population increase to more than 100 million. These populations consist of approximately 64.6% and 35.4% male and female workers, consecutively. Several factors are recognized as the risk factors of anemia among workers. These include inadequacy of dietary iron

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intake and the existence of absorption hindering compounds in foods. Others are socio-economic and lifestyle factors such as education, smoking and drinking habit.[2]

As reported by the MoH, the prevalence of anemia that predominantly caused by iron deficiency among Indonesian adults in 2013 was 18.4–20.1%.[1] Among female workers in timber factory and among workers in shoe factory, the prevalence of anemia were 77.7% and 56.0%, respectively. While in industrial workplace, the prevalence of anemia was 14.1%, consisted of 5.6% in male and 32.1% in female workers.[2] There is no specific report on iron deficiency anemia among workers. This study aims to screen hemoglobin value among workers in Indonesia using rapid and safe assessment during the COVID19 pandemic.

Methods

This study used cross-sectional design, done from December 2020 to January 2021. The subjects were all workers in three different working locations who were eligible to participate in this study, i.e. apparently healthy male and female workers, aged 19 to 64 years old. Pregnant women were excluded.

Data collection were done after receiving ethical clearance from the Ethical Committee Faculty of Medicine Universitas Indonesia (No: KET-1407/UN2.F1/ETIK/PPM.00.02/2020).

Data collected consisted of hemoglobin value assessment using *Masimo® Rad-67 Pulse CO-Oximeter (Masimo SET® Measure-through Motion and Low Perfusion Pulse Oximetry and Non-invasive Total Hemoglobin (SpHb®) Spot-check Monitoring)* and subjects' characteristic data, such as age, gender, marital status (single, married or widowed), working shift (yes or no), and smoking habit (never, currently active or had history of smoking).

The non-invasive multi-wave pulse total-hemoglobinometer Masimo® was purposively chosen because it is a valid device to monitor hemoglobin value and can be used to screen low hemoglobin value in a clinical setting, i.e. during surgery. To have a minimal contact then the device is suitable to be used in a non-clinical setting to screen for low hemoglobin value among apparently healthy population.[7]

During the COVID19 pandemic situation, all enumerators were required to conduct safety protocol for data collection, i.e. wearing protective suit, surgical masks, face shields, applying physical distancing and frequent hand washing with minimal contact with the subjects. The subjects were required to wear masks properly. All enumerators were also required to do PCR-swab test to confirm their safety at before and during the data collection.

The workplaces provided once daily free meal. Daily menu lists for a month were collected from the canteen catering providers and analyzed with Nutrisurvey 2007 for Windows to obtain the energy and nutrient values.

Descriptive analysis was done to obtain subjects' characteristics. Chi-square test was used to analyse risk factors of anemia, and logistic regression analysis was performed to find the determinant factor of anemia among subjects. Data were analysed using the Statistical Package for Social Science (SPSS) program version 20.0.

Results

As shown in **Table 1**, 2386 eligible subjects were included, with mean of age of 36.8 ± 9.2 years old, in which mostly were under 50 years of age (90.2%). By gender, as expected, there were more male than female subjects, i.e. 85.3% versus 14.7%. The subjects were mostly married (79.0%), never smoke (55.8%), and working in shift (68.7%).

Table 2 shows hemoglobin value of the subjects with the mean of 14.2 ± 1.2 g/dL. The anemia status among the subjects was 9.9%. **Table 3** shows that anemia status among female workers was higher, i.e. 24.6% compared to 7.4% in male workers. As also shown in **Table 3,** significant risk factors of anemia among workers were gender (female higher than male), marital status (not married is higher than those who are still married), smoking status (never smoking was higher than those who had history or currently active smoking) and working in shift (non-shift was higher than shift workers). **Table 2** also shows the oxygen saturation data presented by the Masimo® device, in which it has a weak negative association with hemoglobin, that need further explanation.

Data on nutritional facts provided from several menu collected and analyzed to be associated to the

Indonesian RDA for energy, iron and vitamin C intake that should have correction for the intensity working level, was shown in **Table 4**. The menu was provided once from the workplace canteen, in which assumed to contribute approximately 30–40% from total daily energy and nutrients intake. We assumed that the energy intake for one meal at the workplace, based on Indonesian RDA, was 40% x 2000 kcal or 800 kcal for those working in the sedentary working level, in which it was well provided in this study. However, we should add 400 kcal for working level adjustment for those working in a moderate working level.[3] Then the total energy intake of 1200 kcal should be provided within one meal in the workplace. While for iron and vitamin C intake, **Table 4** shows that the inadequacy intake, i.e. less than 80% to fulfill 30-40% of the RDA requirements, even before adjustment correction for the working intensity level.

Discussion

This study included workers aged 19–64 years old at which their intake adequacy was classified based on their age classification in the RDA guidelines for Indonesian.[4] For age category, most of the subjects were at early and middle adulthood period in which they are very productive to have working experience, raising family (i.e. almost 80% were married), and economic earning. By gender, approximately 85% of the subjects were male in which higher as compared to national data of 64.6%. In this study, the higher proportion of male workers in this study might also be related to type of workplaces selected, i.e. more in the factories than offices.

This is also related to the findings that mostly the subjects working in shift, because the factories usually run for 24 hours. In addition, this is also the reason related to the finding that smoking status was still reaching to more than 40%. Marginalization in the labor market is believed to be associated with likelihood of being smoker as well as a heavy smoker. In addition, other factors such as unstable job position, unstable life and less favorable working conditions in precarious work (i.e. low salaries, limited access to welfare benefits and less job control) may prevent workers from quitting smoking. This might be due to the lack of coping resources to manage their stress, However, again, this is also beyond of the scope of this study to explore more.[5]

The assessment of hemoglobin value in this study used a non-invasive multi-wave pulse total-hemoglobinometer Masimo®. The device was used because it is non-invasive, practical and having minimal systematic bias if the subjects were apparently healthy by means having normal perfusion index or predicted hemoglobin value were between 8 and 11 mg/dL and the oxygen saturation is more than 97%.[6] Thus, the Masimo® is suitable to screen hemoglobin value in a non-clinical setting but should be taken into caution as decision-making tool for transfusion.

The mean hemoglobin value found in this study was still in a normal range, i.e. 14.2 ± 1.2 mg/dL. Based on the cut-off point for low hemoglobin value or anemia status, for male of less than 13 mg/dL and for female less than 12 mg/dL,[7] it is revealed that 9.9% of the subjects in this study were categorized as anemic. Based on the World Health Organization (WHO) classifications for public health severity of anemia [8], the proportion between 5.0–19.9% is categorized mild public health problem of anemia.

However, if we stratified by gender, it is revealed that the proportion of anemia among female workers was 24.6% or categorized as moderate public health problem (i.e. between 20.0–39.9%). Female gender is the determinant of anemia found in this study. A study on anemia and its associated factors among women at reproductive age shows that the prevalence of anemia was ranging from 19.23% to 53.98% in eastern Africa. Furthermore, the study also found that using modern contraceptive methods, have a history of terminated pregnancy, and having high parity were associated with a higher prevalence of anemia.[9] It is then recommended by the World Health Assembly, especially for women at reproductive age to reduce the proportion of anemia by 50% by the year 2025. Improvements of nutritional and non-nutritional modifiable factors may be required to reduce anemia among female workers.

For nutritional factors of anemia, food-based intervention is still mostly prioritized for workers by provision of one meal serving during working hours in the workplace canteens or caterings. A study on the effectiveness of workplace nutrition program on

anemia status among non-pregnant female workers in Bangladesh, revealed that provision of lunch meal at the workplace were satisfying, because the lunch was good in quality, quantity, taste and satisfied their hunger. Furthermore, as the most important outcome, the mean hemoglobin was significantly improved.[10] Besides the adequacy of dietary energy intake, dietary iron intake should also be prioritized, while those subjects with non-lunch at workplace mostly consumed only rice with vegetables at home. Along with and/or without the food-based and/or iron-folate supplementation provided at the workplace, they are provided with behavior change communication program. This study shows that by providing a combination of intervention (i.e. a freshly prepared, nutritionally enhanced lunch with fortified rice, increased diversity, and combined with a weekly iron-folate tablet) over a significant period of at least 10 months could reduce anemia significantly.

Based on the findings of this study in several workplaces in Indonesia, it is suggested that meal planning should be re-visited to accommodate dietary iron and vitamin C intake, as the enhancing of iron absorption. It is well-known that iron absorption is regulated by dietary and systemic factors. Dietary iron is predominantly non-heme iron, and its absorption is significantly affected by other components of the diet. Among others, ascorbic acid or vitamin C is the most effective enhancer of non-heme iron absorption, thus should be provided along within the meals rich in iron content.[11] If necessary, additional portion of iron and vitamin C fortified food can help increase the hemoglobin level,[12] before last decision for provision of iron[13] and/or micronutrient supplement is given to those workers with low hemoglobin status.

In this study, we found that there is a weak inversed correlation between hemoglobin value and oxygen saturation. There are several important determinants regarding the delivery of oxygen by arterial blood to the body tissues, i.e. blood oxygen concentration, saturation and partial pressure, hemoglobin concentration and cardiac output. Although assessing arterial oxygen saturation can be done using pulse oximetry, however there are some limitations. Therefore, blood gas analysis or arterial blood sampling remains the gold-standard method of assessing ventilation and oxygenation.[14] Thus, the results of oxygen saturation in this study is needed only to show the prerequisite to assess hemoglobin value of the subjects.

There are several limitations of this study. We did not assess iron status, i.e. individual dietary iron intake and ferritin level. Factors of hindrance and enhancer of iron absorption were also not examined. However, by using nutritional facts of the several meals provided, it is obvious that there is a need to improve the dietary iron and vitamin C intake among workers, especially female worker, aiming to reduce the proportion of anemia.

Table 1. Subjects' characteristics (n = 2386)

Subjects' characteristics	
Age, years	36.8 ± 9.2
Age category, n(%)	
<50 years old	2152 (90.2)
50 years old and over	234 (9.8)
Gender, n (%)	
Male	2036 (85.3)
Female	350 (14.7)
Marriage status, n (%)	
Single or widowed	500 (21.0)
Married	1886 (79.0)
Smoking status, n (%)	
Never	1332 (55.8)
Currently active or had history of smoking	1054 (44.2)
Working in shifts, n (%)	
No	748 (31.3)
Yes	1638 (68.7)

Table 2. Hemoglobin concentration, anemia status and oxygen saturation of the subjects (n = 2386)

Subjects' clinical data	
Hemoglobin, g/dL	14.2 ± 1.2
Anemia, n (%)	237 (9.9)
Oxygen saturation, %	98.4 ± 2.1

Pearson's correlation analysis found a weakly negative significant association between hemoglobin concentration and oxygen saturation (P<0.001 and r = -0.101)

Table 3. Associations between anemia status and subjects' characteristics (n = 2386)

	Anemia	**Non-anemia**	**P-value**	**OR**
Age category, n(%)				
<50 y	221 (10.3)	1931 (89.7)	0.096	0.64
50 y and over	16 (6.8)	218 (93.2)		(0.379–1.086)
Gender, n(%)				
Male	151 (7.4)	1885 (92.6)	<0.001	4.067
Female	86 (24.6)	264 (75.4)		(3.029–5.459)
Marital status, n(%)				
No	76 (15.2)	424 (84.8)	<0.001	1.920
Yes	161 (8.5)	1725 (91.5)		(1.433–2.574)
Smoking status, n(%)				
No	147 (11.0)	1185 (89.0)	0.043	0.753
Yes	90 (8.5)	964 (91.5)		(0.571–0.992)
Work shift, n(%)				
No	105 (14.0)	643 (86.0)	<0.001	0.537
Yes	132 (8.1)	1506 (91.9)		(0.409–0.705)

Logistic regression analysis reveals that only gender was a potential contribution to anemia status (P <0.001, and OR = 4.353)

Table 4. Nutritional facts and its adequacy from meals provided at the three different workplaces

Nutrients content	Workplace-1	Workplace-2	Workplace-3
Energy, kcal	873.8 ± 85.7	717.9 ± 56.0	882.6 ± 53.8
Carbohydrate, g	126.0 ± 10.7	111.5 ± 11.7	118.0 ± 9.2
Fats, g	25.3 ± 6.8	18.3 ± 3.5	33.7 ± 3.8
Iron, mg	5.6 ± 2.5	6.4 ± 2.3	4.6 ± 1.2
Iron (%RDA)			
For men	62.0 ± 27.6	71.3 ± 26.0	51.8 ± 13.7
For women	31.0 ± 13.8	35.7 ± 13.0	25.9 ± 6.8
Vitamin C, mg	46.6 ± 26.6	33.3 ± 17.8	54.9 ± 31.3
Vitamin C (%RDA)			
For men	51.7 ± 29.6	37.0 ± 19.7	61.0 ± 34.8
For women	62.1 ± 35.5	44.4 ± 23.7	73.2 ± 41.7

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Conflict of Interest

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