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Editorial

Development of Food-Based Recommendation and Nutrient-Dense Meal for Female Shift Workers in West Java, Indonesia

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ABSTRACT

Background. Some manufacturing industries employ not only male workers but also female workers, who are required to undergo shift work. Given the altered eating habits as well as metabolic and endocrine profiles of shift workers, this will affect their nutritional needs. Considering that anemia that occurs in female workers is primarily nutritional anemia, this becomes a challenge in the field of occupational nutrition, especially in terms of preparing food for female workers in accordance with their nutritional needs. **Objectives** To develop a set of FBR for female shift workers using the Linear Programming (LP) approach. **Methods.** Dietary data were collected in a cross-sectional survey of female shift workers (n=106) working at a textile factory in Sumedang District, West Java, Indonesia, and a market survey in two local markets. Optifood software was used for LP analysis particularly to identify problem nutrients, and nutrient-dense foods, and compare alternative FBRs. The nutrient-dense menu was developed using the identified nutrient-dense foods. **Results.** The problem nutrients were iron (absolute) and calcium (partial), and the remaining nutrients were still dietary inadequate. The nutrient-dense menu including iron-rich and folate-rich foods can fulfill the nutrient gap for iron from the final FBR (15% RNI of the 7% RNI). **Conclusions**. The inclusion of a nutrient-dense menu for the female factory workers helped to meet the nutrient gap for iron which is the absolute problem nutrient in the optimized FBR. The promotion of optimized FBR and the provision of a nutrient-dense menu should be part of the occupational nutrition program.

Introduction

The number of female workers in Indonesia continues to increase. Based on the data from the Central Bureau Statistics of Indonesia in February 2018 there are around 51 million female workers in Indonesia, of whom work in the manufacturing sector of 8.1 million[1]. According to the Head of the Central Bureau of Statistics of Indonesia, Labor Force Participation Rate (LFPR) by sex in 2018, female LFPR increased from the previous year (2017) by 50.89 percent compared to 55.44 percent. This means that female LFPR has increased by 4.55 percent point during one year[2].

In addition to the increasing number of female workers, some female workers have to work with shift work systems, including those who work night shifts. According to the National Institute for Occupational Safety and Health (NIOSH), night shifts are thought to disturb normal diurnal biological rhythms and have been linked to many health problems[3].

Everyone has a natural cycle (called a cycle/circadian rhythm) where there are differences in biological processes during day and night. This process controls body temperature, heart rate, blood pressure, hormone levels, and gastrointestinal function. It is relevant to consider the impact of shift work on endocrine function, especially those hormones involved in energy balance. The adipocyte-derived hormone, leptin, tends to inhibit food intake, whereas ghrelin tends to stimulate it[4]. Both sleep deprivation and shifts in the timing of the sleep period alter plasma concentrations of these hormones.[4] In an investigation more relevant to shift work, some researchers studied the effects of a nocturnal lifestyle on serum leptin and found that participants consumed more than 50% of their total energy intake in the evening and night, with a greater frequency of eating but less food eaten at each time. This pattern of eating was thought to have resulted in an inadequate suppression of appetite, as evidenced by the decrease in the nocturnal peak of plasma leptin levels[4]. This has an impact on changing habits/eating patterns for shift workers, especially 'snacking' of energy-dense foods that are increasing[4,5]. Results of a study found lower dietary intakes of thiamine, riboflavin, niacin, folate, magnesium, and iron in shift workers compared with day-time workers. Shift work is a risk factor for inflammation, hypertension, and cardiovascular disease[7]. The presence of sleep disorders has been linked to the occurrence of the inflammatory response, including an increase in the number of leukocytes and tumor necrosis factor-alpha (TNF-α), C-reactive protein (CRP) and interleukin-6 (IL-6)[7,8]. The inflammatory process is one of the etiologies of anemia, known as the Anemia of Inflammation and Chronic Disease (AICD). Based on the pathophysiology, AICD is included in the classification of Fe deficiency anemia[9]. Given the altered eating habits as well as metabolic and endocrine profiles of shift workers, it seems even more important to provide evidence-based nutritional recommendations in order to meet adequate nutrition for this population.

Nutrition-based dietary guidelines are generally formulated by considering the most common nutritional problem such as food availability, acceptability, affordability, and food patterns, which needs expert consultation between local health authorities and nutritionist.[10] This cross-consultation is time-consuming and leads to bias due to the multiple factors that are included when deriving the food-based recommendation. The current approach that promises a powerful tool to optimize diet is linear programming (LP)[10,11]. Briefly, LP is an optimization method that can be used to develop Food Based Recommendation (FBR) in order to identify optimal but realistic, available, and affordable foods to meet Recommended Nutrient Intakes (RNIs) of energy and nutrients are given multiple constraints, including those on food availability, food patterns, food portions, and cost[10-12]. Outcomes include a set of optimal, population-specific FBRs and practical information regarding key 'problem nutrients' in the local diet. Such information is valuable for nutrition promotion, as well as nutrition program planning and advocacy[10]. The LP approach has never been applied to workers. Therefore this research was carried out through the LP approach, in an effort to develop an integrated work nutrition program as one of the workplace health promotion programs that could be used as a policy for the government and for manufacturing industries, especially for female shift workers.

Methods

Location. The study was conducted in the Jatinangor sub-district of Sumedang District, West Java, Indonesia. The factory was a textile factory which is located in the industrial area of Dwipapuri Abadi.

*Study design***.** Dietary data were collected in a cross-sectional survey of female shift workers working at a textile factory in Sumedang District, West Java, Indonesia.

Ethical Approval. Ethical approval was obtained from the Health Research Ethics Committee, Faculty of Medicine, Universitas Indonesia. Informed consent to participate in the study was obtained from all participating workers.

Sample size and sampling procedures of the survey. The population in this study was female workers as an operator in the spinning section of a factory who underwent shift work. The sample selection was done using a purposive sampling technique. One hundred and six female shift workers were selected, with the inclusion criteria for participation being a woman of reproductive age (18-49 y.o) inclusively who was not pregnant or breastfeeding and not suffering from severe anemia (Hb <8 mg/dL). All workers had the same working hours and rotation patterns, namely 8 hours per day 6 days per week with a pattern of one week-night shift rotation, one-week afternoon shift, then continued one-week morning shift. To obtain information on food availability and price, market surveys were conducted in two representative local markets around the factory area which are commonly used by the workers. In addition, anthropometric measurements were made (weight and length) by 2 trained anthropometrists. Body weight was measured using SECA weighing scale, following the standard method such as flat surface position, and taking off anything that can contribute to the overall weight of the respondents. The measurements were taken twice with the nearest 0,1 kg. If the difference between the first and second measurements were more than 0,2 kg, then the third measurement was taken. The same with measuring weight, the measurement of height using microtoise was taken twice with the nearest 0,1 cm. If the difference between the first and second measurements were more than 0,2 cm, then the third measurement was taken.

Dietary assessment methods. We used quantitative dietary data which were collected using a 1-day weighed diet record (WDR) for food given by the company on the night shift, combined with repeated 24-h recall for all foods and beverages consumed between 00.00 and 24.00. 24-h recalls were performed by 4 trained research assistants and they recorded all foods and beverages consumed by the workers. Serving sizes for the 24-h recall were estimated using standard household measures. Qualitative dietary data were collected with a 5-d food tally using a self-administered questionnaire. The 24-h recall, WDR, and 5-d food tally were analyzed to characterize each respondent's 7-d food group patterns, create a list of foods consumed by female shift workers in Sumedang, and measure each food' average serving size (g/d) and the percentage of female workers consuming it. One week of dietary data provided us with information regarding a list of foods consumed by the studied respondents and their dietary patterns (serving size and frequency of consumption) which were the required information for the Optifood analysis. Each food item and its nutrient content from the dietary data were analyzed through Nutrisurvey. Nutrient values and food were derived from the Indonesian Food Database. Optifood analysis was based on the actual dietary patterns of the study population. Therefore, weekly dietary data were prepared as input into the Optifood software to set the model parameters in order to formulate the FBRs which is realistic. FBRs were formulated within the existing food availability and food pattern (minimum and maximum serving per week for each food item, food subgroup, or food group) in order to meet or come as close as possible to the requirement of the target group.

Development of FBR. The Linear Programming (LP) approach formulates Food Based Recommendation (FBR) to meet nutrient requirements given local food availability, food patterns, food portions, and food affordability based on problem nutrients in certain populations. LP can generate a list of foods a target population typically consumes, the nutrient content of each food per 100 g, a realistic portion size per eating occasion, the maximum frequency of consumption per week, the food consumption patterns of the target population (low, average, and high levels), the estimated average energy requirements of the target population, and the desired nutrient contents[10,11]. The LP analysis was performed using the Optifood software, a software tool developed by the WHO which has been developed to formulate FBR[13]. FBR was formulated using a 4-phase approach. In brief, in phase 1 we collected the dietary data. In phase 2 the dietary data (food portion, frequency of consumption per week/ food pattern, and diet cost) were converted into Optifood, this process is called LP input. Phase 3 was the development of FBR, using three modules. Phase 4 were determining appropriate nutrient-dense foods, formulating FBRs alternative, and also defining the existing nutrient gaps.

Module I on FBR development (check diets) tested the constraints set in the food list, food groups, and food sub-groups in order to ensure that there was sufficient flexibility in food choice for modeling the diets and to ensure at least some individuals from the target population could consume the diets generated by the Optifood. Module II allowed us to identify the best food and food subgroup sources of micronutrients in the existing diet which could be promoted for the 'problem nutrient' in Module III. 'The problem nutrient' were defined as nutrients that did not reach 100 percent of RNI in Module II. Specifically, Module II runs to select the two best diets food patterns and non-food patterns. Food patterns are defined as a diet that was as close as possible to meet the RNI target by taking dietary patterns into account i.e. as close as possible to the median frequency of intake per week[14]. Non-food patterns are defined as a diet that came as close as possible to meet the RNI target without adhering to dietary patterns i.e. may deviate from the median but still within the range of frequency of intake per week [14]. Before testing the draft FBRs, Module III was first run without adding any foods to provide a baseline diet in order to be compared with different alternative FBRs. This baseline diet could be used to compare nutrient levels when testing each FBRs to assess whether the percent RNI of each nutrient that was being covered in the worst-case scenario was a significant improvement compared with the existing practice. 'Worst-case scenario' was the condition in which the LP model minimizes each specific nutrient to identify the lowest percent of RNI that a nutrient would meet under current FBRs[15]. 'Best-case scenario' was the condition in which the LP model maximizes each specific nutrient to identify the highest percent of RNI that a nutrient would meet under current FBRs[15]. Nutrients that did not achieve 100% RNI in the two best diets and best-case scenario were defined as 'absolute problem nutrients'[12]. While the nutrients that did not achieve 100% RNI in the two best diets but achieved 100% RNI in the best-case scenario were defined as 'partial problem nutrients'[12]. Dietary inadequacy was nutrients that achieved 100% RNI in the two best diets and best-case scenario but did not achieve 65% of RNI in the worst-case scenario[15].

Results and Discussion
Background Characteristics

A total of 106 female shift workers were enrolled in the study (age range 19 to 38 years). The majority of subjects were in the productive age between 20-25 years, high school graduated, married, with monthly family income >IDR 2.000.000 - IDR 10.000.000, had normal nutritional status, and had shift work experience <3 years. (Table 1).

Table 1. Socio-demographic, Occupational, and Nutritional Status of Respondents

Variable	N = 106
Sociodemographic Characteristics	
Age (years); median (min-max)	25 (19-38)
20-25; f (%)	62 (58.49)
26-30; f (%)	30 (28.30)
31-35; f (%)	11 (10.38)
36-40; f (%)	3 (2.83)
Marital Status; f (%)	
Single	48 (45.28)
Married	53 (50)
Widow	5 (4.72)
Level of Education; f (%)	
High School	98 (92.45)
Diploma	8 (7.55)
Monthly Family Income; f (%)	
≤ IDR 2.000.000	8 (7.5)
>IDR 2.000.000 - IDR 10.000.000	98 (92.45)
Family Members; mean (SD)	3.9 (1.4)
1-2; f (%)	12 (11.32)
3-5; f (%)	78 (73.58)
>5; f (%)	16 (15.1)
Nutritional Status (kg/m^2); mean (SD)	22.97 (3.91)
Underweight; f (%)	13 (12.26)
Normal; f (%)	48 (45.28)
Overweight; f (%)	14 (13.21)
Obesity; f (%)	31 (29.25)
Occupational characteristic	
Shift work experience (years); median (min-max)	2.5 (0.2-4)
<3 years; f (%)	80 (75.47)
≥3 years; f (%)	26 (24.53)

f: frequency

Food pattern data that defined linear and goal programming parameters
Food frequency, food serving sizes, and food patterns

In total, 506 food items were recorded from the respondents using 1-day WDR for food given by the company on the night shift, combined with repeated 24-h recall and five days of food records. Afterward, including only foods consumed by at least 5% of the target group, there were only 237 food items included in the LP analysis using Optifood software. The selected food items were divided into 15 food groups and 50 food subgroups. As shown in table 2, grains and grain products, animal protein source foods, added fats, and vegetables were the most commonly consumed food groups (23, 19, 15, and 11 times per week).

Table 2. Frequency of Food Intake per Week for Each Food Category

Food Type	Frequency/week		
	Lower[1]	Average[2]	Maximum[3]
Added fats	7	15	24
Added sugars	0	1	3
Bakery & breakfast cereals	0	4	10
Beverages (non-dairy or blended dairy)	0	4	12
Composites (mixed food groups)	1	4	10
Dairy products	0	1	5
Fruits	0	2	9
Grains & grain products	15	23	33
Legumes,nuts &seeds	4	10	19
Meat,fish & eggs	11	19	32
Miscellaneous	0	3	10
Savory snacks	2	6	13
Starchy roots & other starchy plant foods	0	1	4
Sweetened snacks & desserts	0	1	4
Vegetables	3	11	22

[1] 5th percentile of weekly frequency was used
[2] 50th percentile of weekly frequency was used
[3] 95th percentile of weekly frequency was used

Module II results showed the optimal nutrient content, the specific foods selected, and the selected food patterns (frequency/week) in the optimized seven-day diet (Table 3). Food groups with a positive value difference between food patterns and no food patterns were the potential nutrient-dense food sources that could be promoted for the problem nutrient. They were fruits, composites, vegetables, fish meat and eggs, wheat and its products, as well as nuts and seeds. These nutrient-dense food groups were then included and tested in the alternative sets of FBRs to be tested in Module III.

The two best diets formulated in Module II demonstrated that iron and calcium were identified as 'problem nutrients' because their nutrient levels are below 100% RNI. Fe was an absolute problem nutrient, while calcium was a partial problem nutrient because its nutrient level in the best-case scenario could achieve 100% RNI. Meanwhile, the remaining nutrients such as protein, fat, vitamin C, thiamine, riboflavin, niacin, B6, folate, B12, Vit A, and zinc, were still dietary inadequate since their nutrient intake levels were less than 65% of RNI in the worst-case scenario. (Table 4)

Food-based Recommendation (FBR)

A comparison of nutrient levels in some sets of FBRs was shown in table 5, and based on these alternatives the following was selected as the final FBR.

Recommended Frequency and Portion of Food from FBR for Female Shift Workers in Rancaekek, Sumedang

Weekly Messages of Food-Based Recommendation

1. Consumption of staple food 3 times/day
2. Consumption of animal sources of protein at least 2 servings/day, including chicken liver 1 time/week, fish 2 times/week, small fish with bones 1 time/week, chicken 2 times/week, meatballs 2 times/week, eggs 2 times/week
3. Eat tempe/tofu at least 1 serving/day or consume nuts 3 servings/week
4. Consume vegetables at least 2 servings/day, including 4 times/week of green vegetables, 4 times/week vegetables that contain vitamin A
5. Consume fruit at least 1 portion/day, including 3 times/week fruit containing vitamin C, 2 times/week fruit containing vitamin A

Table 3. Selection of Food Groups and Frequency of Serving per Week Based on 2 Best Diets LP Analysis

Food Choices	*Food Pattern* (serves/week)	*Non-Food Pattern* (serves/week)
Fruits	2	3
Composites (mixed food groups)	4	9
Added sugars	1	1
Vegetables	11	22
Dairy products	1	0.8
Added fats	15	7
Sweetened snacks & desserts	1	0
Beverages (non-dairy or blended dairy)	4	9
Savory snacks	6	2
Miscellaneous	3	9
Bakery & breakfast cereals	4	0
Starchy roots & other starchy plant foods	1	0
Meat, fish & eggs	19	32
Grains & grain products	23	28
Legumes, nuts & seeds	6	8.2

Table 4. Percentage of RNI that can be achieved from the 2 Best Diets in LP Analysis (n = 106)

Nutrition	*Food Pattern*	*Non-food Pattern*	*Food Pattern (%RNI)*	*Best case (max)*	*Worst case (min)*	Nutrient Category
Energy (g)	1994	1994	100	100		-
Protein (g)	68.6	82.5	153.1	184	25	Dietary Inadequacy
Fat (g)	66.5	66.5	100	100	13.5	Dietary Inadequacy
Carbohydrate (g)	246.8	253.8	N/A	N/A		-
Calcium (mg)	842.1	1000	84.2	100	8.3	Partial Problem Nutrient
Vitamin C (mg)	51.2	57	113.8	126.7	0.6	Dietary Inadequacy
Thiamin (mg)	1.8	1.7	165.4	154.4	18.6	Dietary Inadequacy
Riboflavin (mg)	1.6	1.6	145.5	148.6	8.2	Dietary Inadequacy
Niacin (mg)	19.4	21.5	138.9	153.4	9.4	Dietary Inadequacy
Vitamin B-6 (mg)	1.3	1.4	100	104.8	5.3	Dietary Inadequacy
Folic Acid (µg)	813.6	737.7	203.4	184.4	2.7	Dietary Inadequacy
Vitamin B-12 (µg)	5.9	11.3	244.9	472.6	10.1	Dietary Inadequacy
Vitamin A (µg)	1960.6	3431.5	392.1	686.3	2.6	Dietary Inadequacy
Fe (mg)	18.8	27.4	64	93	6.6	Absolute Problem Nutrient
Zinc (mg)	5.4	6.9	110.9	140.1	11.7	Dietary Inadequacy

Nutrient-Dense Meal

Based on the selected FBR calcium, thiamine, riboflavin, niacin, vitamin B6, folate, Fe and Zinc were still below adequacy (EAR or 65% RNI) in the worst-case scenario. These nutrient gaps were then set as the target to be filled by the nutrient-dense meals given as an evening snack (during the night shift) and an additional fruit lunch (during the morning shift). There were 6 types of food menus recommended for the night shift for 1 week with the nutritional content shown in table 5.

- Menu 1: green bean porridge, black sticky rice and papaya fruit
- Menu 2: *Arem-arem* (rice cake with minced beef), *tempe mendoan* (deep fried tempeh with spiced batter), and watermelon

- Menu 3: *Tekwan* (rice noodles, vegetables, chicken and fish meatballs)
- Menu 4: *Kimlo* (glassnoodle, vegetables, beef liver and beef meatballs)
- Menu 5: Meatball noodles and *rempeyek rebon* (small shrimp)
- Menu 6: Meatball noodles and beef liver satay

Table 5. Nutrient Content of Nutrient-Dense Meals based on Nutrient Gap from LP Analysis

Nutrition	Menu 1	Menu 2	Menu 3	Menu 4	Menu 5	Menu 6	Mean
Energy (kkal)	337.2	368.1	252.3	255.4	327.7	292.8	305.58
Protein (g)	9.3	10.8	9.9	12.8	14.1	16.9	12.3
Fat (g)	6.5	18.2	4.1	8.6	17.3	15	11.62
Carbohydrate (g)	60.3	48.7	43.9	31.2	29.2	22.9	39.37
Vit. A (µg)	851.5	147.6	2551.5	4073.3	2511.4	6502.3	2772.9
Vit. B1 (mg)	0.5	0.5	0	0.1	0.2	0.3	0.27
Vit. B2 (mg)	0.6	0.2	0	0.4	0.1	0.4	0.28
Vit. B6 (mg)	0.4	0.2	0.1	0.4	0.2	0.5	0.3
Folic Acid (µg)	67.6	35.5	36.2	98.2	40.8	127.3	67.6
Vit. C (mg)	59.2	8.3	45.8	21	41.4	50.7	37.73
Calcium (mg)	781	69.9	130.6	25.8	215.3	103.3	220.98
Iron (mg)	2.5	4.5	2.9	6	3.1	7.4	4.4
Zinc (mg)	1.3	1.2	0.6	1.2	1.8	1.7	1.3

Discussion

Given the dietary pattern of these female workers, iron and calcium were the two problem nutrients (absolute and partial, consecutively) whereas other nutrients were mostly inadequate. We considered workplace settings as an opportunity to provide meals that can fulfill these nutrient gaps and therefore, we developed a nutrient-dense menu including iron-rich and folate-rich foods. These meals together with the FBR can fulfill the nutrient gap between the optimized diet and nutrient requirements of these female workers.

Comparison with other studies using the LP approach done amongst adolescent girls in East Java Indonesia by Oy et al[16] showed that while their study population had fewer problem nutrients (Fe, Ca vs Fe, Ca, folate, vitamin A) we found more dietary inadequacy in our study. While the median frequency per week in our study population was often higher than that of Oy et al[16], the minimum frequency per week was very low in our study population. This explained that out of 13 nutrients, 8 nutrients were below 10%RNI in their minimized scenario and none achieved an adequacy level of 65% RNI (equivalent to the Estimated Average Requirement (EAR)). This finding informed us that despite comparable socio-economic levels amongst these workers, there was a big variation in terms of their dietary practices. This highlight the need for the importance of promoting nutrition education in the workplace setting for the prevention of anemia.

The term work nutrition means nutrition needed by workers to meet adequate nutrition according to the type of work. As an aspect of nutritional science in general, work nutrition is intended to maintain and improve the health status of the workers and to work productively.[17] Some of the factors that affect work nutrition include workload, labor factors (gender, age, pregnancy, breastfeeding, poor eating habits, and knowledge), and work environment factors as special considerations, which include physical, chemical, biological, ergonomics, and also psychology like shift work.[17.18] The thing that is most affected by the shift work system is the meal time of workers. A publication in the Journal of Occupational Health states that shift workers tend to consume their dinner at irregular times. The irregular times of dinner have also been associated with overweight workers, higher total energy intake, lower fiber intake, vitamin B2, folic acid, vitamin C, potassium, calcium, magnesium, and lower iron.[19]

Based on LP analysis, iron (Fe) and calcium were the problem nutrients, because of their adequacy in no food pattern diet <100% RNI. Calcium was a partial problem nutrient because, in the best-case scenario, the nutritional adequacy rate can reach 100% RNI. This means that these nutrients are actually already in their food basket, but if they are not motivated or forced, the intake will always be low. Fe was an absolute problem nutrient because after being analyzed using the best-case scenario it has not been able to reach 100% RNI, and with the 'worst-case scenario' was still cannot reach 65% RNI. This means that these nutrients are not in their food basket, so these nutrients are the main focus in providing a menu of factory recommendations. The provision of factory meals including nutrient-dense foods which are hardly present in the food basket is an opportunity for nutrition intervention in the workplace setting such as factories, which can further strengthen the improved dietary practice from the promotion of FBR alone. While for protein, fat, vitamin C, thiamine, riboflavin, niacin, B6, folate, B12, Vit A, and zinc were the dietary inadequacy, because in the worst-case scenario, the nutrient adequacy rate was <65% RNI. 'Dietary inadequacy' here means that there is a risk of deficiency of these nutrients in subjects whose diets are very poor.

The recommendations generated from the FBR are in the form of messages/education in consuming daily food and nutrient-dense meal in the factory as an evening snack for the night shift, and an additional form of fruit in the workers' set of lunch (during the morning shift) that are used to fill the existing nutrient gap. Using LP analysis, some sets of FBR were obtained, and 1 set of FBR was selected which after analysis with the worst-case scenario had the highest nutrient content compared to the other three sets of FBRs. Education/messages of FBR were given in the form of leaflets to make it easier to remember. Based on the FBR, there was still a daily nutrient requirement that has not been achieved (nutrient gap) which became the basis for strengthening the food menu in the factory, micronutrients such as calcium, thiamine, riboflavin, niacin, vitamin B6, vitamin C, folate, Fe and Zinc. The cost is also within the company's budget. In other words, the application of the recommendations was still within affordability so it is feasible to be implemented. From table 5 we found that the nutrient-dense meal contributed an average of 305 kcal energy (15.33%), 12.3 g protein (27.44%), 11.6 g fat (17.5%), 0.27 mg Vit B1 (24.2%), 0.28 mg B2 (25.8%), 0.3 mg Vit B6 (23%), 67.6 ug folic acid (16.9%), 221 mg calcium (22.1%), 4.4 mg Fe (15%), 1.3 mg Zinc (26.53%). There is an average increase compared to the previous factory menu of 112% energy, 175% protein, 149% fat, 87% carbohydrate, 4965% Vit A, and 60% Vit. B1, 183% Vit B2, 350% Vit B6, 75% folic acid, 4520% Vit C, 236% calcium, 272% Fe and 160% Zinc.

Determination of energy needs of workers taken into account the variables of age, gender, and level of workload (physical activity) following the reference data available on Optifood. While the weight variable used the median weight of the research subjects. Based on the walkthrough survey it was known that most of the work in the Spinning section was carried out by machines, therefore the subject's physical activity was categorized as mild physical activity (75% are in a standing position, 25% walking/moving)[20], in line with the PAL (Physical Activity Level) 1.55 used in LP analysis. After calculating the BMR (Basal Metabolic Rate) energy, the total energy requirement obtained with physical activity is 2,015 kcal/day. In calculating nutritional and energy needs, researchers still considered the daily intake of the subject. From the baseline data, it was known that the mean energy intake in the subject is 1,698 kcal/day. While still considering the percentage of excess nutritional status (overweight and obesity) which were about 40%, the addition of 305 kcal energy from the nutrient-dense factory meal was still within the limits of the requirement of these workers.

The major strength of this study lies in the use of LP analysis in developing FBR carried out for the female workers' population. Nutritionists in several developing countries have adopted LP analysis to develop FBR to address nutritional problems in certain regions.[21] Many of FBRs were developed for young children,[22,23,12] pregnant mothers,[22] women of reproductive age (GUSNEDI), and adolescent girls (SREYMOM OY). However, no previous studies have developed FBR for the work setting and used it for food intervention including nutrition education and nutrient-dense factory meals. In addition, most previous studies promoting FBRs will be limited to the most optimal % RNI which can be achieved from the 2-best diets, whereas in this study we managed to fill the nutrient gap using nutrient-dense factory meals. The effectiveness of this FBR promotion together with nutrient-dense factory meals in improving dietary practices and hemoglobin amongst these female workers needs to be conducted.

The findings, however, require consideration of the study's limitations. Primarily, the dietary pattern of workers was strongly influenced by the demographic areas so the recommendations generated may not apply to all workplaces.

Declaration

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