FOOD CONSUMPTION AND IMPROVING IRON DEFICIENCY ANAEMIA AMONG WOMEN WORKERS AT TEA PLANTATION IN PENGALENGAN - BANDUNG

PT Penerbit IPB Press
IPB Science Techno Park
Jl. Taman Kencana No. 3, Bogor 16128
Telp. 0251 - 8355 158 E-mail: ipbpress@ymail.com
Penerbit IPB Press @IPBpress

FOOD CONSUMPTION AND IMPROVING IRON DEFICIENCY ANAEMIA AMONG WOMEN WORKERS AT TEA PLANTATION IN PENGALENGAN - BANDUNG

Healthy
ISBN : 978-602-440-255-6
9 786024 402556

FOOD CONSUMPTION AND IMPROVING IRON DEFICIENCY ANAEMIA AMONG WOMEN WORKERS AT TEA PLANTATION IN PENGALENGAN - BANDUNG

Faisal Anwar
Ali Khomsan
Hadi Riyadi
Betty Yosephin
Karina R Ekawidyani
Rian Diana

FOOD CONSUMPTION AND IMPROVING IRON DEFICIENCY ANAEMIA AMONG WOMEN WORKERS AT TEA PLANTATION IN PENGALENGAN - BANDUNG

FOOD CONSUMPTION AND IMPROVING IRON DEFICIENCY ANAEMIA AMONG WOMEN WORKERS AT TEA PLANTATION IN PENGALENGAN - BANDUNG

Prof. Dr. Faisal Anwar
Prof. Dr. Ali Khomsan
Dr. Hadi Riyadi
Dr. Betty Yosephin
Karina R Ekawidyani, MD, MGizi
Rian Diana, MSi

Penerbit IPB Press
IPB Science Techno Park
Bogor - Indonesia

C.1/03.2018

Book Title:
FOOD CONSUMPTION AND IMPROVING IRON DEFICIENCY ANAEMIA AMONG WOMEN WORKERS AT TEA PLANTATION IN PENGALENGAN - BANDUNG

Authors:
Faisal Anwar
Ali Khomsan
Hadi Riyadi
Betty Yosephin
Karina R Ekawidyani
Rian Diana

Corrector:
Dwi Murti Nastiti

Cover Designer & Layouter:
Ardhya Pratama

Pages:
18 + 108 roman pages

Edition:
First Edition, March 2018

PT Penerbit IPB Press
Member of IKAPI
IPB Science Techno Park
Jl. Taman Kencana No. 3, Bogor 16128
Telp. 0251 - 8355 158 E-mail: ipbpress@ymail.com

ISBN: 978-602-440-255-6

Printed by IPB Press Printing, Bogor - Indonesia
Content is Out of Printing Responsibilities

Summary

Anaemia is a nutritional problem which can be encountered in many areas throughout the world, which takes place not only in developing countries but also in developed ones. Anaemia sufferers are estimated to be approximately two millions people, with the largest prevalence in Asia and Afrrica regions. Even WHO mentioned that anaemia is the 10 biggest health problems in this modern century. The high-risk groups of anaemia are women of childbearing age, pregnant mother, school children, and teenagers (MoH 2013[a]). Anaemia is also a nutritional problem which can poses a negative consequence toward prosperity, health, social and economic condition of the people. Among adult people anaemia can cause disorders, especially on physical condition, working productivity, and immunity function (BNF 2006).

The objectives of this study are: (1) to assess socio economic status and income contribution of women workers in tea plantation, (2) to identify iron and vitamin C rich foods consumed by women workers in tea plantation, (3) to measure intake of energy, protein, iron and vitamin C of women workers in tea plantation, (4) to analyze prevalence of anaemia of women workers in tea plantation, (5) to assess nutritional (anthropometry) and health status of women workers in tea plantation, (6) to assess physical fitness of women workers in tea plantation, and (7) to analyze impact of intervention on iron status and productivity of women workers in tea plantation.

This study was started with a cross sectional survey (phase 1) and followed by a quasi-experimental study (phase 2) consisting of 2 treatments (intervention group and control group). This study was conducted at PT Perkebunan Nusantara VIII (PTPN VIII) located in Pengalengan-Bandung, West Java, Indonesia. The selected plantations were Kebun Malabar, Purbasari, Sedep and Talun Santosa. This study was conducted for 18 months, that is, from January 2016 until June 2017. The subjects were women workers in the tea plantation selected, belonged to the category of childbearing age, had

been married, were not pregnant nor breastfeed, healthy, and were willing to follow this study by signing the informed consent. Phase 1 of this study that had been done by the research team was survey with 250 samples. Phase 2 was an action research with 89 samples (45 subjects for the control group and 44 subjects for the intervention group) who were willing to participate.

Data collection also included 2 phases. Phase 1, survey data collection on socio-economic characteristics, sanitation and hygiene, food consumption, health history, haemoglobin measurement, and nutritional status. Phase 2, baseline-endline data collection on iron status (Hb, Ht, ferritin serum), physical fitness, productivity, nutritional knowledge, consumption of iron and vitamin C rich foods, and absenteeism.

Statistical data analysis was based on the aims of the research and available data to answer the research problem objectively. Descriptive analyses cover the mean, standard deviation, maximum score, minimum score, frequency, and proportion. A statistical test was done to find out the data variability of the whole variables among the intervention groups (baseline and endline data). A paired t-test (parametric) was used to compare the differences of the variables before and after the intervention. Independent t-test was used to compare the data of the control group and the intervention one. Ancova test (parametric) was used to compare the differences of the variables before the interventions with α=0.05. The research results are:

1. On average the women workers as tea-pickers were 42.1 years old with low education level (90.4% had elementary school as their highest education). The number of family members in the household of women workers of tea pickers is 3.9 people. On average the women workers as tea pickers have worked for 17.5 years. The average income of the women workers as tea pickers was IDR 1,104,905 and contributed 50% to household income.
2. The majority of women workers as tea pickers lacked eating food of iron and vitamin C sources. Foods of iron sources that were very rarely consumed were beef and vegetables, which were consumed in small amounts, among others, kale, spinach leaves and cassava leaves.
3. Most (68-91%) of the women workers as tea pickers experienced inadequate intake of energy, protein and vitamin C. Most (44%) of the women workers as tea pickers also experienced inadequate iron intake.

4. Based on the examination using Hemocue, the prevalence of anaemia among the women workers as tea pickers is 28.4%. This figure is higher than the national prevalence of 22.7%.
5. The women workers as tea pickers generally suffered from overweight and obesity (57.2%). Almost none of the women workers as tea pickers experienced chronic energy deficiency (1.2%). A total of 54.8% women workers as the tea pickers suffered from central obesity at risk of developing chronic disease with an average body fat of 32.0%.
6. The mean values of VO_2max at the baseline and endline in the control group were 52.1 ml/kg/min and 53.8 ml/kg/min respectively, while in the intervention group 49.7 ml/kg/min and 51.1 ml/kg/min respectively. On average the VO_2max value that reflects the physical fitness of the women workers as tea pickers is good enough. There is no difference in the impact of micronutrient supplementation on physical fitness.
7. The interventions of micronutrient supplementation and nutritional education were not able to increase haemoglobin or ferritin levels significantly. Nevertheless, there was a tendency to increase the ferritin levels of the intervention group by almost threefold compared to the increase in the control group. The increase in ferritin levels is also evident from the decrease in the proportion of iron-depleted subjects (from 20.5% to 11.6%). There were significant differences ($p<0.01$) between the productivity of the control group and that of the intervention group, where the productivity of the intervention group increased significantly. The increase of tea leaf picking productivity in the intervention group was 15 kg/day (23.9%).

Based on the findings presented above, anaemia is still a health problem that needs to get more attention from various parties. Therefore, prevention and treatment are of paramount importance to be done. We recommend to increase the consumption of food, especially food sources of iron and vitamin C by utilizing the yard/land around the plantation to grow green vegetables. But we all realize that the prices of animal foods such as beef and chicken meat, which is the best source of iron food, is quite expensive. In addition, since the education of the women workers as tea pickers is generally low then they also need to be given skill education to improve the quality of life and their income. This is very important to improve their purchasing power and

can be a life provision if they stop/retire as tea pickers. We also recommend to plantation management to implement micronutrients supplementation to improve the productivity of women workers as tea pickers. The plantation management can also improve housing condition for the tea workers in the tea plantation by: 1) increasing number of permanent and semi-permanent (half wall, half wood) houses. In the tea plantation, there were still a lot of non-permanent houses (made of wood or bamboo), 2) improving house ventilation because more than half of the houses did not have good ventilation, 3) the household should use liquified petroleum gas for fuel as recommended by the government. At this time, most households of the tea workers still use firewood (39.2%) taken from waste of tea twigs in the plantation, 4) the housing for the tea workers should have its own toilet so the sanitation was maintained. At this time, most households of the tea workers still used public toilet (46.4%).

The plantation management should continuously socialized the importance of personal hygiene for workers especially on hand washing using clean water and soap, because more than 45% of the workers not always washed their hands using clean water and soap. The plantation management also should conduct deworming once every 6 months to the tea workers. Supplementation of micronutrients in subsequent studies is suggested with a frequency of three times/week because the prevalence of anemia in the study sites was 28.4%. If the prevalence of anemia was more than 40%, according to WHO iron supplementation should be given daily.

Acknowledgments

This project consumed a huge amount of work and dedication. Still, the study would not have been possible if we did not have a support of many individuals and organizations. Therefore we would like to extend our sincere gratitude to all of them.

First of all we are thankful to the Neys-van Hoogstraten Foundation, The Netherlands for funding the study and for providing necessary guidance concerning project activities and implementation.

We are also grateful to the head of management, staffs, and workers of PT Perkebunan Nusantara VIII, Pengalengan-Bandung who allowed us to carry out the research in their tea plantation.

Appreciation to Dean of Faculty of Human Ecology and Chairman of Department of Community Nutrition, Bogor Agricultural University for granting us the opportunity to carry out the joint research with Neys-van Hoogstraten Foundation, The Netherlands. This research is a mean of making cooperation with foreign agency and enriching the dimension of research at Bogor Agricultural University.

We would like to express our sincere thanks towards the enumerators (data collectors) who worked with an extra ordinary patience in fields. They are Bogor Agricultural University (IPB) graduates who have applied the knowledge learned at the university.

Nevertheless, we would also like to give our highest appreciation to the research assistants: Catur Dwi Anggarawati SP and Puspita Dewi SGz, who showed extraordinary dedication during the research.

List of Contents

List of Tables

List of Figures

1
Introduction

1.1 Background

Anaemia is a nutritional problem which can be encountered in many areas throughout the world, which takes place not only in developing countries but also in developed ones. Anaemia sufferers are estimated to be approximately two millions people, with the largest prevalence in Asia and Afrrica regions. Even WHO mentions that anaemia is the 10 biggest health problems in this modern century. The high-risk groups of anaemia are women of childbearing age, pregnant mother, school children, and teenagers (MoH 2013[a]).

Even though anaemia has been identified as a public nutritional problem for years, the progress in its decrease of prevalence is still considered very low. Even in some countries there is an increase of anaemia prevalence among adult women. Based on the classification of public health problems, the prevalence of anaemia belongs to heavy if its prevalence is ≥40%, moderate 20-39%, light 5-19%, and normal <5% (MOST 2004). The prevalence of anaemia in Indonesia belongs to moderate but for some age groups it is catagorized as heavy. The prevalence of anaemia in Indonesia is still high, and its development from year to year does not show any significant decrease. The last data showed the prevalence of anaemia by sufferer group, that is, the prevalence of anaemia among the women of childbearing age belonged to catagory moderate, that is, 18.4-20.1% (MoH 2013[a]).

The amount of iron that the body needs is little, that is, just 3-5 mg/day but it has a very significant role. The important role of iron is to form haemoglobin and help various metabolic processes in the body. Anaemia is a nutritional problem which can be encountered in many countries, and poses a negative consequence toward prosperity, health, social and economic condition of the people. Among adult people anaemia can cause disorders,

especially on physical condition, working productivity, and immunity function (BNF 2006).

Anaemia was also affected by worm infection, consequently there was a decrease of blood in the body (Pawlowski *et al.* 1991). According to Dahro *et al.* (1991) in Rasmaliah (2004), worm infection and anaemia are correlated and easily found in the community because of low economic status of the people and lack of sanitation. Sunarti *et al.* (2008) stated that 44.0% women workers of tea plantation lived in houses with earth as some of its floor and the condition of some ventilation and windows in the houses (44.2%) was relatively inadequate.

Many studies show that there is a decrease in physical abilities due to iron deficit which leads to an increase of lactate concentration in the blood. This physical decrease has occured since there is a light iron deficit (Hb normal), but this will recover after the sufferer is given iron supplement capsules. The mechanism is an Hb decrease will reduce the oxygen transportation, the muscle ability to catch oxygen decreases and this causes lactate accumulation because of an anaerobic metabolism. Chronic fatigue could recover among iron-deficit sufferers who were given iron capsules (BNF 2006).

Initially, the iron supplementation program was recommended by WHO to be directed to pregnant mothers. In its subsequent development there were some changes of the WHO recommendation concerning with the iron supplementation program, including the amount of dosage, kind and length of intervention, as well as its targets. At present the intervention targets are not only pregnant mothers but also women of childbearing age.

Anaemia is not only due to iron deficiency but also due to low consumption of other nutrients such as a lack of vitamin C consumption. Foods of vitamin C sources are vegetables and fruits. Even though vitamin C can be found in many food materials, it is perishable very easily, either when they are harvested or when they are processed into food.

Nutritional knowledge becomes an essential foundation that leads to a good nutritional attitude and behaviour. Up to now, few studies related to nutritional education have shown positive results for improving knowledge, attitudes, and practice of nutrition, as well as nutritional status (Kabahenda *et al.* 2011; Inayati *et al.* 2012). A study by Jamil (2001) showed that discipline in taking in iron pills and the pregnant mothers' haemoglobin level in the

group which were given nutritional education was higher than the group which was not given any nutritional education. Sarwa (2003) showed that intensification of nutritional counselling in the supplementation of iron tablets was determinant to the achievement of the expected haemoglobin level of pregnant mothers. Study by Khomsan *et al.* (2013) showed that nutritional education was able to improve the nutritional knowledge of mothers. There was also a significant difference between the nutritional attitude score of mothers with and without nutritional education interventions. The importance of the nutritional education in a long term is to improve the eating habits or quality of diets of people.

Women workers of tea plantations are usually part time workers with low productivity and income, and vulnerable to food safety. As workers, they have to leave their children; meanwhile they have the major role in taking care of their children. Other obstacles of women workers in bringing up their children are limited safe water, sanitation, and health care. The average quantity of tea leaves picked each day is about 33.4 kg, ranging from 14 to 70 kg. In a day a sample only gets salary as much as IDR 10,786 (Sunarti *et al.* 2008). Poor people are vulnerable to food and nutrition insecurity. However, there is also diversity in poverty contexts. Poor rural people find cheap food resources in their environment that reduce their vulnerability (Niehof 2010).

This research will find out the effect of multinutrient supplementation accompanied by nutritional education to iron status and productivity of the tea-leaf picking workers. This research will be conducted in a tea plantation because the tea plantation provides a valuable opportunity to assess its workers' productivity with a reason that a job which is performed by one worker can be quantified as kilograms of tea-leaves which she can pick a day.

1.2 Objectives

1. To assess socio economic status, productivity and income contribution of women workers in a tea plantation.
2. To identify iron and vitamin C rich foods consumed by the women workers in the tea plantation.
3. To measure intake of energy, protein, iron and vitamin C of the women workers in the tea plantation.

4. To analyze prevalence of iron deficiency anaemia of the women workers in the tea plantation.
5. To assess nutritional (anthropometry) and health status of the women workers in the tea plantation.
6. To assess physical fitness of the women workers in the tea plantation.
7. To analyze impact of intervention on iron status and productivity of the women workers in the tea plantation.

2
Literature Review

Iron Deficiency Anaemia

Anaemia is one of the most common health problems today (SPRING 2016). Anaemia is a condition in which the number and size of red blood cells, or the haemoglobin concentration falls below an established cut-off value, consequently impairing the capacity of the blood to transport oxygen around the body. Anaemia is an indicator of both poor nutrition and poor health (WHO 2014). Practically anaemia is indicated by a decrease in haemoglobin, hematocrit levels or red cell count, but the most common is the haemoglobin level, then the hematocrit level.

According to WHO and MoH 1999 guidelines, cut-off point of anaemia varies between age groups as well as individual groups. Certain age groups or classes of individuals are considered more susceptible to anaemia than other groups. The cut-off point of anaemia for children under five (12-59 months) is Hb level below 11.0 g/dL. Schoolchildren aged 6-12 are considered to have anaemia if their Hb level is below 12.0 g/dL. On the other hand, pregnant women are considered to be one of the groups susceptible to anaemia, although the type of anaemia in pregnancy is generally 'physiological'. The anaemia occurs due to an increase in plasma volume resulting in dilution of Hb content without red cell shaping. Pregnant women are considered to have anaemia when their Hb levels are below 11.0 g/dL. Meanwhile, men aged ≥15 years are considered to have anaemia when their Hb is below 13.0 g/dL and women of reproductive age 15-49 years have anaemia when their Hb is below 12.0 g/dL (MoH 2013[a]).

Although the most reliable indicator of anaemia at the population level is blood haemoglobin concentration, measurements of this concentration alone do not determine the cause of anaemia. Anaemia may result from a

number of causes, with the most significant contributor being iron deficiency. Approximately 50% of cases of anaemia are considered to be due to iron deficiency, but the proportion may vary among population groups and in different areas, according to the local conditions. Other causes of anaemia include other micronutrient deficiencies (e.g. folate, riboflavin, vitamins A and B12), acute and chronic infections (e.g. malaria, cancer, tuberculosis and HIV), and inherited or acquired disorders that affect haemoglobin synthesis, red blood cell production or red blood cell survival (e.g. haemoglobinopathies) (WHO 2015).

Iron deficiency anaemia is defined as anaemia with biochemical evidence of iron deficiency. Serum ferritin, transferrin saturation, transferrin receptor, and erythrocyte protoporphyrin are indicators used as biochemical evidence of iron deficiency. Iron deficiency generally develops slowly and is not clinically apparent until anaemia is severe even though functional consequences already exist (WHO 2015). Women of childbearing age are at higher risk for iron-deficiency anaemia because of blood loss during their monthly periods. About 1 in 5 women of childbearing age has iron-deficiency anaemia (NHLBI 2014).

Iron deficiency anaemia in women of childbearing age can lead to a decrease in labor productivity especially among woman workers. Lack of iron causes fatigue and sluggishness resulting in reduced work capacity and eventually decreased work productivity which can lead to wage decline, and this results in low economic levels (Citrakesumasari 2012). According to MoH (1998) if a woman has iron deficiency or suffers from anaemia since adolescence, the more severe the condition will be when the woman is pregnant. When pregnant, a woman needs more amount of iron for the growth and development of fetus. Pregnant women with anaemia will heighten the mother's risk for miscarriage, bleeding during childbirth, and infants with low birth weight (LBW).

Iron deficiency usually occurs in several stages before it becomes anemic. The first stage is the state of iron reserves in the liver declines, but the provision of iron for the formation of red blood cells has not been disturbed. The second stage is iron deficiency for erythropoesis, a condition in which the supply of iron is insufficient for the formation of red blood cells, but the haemoglobin (Hb) level has not been affected. The third stage is a decrease in Hb levels due

to empty iron reserves and there have already been visible symptoms of iron deficiency anaemia (Sacher & Mc Pherson 2000).

In iron deficiency anaemia usually the haemoglobin decreases slowly; this thereby allows the process of compensation from the body, so that the symptoms of anaemia are not too visible or felt by the patient. Bakta (2007) mentions clinical symptoms of iron deficiency anaemia can be divided into three parts:

1. Common symptoms of anaemia itself, which is often referred to as anaemia syndrome is a collection of symptoms of anaemia, where it will be obvious if the haemoglobin is under 7-8 g/dL with signs of body weakness, lethargy, fatigue, pallor, dizziness, palpitations, decreased concentration, difficulty in breathing (especially during physical exercise), blurred eyes, ears ringing, decreased immunity, and cold sweat.
2. Symptoms of iron deficiency anaemia: these symptoms are typical of iron-deficiency anaemia and are not found in other types of anaemia, namely: 1) Koilonychia/spoon nail where the nail turns into brittle, vertical stripes and so concave that is similar to spoon; 2) Atrophy of the tongue, the surface of the tongue appears slippery and shiny due to the loss of papil tongue; 3) Angular stomatitis/inflammation around the corner of the mouth; 4) Glossis; 5) Pica/unusual eating desire; 6) Dysphagia is a pain caused by pharyngeal web; 7) Gastric mucosal atrophy; 8) Plummer Vinson syndrome/Paterson Kelly's syndrome is a symptom of microcytic hypochromic anaemia, tongue papillary atrophy and dysphagia.
3. Symptoms resulting from the underlying disease of iron deficiency anaemia, for example which is caused by hookworm infection will be encountered symptoms of dyspepsia, parotid glands swell, yellow palm skin like straw. If it is caused by chronic hemorrhage resulting from a carcinoma then the symptoms are dependent on the location of the carcinoma and its metastases

Iron

Iron (Fe) is the most abundant micro mineral in human and animal body, that is, as much as 3-5 g in adult human body (Almatsier 2000). Iron acts as a catalyst for various metabolic functions. Iron is needed by the body

in transporting oxygen in the form of haemoglobin which is important for cell respiration. Iron in the form of myoglobin is required in the storage of oxygen in the muscle. Iron is also a component of various tissue enzymes, such as cytochrome, which are important in energy production (Strain & Cashman 2002). The amount of iron in the body varies, depending on age, sex, pregnancy and growth (Marliyana & Kustiyah 2008).

Naturally, iron is obtained from food. The iron contained in foodstuffs can come from both animals and plants. The form of iron contained in the diet can affect the absorption of iron by the body. Plant-derived iron (nonheme iron) has a lower bioavailability (5%) than heme iron, that has high bioavailability (15%). Heme is derived from animals such as meat, fish, and chicken, while nonheme iron is found in vegetable foods, such as vegetables, seeds, nuts, and fruits (UNICEF 1998).

Food sources of iron, especially heme iron, whose bioavailability is high, are very rarely consumed by people in developing countries, most of whom meet their iron needs from vegetable products (Backstrand *et al*. 2002). In Indonesia, the insufficient amount of iron in the diet occurs because the consumption pattern of Indonesian people is still dominated by vegetables as a source of iron that is difficult to absorb. Meanwhile, meat and animal food as a good source of iron (heme iron) are rarely consumed primarily by rural communities (MoH 1998).

The absorption of nonheme iron is strongly influenced by both inhibiting and promoting factors, while heme iron is not (Thankachan *et al*. 2008). The factors that facilitate the absorption of nonheme iron are vitamin C (ascorbic acid) (UNICEF 1998). Vitamin C can increase the absorption of non-heme iron up to four times (Wirakusumah 1998).

In addition to factors that support the absorption of nonheme iron, there are also inhibiting factors. According to Thankachan *et al*. (2008), substances that inhibit the absorption of iron include phytic acid, oxalic acid, and polyphenols such as tannins contained in tea and coffee. Phytic and phosphoric acid is found in many plant foods, such as cereals. A person who eats a lot of rice, but lacks eating vegetables and fruits and side dishes, will be anemic (Syarief 1994).

Some types of green vegetables also contain oxalic acid which can inhibit the absorption of iron, but its inhibiting effect is relatively smaller than phytic acid in cereals and tannins contained in tea and coffee. Coffee can reduce iron absorption when consumed after meals by 39% because coffee contains polyphenol substances that can bind iron. Tannins contained in tea, coffee, some vegetables and fruits also inhibit iron absorption by binding it (Almatsier 2000). Iron absorption in foods of high tannin content will decrease by about 1-2% (UNICEF 1998).

If the food consumed daily does not contain enough iron or low absorption, then the availability of iron for the body is not enough to meet the needs of iron. This especially occurs in people who eat less diverse foods, such as food only consisting of rice and beans. However, if in the menus there are also foods that increase iron absorption such as meat, chicken, fish, and fruits, the availability of iron in the diet can be increased so that the need for iron will be met (Briawan 2008) .

Iron Supplementation

Iron supplementation is one of the strategies for the prevention and treatment of iron deficiency anaemia and can result in substantial improvements in the functional performance of iron-deficient individuals as well as in populations (Allen 2002). The purpose of supplementation may be medicinal (curative) or preventative (depending on the level of iron deficiency). If supplements are given to a real target of anaemia, then this method is more curative. It can be preventive if they are given in order to prevent it from iron deficiency; and if it has been prevented, they are to prevent anaemia from occuring (Soekirman 2000). Based on the results of several studies it is known that supplementation which is effective and gives optimal results is after intervention for ± 3 months (MoH 1998).

WHO (2011[a]) in *Guideline: Intermittent Iron and Folic Acid Supplementation in Menstruating Women* states daily iron-folic acid supplementation for three months has been used as a standard approach in the prevention and treatment of iron deficiency anaemia in non-pregnant women. Nevertheless, the efficacy of daily supplementation in public health programs is limited. This is due to low levels of adherence due to side effects (such as constipation, odor and unpleasant taste), and inefficient distribution of tablets.

Many studies have proven that iron (Fe) can increase Hb levels and productivity of anemic women workers (World Bank 2006). Li *et al.* (1994) in China proves that the administration of Fe in anemic women workers may increase Hb and ferritin serum and decrease heart rate at work. The UNICEF/WHO/UNU(1999) recommends improving the nutritional status of WUS required multivitamin minerals (MVM) containing 15 kinds of vitamins and minerals because they are not sufficient to be given Fe supplements and folic acid alone. Provision of MVM capsules is expected to preserve iron homeostasis in the blood.

The dosage for iron supplementation in mass programs is unchanged from previous recommendations, except that the pregnancy dose has been reduced to 60 mg/day. Because the efficiency of absorption of iron increases as iron deficiency anaemia becomes more severe, this dose should provide adequate supplemental iron to women who do not have clinically severe anaemia if it is given for an adequate duration. However, if the duration of supplementation during pregnancy is short, a higher dose (120 mg/day) is recommended (Stoltzfus & Dreyfuss 1998).

Supplementation is considered to be more effective at a dose of 60 mg of iron daily for 20 weeks compared to short-term high-dose administration. Problems often encountered in developing countries including Indonesia are low coverage to get blood-supplement tablets (BST) and compliance. This circumstance leads to the way of supplementation is often doubtful of its success in some of these countries. One suggestion for increasing the coverage and compliance of taking iron pills is to provide intensive nutritional education to the target before supplementation (Soekirman 1999 in Adriyani 2008).

Nutritional Education

There are several efforts that can be done to prevent and cope with anaemia due to lack of iron consumption. One effort that can be done is to increase the consumption of iron from natural sources through education, especially food sources of animal (heme iron) are easily absorbed such as liver fish, meat and others. In addition, it is also necessary to increase the foods that contain many vitamin C and vitamin A (fruits and vegetables) to help the absorption of iron and to help the process of formation of haemoglobin (MoH 1996). Nutritional education is a combination of various forms of

educational strategies, supported by the environment, designed to facilitate the selection of food and nutritional behavior for health and well-being (Contento 2011). According to Suhardjo (1989), nutritional education is an educative approach to produce the individual or community behavior that is necessary in improving food and nutritional status. It is expected that people can understand the importance of food and nutrition, so they want to behave and act according to nutritional norms. Basically nutritional education programs are aimed at changing a less healthy behavior to be a healthier behavior, especially eating behavior (Sahyoun *et al.* 2004).

Worsley (2002) in Marzuki (2006) states that society will get a better health level if its nutritional knowledge increases. The higher the level of one's knowledge is, the easier it is to receive information. With a relatively high mindset, the level of a person's knowledge is not just knowing, that is recalling, but she will be able to understand (comprehension), even to the level of application, that is, the ability to use the material that has been studied in the actual situation or condition (Notoatmodjo 2003). This causes the more effective information to be understood so that the level of knowledge will be relatively high (Kurniawati 2012). Lack of nutritional knowledge results in less ability to apply information in everyday life and is one of the causes of nutritional disorders (Suhardjo 1996).

Experts point out several factors that affect a person's knowledge, including: education, employment, information, and experience. Health knowledge is the result of investment from health education in a short term. Health knowledge will affect the behavior as a result of medium-term investment and subsequently health behavior will affect the improvement of public health indicator as output from health education (Notoatmodjo 2003). According to Suharjo (1989) nutritional knowledge is one of the variables that influences one's lifestyle in addition to other variables such as health knowledge, income, occupation, education, tribe, location or residence, religion and psychological characteristics. This lifestyle will then determine the behavior of individuals in consuming food.

Physical Fitness and VO_2max

Physical or physical fitness is defined as the ability of a person's body to perform his/her daily work tasks without causing significant fatigue and s/he

still has spare energy to enjoy leisure time and to do a sudden business (Riyadi 2007; Indriani *et al.* 2011). Giriwijoyo (2005) defines physical fitness as one's certain dynamic degree that can cope with physical demands in performing the tasks of everyday life and s/he still has reserves of ability to perform extra physical activities and recovers before performing her/his daily task. Physical fitness is of paramount importance for supporting one's daily life activities.

Physical fitness is a quality or physiological condition and therefore it is distinctly different from physical activity and physical exercise which is another type of behavior. Physical fitness can be classified as fitness related to health and fitness related to performance. Health-related fitness includes fitness cardiorespiratory, muscle strength and resilience, body composition and flexibility. Fitnesss related to performance include cardiorespiratory fitness, muscle strength and endurance, body composition, flexibility, muscle power, speed, agility, and balance (Gibney *et al.* 2008). Fitness can be influenced by several factors namely, age, gender, heredity, food and balanced nutrition, and smoking habits. The characteristics of good physical fitness are able to work in a long time, not quickly getting tired, not easily affected by stress, not susceptible to disease, and high work productivity (Riyadi 2007).

The physical fitness degree of each person varies according to the task or profession of each and depends on the provision of oxygen in the muscles that work so it is often called aerobic ability and can be measured with maximum oxygen consumption (VO_2max) (Lamb *et al.* 1988). Physical fitness criteria based on cardiac endurance (cardiorespiratory endurance) are most often performed in the field and are best assessed by measuring VO_2max. Physical fitness of a person who has an active activity can be determined by aerobic capacity measurement, through body composition measurements as well as by a heartbeat examination test in a resting state (Sharkey 1991).

Ganong (2008) defines VO_2max as a result of maximum cardiac output and maximal oxygen extraction by tissue, and both increase with exercise. The changes that occur in skeletal muscles with exercise are an increase in the number of mitochondria and enzymes that play a role in oxidative metabolism. There is an increase in the number of capillaries and the distribution of blood to muscle fibers becomes better. The final effect is the more complete extraction of oxygen and consequently for the same workload the increase of lactate formation is lower. The increase of blood flow to muscle becomes

lower and because of this, the heart rate and cardiac output is less than those of the untrained person.

A person who is in good health has a higher VO_2max value and can perform better activities than individuals who are in an unhealthy condition. The factors that can affect one's VO_2max according to Ganong (2008) are as follows:

a. Cardiac output

Cardiac output is the volume of blood pumped by the heart in one minute. Cardiac output is the result of a stroke volume with the heart rate. Stroke volume is the volume of blood pumped out of the right or left ventricle per minute. Heart rate is the number of heart contractions per minute. On average cardiac output of individuals in a resting state is about 5 liters/minute. The heart rate of an individual who is not trained is about 72 times per minute in normal circumstances, so its stroke volume is about 70 milliliters. Stroke volume will increase with exercise and maximum cardiac output in highly trained individuals can reach 40 liters/minute. The ability to produce high cardiac output is a key determinant to having a high maximal oxygen uptake value.

b. Amount of Haemoglobin

In some individuals, the amount of haemoglobin in the blood is about 15 g/100 ml of the blood. Each gram of haemoglobin can bind about 1.34 ml of oxygen. Thus, 15 g of haemoglobin in 100 ml of the blood can carry about 20 ml of oxygen after passing through the lungs. The ability of tissues to take oxygen from the blood is called oxygen extraction.

c. Muscle Mass

The greater the skeletal muscle mass is given the workload, the greater the potential to increase the body's oxygen uptake will be. Muscles which are accustomed to exercise have a greater ability to extract oxygen from the blood because the muscles use oxygen quickly and have more blood vessel capillaries.

d. Gender

VO_2max of men is higher than women. This is because the concentration of haemoglobin in the blood in men is higher than that of women.

e. Age

VO_2max value reaches its peak at the ages of 18-20 years. This value will decrease gradually (1% per year) after the age of 25 years. Among people who are physically active, the decline occurs 5% per decade, whereas among people with sedentary lifestyles, the decline in VO_2max reaches 10% per decade.

f. Altitude

VO_2max decreases with an increasing altitude above 1600 m. For every 1000 m increase above 1600 m, the maximum oxygen uptake will decrease by about 8% -11%. VO_2max is reduced by 26% at an altitude of 4000 m. This decrease occurs due to decreased cardiac output (stroke volume by heart rate). Stroke volume decreased due to decreased the blood plasma volume.

g. Exercise

Exercise is a structured activity that is planned and designed to improve overall physical fitness. The practice habits of a person make a significant contribution to VO_2max. The value varies between 5% -20% depending on fitness during a fitness test.

3
Conceptual Framework

Anaemia is a nutrition problem that is relatively difficult to solve. This problem happens broadly in the community, in numbers of children and women in developing countries. It also makes iron become the only nutrient that is still found deficient in developed countries. More than 30% of population in the world are anemic, which mostly caused by iron deficiency, and in several regions are worsened by the present of infectious diseases. Generally, poor and low educated people are the most vulnerable group to be iron deficient and they were also the one who will be affected the most (WHO 2008).

From the global prevalence of anaemia in 2011, the highest prevalence of anaemia was in children (42.6%) and the lowest prevalence was in non-pregnant women (29.0%). In addition, the global prevalence of anaemia for pregnant women was 38.2% and for all women of reproductive age was 29.4% (WHO 2015).

Women workers at childbearing age are one of productive groups in the community who are vulnerable to have iron deficiency anaemia (IDA). Iron deficiency and anaemia can decrease work capacity or maximum aerobic capacity (VO_2max) and also cause decrease in work productivity through decrease of oxygen supply for tissue. Oxygen supply is determined by the frequency of heart beat, blood volume transported by each beat, and number of oxygen molecules in blood. VO_2max value is volume of oxygen consumed by the body each minutes (ml/kg/minutes) during work at maximum heart beat frequency and it describes how fit someone is.

Iron deficiency anaemia in adults contributes to low work productivity and has a negative impact on the economy. A linear relationship has been reported between iron deficiency and work capacity for agricultural workers in Colombia, Guatemala, Indonesia, Kenya, and Sri Lanka. Work capacity returned rapidly to normal with iron supplementation. Similarly, iron

supplementation increased work output among road workers and rubber tappers in Indonesia; tea pickers in Indonesia and Sri Lanka; agricultural workers in India, Guatemala, and Colombia; and industrial workers in Kenya, China, and other countries. Gains in productivity and take-home pay ranged from 10% to 30% of previous levels (WHO 2001).

Compared with non-anemic women, anemic female workers in China were 15% less efficient in performing their work. They spent 6% less energy on their out-of-work activities, had 4% lower maximal work capacity, and had 12% lower overall productivity, as compared to levels achieved after anaemia was corrected by iron treatment for 4 months. Similarly, non-anemic iron-deficient adolescent female runners significantly improved their levels of endurance and physical performance after supplementation with iron, as compared with those of a placebo control group (WHO 2001). A cr*oss sectional* study conducted by Hardiyanti *et al.* (2013) in garment factory stated that there was significant correlation between anaemia incidence and work productivity of woman workers.

The effort to decrease the prevalence of iron deficiency in infant and pregnant women is suggested to be started long before a woman is pregnant by consuming iron tablets. Previous researches have proved that provision of iron tablets can increase haemoglobin level and productivity of women workers who are anemic. Besides, 60 mg iron supplementation also can increase ferritin serum, decrease heart beat and excess energy expenditure during work thus increasing work productivity (Li 1993; Edgerton *et al.* 1981; Soehardjo 1986).

Supplementation frequency suggested for non-pregnant women of reproductive age is once a week and everyday during menstruation. With assumption that reproductive age women workers have menstruation for 4-8 days, in one month it is expected that they must consume 8-12 supplement pills. The frequency of supplementation can be three times a week or 12 times a month. This amount is similar to the amount suggested. It is considered to give chance to the gut mucosa to change and adapt. Besides, if it is given every day, it will cause many complaints so the compliance rate will be low. On the contrary, if supplementation frequency is only twice a week (8 pills per month), according to previous studies, it cannot increase haemoglobin level significantly (Angeles-Agdeppa *et al.* 1997; Ahmed *et al.* 2005).

Provision of micronutrient as supplement is indicated to improve iron status among women workers with marginal Hb level, especially to increase Hb level to normal. Besides, supplementation is expected to increase physical fitness and iron status of reproductive age women workers (WHO 2008; Hellberg & George 2001).

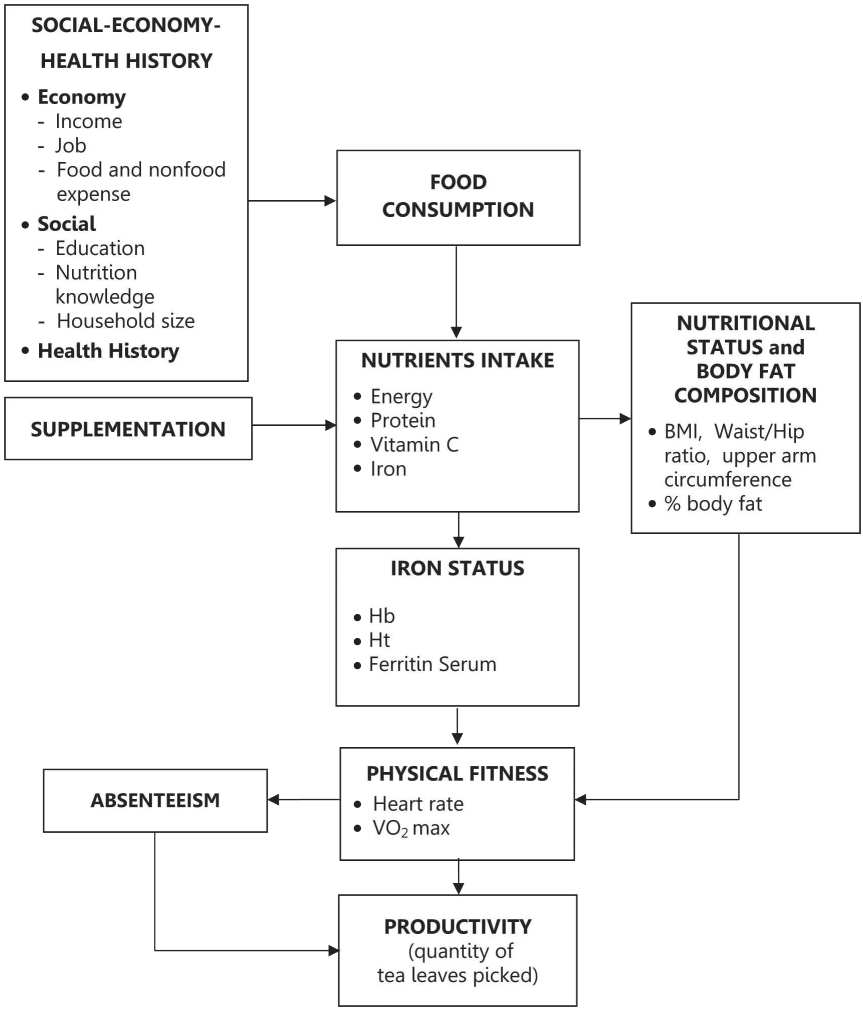

Figure 1. Conceptual Framework

4
Methods

4.1 Research, Design, Location and Time

The study was started with a cross sectional survey and followed by a quasi-experimental study consisting of 2 treatments (intervention group and control group). The allocation of the sample to the treatment group was not randomized because the intervention was carried out on one garden/*afdeling* making it difficult to avoid contamination in the control group. Allocation of intervention and control groups is based on Hb levels by screening at the beginning of the study (at the time of the survey). The intervention group was a group having a Hb level of less than 12 g/dL (anaemia) and the control group had a Hb greater than 12 g/dL (normal). The intervention group was given micronutrients supplements and nutritional education for 4 months while the control group was not given anything.

The research was conducted at PT Perkebunan Nusantara VIII (PTPN VIII) located in Pengalengan-Bandung, West Java, Indonesia. The selected plantations are Kebun Malabar, Purbasari, Sedep and Talun Santosa. This study was conducted for 18 months, namely, January 2016 until June 2017.

4.2 Sampling

Tea plantation in Bandung Region was selected as the research location based on its willingness to collaborate in this study. *Population in this study is women worker in their productive age between 15-49 years old who worked as tea picker in PT Perkebunan Nusantara VIII (PTPN VIII) which is located in* Bandung, West Java, Indonesia.

The subjects were women workers in the tea plantation selected, belonged to the category of childbearing age, had been married, were not pregnant nor breastfeed, healthy, and were willing to follow this study by signing the

informed consent. Total samples were 250 women workers and all were interviewed and screened (to answer objective 1-5) and then sub samples of 90 women were allocated into treatment and control groups.

The sample size of the quasi experimental trial was based on an assumption that α=5% ($Z\alpha$=1.96), power of test=90% ($Z\alpha$=1.28), the average of Hb before intervention was 12.44 g/dL and after intervention 13.56 g/dL, the standard deviation of Hb was 1.45 g/dL (Briawan 2008) so 38 samples were obtained. To anticipate the subjects who may drop out of this study the number of the samples were added to be 45 for each group. So, the total subjects were 90 people consisted of 45 subjects of anaemic workers (treatment group) and 45 subjects of non anaemic workers (control group). Socialization to the tea plantation administrations and subjects concerning the intervention implementation was done prior to the baseline data collection. All 90 subjects were treated with deworming tablets before intervention.

The plantation in Pangalengan (PT Perkebunan VIII) is a vast expanse of the tea plantation and is managed by several plantation administrators to facilitate the management of the plantation. There were 4 tea plantation administrations selected, i.e. Malabar, Purbasari, Sedep, and Talun Santosa. The four selected plantations are unified plantations and this will facilitate the intervention activities undertaken. Because they are in a stretch and the socioeconomic state of the tea picker is relatively no different and accordingly there will be no bias in the sampling.

From each administration, a few *afdelings* (units) were chosen as recommended by the administrations. Number of *afdelings* chosen from Malabar Administration were 4 *afdelings* (North Malabar, South Malabar, Sukaratu, and Tanara), from Purbasari were 2 *afdelings* (Kiararoa and Purbasari), from Sedep were 5 *afdelings* (Kendeng, Papandayan, Cibutarua, Cileuleuy and Sedep), and from Talun Santosa were 3 *afdelings* (Santosa, Talun, and Lodaya). Samples were part of population that fulfill the inclusion criteria and were willing to participate in the study.

Phase 1 of this study that had been done by the research team was survey with 250 samples. The total population of women tea picker was 792 persons. Of the 792 people, as many as 270 women fulfilled the inclusion criteria and were invited to have medical examinations. Of the 270 women, 15 were absent, and 1 sick, bringing the total sample to 254 women. After a medical

examination and screening of the 254 women, the results showed that 2 people were pregnant and 2 had their uterus removed (sterile). So the total sample is 250 women who are eligible and willing to be a research sample. Sampling procedure can be seen in Figure 2.

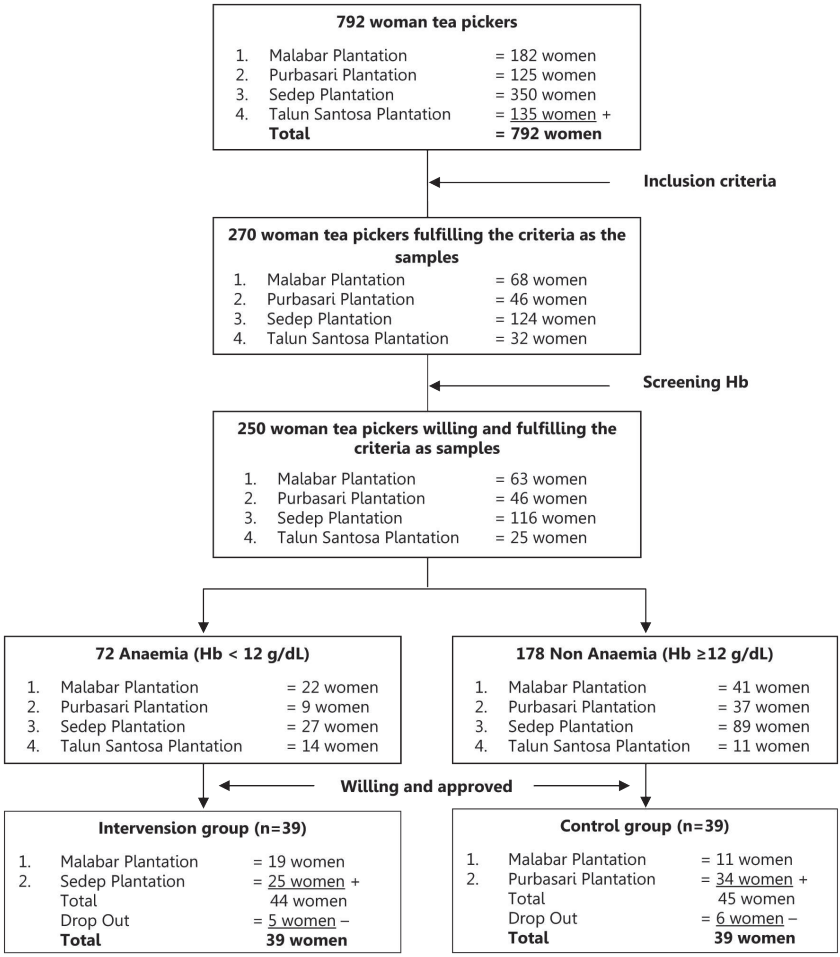

Figure 2. Schema of the sampling

Screening for Hb level (based on hemocue method) was done to 250 samples to determine to which groups they belong to i.e. anemic (intervention) or non-anemic (control) groups. Screening process included blood Hb level measurement, anthropometric measurement and health examination (blood

pressure measurement). The PTPN VIII tea plantation was located at altitude 1,550 m above sea level. Therefore according to anemic diagnostic guideline based on haemoglobin concentration published by WHO (2011[c]), the haemoglobin level at high altitude must be adjusted. Phase 2 was an action research with 89 samples who were willing to participate.

The number of samples at the baseline intervention was 45 for the control group, 44 for the intervention group. In the control group as many as 4 subjects stopped working in PTPN VIII, and 2 subjects were pregnant so at the endline the total sample was 39 subjects. In the intervention group as many as 3 pregnant subjects, 1 menopause, and 1 person withdrew from the study so that at the endline the total samples were 39.

4.3 Data Collection

Data collection was done by anthropometric measurement, blood sampling, health examination, and interview using a structured questionnaire. Data collection included 2 phases. Phase 1, survey data collection on socio-economic characteristics, sanitation and hygiene, food consumption, health history, haemoglobin measurement, and nutritional status. Phase 2, baseline-endline data collection on iron status (Hb, Ht, ferritin serum), physical fitness, productivity, nutritional knowledge, consumption of iron and vitamin C rich foods, and absenteeism.

In phase 1, blood sampling for Hb measurement was drawn from the tip of the left hand finger. The Hb level was analyzed using HemoCueHb 201[+]. The health examination was conducted by a medical doctor. The anthropometric measurement included weight and fat mass was measured using Omron Karada Scan Body Composition Monitor HBF-358-BW. Body height was measured by microtoise.

Anthropometric measurement and interview using questionnaire were conducted by trained assistants and enumerators who were graduates of undergraduate and magister program of Community Nutrition. Before data collection, the research team coordinated with PTPN VIII to obtain research permission and to inform the objectives of the study. Samples had to sign the informed consent before data collection.

For the Hb measurement, the tea plantation administrations had informed the chosen women tea picker to gather at the *afdeling*. The research team, assistant, and enumerators come to each *afdeling* in every tea plantation accompanied by the official from the administrations. The interview was conducted from afternoon until night. This was done to suit the work schedule of the samples in the tea plantation.

In phase 2, blood taking was done in the morning at 8:00 to 10:00 am. Blood was taken from the median cubital vein as much as 5 ml. Hb was analyzed by photometric method using a cyanide-free SLS reagent. Hematocrit analysis used Cumulative Pulse Height Detection method. Ferritin serum was analyzed using Immunochemiluminescent method. Productivity and attendance data were taken during the 4-month intervention period based on data collected by the afdeling head of PTPN VIII.

Physical fitness was measured using a Queen's College Step Test (QCT). The subjects were requested up and down stool for 3 minutes. The pulse of the subjects were measured before and after the test.

Nutrition knowledge was measured to determine the impact of nutritional education conducted. The measurement of their nutritional knowledge used 15 questions.

Table 1. Data-collecting methods

No	Aspects	Variables	Data-collecting methods	Note
1	Characteristics of the subjects	Age Number of household members Education Income Expenditure	Questionnaire	Baseline
2	Nutritional knowledge	Nutritional knowledge	Questionnaire	Baseline and endline
3	Food consumption	Quantity and kind of food consumption Eating habit	Recall 2x24 hours Semi-quantitative food frequency questionnaire (FFQ)	Baseline

Table 1. Data-collecting methods (continued)

No	Aspects	Variables	Data-collecting methods	Note
4	Consumption of Fe and vitamin C rich foods	Amount, kind and frequency of consumption	Questionnaire	Baseline and endline
5	Productivity	Quantity of the tea leaves picked (kg) per week	Questionnaire	During intervention
6	Nutritional status	Anthropometric measurement - Body weight (BW) - Body height (BH) - Body fat compositions	Physical assesment using: - Digital scale - Microtoise - Bioelectrical Impedance Analysis (BIA)	Baseline
7	Iron Status	Examination of blood biochemistry: - Hb - Ht - Ferritin Serum	Laboratory analysis	Baseline and endline
8	Physical Fitness	- Heart rate - VO_2 max	Queen's College Step Test (QCT)	Baseline and endline
9	Absenteeism	The number of days absent from work	Recording	During intervention
10	Health History	Infectious and non communicable diseases	Health examination	Baseline
11	Hygiene and sanitation	Hygiene and home sanitation	Questionnaire	Baseline

4.4 Implementation of Intervention

In this study there were 2 groups of intervention group (anaemia) and control group (normal). The intervention group was given 2 types of treatment, that is, supplementation for 4 months taken twice a week (total 35 capsules) and nutritional education given for 4 months with total 8 extension topics. The control group was not given nutritional supplements nor nutritional

education. Prior to blood sampling for the baseline data, a worming drug (pirantel pamoat 2 tablet x 250 mg) were administered to all of the subjects included in the control and intervention groups to eliminate the impact of worm infection on the appearance of anaemia. Thus, feces collection is not necessary. Implementation of the intervention is done through the following activities:

1. Supplementation of micronutrients
    a. A socialization about the treatment to be given was held to the subjects
    b. The supplements provided are commercial supplements that are easily available on the market. The supplements contain ferrous gluconate 250.0 mg, manganese sulphate 0.2 mg, 0.2 mg copper sulphate, 1.0 mg folic acid, 7.5 mg vitamin B, vitamin C 50.0 mg, and sorbitol 25.0 mg.
    c. Distribution of supplements were conducted biweekly by health workers at the health clinic of PTPN VIII to the subjects. The supplements were taken by the subjects 2 times a week (Monday and Thursday) for 4 months.
    d. To maintain compliance with supplement consumption was done with various efforts such as socialization at the beginning of the activity, filling compliance form supplement consumption, reminiscent of supplements in health polyclinics and nutritional education.
2. Nutritional Education
    a. Preparation for production of nutritional education materials which covers: 1) Basic nutrition, 2) Balanced diet, 3) Sanitation and hygiene, 4) Public health, 5) Anaemia and productivity, 6) Food choice and consumption, 7) Nutrition and fitness, and 8) Food safety.
    b. Preparation for providing nutritional education media (powerpoint, booklet, matchmaking card, and nutrition box).
    c. Nutritional education interventions were given for 4 months. The extension sessions consisted of pre-test, material delivery, discussion, game play, and post-test.

d. Evaluation of nutritional education was done in 2 ways, namely pre-test and post-test given before and after nutritional education respectively, and measurement of nutritional knowledge of baseline and endline.

4.5 Data Analysis

Data processing was done through the process of editing, coding, data entry, and cleaning using Microsoft Excell 2013. Data analysis was done descriptively and inferentially using IBM SPSS version 22. Food consumption data through a food recall for 2x24 hours were recapitulated and identified in term of the amount and type of food consumed. The types of food consumed were classified into 10 food groups, namely: (1) Cereals and Tubers, (2) Meat, (3) Fish, (4) Egg & Milk, (5) Nuts & Beans, (6) Vegetables, (7) Fruits, (8) Snacks, (9) Drinks, and (10) Oils and Fats. The amount of food consumed is converted into energy, protein, iron, and vitamin C nutrients using Food Composition Table. To calculate the nutrition adequacy level used Recomended Dietary Allowance 2013 (MoH 2014). The category of energy adequacy level and protein adequacy level are divided into 2 categories namely insufficient (adequacy level <100%) and sufficient (adequacy level ≥100%). The categories of iron and vitamin C adequacy levels are divided into 2 categories namely insufficient (adequacy level <77%) and sufficient (adequacy level ≥77%) (Gibson 2005).

The nutritional status data seen from the mid-upper arm circumference is categorized into chronic energy deficiency (MUAC <23.5 cm) and normal (MUAC ≥23.5 cm). The nutritional status based on body mass index (BMI) is divided into 4, namely, thin (BMI <18.5 kg/m^2), normal (BMI 18.5-25.0 kg/m^2), overweight (BMI 25.0-26.9 kg/m^2), obese (BMI ≥ 27 kg/m^2). Fat composition is seen from total body fat and visceral fat. Total body fat is grouped into 5, namely, lean (<13%), optimal (13% -23%), slightly overfat (24% -27%), fat (28% -32%), and obese (>32%). Visceral fat is categorized into 3, namely, normal (≤9%), increased risk (10-15%), high risk (>15%) (Lee & Nieman, 1996). Nutritional knowledge is grouped into 3, namely, low (score <60), moderate (score 60-80), good (score> 80) (Khomsan, 2000).

Anaemia status is grouped according to Hb level to anaemia (Hb <12 g/dL) and non anaemia (Hb ≥12 g/dL). Based on ferritin serum , iron status is

divided into two, namely, depleted (ferritin <15 ng/mL), and non-depleted (ferritin≥15 ng/mL) (UNICEF/UNU/WHO, 2001). Based on its severity, WHO (2011[c]) categorizes Hb levels into three: moderate (Hb 8-10.9 g/dL), mild (Hb 11.0-11.9 g/dL), and normal (Hb ≥12 g/dL). Physical fitness is categorized by normative heart rate after 3-Minute Step Test for Women: excellent, good, above average, below average, and poor (McArdle *et al.* 1972).

Table 2. Normative heart rate after 3-Minute Step Test for Women (McArdle *et al.* 1972)

Age	18-25	26-35	36-45	46-55	56-65	65+
Excellent	<85	<88	<90	<94	<95	<90
Good	85-98	88-99	90-102	94-104	95-104	90-102
Above Average	99-108	100-111	103-110	105-115	105-112	103-115
Average	109-117	112-119	111-118	116-120	113-118	116-122
Below Average	118-126	120-126	119-128	121-129	119-128	123-128
Poor	127-140	127-138	129-140	130-135	129-139	

Descriptive analyses cover mean, standard deviation, maximum score, minimum score, frequency, and proportion. Chi square and coeficient contingency were done to correlate non parametric data. A statistical test was done to find out the data variability of the whole variables among the intervention groups (baseline and endline data). A paired t-test (parametric) was used to compare the differences of the variables before and after the interventions. Independent t-test was used to compare data of the control group and the intervention one. Ancova test (parametric) was used to compare the differences of the variables before the interventions with $\alpha=0.05$.

5
Description of The Study Sites

5.1 Company Profile

PT Perkebunan Nusantara (PTPN) VIII is one of the plantations owned by the State of Indonesia established under Government Regulation no. 13 of 1996, as stated in Notarial Deed No. 38 of Harun Kamil, S.H.No. 41 dated March 11, 1996 and has been approved by the Minister of Justice of the Republic of Indonesia through Decree C2-8336.HT.01.01.TH.96 dated August 8, 1996. The deed of establishment was subsequently amended by Notarial Deed Sri Rahayu Hadi Prasetyo, S.H., No. 05 dated 17 September 2002 and has been approved by the Minister of Justice and Human Rights of the Republic of Indonesia in his Decision Letter no. C-20857 HT.01.04. TH.2002 dated October 25, 2002.

The company was established with an intention and purpose to conduct business in the field of agro-business and agro industry, and optimize the utilization of the company's resources to produce high quality and competitive goods and/or services, and to pursue profit to increase the value of the company by applying the principles of Limited Liability Company.

The company's business activities include cultivation of crops, processing/production, and sale of plantation commodities such as tea, rubber, palm oil, quinine, and cocoa. The center of business activity is in the Office of Directors Jl. Sindangsirna No. 4 Bandung, West Java with a plantation/business unit managed by 41 plantations which spread across 11 districts/cities in West Java Province (Bogor, Sukabumi, Cianjur, West Bandung regency, Bandung, Subang, Purwakarta, Garut, Tasikmalaya and Ciamis) And 2 districts in Banten Province (Lebak and Pandeglang).

Up to now (until the 1st semester of 2014), the number of employees of PT Perkebunan Nusantara VIII (Persero) was 52,565 people with details of 19,828 permanent employees and 32,737 non-permanent employees (Perkebunan Nusantara VIII 2017).

5.2 Company History

State-owned plantation companies in West Java and Banten came from Dutch-owned plantation companies, which when the transfer of sovereignty they automatically became the property of the Government of the Republic of Indonesia, which became known as *Perusahaan Perkebunan Negara (PPN) Lama* (the Old State Plantation Company). Between 1957 - 1960 in the framework of nationalization of Dutch/foreign private owned plantation companies (among others: Britain, France and Belgium) was formed a new PPN, a branch of West Java.

In the period 1960 - 1963 there was a merger of the companies in the scope of *PPN-Lama dan PPN-Baru* to: *PPN Kesatuan Jawa Barat I* (PPN Unity of West Java I), *PPN Kesatuan Jawa Barat II* (PPN Unity of West Java II), PPN Kesatuan Jawa Barat III (PPN Unity of West Java III), *PPN Kesatuan Jawa Barat IV* (PPN Unity of West Java IV), and *PPN Kesatuan Jawa Barat V* (PPN Unity of West Java V).

Furthermore, during the period 1963 - 1968 was held a reorganization with the aim that the management of plantations became more appropriate, were formed *PPN Aneka Tanaman VII* (PPN VII of Various Plants), *PPN Aneka Tanaman VIII* (PPN VIII of Various Plants), *PPN Aneka Tanaman IX* (PPN IX of Various Plants IX), *PPN Aneka Tanaman X* (PPN X of Various Veterinary Plants), which manages tea and quinine plants, and *PPN Aneka Tanaman XI* and *PPN Aneka Tanaman XII* which manage rubber plantations. In order to increase the efficiency and effectiveness of the company, in the period 1968 - 1971, the existing PPN in West Java was reduced to three *Perusahaan Negara Perkebunan (PNP*) (State Plantation Companies) covering 68 plantations, namely:

- PNP XI is located in Jakarta (24 plantations), covering ex- *PPN Aneka Tanaman X*, and *PPN Aneka Tanaman XI*;

- PNP XII is located in Bandung (24 plantations), covering several plantations of former PPN *Aneka Tanaman XI*, *PPN Aneka Tanaman XII*, part of ex-*PPN Aneka Tanaman VII*, and *PPN Aneka Tanaman VIII*;
- PNP XIII is located in Bandung (20 plantations), covering several plantations ex-*PPN Aneka Tanaman XII*, *PPN Aneka Tanaman IX*, and *PPN Aneka Tanaman X*.
- Since 1971, PNP XI, PNP XII and PNP XIII have changed their status to Limited Liability Company (Persero).

In the framework of Restructuring of *BUMN Perkebunan* (a state-owned enterprise of plantations) from April 1, 1994 to March 10, 1996, the management of PT Perkebunan XI, PT Perkebunan XII, and PT Perkebunan XIII are combined under the management of PTP Group Jabar. Furthermore, since March 11, 1996, PT Perkebunan XI, PT Perkebunan XII, and PT Perkebunan XIII are merged into PT Perkebunan Nusantara VIII (Persero) (Perkebunan Nusantara VIII 2017).

5.3 Working Area

PT Perkebunan Nusantara VIII is a state-owned enterprise engaged in a plantation sector with business activities covering cultivation of crops, cultivation of land, nurseries, planting, maintenance and sale of plantation commodities. The main commodities of *PT Perkebunan Nusantara VIII* are tea, rubber and palm oil and quinine as its supporting commodities, as well as the development of fruits starting in 2012. Until now, *PT Perkebunan Nusantara VIII* manages 41 plantations and 2 non-farming units namely Agrotourism and *Industri Hilir Teh (IHT)* (Downstream Tea Industry) spread over 11 regencies/cities in West Java and 2 districts in Banten Province with concession area of 113.958 ha. *PT Perkebunan Nusantara VIII* has 53 units of factories, consisting of 32 tea factories, 1 unit of a palm factory, and 19 units of rubber factories (Perkebunan Nusantara VIII 2017). Here are the leading commodities *PT Perkebunan Nusantara VIII*:

a. Tea

PTPN VIII manages 24 tea plantations on productive land area of 20,984 ha and is a large plantation in 6 districts of Sukabumi (2 plantations),

Bogor (2 plantations), Cianjur (3 plantations), Subang (2 plantations), Bandung Regency and Regency of West Bandung (12 plantations) and Garut Regency (3 plantations). There are two types of black tea processing: Orthodox and CTC (Crushing Tearing and Curling).

b. Oil Palm

PTPN VIII develops oil palm cultivation in the plantations of Kertajaya, Bojong Datar, Cikasungka, Cisalak Baru, Sukamaju, Gedeh (Vada) and Tambaksari with an area of about 19.454 Ha. Palm oil is sold in the form of CPO (Crude Palm Oil) and kernels for the domestic market.

c. Rubber

Rubber plants which are managed by *PTPN VIII* are as wide as 23,634 ha spread in 12 plantations. The number of factories that produce RSS (Ribbed Smoked Sheet) is 13 with 2 TPC (Thin Pale Creepe), 3 concentrated latex, with an installed capacity of 35,750 tons. The rubber production which is sold in domestic markets is 80% while the remaining 20% is exported to Asia, Europe and America.

d. Quinine

The quinine plant managed by PTPN VIII is 683 ha. The dried quinine skin is processed into SQ-7, that is, quinine saline which contains quinine sulphate, quinine bisulphate, and other contents. Now the production is done by PT Sinkona Indonesia Lestari (PT SIL). The company's products are exported to Europe, Canada and America.

5.4 Profile of the Tea Plantations

Malabar plantation is one of the 24 tea plantations managed by PTPN VIII, located in the sub district of Pengalengan, Bandung Regency, and 53 Km from Bandung. It is at 1500-1550 meter above the sea level, of hilly topography, mostly of andosol type of soil, annual rainfall of 2300-3200 mm and daily temperature of 20-26 ^{0}C (Sunarti *et al.* 2008). The Malabar tea plantation has a total area of 2,022.14 Ha, consisting of 4 afdeling namely afdeling North Malabar with 444.41 Ha plantation area, South Maldar Afdeling with 624.72 Ha plantation, Sukaratu afdeling with 458.42 Ha plantation area and Tanara afdeling with 494.69 Ha plantation area (Hamid, 2008).

Purbasari Plantation is a merger of Purbasari Plantation (founded in 1928 in the afdeling of Purbasari), Wanasuka Plantation (formerly Fa Jon Peet & Co, founded in 1928 in the afdeling of Wanasuka) and Pasir Junghuhn Plantation (formerly Old PPN, founded in 1930). The total acreage of Purbasari is 2,115.97 ha, with acreage of each afdeling, namely Afdeling Purbasari (535 ha), Afdeling Kiararoa (545 ha), Afdeling Srikandi (541 ha), and Afdeling Citawa (535 ha) (Sunarti *et al.* 2008).

Talun Santosa Plantation, located in the village of Santosa, sub district of Kertasari, Regency of Bandung, is a merger of several plantations (Santosa, Talun, Cikembang, and Lodaya). It is 1514 meter above sea level, with an average annual rainfall of 2850 mm, average temperature of 20 ^{0}C, annual humidity of 92%, and andosol soil with PH 6.68. The plantation cultivates tea commodity (1187 ha) and quinine (651 ha), and controls four afdelings: Sukatinggal (286.37 ha), Talun (298.13 ha), Santosa (314.26 ha) and Lodaya 9380.37 ha) (Sunarti *et al.* 2008).

Sedep Plantation was opened in 1898 by a Dutch man called Kordele. Sedep Plantation is located in the high land of Priangan, Regency of Bandung and Regency of Garut, West Java Province, on the hill of mount Malabar in the north and mount Papandayan in the south, with the latitude of 1,500 m – 1,950 m above sea level, average remperature of 18 ^{0}C, annual rainfall of 3,250 mm within ten years. Its topography ranges from flat to very slanting types, with andosol and latosol types of soil, covering an area of 2,558.12 ha (after the addition from Talun Plantation on January 1st 1993). Now the Sedep plantation has a total area of 1,723.90 Ha, which consists of Afdeling Sedep (394.15 Ha), Kendeng (340.12 Ha), Papandayan (348.70 Ha), Cibutarua (322.23 Ha), and Cileuleuy (318.70 Ha).

6
Socioeconomic Characteristics and Income Contribution

6.1 Characteristics of Woman Workers

The total workforce in Indonesia increases annually and currently reaches 118.19 million people while the working population reaches 110.80 million people. The growth of female workers increased annually and 38% of the workers were women (Central Bureau of Statistics 2013). In this study, woman workers were between 15 to 49 years old with an average of 42.1 ± 5.4 years (Table 3). Working ability is also affected by age. At age 50, work capacity decreases to 80%. At 60 years old, work capacity is only 60% when compared to the capacity of young women workers who are 25 years (MoH 2013[b]).

Woman workers have a dual role, namely as housewives as well as workers, both must be performed properly. The greater the number of family members is, the greater the responsibility of the workers will be. Based on the results of the study, it was obtained that as many as 72.8% of the subjects had the number of family members between 1-4 people and only 2.8% who had a large family. In general, the average number of family members is 3.9 ± 1.3 people.

The level of education plays an important role in individual development and job assignment. The higher a person's education, the easier one will think broadly and the easier it will be to find efficient ways to get the job done properly (Setyawati, 2010). Viewed from the level of education, the majority of the woman workers working in the tea plantation (55.6%) completed their education at the primary school level and only one (0.4%) had a high school diploma.

Table 3. Distribution of the subjects by social characteristics

Characteristics	n	%
Age		
18-<40 years	61	24.4
≥40 year	189	75.6
Mean±SD	42.1±5.4	
Household Size (person)		
Small (≤ 4)	182	72.8
Moderate (5-6)	61	24.4
Big (>6)	7	2.8
Mean±SD	3.9±1.3	
Education Level		
No formal education	87	34.8
Elementary School	139	55.6
Junior High School	23	9.2
Senior High School	1	0.4
Mean±SD (Year)	5.4±1.9	

Workers who have worked with a longer tenure of course have more working experience than those who work not too long (Setyawati 2010). The results showed that 68.7% had worked 10-20 years and 7.4% had worked less than 10 years, with an average working duration of 17.5 ± 7.6 years (Table 4).

Table 4. Distribution of the subjects by working length

Working Length	n	%
<10 years	18	7.4
10-20 years	167	68.7
20-30 years	27	11.1
>30 years	31	12.8
Mean±SD (year)	17.5±7.6	

6.2 Income Contribution and Expenditure

Based on Decree of West Java Governor No. 561/Kep. 1191-Bangsos/2016, the minimum wages per month for Bandung District is IDR 2,463,461.49 (≈USD 184.89). The average family income was IDR 2,493,400 or equal to USD 187.14 (Table 5). It is slightly above the minimum wages of the districts. The subjects' income contributed approximately 50% to the family income.

Table 5. The average contribution of the tea pickers' income to family income

Income contribution	Income
Family income (IDR/month)	2,493,400±1,198,376
Tea pickers' income (IDR/month)	1,104,905±376,950
Contribution from tea pickers per month (%)	50,0±20,2
Family income per capita (IDR/month)	733,124±517,968

Total expenditure of households is shown on Table 6. More than half of household expenditure was spent on non-food items (52.5%). The top three of non-food expenditure were spent on cigarette, children education and installment/credit/regular social gathering. Total food expenditure was IDR 1,090,752 (≈USD 81.86) which comprised 47.5% of total household expenditure. The food expenditure was mainly for staple food, snacks and vegetables, respectively.

The expenditure spent on cigarette was larger than those spent on staple food (IDR 329,335 vs IDR 320,972). This indicated a wrong priority on household expenditure. Efroymson *et al.* (2001) who conducted an analysis on the economy impact of tobacco consumption among the poor in Bangladesh stated that cigarette expenditure is a great burden to the poor household. The poorest households are twice as likely to smoke as the wealthiest. The expenditure spent on cigarette could be diverted to food and health expenditure as the study also affirmed. Daily tobacco expenditure could add over 500 calories to the diet.

A study on anaemia clustering among women and children in Indonesia (Souganidis *et al.* 2012) found that paternal smoking increased the risk of anaemia clustering in rural families because family resources were diverted from food to tobacco. As seen in Table 6, health/medication expenditure only comprised 3.0% of total non-food expenditure. Side dishes which comprised 8.8% of total food expenditure were mostly spent on plant protein food source. Expenditure on cigarette could be spent to buy animal protein food source which have better iron bioavailability than plant protein food source.

Table 6. Average household expenditure (IDR/month)

Type of expenditure	Amount	Contribution (%)
Food		
Staple food	320,972	15.3
Snacks	297,612	11.9
Vegetables	237,406	10.1
Side dishes	199,948	8.8
Fruits	34,813	1.5
Total Food Expenditure	**1,090,752**	**47.5**
Non-food		
Cigarette	329,335	13.0
Children education	259,740	11.0
Installment/credit/regular social gathering	203,309	8.3
Fuel	183,598	7.7
Sanitation	90,673	4.2
Clothing	91,268	4.0
Health/Medication	63,580	3.0
Phone credit	34,645	1.4
Total Non-food Expenditure	**1,251,407**	**52.5**
Total Expenditure	**2,339,687**	**100.0**

6.3 Environmental Sanitation and Personal Hygiene

WHO (2017[a]) stated that housing-related health risks include: respiratory and cardiovascular diseases from indoor air pollution; illness and deaths

from temperature extremes; communicable diseases spread because of poor living conditions, and risks of home injuries. WHO estimates that nearly 2 million people in developing countries die from indoor air pollution caused by the burning of biomass and coal in leaky and inefficient household stoves. Inadequate ventilation is also associated with a higher risk of airborne infectious disease transmission, including tuberculosis, as well as the accumulation of indoor pollutants and dampness, which are factors in the development of allergies and asthma. Poor housing quality and design also can exacerbate the health impacts from exposure to temperature extremes, which are occurring more frequently due to climate change.

The results of this study (Table 7) show that the type of house of most of the subjects was not permanent (56%), with the stage house form (50.8%) and not the stage (49.2%). The subject's house floor consisted mostly of bamboo/wood (53.2%). The subjects' ventilations which had fulfilled the health requirement (>15% of the space) is 45.8% while the remaining 54.2% still did not meet the health requirement (<15% of room area).

Table 7 also shows that the use of fuel for household use, that is, the subjects using gas/LPG/electric fuel was 60.4%. The number is slightly higher than the Basic Health Research data in 2013 of 51.7% in rural areas in Indonesia that already used gas/electricity (MoH 2013[a]). However, the results of this study also show that there were still some of the subjects who used firewood (39.2%) as the main source of fuel for their household needs.

Water is essential for life. The amount of fresh water on earth is limited, and its quality is under constant pressure. Preserving the quality of fresh water is important for the drinking-water supply, food production and recreational water use. Water quality can be compromised by the presence of infectious agents, toxic chemicals, and radiological hazards (WHO 2017[b]).

The results of this study indicate that most of the subjects' main sources of drinking water (69.6%) and bath water (72.0%) were springs. Only 5.6% of the subjects had used PAM (The Indonesian Government Enterprise of Drinking Water)as a source of drinking water and water (Table 8). WHO (2011[b]) stated the greatest risk to public health from microbes in water is associated with consumption of drinking-water that is contaminated with

human and animal excreta. Infectious diseases caused by pathogenic bacteria, viruses and parasites (e.g. protozoa and helminths) are the most common and widespread health risk associated with drinking-water.

Table 7. Distribution of the subjects based on residential environment characteristics

Variable	n	%
House type		
Permanent	32	12.8
Semi permanent (half wall and the other are wood)	78	31.2
Not-permanent (bilik)	140	56.0
House form		
Stage	127	50.8
Not stage	123	49.2
House floor		
Soil	5	2.0
Plester (cement)	91	36.4
Ceramics	20	8.0
Half soil, and half cemented (plester)	1	0.4
Bamboo/wood	133	53.2
House Ventilation		
Fulfilling the health requirement (>15% of house space)	114	45.8
Not fulfilling the health requirement (<15% house space)	135	54.2
Lighting		
Electicity	249	99.6
Petromaks (pump lamp	1	0.4
Main source of fuel		
Kerosene	1	0.4
Gas	151	60.4
Firewood	98	39.2

CDC (2015[a]) stated throughout the world, an estimated 2.5 billion people lack basic sanitation (more than 35% of the world's population). Basic sanitation is described as having access to facilities for the safe disposal of human waste (feces and urine), as well as having the ability to maintain hygienic conditions, through services such as garbage collection, industrial/ hazardous waste management, and wastewater treatment and disposal.

Table 8. Distribution of the subjects based on the characteristics of water resources

Variable	n	%
Main sources of drinking water		
Spring	174	69.6
Well	59	23.6
PAM	14	5.6
Commercial processed water	2	0.8
Others	1	0.4
Main sources of bath water		
Spring	180	72.0
Well	51	20.4
PAM	14	5.6
Commercial processed water	3	1.2
Others	2	0.8
Bathroom ownership		
Self-owned	188	75.2
Public facility	62	24.8
Toilet		
Self-owned toilet	133	53.2
Public toilet	116	46.4
River	1	0.4
Distance between septic tank and the water main source		
< 10 m	32	27.1
≥ 10 m	86	72.9
Place for rubbish disposal		
A designed place for rubbish disposal	208	83.5
River, ditch, and others	41	16.5

According to MoH (2013[a]), the proportion of households in Indonesia using their own toilet facility is 76.2%, that of joint property 6.7%, and the public facilities 4.2%. There are still some households that do not have toilet facilities, which is 12.9%. In this study (Table 8), the subjects who had their own toilet facilities were as many as 53.2% and who used public toilet as many as 46.4%. There were still a few subjects who made the river as a place of defecation, that is, as many as 0.4%.

Worm disease is a disease that is still common in all parts of Indonesia. Worm infection can cause decreased appetite, discomfort in the stomach, itching, anaemia, and etcetra. The results of Haidar's study (2010) show that worms due to the habit of defecation in open places are associated with anaemia. The problem of worms is related to climate, hygiene and environmental sanitation. Based on a contingency coefficient test, house type, house floor, main source of drinking water, hand washing habit using soap, and habit of using footwear outside the home did not show any significant correlation with worms. Of the 250 samples interviewed, as many as 12 people (4.8%) had worms. Because of this small number there has not been seen any statistically significant correlation with hygiene and sanitation variables. The worm infected prevalence (4.8%) was obtained based on interview with respondents whether they have been diagnosed with worm infestation by the doctor. There was weakness in this self-reported method; it was possible that the respondents had not been assessed by doctors on worm infestation, thus they reported that they never been infected by worm. The use of footwear among these tea workers (93.2% used footwear) and the majority of the tea workers' houses' floor were made of cement and bamboo (not dirt) could prevent worm infestation.

Hygiene refers to acts that can lead to good health and cleanliness, such as frequent handwashing, face washing, and bathing with soap and water. Keeping hands clean is one of the most important ways to prevent the spread of infection and illness. However, in many areas of the world, practicing personal hygiene is difficult due to lack of resources such as clean water and soap. Many diseases (including diarrheal diseases) can be spread when hands, face, and body are not washed appropriately at the key times. Dental hygiene refers to the practice of keeping the mouth, teeth, and gums clean and healthy to prevent disease. Dental hygiene and oral health are often taken for granted but are essential parts of our everyday lives. Tooth decay (cavities) is a common problem for people of all ages. Adults of some racial and ethnic groups experience more untreated decay. Proper tooth brushing is critically important to good dental hygiene (CDC, 2015[b]).

Table 9. Distribution of the subjects based on personal hygiene

Hygiene	n	%
Bathing practice		
1 time	3	1.2
2 times	184	73.6
3 times	63	25.2
Using soap when bathing		
Yes	250	100
No	0	0
Tooth-brushing practice		
2 times	66	26.4
3 times	184	73.6
Applying toothpaste when brushing teeth		
Yes	250	100
No	0	0
Hairwashing practice (per week)		
1 time	3	1.2
2 times	33	13.2
≥3 times	214	85.6
Handwashing practice by using clean water and soap		
Yes	136	54.8
No	18	7.3
Sometimes	94	37.9
Wearing footwear when walking outside		
Yes	233	93.2
No	1	0.4
Sometimes	16	6.4
Cutting-nail practice at least once a week		
Yes	219	87.6
No	23	9.2
Sometimes	8	3.2

Table 9 shows that the majority of the subjects (>70%) had good hygiene behaviors with bathing for 2 times a day using soap, brushing their teeth using toothpaste for 3 times a day, shampooing ≥3 times a week, using footwear when outdoors, and cutting nails at least once a week. However, the very important hygiene behavior of hand washing with water and soap was still poorly practiced by the subjects. Only about 50% of the subjects who already had a habit of washing hands using water and soap. According to CDC (2015[b]), a large percentage of foodborne disease outbreaks are spread by contaminated hands. Appropriate hand washing practices can reduce the risk of foodborne illness and other infections. It is estimated that washing hands with soap and water could reduce diarrheal disease-associated deaths by up to 50%.

Table 10. Distribution of the subjects by clothing hygiene

Hygiene	n	%
Using self-owned towel/not using the same towel with others		
Yes	211	84.4
No	36	14.4
Sometimes	3	1.2
Practice of putting the towel under the sunshine after use		
Yes	245	98
No	2	0.8
Sometimes	3	1.2
Practice of washing towel in a month		
1 time	9	3.6
2 times	35	14
3 times	32	12.8
≥ 4 times	174	69.6
Practice of changing clothes in a day		
1 time	40	16
2 times	182	72.8
3 times	28	11.2

Clothing hygiene is a healthy practice aiming to maintain personal health and prevent diseases. The practice includes using towel, drying the towel after using it, frequency of washing the towel in a month, and frequency of

changing cloth in a day. Table 10 shows that the most of subjects' practice of clothing hygiene had relatively good such as having habitual using personal towel and drying it after using it. They usually wash the towel 4 times per month and changing clothes 2 times per day.

7
Food Habits and Nutrients Intake

7.1 Frequency of Food Consumption

The three most commonly consumed staple foods were rice, potatoes, and bread (Table 11). Rice was the staple food consumed daily (88.4 times/month or 3 times daily) with consumption per time 187.6 g or equivalent to 2 servings. Based on MoH (2014), staple food is consumed 3 times a day with a total of 3-4 servings in a day or 1-1 ½ portion per meal. The amount of staple food eaten by the subjects exceeds the recommendation. MoH (2014) also mentions to eat a variety of staple foods. The subjects have eaten a wide variety of staple foods other than rice but the frequency is not high.

Table 11. Average consumption of cereals and tubers

Food	Frequency (times/month)	g/consumption
1. Rice	88.4	187.6
2. Potato	17.1	63.0
3. Bread	16.4	41.3
4. Noodle	8.4	66.1
5. Jelly Noodle	6.1	32.9
6. Cassava	3.4	46.7
7. Sweet potato	2.4	114.1
8. Corn	1.5	196.8
9. Taro	.9	100.3

According to Table 12, animal foods are rarely consumed by the subjects (0.1-12.4 times/month). The most commonly consumed animal foods were eggs, milk, and salted fish. Animal foods are a source of iron with high bioavailability. Unfortunately, the subjects rarely consumed animal foods which are a source of iron such as chicken, beef, lamb, and liver. Consumption

of animal foods per time is equivalent to one serving. The rare consumption of animal foods is probably due to the low socio-economic background of the subjects, who can not afford to buy relatively expensive animal foods.

Table 12. Average consumption of meat, fish, egg, & milk

Food	Frequency (times/month)	g/consumption
1. Egg	12.4	55.7
2. Salted fish	8.2	18.2
3. Milk	8.9	190.3
4. Steamed Fish	3.4	33.4
5. Fresh fish	2.2	45.5
6. Chicken*	1.6	67.1
7. Liver*	1.6	24.4
8. Sea fish	1.3	36.0
9. Sardene	1.1	27.1
10. Beef*	.2	64.6
11. Lamb*	.1	66.3

*foods of iron sources

The most commonly consumed foods of plant protein sources were tempeh and tofu, where each subject consumed 21.2-23.4 times (5-6 times/week) (Table 13). The amount of one meal was a half portion of tofu and one serving of tempeh. The portion eaten is still under the recommendation of Balanced Nutrition Guide. Plant food is a source of plant protein. With low consumption of animal foods, the subjects should eat plant foods at all meals.

Table 13. Average consumption of beans and lentils

Food	Frequency (times/month)	g/consumption
1. Tofu	23.4	55.7
2. Tempeh	21.2	48.4
3. Peanut	4.0	42.3
4. Green bean	3.2	69.4
5. Red bean	3.8	27.7
6. *Oncom* (fermented processed bean)	2.8	22.9
7. *Jengkol* (a bean with a strong smell)	1.8	27.7
8. *Petai* (a green bean with a strong smell)	1.6	15.8

Types of vegetables consumed by the subjects are quite diverse. The most common vegetables consumed were cabbage, carrots, and water spinach (Table 14). Green vegetables are a source of iron with low bioavailability and also a source of vitamin C. The most commonly consumed green vegetables were water spinach, spinach, and cassava leaves. The most frequently consumed fruit vegetables were tomatoes, squash, and cucumber (Table 15). Tomatoes are a fruit that contains lots of vitamin C needed to increase iron absorption. The most consumed fruit vegetable was cucumber.

Table 14. Average consumption of vegetables

Food	Frequency (times/bean)	g/Consumption
1. Cabbage	13.7	34.3
2. Carrot	9.7	35.2
3. Water spinach*	5.5	35.5
4. Mustard greens	5.2	33.1
5. Lettuce	4.8	28.9
6. Spinach*	4.4	35.4
7. Cassava leaf*	4.1	33.8
8. Long bean	3.4	31.3
9. Papaya leaf*	2.7	29.8
10. Melinjo leaf*	1.6	23.4

*food of iron dan vitamin C sources

Table 15. Average consumption of fruit vegetables

Food	Frequency (times/month)	g/Consumption
1. Tomatto*	12.7	49.5
2. Squash	7.5	35.5
3. Cucumber	6.3	84.8
4. Eggplant	4.0	44.6
5. Baby jackfruit	2.7	34.5
6. *Melinjo* (a kind of nut)	2.0	11.6
7. Baby pepaya	1.5	31.6

*food sources of vitamin C sources

Fruits are a source of vitamin C that acts as an iron absorption enhancer. According to Table 16, the subjects seldom consumed fruit (0.9-1.7 times per month). This is likely due to the low socio-economic background of the

subjects and the difficult access to markets. The most commonly consumed fruit was guava that is high in vitamin C.

Table 16. Average consumption of fruits

Food	Frequency (times/month)	g/consumption
1. Guava*	17.2	99.5
2. Banana	5.2	49.4
3. Avocado	2.9	119.5
4. Papaya*	2.8	60.8
5. Orange*	2.2	72.4
6. Rambutan	2.1	47.4
7. Apple*	1.6	135.1
8. Mango*	1.6	92.1
9. Pineapple*	.9	57.0

*Foods of vitamin C sources

The most frequently consumed snack/street food was chips/crackers and fried foods (Table 17). Snack/street food is of high calorie but poor micronutrients. Consumption of the food which is too often (e.g. fried foods daily) causes excessive calorie intake and may cause individuals tend to be overweight.

Table 17. Average consumption of snack/street food

Food	Frequency (times/month)	g/ Consumption
1. Crisp/cracker	45.3	19.5
2. Fried snack	33.8	84.6
3. *Cilok* (a kind of steamed snack, made of starch flour)	9.9	82.7
4. *Siomay* (a kind of steamed snack, made of starch flour and fish)	5.5	154.5
5. Meatball	4.2	309.2
6. Chicken noodle	3.1	326.4

Tea contains tannin which is a substance that can inhibit iron absorption. Tea is a drink that was often consumed by the subjects with a frequency of 94.9 times per month or about three times per day (Table 18).

Table 18. Average consumption of drink

Drink	Frequency (times/month)	ml/consumption
1. Tea	94.9	263.1
2. Coffee	19.2	180.6

7.2 Quantity of Food Consumption

Table 19 shows that the subjects consumed cereals and roots 668.1 g per day (or equal to 6 portions of rice). Based on MoH (2014), people should consume 3-4 portions of staple food a day. Therefore, the consumption of staple food among the subjects exceeded the recommended guidelines. On the other hand, the consumption of animal protein food source was very low, far from the guidelines. It is recommended to take 2-4 portions of animal protein food source a day or equal to 70-140 g (2-4 medium piece) of meat, or 80-160 g (2-4 medium piece) of chicken, or 80-160 g (2-4 medium piece) of fish. The subjects' protein intake was mostly from plant protein food source (beans and lentils). However, it is still below the recommended guidelines which is 2-4 portions a day, or equal to 100-200 g (4-8 medium piece) of tempeh or 200-400 g (4-8 medium piece) of tofu.

Table 19. Quantity and kind of food consumption per day based on food group

Food consumption	Weight (g)	Energy (kcal)	Protein (g)	Iron (mg)	Vitamin C (mg)
Cereals & roots	668.1	1135	15.3	3.08	4.2
Meat	4.7	9	0.6	0.05	0.0
Fish	13.0	27	2.8	0.31	0.0
Egg & milk	22.9	73	3.2	0.59	0.3
Beans & lentils	102.5	182	12.2	3.41	0.5
Vegetables	46.4	19	0.7	0.32	9.6
Fruits	20.3	12	0.1	0.14	9.8
Snacks	133.0	319	5.8	3.58	0.7
Beverages	1326.0	25	1.0	0.50	0.2
Oil & fats	11.0	85	0.0	0.00	0.0

Vegetables and fruit intakes were also below the recommended guidelines. Adolescents and adults in Indonesia are recommended to consume vegetables and fruits 400-600 g per day, with two thirds (250-400 g) consist of vegetables.

MoH (2013[c]) stated that consumption of sugar more than 50 g (4 tablespoon), sodium more than 2000 mg (1 teaspoon) and fat/total oil more than 67 g (5 tablespoon) per day could increase hypertension, stroke, diabetes and heart attack risk. Therefore, the consumption of sugar, salt and oil should be limited. Subjects in this study consumed oil and fats below the limit.

The recommended intake of water is 1500-2000 ml per day. These subjects drank beverages a little less than recommendation.

7.3 Energy and Nutrients Intake

The average energy, protein, iron and vitamin C intakes of the subjects were less than RDA (Table 20). The energy and protein intakes were inadequate, as the subjects in average only consumed 86.3% of energy RDA and 72.1% of protein RDA. The iron intake was adequate as the subjects consumed 90.5% of RDA. On the other hand, the vitamin C intake was low, only 32.6% of RDA was consumed.

In Table 21, it is shown that most of the subjects had inadequate energy, protein and vitamin C intakes (68.4%, 87.6% and 90.8%, respectively). Energy food source mostly consumed by the subjects were rice and fritters. Protein source consumed by the subjects were mostly from plant source such as fried tempeh, fried tofu and peanuts. Animal protein food source was from salted fish. Low intake of vitamin C was caused by low intake of vegetable and fruit (Table 19). The subjects mostly consumed guava, cabbage, cauliflower and chinese cabbage.

Meanwhile, more than half of the subjects (55.6%) had adequate iron intake. The iron food source of these subjects was mostly from iron-fortified flour in form of processed food such as fritters (fried mix vegetables/*bakwan*, fried tapioca/starch flour/*cireng* and fried tempeh). MoH 2003 stated that flour produced, imported and distributed in Indonesia must be fortified with iron (min 50 ppm), zinc (min 30 ppm), vitamin B1/thiamine (min 2.5 ppm), vitamin B2/riboflavin (min 4 ppm) and folic acid (min 2 ppm).

Table 20. Average intake of energy and nutrients, RDA and % RDA

Nutrients	Mean	Standard Deviation
Energy		
Intake (kcal)	1859	608
RDA (kcal)	2154	20
% RDA	86.3	28.3
Protein		
Intake (g)	41.1	14.3
RDA (g)	57.0	0.2
% RDA	72.1	25.0
Iron		
Intake (mg)	11.79	5.47
RDA (mg)	13.00	0.00
% RDA	90.5	42.2
Vitamin C		
Intake (mg)	24.4	25.2
RDA (mg)	75.0	0.0
% RDA	32.6	33.6

Table 21. Intake of energy, protein, iron and vitamin C of the women workers in the tea plantation

Adequacy Level (AL)	n	%
Energy		
Inadequate (AL<100%)	171	68.4
Adequate (AL≥100%)	79	31.6
Protein		
Inadequate (AL<100%)	219	87.6
Adequate (AL≥100%)	31	12.4
Iron		
Inadequate (AL<77%)	111	44.4
Adequate (AL≥77%)	139	55.6
Vitamin C		
Inadequate (AL<77%)	227	90.8
Adequate (AL≥77%)	23	9.2

The result of the research showed that there was no significant correlation between socioeconomic factors and demographic characteristics of the women tea-leaf pickers with nutrient intake and adequacy level. This was due to the socio-economy data of the tea workers is homogenous. As many as 90.4% of respondents had low education level (34.8% had no formal education and 55.6% only finish elementary school). The income of the tea workers was given monthly and the average income was IDR 1,104,905±376,950, thus their socioeconomic characteristics did not varied.

The results of this study differ from the results of the national socioeconomic survey (Central Bureau of Statistics 2016) which shows an increase in energy and protein intake along with the increase in the family income. The results of the study by McCartney *et al* (2013) show low nutritional intake in women with poor socioeconomic conditions. The literature study conducted by Mor & Sethia (2013) explains that food consumption is influenced by various factors such as income, demographic characteristics, education level, assets owned, time, knowledge, and social conditions. This can happen because the socioeconomic and demographic data in this study is quite homogeneous, so it can not show any statistical relationship with the intake and nutritional adequacy level. In this study, the majority of the subjects had small number of family members (≤4 people), and low level of education (no school and primary school). Furthermore, tea pickers' income was under UMR (the regional minimum wage) of Bandung District, and almost half of their total expenditure was used for food expenditure.

7.4 Supplement Consumption

Consumption of supplements is intended to increase the nutritional intake which may be not adequate from the daily diet. The supplements consumed are generally vitamins/minerals and some of them are antioxidants. Table 22 shows that only about 10% of the subjects consume supplements and the supplement types consumed are vitamin B (1.2%), vitamin C (2.4%), multivitamins (1.6%), and iron + multivitamin combination (1.2%). In addition, some of the subjects took supplements of mangosteen skin extract, LIVRON B PLEX, fish oil etc.

Vitamin B complex serves to help the digestive process, especially in the breakdown of carbohydrates into energy. In addition, vitamin B complex also plays a role in the nervous system. Meanwhile, vitamin C is used as an antioxidant and with other functions is to prevent scorbut, useful in collagen synthesis, and improve body immunity. By taking vitamin supplements, it is expected that stamina and health performance of a person will be better.

Basically the consumption of supplements is not necessary if someone has a good appetite, as well as his/her daily food consumption can meet the nutritional intake of a person even without taking supplements. Only under certain conditions supplements may be necessary, for example when a person is ill or is experiencing appetite problems.

Table 22. Distribution of the subjects by supplement consumption habit

Supplement consumption habit	n	%
Yes	24	9.6
- Vitamin B	3	1.2
- Vitamin C	6	2.4
- Multivitamin	4	1.6
- Iron and multivitamin	3	1.2
- Others	8	3.2
No	226	90.4

Others: supplements of mangosteen skin extract, LIVRON B PLEX, fish oil, appetite enhancer, and not mentioned

Each supplement has a specific property. For example, fish oil supplements for the prevention of heart disease would be more suitable consumed by adults (men >40 yo, women after menopause). While vitamin or mineral supplements can be consumed by children or adults. The elderly have an obstacle to eating a balanced diet because their teeth are already damaged, the taste bud is less functioning, accordingly they may require vitamin/mineral supplements because the risk of nutritional deficiencies of vitamins/minerals is greater than those of young people whose appetite is still good. Consumption of supplements is not sex dependent, but may depend on the health risks that a person will face. Menopausal women are more susceptible to osteoporosis so that if calcium needs can not be met from food, then menopausal women will need more calcium supplements.

For tea-picking women in plantations with limited earnings, the cost of buying supplements will cost their food. Therefore, the percentage of the subjects who consume supplements is not too much. Supplements can be obtained at pharmacies, drug stores, or small stalls that sell daily needs.

8
Health and Nutritional Status

8.1 Health Status

Based on Table 23, acute respiratory tract infection was the most common infectious disease among subjects (79.6%). There were also a few subjects who have been infected by worm, hepatitis, malaria and tuberculosis which can contribute to anaemia. Worm infestation caused blood loss from gastrointestinal tract and in long term may cause anaemia. In malaria, the parasite infected red blood cells and liver cells causing inflammation. Tuberculosis is a chronic infection. In chronic infection, there is decreased blood cell production that may be caused by iron metabolism disorder (Stopler 2008).

For non-communicable disease, the three most common diseases among the subjects were joint disease (70.4%), hypertension (41.2%) and hyperuricemia (36.8%). The prevalence of joint disease might be caused by type of work which is hard work and the age of the subjects who were mostly more than 40 years old. In general, the risk factors for degenerative diseases are age, nutritional status, food intake and physical activity. The risk factors that may contribute to hypertension and hyperuricemia in these subjects are age and nutritional status (Rolfes *et al*. 2008). Most subjects were more than 40 years old and more than half of the subjects were overweight and obese.

Table 23. Distribution of the subjects based on disease history

Disease	n	%
Infectious disease		
Acute Respiratory Tract Infection	199	79.6
Worm infestation	12	4.8
Hepatitis	12	4.8
Tuberculosis (TBC)	4	1.6
Malaria	4	1.6
Non-communicable disease		
Joint pain	176	70.4
Hypertension	103	41.2
Hyperuricemia	92	36.8
Asthma	10	4.0
Cardiovascular disease	6	2.4
Renal disease	2	0.8
Diabetes Mellitus	1	0.4

Acute respiratory tract infections (ARI) such as cough and runny nose were common illnesses. Cross-tabulation and contingency test showed significant relationship between type of house (p=0.003) and house floor (p=0.000) with ARI occurrence (Table 24). Samples living in non-permanent (47.6%) and semi-permanent house (20.8%) had a higher proportion of ARI occurrence than those of permanent (11.2%). Samples living in homes with bamboo or wooden floors (44.4%) and plaster or cement (26.8%) had a higher proportion of ARI compared to other home floors. The handwashing habit using soap associated with ARI (p=0.023). Samples who had handwashing habit using soap had a higher proportion not getting ARI compared to samples who don't have the habit. The main source of drinking water and the use of outdoor footwear did not not indicate a significant relationship based on the contingency test. Viewed from the proportion, more samples with ARI made the springs and wells as a source of drinking water at home.

Table 24. Cross-tabulation between sanitation and hygiene with ARI [n (%)]

Variable	ARI		p value
	Yes	No	
Type of house			
Permanent	28 (11.2)	4 (1.6)	0.003
Semi-permanent	52 (20.8)	26 (10.4)	
Non-permanent	119 (47.6)	21 (8.4)	
Total	199 (79.6)	51 (20.4)	
House floor			
Ground	1 (0.4)	4 (1.6)	0.000
Plaster (cement)	67 (26.8)	24 (9.6)	
Tiles/ceramics	20 (8.0)	0 (0.0)	
Half ground and half plaster	0 (0.0)	1 (0.4)	
Bamboo/wood	111 (44.4)	22 (8.8)	
Total	199 (79.6)	51 (20.4)	
The main source of drinking water			
Spring water	135 (54.0)	39 (15.6)	0.147
Well water	49 (19.6)	10 (4.0)	
PAM water	13 (5.2)	1 (0.4)	
Refill water	2 (0.8)	0 (0.0)	
Others	0 (0.0)	1 (0.4)	
Total	199 (79.6)	51 (20.4)	
Handwashing habit using soap			
Yes	103 (41.5)	33 (13.3)	0.023
Never	12 (4.8)	6 (2.4)	
Sometimes	83 (33.5)	11 (4.4)	
Total	198 (79.8)	50 (20.2)	
The use of footwear outside house			
Yes	186 (74.4)	47 (18.8)	0.790
Never	1 (0.4)	0 (0.0)	
Sometimes	12 (4.8)	4 (1.6)	
Total	199 (79.6)	51 (20.4)	

8.2 Nutritional Status

Nutritional status is determined by anthropometric method with two approaches. The first approach is measuring body size to determine chronic energy deficiency and the second is measuring body composition. Body composition is determined by body mass index (BMI), waist circumference, waist-hip ratio, total body fat, and visceral fat. Thus, body composition is assessed from the total body fat aspect and body fat distribution.

8.2.1 Chronic Energy Deficiency

Based on the mid-upper arm circumference (MUAC), the prevalence of chronic energy deficiency are low (2.8%) with a MUAC mean 28.9 cm (Table 25). The mean MUAC indicates that workers in general do not experience chronic energy malnutrition. The result of 2013 Basic Health Research in Indonesia shows chronic energy deficiency prevalence in adult women is 24.2% (MoH 2013[a]). Chronic energy deficiency prevalence of tea pickers are much lower (almost ten times lower) compared to chronic energy deficiency prevalence in adult women in Indonesia. This indicates that the nutritional status of women picker tea is better than the nutritional status of adult women in Indonesia in general. Low MUAC is associated with poor health outcomes in adults (Tang *et al.* 2013). With MUAC classified as normal in this study, the subjects are not at risk to poor health outcomes.

Table 25. Distribution of the subjects based on MUAC

Mid-upper arm circumference	n	%
Chronic energy deficiency (MUAC <23.5 cm)	7	2.8
Normal (MUAC ≥23.5 cm)	243	97.2
Mean±SD (cm)	28.9±2.9	

8.2.2 Body Composition

Based on various indicators of body composition, in general, women tea pickers tend to be obese than the thin and normal. This can be seen from the mean percentage of body fat, BMI, and visceral fat that is high enough. The ratio of body weight and height indicates weight in relation to height and is useful for measuring overweight and obesity in adults (Gibson 2005). Validity

of body mass index as body fat percentage index has been studied and can be said to be valid (Gibson 2005). Nevertheless, there are still confounding factors in the relationship between body mass index (BMI) and body fat. First, the BMI relationship with body fat depends on age and sex; second, the relationship between BMI with body fat varies according to ethnic group (Gibson 2005).

Currently the ratio of weight and height most often used is the body mass index or also called the Quatelets index. Body mass index is one of the easiest and simplest ways. Based on BMI, approximately 39.2% of the subjects are classified as obese and 18% are classified as overweight (Table 26), thus the prevalence of BMI above 25 is 57.2%. Only about 1.2% are classified as thin. The results of this study indicates the subjects tend to be obese. The result of Basic Health Research 2013 study showed the prevalence of BMI above 25 in Indonesian adult women was 32.9% (MoH 2013[a]). The woman tea pickers have a higher prevalence of overweight than Indonesian adult women in general. A research on garment workers showed that the prevalence of women with BMI above 25 was only 14.9% (Yosephin *et al.* 2016). Another study of woman workers at the Pineapple Plantation in Lampung found that the prevalence of women with BMI above 25 (overweight and obese) was 23% (Indriani *et al.* 2013).

Inadequate food and diseases are the immediate causes of malnutrition (UNICEF 1992). Diseases, in certain infectious diseases, affect food intake and nutrient utilization, and in many cases malnutrition results from a combination of inadequate dietary intake and diseases. Diseases are affected by the state of environmental health (hygiene and sanitation) and health services. Chi square test showed that water source characteristics, in this case drinking water source, bath water source, bathroom ownership, defecation, septic tank distance with water source, and garbage disposal were all not statistically related to nutritional status ($p>0.05$). The absence of the association is suspected because the prevalence of malnutrition is very small, whereas poor environmental conditions have more influence on infectious diseases that are closely related to malnutrition. Chi square test also showed that there was no relation between handwashing habit with soap with nutritional status ($p>0.05$). This is presumably because the proportion that does not wash hands with soap is very small, meaning that the subjects are used to washing hands.

Table 26. Distribution of the subjects based on body composition

Body Composition	n	%
Body Mass Index (kg/m²)		
Thin (IMT<18.5)	3	1.2
Normal (IMT 18.5-24.9)	104	41.6
Overweight (IMT 25.0-26.9)	45	18.0
Obese (IMT ≥ 27)	98	39.2
Mean±SD	26.0±3.9	
Total body fat (%)		
Lean (<13)	0	0
Optimal (13-23)	7	3.1
Slightly overfat (24-27)	29	12.9
Fat (28-32)	79	35.3
Obese (>32)	109	48.7
Mean±SD	32.0±4.6	
Visceral fat (%)		
Normal (≤9)	170	68.0
Increased risk (10-15)	66	26.4
High risk (>15)	14	5.6
Mean±SD	8.3±4.1	
Waist circumference (cm)		
Not at risk (LP<80)	113	45.2
At risk (LP≥80)	137	54.8
Mean±SD	82.5±10.6	
Hip circumference (cm)	96.4±8.0	
Waist-hip ratio		
Not at risk (WHR<0.8)	8	3.2
At risk (WHR≥0.8)	242	96.8
Mean±SD	0.9±0.1	

To see body fat distribution, waist circumference and waist-hip ratio are measured. Both of these indices describe the distribution of body fat or central obesity. Body fat distribution is classified into two types, namely (1) upper body, android, or male type; and (2) lower body, gynoid, or female type (Lee & Nieman 2012). This index is closely related to the risk of chronic diseases, such as coronary heart disease, diabetes, and hypertension (Lee and Nieman 2012; WHO 2011[d]; Ashwell, Gunn & Gibson 2012).

Table 26 shows that the waist circumference average is 82.5 cm and about 54.8% of subjects have waist circumference above 80 cm. They are classified as at risk for chronic diseases, such as coronary heart disease, diabetes, and hypertension (Lee & Nieman 2012, WHO 2011[d]). Longitudinal study showed an average waist circumference of adult women was 81.92±9.45 cm (Sudikno *et al.* 2015). The average waist-hip ratio (WHR) was 0.9 and the proportion at risk for chronic disease (WHR>0.8) was 96.8%. This means that almost all workers are at risk for chronic diseases. Research on working women in Pineapple Plantation in Lampung found that WHR at risk (>0.80) was 42% (Indriani *et al.* 2013).

Nuttall (2015) explains that fat accumulation at the top of the body is associated with an increased risk of coronary heart disease, diabetes, kidney stones, and gout compared with fat accumulation in the lower body. The results of a study by George *et al.* (2016) showed that measurement of central adiposity was associated with an increased risk of hypertension compared with total body fat. Increased risk of non-infectious diseases is slightly lower in people who have accumulated lower body fat. Abdominal fat consists of visceral fat and subcutaneous fat tissue. The proportion of fat between the two components varies depending on sex and race. Excess visceral fat is a risk factor for health complications due to obesity, while excess abdominal subcutaneous fat implies decreased glucose regulation (Power & Schulkin 2008). A review by Kulie *et al.* (2011) revealed that obese women had a higher risk of developing diabetes and coronary heart disease, cancer diseases such as endometrial cancer, cervical cancer, breast cancer, and ovarian cancer.

Body composition was assessed using BIA (Bioelectrical Impedance Analysis). As many as 48.7% of the subjects were classified as obese, with mean body fat 32.0%. Based on body fat proportion, those who were optimum were only 3.1%, the rest tended to have excessive body fat.

Visceral fat is a form of fat that is considered at risk for chronic diseases. Table 26 shows that the average visceral fat is 8.3%. The subjects who had visceral fat above normal were 32%, and 5.6% of them had a high visceral fat thus have a higher risk for chronic diseases. The average age of the women tea workers was 42.1 years old and most of the tea workers (75.6%) aged more than 40 years old. Theoretically, as a person gets older, her visceral fat will increase. In women, increased visceral fat along with increased age can be

explained by a decrease in circulating estradiol, that is a decreased estrogen/testosterone ratio associated with the menopause (Nuttall 2015). Estradiol increases preadipocyte proliferation in vitro. Low levels of estrogen in women led to increased weight and increased proportion of visceral fat (Power & Schulkin 2008).

Pearson correlation test results showed total household expenditure was not correlated with nutritional status, body composition, blood pressure, pulse rate, and VO_2max, but food expenditure was negatively correlated with waist-to-hip ratio ($r=-0.180$; $p<0.01$). Food expenditure can describe the economic condition of a family. The higher the proportion of spending on food is, the less favorable or poorer the economic conditions are. The subjects with high household food expenditure tend to have smaller waist-to-hip ratios.

Nutrient intakes and nutritional adequacy levels did not show any significant correlation with nutritional status (BMI), body composition, pulse rate, and VO_2max. Data of nutrient intakes and nutrient adequacy levels which are homogeneous enough so it can cause the correlation not statistically significant.

8.3 Anaemia

Anaemia is one of the most common health problems today (SPRING 2016). Anaemia is a very prevalent nutritional problem in Indonesia, especially in non-pregnant and pregnant women. Table 27 presents the prevalence of anaemia in the women workers in the tea plantations. Table 27 shows anaemia prevalence is 28.4% which was analyzed by hemocue method. The prevalence is higher than the prevalence of anaemia in women of childbearing age based on the results of Basic Health Research 2013, which amounted to 22.7% (MoH 2013[a]).

The prevalence of anaemia in the tea plantations is high, as this may have adverse effects on productivity (Rhee 2012), and nutritional deficiencies in general will also adversely affect tea productivity (De Vries *et al.* 2013). Anaemia in women of childbearing age can have adverse effects on preterm birth, low birth weight, stillbirths, maternal and child mortality, and illness (Kraemer & Zimmermann 2007). Anaemia in working women can lead to a decrease in productivity (Rhee, 2012).

Table 27. Prevalence of anaemia of the women workers in the tea plantation

Anaemia Category	n	%
Moderate (Hb 8-10.9 g/dL)	21	8.4
Mild (Hb 11.0-11.9 g/dL)	50	20.0
Normal (Hb ≥12 g/dL)	179	71.6
Mean±SD (g/dL)	12.6±1.1	

The prevalence of anaemia of children under five in Indonesia were 28.1%, children aged 5-12 years 29%, pregnant women 37.1%, teens 13-18 years 22.7%, and women aged 15-49 years 22.7% (MoH 2013[a]). The main cause of anaemia in developing countries was iron deficiency anaemia (Rhee, 2012). Globally, 43% of children under five, 38% of pregnant women, and 29% of women of childbearing age had anaemia (Kassebaum *et al*. 2014; Kassebaum 2016). Indriani et al. (2013) found a high prevalence of anaemia, 84% in married women and 47% in unmarried women, they also found a high prevalence of iron deficiency in women workers in pineapple plantations in Lampung, i.e. 64% in married women and 47% in unmarried women. This situation shows that anaemia in working women in Indonesia is largely due to iron deficiency. The results of meta-analysis on iron supplementation studies, which tested the proportion of anaemia treated with iron supplementation, also showed that about 50% of anaemia was due to iron deficiency (WHO 2015; Stevens *et al*., 2013).

Food expenditure had a negative correlation with blood Hb levels ($r=-0.127$; $p<0.05$). This study shows a high proportion of expenditure was used to purchase staples (rice), snacks and vegetables. Food sources of protein which is a good source of iron, is not a priority food expenditure. The most common source of iron consumed by the subjects is wheat flour, especially in snack (fried foods). Wheat flour in Indonesia has been fortified iron.

The Chi square test also shows that there was no correlation between the characteristics of the water source (drinking water source, bathroom ownership, defecation, septic tank distance with water source, and garbage disposal) and hand washing using soap with anaemia. This situation indicates that anaemia occurs not because of poor hygiene and sanitation conditions, but because of poor diet quality factors.

9
Impact of Intervention

9.1 Nutrition Knowledge

Knowledge of nutrition and health is an important factor for the establishment of good health nutrition practice. The baseline data showed that more than half of the subjects in the control group had low nutritional knowledge while intervention group had moderate knowledge. Table 28 showed that the mean score of nutritional knowledge at baseline in the intervention group (64.1) was slightly higher than the control group (63.1) but was not significant (p=0.656).

The treatment given to the intervention group was a micronutrient supplement accompanied by nutritional education for 4 months. The materials given during nutrition education done 2 times a week were: 1) Basic Nutrition, 2) Balanced Nutrition, 3) Sanitation and Hygiene, 4) Public Health, 5) Anaemia and Productivity, 6) Food Choice and Consumption, 7) Nutrition and Fitness, and 8) Food Safety. Measurement of the success of nutritional education is seen from the results of the pre and post-test administered just before or after education.

Table 28. Percentage of subjects according to nutritional knowledge (baseline and endline)

Score of Nutritional Knowledge	Control (%)		Intervention (%)	
	Baseline	Endline	Baseline	Endline
Low (<60)	53.3	39.0	34.1	32.6
Moderate (60-80)	44.4	61.0	65.9	65.1
Great (>80)	2.2	0.0	0.0	2.3
Mean±SD (year)	63.1±10.2	65±8.5	64.1±10.5	65.7±11.6
Paired t-test	0.241		0.298	
Independent t-test	0.873			

The endline data show no significant increase in knowledge in the intervention group (p=0.298). Independent t-test results also show no significant differences between control and intervention groups after nutritional education (p=0.873). The results of the pre and post-test conducted just before and after the nutritional education in Table 29 indicate a significant increase in nutritional knowledge (p=0.014). The nutrition education did not make much of a difference between control and intervention due to the fact that most of the respondents (more than 90 %) only had elementary schools/ or no formal education. That's why they had the lack of ability to absorb new information (nutrition knowledge). Furthermore, age of subjects in the intervention group was higher (44.3 yo) than in the control group (37.2 yo). De Vriendt *et al.* (2009) found that an important factor affecting nutritional knowledge was the level of education, age, and occupation of women. However, based on pre- and post-test of the nutritional knowledge there was a significant difference before and after nutrition education (short term).

Table 29. Percentage of the subjects according to nutritional knowledge (pre and post-test)

Score of Nutritional Knowledge	Pre-test	Post-test
Low (<60)	12 (27.3)	7 (7.9)
Moderate (60-80)	22 (50.0)	19 (43.2)
Great (>80)	10 (22.7)	18 (40.9)
Mean±SD (tahun)	68.9±17.1	73.9±17.7
Paired t-test	0.014	

Nutrition education is expected to improve nutritional and health knowledge, compliance to health supplement consumption, as well as to improve the subjects' attitudes and behavior related to their food consumption to prevent and/or reduce the impact of anaemia. Most of the subjects can answer the nutritional question or statement correctly. There are 4 questions that have not been answered correctly, i.e. the question of anemic can not be cured or prevented, the food source of iron that is more easily absorbed by the body is vegetable food compared to animal food, questions related to the benefits of vitamin D in increasing the absorption of iron in the body and the last one is question related to women's higher iron requirement compared to men. The four kinds of knowledge have not been understood by the subjects in both groups.

Table 30. Percentage of the subjects who answered the nutritional knowledge questions correctly (baseline and endline)

Nutritional knowledge	Control (%)		Intervention (%)	
	Baseline	Endline	Baseline	Endline
1. Weakness, fatigue, loss of appetite, decreased concentration and headache or dizziness are early symptoms of anaemia or lack of blood.	95.6	100	95.5	93
2. Anaemia is not a disease due to lack of sleep.	8.9	12.2	6.8	14.0
3. Anaemia decreases work productivity.	95.6	97.6	93.2	90.7
4. Iron deficiency can lead to anaemia.	91.1	87.8	86.4	90.7
5. Anaemia can not be treated / prevented.	82.2	82.9	75.0	72.1
6. Iron derived from vegetables (spinach) is more easily absorbed by the body than those derived from animal (meat).	26.7	14.6	27.3	7.0
7. Vitamin D is beneficial to increase the absorption of iron in the body.	11.1	4.9	11.4	14.0
8. Drinking tea after meals can inhibit the absorption of iron.	40.0	73.2	47.7	72.1
9. Excessive menstruation can cause anaemia.	71.1	85.4	61.4	79.1
10. Worm can cause anaemia.	62.2	73.2	68.2	79.1
11. Anaemia in pregnant women can cause preterm birth and low birth weight (LBW)	86.7	80.5	86.4	86.0
12. Eggs include food sources of iron.	68.9	73.2	79.5	86.0
13. Iron requirement for male is greater than for female.	24.4	4.9	27.3	16.3
14. Pregnant women are important to consume iron supplements.	82.2	90.2	95.5	90.7
15. Chicken liver is a good food for those who have less blood.	100	95.1	100	95.3

In general, the samples have known the symptoms of anaemia, the cause and effect of anaemia and iron food sources. Most of the samples know that weakness, fatigue, loss of appetite, decreased concentration and headache or dizziness are common symptoms of anaemia. Causes of anaemia such as iron deficiency, menstruation, and intestinal worms are also known by most samples. The most commonly known effects of anaemia are decreased labor productivity and the effects of anaemia can lead to premature baby birth and LBW. Well-known food sources containing iron are chicken liver, eggs and

spinach, but the samples could not distinguish the food sources containing iron that are more easily absorbed by the body. Most of the samples know that pregnant women should be given iron supplements, but they do not know that women's iron requirement is higher than men.

9.2 Consumption of Iron and Vitamin C Rich Food

Iron retention is the result of iron intake and bioavailability in the diet, and when there is an excess, it will be stored in the body. A common occurrence is a negative balance, namely the occurrence of cases of iron deficiency due to a low intake of food. The main problem of iron utilization by the body is the low absorption in the intestine. The absorption of iron is determined by two factors: absorption of heme iron and non heme iron which indicates the presence of two types of iron in the diet. The sources of heme iron in food are meat, fish and poultry, while non heme iron sources are vegetables, cereals and nuts. Therefore the low quality of food consumption is also suspected as the cause of the low level of iron absorption.

Good food sources of iron which include animal foods are meat (beef, goat), liver, poultry, and fish. The average iron contained in those foods is high. While the vegetable foods as sources of high iron are green vegetables such as spinach, water spinach, *katuk* leaves, papaya leaves, cassava leaves and others.

Common sources of heme iron consumed by the subjects include liver, chicken, beef, and lamb. The frequency of food consumption containing iron that was consumed by the subjects can be seen in Table 31. The frequency of chicken consumption in the control and intervention groups increased 2.5 times in the post intervention (control group 1.1 to 2.7 and intervention group 2.0 to 4.5). The average amount food containing iron consumed also increased slightly. The frequency of chicken intake of intervention group is twice higher than the control group is. This shows that although the frequency of consumption is still relatively low, chicken consumption in the intervention group increased from twice a month to once per week.

Table 31. Frequency and quantity of food consumption of iron (per month)

Food sources of iron	Control				Intervention			
	Baseline		Endline		Baseline		Endline	
	Freq	g	Freq	g	Freq	g	Freq	g
Chicken	1.1	66.7	2.7	70.7	2.0	66.5	4.5	67.2
Beef	0.2	67.7	0.4	62.8	0.2	62.4	1.2	45.5
Lamb	0.1	57.6	0.2	74.2	0.1	54.8	0.2	40.9
Liver	1.6	23.9	2.0	21.9	1.5	25.9	4.4	32.9

The frequency of beef consumption also increased in both control and intervention groups. In the intervention group, the frequency of consumption increased 6 times (0.2 to 1.2 times per month) but the amount consumed was lower (62.4 to 45.5 grams per consumption). The frequency of beef consumption in control group was 0.2 to 0.4 times per month with an average consumption of 66.7 g to 62.8 g. Beef is the best source of iron with the best absorption of 20-30%. Before the intervention, the two groups had a relatively low frequency of beef consumption. They only consumed once every five months. After the intervention, the intervention group experienced an increase in beef consumption frequency from 1 time every five months to 1 times a month.

The frequency of lamb consumption between the intervention and the control group is relatively similar between the pre and post, that is, 0.1 to 0.2 times per month. The average pre and post meat consumption of the control group is 57.6 g to 74.2 g and the intervention group 54.8 g to 40.9. Similar to beef, lamb is a good source of iron, but the frequency of lamb consumption is relatively low, i.e. only once every 5 months for both the control group and the intervention group.

The frequency of liver consumption of the control group and the intervention group can be seen in Table 31. The frequency of liver consumption of the control group has increased slightly, from 1.6 to 2.0 times per month with an average consumption of 23.9 g to 21.9 g. The frequency of liver consumption of the intervention group was 1.5 to 4.4 times per month with an average consumption of 25.9 to 32.9 g. It shows that frequency of liver

consumption of the intervention group increased almost 3 times from one time every three months to one and a half times each week. Liver is the best source of iron with high absorption.

Overall, the frequency of meat consumption (beef, lamb, and chicken) and liver of the subjects in both groups is still very low. Meat and liver are good sources of iron. Ideally meat consumption is always in the menu that is between two to three times a day. The average frequency of meat consumption of the subjects, especially the intervention groups, is only once a week. This indicates that the consumption of meat of the subjects is still very low.

The absorption of iron from food is determined by two factors: the increasing factor and the inhibiting factor. The presence of vitamin C in food and meat (red and white) can increase the absorption of iron in milk. The inhibiting factors are phytate, inositol and polyphenols. The inhibiting compounds present in cereal, nuts, coffee, tea, vegetables and spices. While vitamin C which can increase the absorption of iron are found in many fruits.

Yellow fruits such as mango, papaya, and plantain contain high levels of beta carotene, while fruits that have a sour taste like oranges, guava, papaya and *rambutan* are rich in vitamin C. Fruits are generally eaten in raw form and fruit is the main source of vitamin C (Almatsier 2002). Based on Table 32, it can be seen that the type of fruit most often consumed by the subjects is guava.

Foods containing vitamin C which are often consumed by the subjects, among others are guava stone, papaya, orange, mango, pineapple, and apple. The food consumption of vitamin C of the control group and the intervention group can be seen in Table 32. The frequency of consumption of guava in the control group decreased significantly from 23.7 to 7.3 times per month with average consumption of 111.1 g to 93.4 g. In the intervention group, the frequency of guava consumption has decreased slightly from 10.4 to 9.7 times per month with an average consumption of 89.3 g to 88.5 g. The frequency of guava consumption in the intervention group is relatively similar, while the control group shows a significant decrease.

Table 32. Frequency and quantity of consumption of fruits of vitamin C sources (per month)

Fruits containing vitamin C	Control				Intervention			
	Baseline		Endline		Baseline		Endline	
	Freq	g	Freq	g	Freq	g	Freq	g
Guava	23.7	111.1	7.3	92.4	10.4	89.3	9.7	88.5
Papaya	2.1	54.7	4.5	75.0	2.7	61.4	7.2	74.2
Orange	2.1	82.0	4.9	80.0	2.6	76.6	7.7	80.5
Mango	1.1	127.4	2.3	234.1	1.6	103.1	3.7	258.7
Pineapple	1.1	63.0	0.9	58.4	1.1	52.5	2.1	64.4
Apple	0.9	139.8	2.6	116.1	2.0	135.1	4.3	88.3

In addition to guava, fruits rich in vitamin C often consumed by subjects are papaya and orange. The frequency of papaya and orange consumption in the control group increased more than doubled and in the intervention group nearly quadrupled. In the intervention group, the increasing consumption of papaya is 13 g, while orange consumption is relatively the same.

Pineapple and apple are rarely consumed by the subjects. The average frequency of pineapple consumption in the control group has decreased slightly from 1.1 to 0.9 times per month, with an average consumption of 63.0 to 58.4 g. Different conditions in the intervention group, there is an increase in average frequency of pineapple consumption from 1.1 to 2.1 times per month, with average consumption of 52.2 to 64.4 g. The frequency of apple consumption in both groups is seen to increase quite well, that is, doubled.

The average consumption of both subjects in the intervention group and control grop is relatively low except for the consumption of guava. The average consumption of papaya and oranges in both groups is 2 times per month at baseline to 4 times per month (control) and 7 times per month (intervention) at endline. Ideally, fruit consumption is one portion for every meal or two to three times each day (MoH 2014). Fruits are good sources of vitamin C to increase iron absorption.

Vegetables are a menu that are almost always present in the daily dishes of Indonesian society, whether in raw (fresh vegetables) or after being processed into various forms of cuisine (Santoso 2011). There are also types of vegetables that are the most commonly consumed by the subjects. Those

are water spinach, bean sprout, spinach, and carrots. According to Karyadi (1996), consuming foods that contain lots of vegetables can prevent the emergence of deficiencies of vitamins and minerals. Vegetables are sources of iron, calcium and potassium minerals and vitamin sources, especially vitamin C and beta carotene.

Types of vegetables containing of iron and vitamin C which are often consumed by the subjects are water spinach, spinach, and cassava leaves. The subject's increase in vegetable consumption containing iron and vitamin C in the control and the intervention group at the pre and post stage can be seen in Table 33. Frequency of water spinach consumption in the control group in the pre and post is 4.6 to 7.6 times per month with an average consumption weighing 38.8 to 33.9 g. Increased consumption frequency in the intervention group, in the pre and post, is slightly higher at 5.7 to 8.4 times per month with an average consumption of 32.3 to 30.7 g. The consumption frequency of the intervention group is slightly higher than that of the control group, which is 2 times.

Table 33. Frequency and quantity of consumption of vegetable containing iron and vitamin C (per month)

Vegetable containing iron and vitamin C	Control				Intervention			
	Baseline		Endline		Baseline		Endline	
	Freq	g	Freq	g	Freq	g	Freq	g
Water spinach	4.6	38.8	7.4	33.9	5.7	32.4	8.4	30.7
Spinach	4.2	37.6	5.4	34.7	5.1	33.1	7.2	33.0
Cassava leaves	4.6	36.4	5.5	38.7	4.4	31.9	6.5	35.8
Papaya leaves	-	-	0.8	26.4	2.1	27.0	2.1	36.1
Melinjo leaves	-	-	1.5	18.5	0.8	25.0	3.4	28.1

The frequency of spinach consumption in the control group at the pre and post is 4.2 and 5.4 times per month respectively with an average consumption of 37.6 g to 34.7 g. In the intervention group, the frequency of spinach consumption at the pre and post is 5.1 and 7.2 times per month respectively with an average consumption of 33.1 g to 33.0 g. It can be seen that the frequency of spinach consumption in the intervention group has increased slightly.

Cassava leaves are also vegetables most consumed by the subjects, whose frequency of consumption of cassava leaves at the pre and post in the control group is 4.6 to 5.5 times per month with an average consumption of 36.4 to 38.7 g. The frequency of consumption in the pre and post in the intervention group also increased from 4.4 to 5 times per month with an average consumption of 31.9 g to 35.8 g.

Papaya leaves and *melinjo* leaves are rarely consumed by the control group and the intervention group. In the baseline, there is no subject in the control group that consumes papaya leaves and melinjo leaves. While in the endline, there were subjects in the control group who consumed papaya leaves and melinjo leaves. In the control group, there are 0.8 and 1.5 times per month, the consumption frequency of papaya leaves and melinjo leaves in the baseline is 26.4 and 18.5 g per month. For the intervention group, the frequency of papaya-leaf and melinjo-leaf consumption in baseline is 2.1 and 0.8 times per month with an average consumption of 27.0 and 25.0 g per month. While the endline frequency of papaya-leaf and melijo-leaf consumption is 2.1 and 3.4 times per month with an average consumption of 36.1 and 28.1 g per month respectively.

Green-leaf vegetables are good sources of iron despite the low absorption of vegetables is only about 4%, but the availability of green vegetables is quite good. Frequency of green-vegetable consumption of the subjects is still very low. They only consumed 2 to 3 times a week. Ideally, the consumption of the vegetables is two or three times a day. To achieve a balanced menu, each meal should have one serving of vegetables (MoH 2014).

9.3 Compliance of Iron Supplementation

One of the factors that influences the success of iron supplementation is the compliance with iron tablets. With high adherence level in consuming iron tablets then it is expected that the effect will be meaningful. In Table 34, the distribution of the subjects based on their compliance with iron tablets are presented.

Table 34 shows the average compliance rate of consuming iron tablets is 94.4%. These data indicate that the average total iron tablets consumed as much as 33 tablets from 35 tablets were administered during 4 months

of intervention. The iron tablet compliance rate is relatively high, although there are still 10.3% of the subjects whose compliance rate is below 80%. The reason of the subjects who are less obedient is forgetting to consume, not good, etc.

Table 34. The distribution of the subjects based on compliance consumption of iron tablets

Compliance	n	%
<70%	3	7.7
70%-80%	1	2.6
80%-90%	0	0.0
>90%	35	89.7
Mean±SD	94.4±18.0	

9.4 Iron Status

Iron plays an important role in the function of neurotransmitters throughout life, which affects cognitive function. Therefore, iron deficiency during pregnancy will lead to worse cognitive function in later life. Productivity is also affected, this is because iron deficiency anaemia is assessed by the amount of haemoglobin in the blood, which is directly related to the amount of oxygen delivered to the body tissues. Iron deficiency without anaemia, although not directly correlated with haemoglobin levels, still has the potential to affect productivity, particularly endurance, due to its influence on the ability of tissues and organs to perform metabolic functions (Haas 2006).

Table 35 presents an anaemia status based on the examination using the cyanmethaemoglobin method. The control group is the group with normal Hb levels at the time of screening using the hemocue method, and at the beginning of the intervention all remained normal identified by the cyanmethaemoglobin method. The intervention group is a group with below normal Hb levels at screening using hemocue before intervention, and at baseline the intervention is only 20.9% classified as anaemia based on the examination using the cyanmethaemoglobin method. In the intervention group, the baseline data show about 75% of the anaemia is iron deficiency anaemia, examined from ferritin concentration. This suggests that in general

anaemia is caused by iron deficiency. The ferritin examination depicting iron deposits shows that about 20.5% is iron depleted, this proportion is almost equal to the proportion of anaemia. This again confirms that anaemia is largely due to iron deficiency. The result of this study is in line with the result of a meta-analysis of iron supplementation studies, which also show that about 50% of anaemia is due to iron deficiency (WHO 2015; Stevens *et al.* 2013).

Table 35. Percentage of anaemia and non-anaemia of women workers in the tea plantation

Status	Control (%)		Intervention (%)	
	Baseline	Endline	Baseline	Endline
Anaemia Status				
Anaemia (Hb<12)	0.0	0.0	20.9	14.0
- Iron	0.0	0.0	16.3	9.3
- Non-iron	0.0	0.0	4.7	4.7
Non-Anaemia Hb≥12)	100.0	100.0	79.1	86.0
Iron Stores (Ferritin)				
Depleted (Ferritin<15)	0.0	2.4	20.5	11.6
Non-Depleted (Ferritin≥15)	100.0	97.6	79.5	88.4

Table 36 presents haemoglobin (Hb) and ferritin levels before and after intervention. Table 36 shows that iron+folate intervention is not able to increase haemoglobin or ferritin levels. Nevertheless, there is a tendency to increase the ferritin levels of the intervention group by almost three times compared to the increase in the control group. The increase in ferritin levels is also evident from a decrease in the proportion of the iron-depleted subjects (from 20.5% to 11.6%) (See Table 35).

Table 36. Iron status of the women workers in the tea plantation before and after intervention

Blood Test	Control		Intervention		p value
	Baseline	Endline	Baseline	Endline	
Hb (g/dl)	14.1±0.8[a]	14.0±0.9[a]	12.9±1.1[a]	13.0±1.0[a]	
ΔHb (g/dl)	-0.08±0.77		0.06±1.03		0.489
Ferritin (μg/L)	81.4±31.1[a]	83.7±51.0[a]	64.8±57.2[a]	70.1±43.7[a]	
ΔFerritin (μg/L)	2.26±43.87		6.49±29.09		0.602

The corrective response which was not so responsive in the intervention group is suspected to be due to the fact that most (about 80%) of the intervention group subjects are normal. Absorption of iron is higher in the subjects of anaemia (Arora 2012). The iron stores in the body are regulated by intestinal absorption. Intestinal absorption of iron is itself a regulated process and the efficacy of absorption increases or decreases depending on the requirements of iron (Arora 2012). In addition, other factors also influence, such as the form of iron compounds and frequency of iron. Other factors that also determine iron absorption are diet quality and protein status of the subject (Arora 2012). The frequency of giving iron tablets only 2 times per week is suspected to be less than optimal in improving Hb and ferritin levels, which is very different from other studies in women of childbearing age who were generally given iron tablets every day (Pasricha *et al*. 2014; Low *et al*. 2016). WHO (2016) recommends (strong recommendation, moderate quality of evidence) of daily iron tablets (in the context of iron supplements, including fortified foods, multiple micronutrient powders, lipid-based nutrient supplements) for women of childbearing age in areas with prevalence of anaemia >40%. In this study, because the prevalence of anaemia was not up to 30%, the researchers did not provide supplements every day.

This study shows a tendency of Hb and ferritin improvement although it is not statistically significant (Table 36). The results of this study are not in line with the results of meta-analysis performed by Low *et al*. (2016) which demonstrates daily iron supplementation effectively reduces the prevalence of anaemia and iron deficiency, raises haemoglobin and iron stores, improves exercise performance and reduces symptomatic fatigue.

The effect of supplementation in this study that had no significant effect on haemoglobin and iron status was suspected due to the habit of tea drinking among the tea workers, they drank tea three times a day. Tannin in the tea can inhibit iron absorption.

9.5 Physical Fitness

Physical activity and nutrition are two lifestyle aspects which affect physical fitness and health (Bushman 2011). Other aspects that also affect fitness are age, gender, physiology status, and physical exercise (Bushman 2011). The fitness consists of two components such as Health-related

components and sport-related components (sport-specific related and skill-related components). Health-related components of fitness are cardio-respiratory or aerobic (cardiovascular-respiratory endurance (aerobic power), body composition, and muscular fitness which consists of muscular strength, muscular endurance, and flexibility (Plowman & Smith 2014). Sport-specific related components of fitness are agility, coordination, balance, reaction time, power, and speed of movement (Plowman & Smith 2014).

As mentioned before, age is one of the aspects which affects human's fitness. Table 37 shows the average age in both groups. It also shows that the average age in the control group was significantly lower than the average age of the intervention group. In the control group the average age was 37.2 years and in the intervention group it was 44.3 years. In terms of proportion, about 51% of the subjects in the control group were less than 40 years old, while in the intervention group more than 90% were over 40 years old. Older age in the intervention group may lead to lower fitness than the younger control group. In this study, fitness measurements are conducted to see the cardiovascular-respiratory endurance component. Cardiovascular-respiratory endurance is very important for tea picker workers.

Table 37. Age of the subjects in the control and intervention groups

Age	Control (%)	Intervention (%)
18 - <40 years	51.1	9.1
≥40 – 65 years	48.9	90.9
Mean±SD	37.2±7.5[a]	44.3±3.8[b]

Table 38 shows the distribution of the subjects according to physical fitness category before and after the intervention. The table shows that at the baseline, more than 80% of the subjects in the control group had above average fitness to excellent, while in the intervention group only about 40% were classified above average to excellent. At the endline, the proportion of above average to excellent slightly decreased in the control group (from 81% to 74%), and in the intervention group the decline was sharper (from 40% to 10%). A sharper decrease in the intervention group was thought to be due to older age factors and lower Hb levels than those of the control group. The results of Anova show that age significantly affects the fitness (p=0.000).

Table 38. Distribution of the subjects (the workers) by physical fitness category

Physical Fitness	Control (%)		Intervention (%)	
	Baseline	Endline	Baseline	Endline
Excellent	34.1	59.0	6.8	2.5
Good	25.0	12.8	13.6	0.0
Above Average	22.7	2.6	20.5	7.5
Average	11.4	2.6	20.5	20.0
Below Average	6.8	12.8	27.3	47.5
Poor	0	10.3	11.4	22.5

The average values of VO_2max at the baseline and endline in the control group are 52.1 ml/kg/min and 53.8 ml/kg/min each respectively, while in the intervention group 49.7 ml/kg/minand 51.1 ml/kg/min each respectively (Table 39). On average, the VO_2max of the subjects are good enough at the baseline.

Table 39. Physical fitness (VO_2max) of the women workers in the tea plantation before and after intervention

Physical Fitness	Control		Intervention	
	Baseline	Endline	Baseline	Endline
Mean VO_2 max (ml/kg/min)	52.1±3.0	53.8±4.9	49.7±3.0	51.1±49.2
Paired t-test	0.003		0.165	
Δ VO_2 max (ml/kg/min)	2.1±4.4		1.4±6.6	
Independent t-test	0.560			

The statistical analysis showed that there was an increase of VO_2max value at the baseline and endline in the control group (p=0.003), while in the intervention group there was no difference in VO_2max value at the baseline and endline (p=0.165). The independent t-test of VO_2max difference between the two treatments showed no significant difference (p=0.560) (Table 39). The age factor and anaemia condition that were less favorable in the control group were thought to affect physical fitness. Actually another factor, i.e. daily physical activity also affects physical fitness. Workers who become the samples of this study are accustomed to walking everyday even on the

road climbs, and doing a challenging activities while carrying the burden of tea. Although activity factors affect fitness, in this study the pattern of daily activity is assumed to be relatively similar between the two groups because their daily tasks are the same, especially when working in the plantation. The results of this study are not in line with other studies showing the benefits of iron supplementation to physical performance (VO_2max) in women of childbearing age (Pasricha *et al* 2014, Low *et al.*, 2016). A Pearson correlation test showed a correlation between pulse with total body fat ($r=0.238$; $p<0.05$), Hb level ($r=-0.497$; $p<0.001$), and VO_2max ($r=-0.722$; $p<0.001$). This study is inconsistent with Lutfi (2011) which shows that the subjects with low Hb concentrations own a weak pulse.

9.6 Productivity

Normally, tea picking is done using machine operated by 5-6 tea pickers. However, in the plantations with a certain level of sloping position, tea picking is done manually by hand or scissors. In this study, researchers asked the plantation management to measure productivity of subjects by picking tea manually using scissors. The productivity of tea pickers in plantations besides to be affected by individual conditions also depends on the potential of the area.

Table 40 shows that in the control group the average productivity was 62.0 kg/day at the baseline and decreased to 44.4 kg/day at endline. Based on the information we obtained from the plantation management, the growth of tea plants are affected by several factors; not all could be controlled by human (climate, rainfall, soil fertility, etc.). According to the plantation management in the control area, during endline the growth of tea plants were not optimal, therefore the productivity of tea picking in the control group became low. While in the intervention group the average productivity increased from 62.8 kg/day (baseline) to 76.5 kg/day (endline). The statistical test showed that there were significant differences ($p<0.01$) between the productivity of the control group and of the intervention, where the productivity of the intervention group increased significantly.

Table 40. Percentage of the women workers based on quantity of tea leaves picked

Productivity	Control (%)		Intervention (%)	
	Baseline	Endline	Baseline	Endline
<25 kg/day	0.0	0.0	4.5	0.0
25-50 kg/day	33.3	61.0	29.5	28.6
50-75 kg/day	40.0	39.0	38.6	35.7
75-100 kg/day	24.4	0.0	20.5	4.8
>100 kg/day	2.2	0.0	6.8	31.0
Mean±SD (kg/day)	62.0±19.4	44.4±8.2	62.8±23.0	76.5±40.5
Paired t-test	0.000		0.038	
Delta of productivity	-18.0		15.0	
Independent t-test	0.000			

Tea picking is a physical job that requires high energy and stamina. If the health status of tea picker workers is bad (eg: illness, anaemia etc.), then their productivity will decrease. Intervention of iron tablets on the subjects can improve the iron status which then has a positive impact on productivity.

From Table 40, the number of the control group subjects at the baseline who picked tea 25-75 kg/day was 73.3%, while in the intervention group 68.1 kg/day . While the subjects who picked tea >100 kg/day was 2.2% (control) and 6.8% (intervention). This situation indicates that at the baseline, both groups of the subjects have a relatively similar productivity. However, after the intervention, in the intervention group there was a considerable increase in the number of the subjects who picked tea >100 kg/day from 6.8% to 31.0%.

In tea plantations, laborers who take care of the plantation and pick tea are dominated by women. The tea plantations in the study sites have provided employment opportunities for women so they can help the household economy. Women working in plantations turn into communities, where they live on plantations and can enjoy the facilities provided by the plantation such as housing, clinics, hospitals, schools, sports fields etc.

Body composition component/Waist to Hip Ratio (WHR) is negatively correlated with productivity ($r=-0.235$; $p<0.05$). WHR is useful for determining the risk of non-communicable diseases such as diabetes, coronary

heart disease and hypertension (Lee & Nieman 2012). Subjects who have a high WHR describe the high concentration of fat in the waist or central obesity. Fat subjects tend to have lower productivity levels.

9.7 Absenteeism

The presence of tea pickers will certainly be influenced by their health condition. Tea pickers who are sick or unhealthy are potentially out of work for health reasons. Workplace absenteeism can also be caused by other things such as death, marriage, circumcision and other community events. Table 41 shows details of attendance at work during September-December 2016. In the control group the range of work-entry days in those months is 23 days, whereas in the intervention group 19-23 days with a maximum working day of 26-27 days. This means that every month, the subjects do not work for 3-7 days.

Table 41. Number of days of absenteeism in the control and intervention group

Absenteeism	Control	Intervention	p value
September 2016 (26 days of working days)	23.0±2.0	19.0±9.0	0.031
October 2016 (26 days of working days)	23.0±3.0	23.0±6.0	0.948
November 2016 (26 days of working days)	23.0±3.0	23.0±6.0	0.470
December 2016 (27 days of working days)	23.0±4.0	22.0±6.0	0.920

In September 2016, the presence of the intervention group (19 days) was lower than that of the control group (23 days) ($p<0.05$), but in subsequent months the presence in both groups did not differ significantly. For tea pickers who do not attend three days in a row for no reason (defaulters) will get a warning letter from the plantation. The absence of tea pickers in the workplace will affect the amount of tea picked and can have a negative impact on plantation productivity. The tea pickers in the plantations get a 12-day leave per year, and every 6 years get a sabbatical for 1 month.

Hb level is positively correlated with absence/attendance ($r=0.280$; $p<0.05$). The subjects who have high Hb levels have a tendency to attend higher. High Hb levels show no anaemia so absence due to sickness, weakness, lethargy does not occur.

10
Conclusions and Recommendations

10.1 Conclusions

1. On average the women workers as tea-pickers were 42.1 years old with low education level (90.4% had elementary school as their highest education). The number of family members in the household of women workers of tea pickers is 3.9 people. On average the women workers as tea pickers have worked for 17.5 years. The average income of the women workers as tea pickers was IDR 1,104,905 and contributed 50% to household income.
2. The majority of women workers as tea pickers lacked eating food of iron and vitamin C sources. Foods of iron sources that were very rarely consumed were beef and vegetables, which were consumed in small amounts, among others, kale, spinach leaves and cassava leaves.
3. Most (68-91%) of the women workers as tea pickers experienced inadequate intake of energy, protein and vitamin C. Most (44%) of the women workers as tea pickers also experienced inadequate iron intake.
4. Based on the examination using Hemocue, the prevalence of anaemia among the women workers as tea pickers is 28.4%. This figure is higher than the national prevalence of 22.7%.
5. The women workers as tea pickers generally suffered from overweight and obesity (57.2%). Almost none of the women workers as tea pickers experienced chronic energy deficiency (1.2%). A total of 54.8% women workers as the tea pickers suffered from central obesity at risk of developing chronic disease with an average body fat of 32.0%.
6. The mean values of VO_2max at the baseline and endline in the control group were 52.1 ml/kg/min and 53.8 ml/kg/min respectively, while in

the intervention group 49.7 ml/kg/min and 51.1 ml/kg/min respectively. On average the VO_2max value that reflects the physical fitness of the women workers as tea pickers is good enough. There is no difference in the impact of micronutrient supplementation on physical fitness.

7. The interventions of micronutrient supplementation and nutritional education were not able to increase haemoglobin or ferritin levels significantly. Nevertheless, there was a tendency to increase the ferritin levels of the intervention group by almost threefold compared to the increase in the control group. The increase in ferritin levels is also evident from the decrease in the proportion of iron-depleted subjects (from 20.5% to 11.6%). There were significant differences ($p<0.01$) between the productivity of the control group and that of the intervention group, where the productivity of the intervention group increased significantly. The increase of tea leaf picking productivity in the intervention group was 15 kg/day (23.9%).

10.2 Recommendations

1. Considering that the education of the women tea picking workers is generally low, it is necessary to provide skill education to improve the quality of life and income. This is very important for the provision of life if they stop or retire as tea picking workers.
2. Efforts to increase consumption of food sources of iron and vitamin C can be done by the women tea picking workers by utilizing the yard/land around the plantation to grow green vegetables.
3. The plantation management can implement micronutrient supplementation to improve the productivity of the women tea picking workers.
4. The plantation management can improve housing condition for the tea workers in the tea plantation by:
    a. Increasing number of permanent and semi-permanent (half wall, half wood) houses. In the tea plantation, there were still a lot of non-permanent houses (made of wood or bamboo).
    b. Improving house ventilation because more than half of the houses did not have good ventilation.

c. The household should use liquified petroleum gas for fuel as recommended by the government. At this time, most households of the tea workers still use firewood (39.2%) taken from waste of tea twigs in the plantation.

d. The housing for the tea workers should have its own toilet so the sanitation was maintained. At this time, most households of the tea workers still used public toilet (46.4%).

5. The plantation management should continuously socialized the importance of personal hygiene for workers especially on hand washing using clean water and soap, because more than 45% of the workers not always washed their hands using clean water and soap.

6. The plantation management should conduct deworming once every 6 months to the tea workers.

7. Supplementation of micronutrients in subsequent studies is suggested with a frequency of three times/week because the prevalence of anemia in the study sites was 28.4%. If the prevalence of anemia was more than 40%, according to WHO iron supplementation should be given daily.

11
Bibliography

Adriyani A. 2008. The Success Determinant of Iron Supplementation Program Among Adolescent Females at Bekasi City (*Determinan Keberhasilan Program Suplementasi Zat Besi pada Remaja Putri (Siswi SMP dan SMK) di Kota Bekasi*) [Skripsi]. Bogor: Jurusan Gizi Masyarakat dan Sumberdaya Keluarga, Fakultas Pertanian IPB.

Ahmed F, Khan MR, Akhtaruzzaman M, Karim R, Marks GC, Banu CP, Nahar B, Williams G. 2005. Efficacy of twice-weekly multiple micronutrient supplementation for improving the hemoglobin and micronutrient status of anemic adolescent schoolgirls in Bangladesh. Am J Clin Nutr 2005;82:829–35. Available from: . [cited in 2015 September 30].

Allen LH. 2002. Iron supplements: scientific issues concerning efficacy and implication for research and programs. J Nutr. 132: 813S–819S.

Almatsier S. 2000. The Basic Principles of Nutrition Science (*Prinsip Dasar Ilmu Gizi*). Jakarta : PT Gramedia Pustaka Utama.

Angeles-Agdeppa I, Schultink W, Sastroamidjojo S, Gross R, Karyadi D. 1997. Weekly micronutrient supplementation to build iron stores in female Indonesian adolescents. Am J Clin Nutr 1997; 66:177-83. Available from: http://ajcn.nutrition.org/ content/66/1/177.full.pdf+html. [cited in 2015 September 30].

Arora S. 2012. Iron Metabolism. Rijeka : InTech

Ashwell M, Gunn P & Gibson S. 2012. Waist-to-height ratio is a better screening tool than waist circumference and BMI for adult cardiometabolic risk factors: systematic review and meta-analysis. Obesity reviews (2012) 13, 275–286

Backstrand JR, LH Allen, AK Black, M deMata, GH Pelto. 2002. Diet and iron status of nonpregnant women in rural Central Mexico. *The Journal of Nutrition* 76:156–64 [5 April 2008].

[BPS] Central Bureau of Statistics. 2013. Statistics data of Indonesia (*Data Statistik Indonesia*). Avaible from: http://www.datastatistik-indonesia.com.

[BPS] Central Bureau of Statistics. 2016. Calory and Protein Consumption of Indonesian and Province 2016 Book 2 (*Konsumsi Kalori dan Protein Penduduk Indonesia dan Provinsi 2016 Buku 2*). Jakarta, BPS.

Bakta IM. 2007. Clinic Hematology Concise (*Hematologi Klinik Ringkas*). Jakarta: EGC.

Briawan D. 2008. *Efikasi Suplementasi Besi-Multivitamin tehadap Perbaikan Status Besi Remaja Wanita* (The Efficacy of Iron-multivitamin Supplementation on Improving Iron Status of Adolescent Females) [Disertasi]. Bogor: Sekolah Pasca Sarjana Institut Pertanian Bogor.

[BNF] British Nutrition Foundation. 2006. Iron : Nutritional and physiological significance. Chapman and Hall. London.

Bushman B (Ed). 2011. ACSM's complete guide to fitness & health. Champaign, IL: Human Kinetics.

[CDC] Centers for Disease Control and Prevention. 2015[a]. Sanitation & Hygiene. https://www.cdc.gov/healthywater/global/sanitation/index.html. [cited in 2017 April 4]

[CDC] Centers for Disease Control and Prevention. 2015[b]. Water, Sanitation & Environmentally-related Hygiene. https://www.cdc.gov/healthywater/hygiene/. [cited in 2017 April 4].

Citrakesumasari. 2012. Nutrition Anaemia Problems and Its Prevention (*Anaemia Gizi Masalah dan Pencegahannya*). Yogyakarta: Kaliaka.

Contento IR. 2011. Nutrition Education, Linking Research, Theory, and Practice. 2nd ed. Massachusetts: Jones and Bartlett Publishers.

De Vriendt T, Mattys C, Verbeke W, Pynaert I, De Henauw S. 2009. Determinants of nutrition knowledge in young and middle-aged Belgian women and the association with their dietary behavior. Appetite 52 (2009) 788–792. doi:10.1016/j.appet.2009.02.014.

De Vries K, McClafferty B, Van Dorp M, Weiligmann B. 2013. Increasing tea productivity through improved nutrition – A call to action, Concept Brief.

Decree of West Java Governor No. 561/Kep. 1191-Bangsos/2016 about District/City Minimum Salary on West Java Province year 2017 (*SK Gubernur Jabar No. 561/Kep. 1191-Bangsos/2016 tentang Upah Minimum Kabupaten/Kota di Daerah Provinsi Jawa Barat tahun 2017*).

Edgerton VR, Ohira Y, Hettiarachchi J, Senewiratne B, Gardner GW, Barnard RJ. 1981. Elevation of hemoglobin and work tolerance in iron-deficient subjects. Journal of nutritional science and vitaminology 27:2, p. 77-86. Available from: . [cited in 2015 September 30].

Efroymson D, Ahmed S, Townsend J, Alam S M, Dey A R, Saha R, Dhar B, Sujon A I, Ahmed K U, Rahman O. 2001. Hungry for tobacco: an analysis of the economic impact of tobacco consumption on the poor in Bangladesh. *Tobacco Control* 2001;10:212–217.

Ganong WF. 2008. Teaching Book of Medical Physiology 22th Edition (*Buku Ajar Fisiologi Kedokteran Edisi 22*). Jakarta: Buku Kedokteran EGC.

George C, Goedecke J, Crowther NJ, Jaff NG, Kengne AP, Norris SA, Micklesfield LK. 2016. The role of body fat and fat distribution in hypertension risk in urban black South African women. PLoS ONE 11(5); e0154894. DOI:10.1371/journal.pone.0154894.

Gibney J, Margetts B, Kearney J, Arab L. 2008. Public Health Nutrition (*Gizi Kesehatan Masyarakat*). Jakarta: Buku Kedokteran EGC.

Gibson RS. 2005. Principles of Nutritional Assessment. Second edition. New York : Oxford University Press.

Giriwijoyo S. 2005. Sport Science (*Ilmu Faal Olahraga*). Bandung: Fakultas Pendidkan Olahraga dan Kesehatan. Universitas Pendidikan Indonesia.

Haas, JD. 2006. The effects of iron deficiency on physical performance. *In Mineral Requirements of Military Personnel: Levels Needed for Cognitive and Physical Performance during Garrison Training*, edited by the Food and Nutrition Board, Institute of Medicine (IOM), The National Academies Press, Washington D.C, 451-61, 2006.

Haidar J. 2010. Prevalence of anaemia, deficiencies of iron and folic acid and their determinants in Ethiopian women. J Health Popul Nutr 2010 Aug;28(4):359-368.

Hamid FA. 2008. The Relationship of Nutritional Status and Playing Activities to Athletic Potency among the Children of the Women Tea-Pickers' at the Tea Plantation of Malabar and Purbasari, PTPN VIII Bandung. Sekolah Pascasarjana IPB.

Hardiyanti MW, Mahawati E, Ernawati D. 2013. Relations of nutritional status and anaemia with the productivity of women worker at garment unit of PT Apac Inti Corpora Bawen (*Hubungan status gizi dan anaemia dengan produktivitas karyawati unit garment PT Apac Inti Corpora Bawen*). [Artikel Penelitian]. Semarang: Fakultas Kesehatan Universitas Dian Nuswantoro. Available from: http://eprints.dinus.ac.id/6482/1/jurnal_12034.pdf. [cited in 2015 September 30].

Hellberg L, George IN. 2001. Iron Nutrition in Health and Diseases. England: Pub. John Libbey & Company Ltd.

Inayati DA, Scherbaum V, Purwestri RC, Wirawan NN, Suryantan J, Hartono S, Bloem MA, Pangaribuan RV, Biesalski HK, Hoffmann V, Bellows CV. 2012. Combined intensive nutrition education and micronutrient powder supplementation improved nutritional status of mildly wasted children on Nias Island Indonesia. Asia Pac J Clin Nutr, 3:361-373.

Indriani Y, Riyadi H, Zuraida R. 2011. Study on Nutritional Status and Physical Fitnessof the Non Pregnant Women Workers to Support Household Socio Economic. Lampung: Department of Agricultural Socio-Economics, University of Lampung, Indonesia and Neys-van Hoogstraten Foundation.

Indriani Y, Khomsan A, Sukandar D, Riyadi H, Zuraida R. 2013. The influence of the provision of iron and folic acid compared to multivitamin and mineral on childbearing age women worker in pineapple agroindustry (*Pengaruh pemberian zat besi dan asam folat dibandingkan dengan multivitamin dan mineral pada pekerja wanita usia subur di agroindustri nanas*). Makara Seri Kesehatan 17(1):17-25.

Jamil MD. 2001. Nutrition Education for Husband and It's Effect on Iron Tablet Consumption and Hb of Pregnant Women in Bantul District, Yogyakarta (*Pengaruh Pendidikan Gizi pada Suami terhadap Kepatuhan Minum Pil Besi dan Kadar Hemoglobin (Hb) Ibu Hamil di Wilayah Kabupaten Bantul, Daerah Istimewa Yogyakarta*). Program Pascasarjana Universitas Gajah Mada. Yogyakarta.

Kabahenda M, Mullis RM, Erhardt JG, Northro C, Nickols SY. 2011. Nutrition education to improve dietary intake and micronutrient nutriture among children in less-resourced areas: A randomised controlled intervention in Kabarole district, western Uganda. S Afr J Clin Nutr, 24:83-88.

Karyadi D. 1996. The role of health food in preventing degenerative disease (*Peranan makanan kesehatan dalam mencegah penyakit degeneratif*). Makalah Seminar Nuansa Pangan dan Gizi IPB, Bogor.

Kassebaum, Nicholas J. 2016. "The Global Burden of Anaemia." Hematology/ Oncology Clinics of North America 30 (2): 247–308. doi:10.1016/j. hoc.2015.11.002.

Kassebaum, Nicholas J., Rashmi Jasrasaria, Mohsen Naghavi, Sarah K. Wulf, Nicole Johns, Rafael Lozano, Mathilda Regan, et al. 2014. "A Systematic Analysis of Global Anaemia Burden from 1990 to 2010." Blood 123 (5): 615–24. doi:10.1182/blood-2013-06-508325.

Khomsan, A. 2000. Measurement Technique of Nutrition Knowledge (*Teknik Pengukuran Pengetahuan Gizi*). Jurusan Gizi Masyarakat dan Sumberdaya Keluarga, Fakultas Pertanian, Institut Pertanian Bogor.

Khomsan A, Sukandar D, Anwar F, Riyadi H, Herawati T, Dewi M, Fatchiya A. 2013. A Multi-Approach Intervention To Empower Posyandu Nutrition Program To Combat Malnutrition Problem In Rural Areas. Department of Community Nutrition, Bogor Agricultural University and The Nesle Foundation.

Kraemer K & Zimmermann MB (Eds). 2007. Nutritional anaemia. Basel : SIGHT AND LIFE Press.

Kulie T, Slattengren A, Redmer J, Counts H, Eglash A, Schrager S. 2011. Obesity and women's health: An Evidence-based review. J Am Board Fam Med 2011;24:75-85. doi:10.3122/jabfm.2011.01.100076.

Kurniawati E. 2012. The correlation of nutritionknowledge of Mother with nutritional status of children under five in Baledono Village, Purworejo Sub District, Purworejo District (*Hubungan Tingkat Pengetahuan Ibu tentang Gizi dengan Status Gizi Balita di Kelurahan Baledono, Kecamatan Purworejo, Kabupaten Purworejo*). ejournal.akbidpurworejo. ac.id/ index.php/ jkk5/ article/ view/70/68.

Lamb KL, Brodie DA, Roberts K. 1988. Physical fitness and health-related fitness as indicators of a positive health state. Health Promotion Oxford University Press.3(2):171-182.

Lee R D and Nieman D C. 2012. Nutritional Assessment. Sixth edition. New York : McGraw-Hill.

Li R. 1993. Functional consequences of iron deficiency in Chinese female workers. [tesis]. Dutch: University of Wageningen. Available from: . [cited in 2015 September 30].

Li R, Chen X, Yan H, Deurenberg P, Garby L, Hautvast JG. 1994. Functional consequences of iron supplementation in iron deficient female cotton mill workers in Beijing, China. Am J Clin Nutr, 59, 908-913.

Low MSY, Speedy J, Styles CE, De-Regil LM, Pasricha SR. 2016. Daily iron supplementation for improving anaemia, iron status and health inmenstruating women. Cochrane Database of Systematic Reviews 2016, Issue 4. Art. No.: CD009747. DOI: 10.1002/14651858. CD009747.pub2.

Lutfi MF. 2011. Effects of hemoglobin concentration on heart rate variability. International Journal on Pharmaceutical and Biological Research (IJPBR) Vol. 2(5), 127-131.

Marliyana SA, Kustiyah L. 2008. Book of Basic Nutrition Science (*Diktat Ilmu Gizi Dasar*). Bogor. Jurusan Gizi Masyarakat dan Sumberdaya Keluarga, Fakultas Pertanian IPB.

Marzuki M. 2006. Analysis of social economic relations with protein adequate level of students in TPB IPB dormitory 2005-2006 (*Analisis Hubungan Sosial Ekonomi dengan Tingkat Kecukupan Protein Mahasiswa di Asrama TPB IPB 2005-2006*). [Skripsi]. Bogor: Jurusan Gizi Masyarakat dan Sumberdaya Keluarga, Fakultas Pertanian IPB.

McArdle, WD *et al.* 1972. Reliability and interrelationships between maximal oxygen uptake, physical work capacity and step test scores in college women". *Medicine and Science in Sports* 4:182-186. http://www.topendsports.com/testing/tests/step-queens.htm.

McCartney DMA, Younger KM, Walsh J, O'Neill M, Sheridan C, Kearney JM. 2013. Socio-economic differences in food group and nutrient intakes among young women in Ireland. British Journal of Nutrition, IF.345, 1-14. doi:10.1017/S0007114513001463.

[MoH] Ministry of Health. 1996. Treatment Guideline of Nutrition Anaemia in Indonesia (*Pedoman Penanggulangan Anaemia Gizi di Indonesia*). Jakarta: Direktorat Bina Gizi Masyarakat.

[MoH] Ministry of Health. 1998. Treatment Guideline of Nutrition Anaemia for Female Adolescents and Childrenbearing Age Woman (*Pedoman penanggulangan anaemia gizi untuk remaja putri dan wanita usia subur*). Jakarta: Direktorat Jenderal Pembinaan Kesehatan Masyarakat. Direktorat Bina Gizi Masyarakat.

[MoH] Ministry of Health. 2003. Sentence of Health Ministry of Indonesia Number 1452/MENKES/SK/X/2003 about Flour Fortification (*Keputusan Menteri Kesehatan Republik Indonesia Nomor 1452/MENKES/SK/X/2003 tentang Fortifikasi Tepung Terigu*). Jakarta: Ministry of Health

[MoH] Ministry of Health of Indonesia. 2013[a]. Result of 2013 Basic Health Reseach (*Riset Kesehatan Dasar 2013*). Jakarta: Bureau of Health Research and Development (*Badan Penelitian dan Pengembangan Kesehatan*).

[MoH] Ministry of Health. 2013[b]. Guideline of Nutrition Adequate Fulfillment of Worker during Work (*Pedoman Pemenuhan Kecukupan Gizi Pekerja Selama Bekerja*). Jakarta. Kementerian Kesehatan RI.

[MoH] Ministry of Health. 2013[c]. Ministry of Health Regulation no. 30/2013 about Information Labelling on Sugar, Salt and Fat Content and Health Message for Processed Food and Fast Food. Jakarta: Ministry of Health.

[MoH] Ministry of Health of Indonesia. 2014. Guideline of Balanced Nutrition (*Pedoman Gizi Seimbang*). Jakarta, Kemenkes RI.

Mor K and Sethia S. 2013. Factors that influence household and individual food consumption: a review of research and related literature, Gyanpratha-ACCMAn Journal of Management, 5(2).

MOST, USAID Micronutrient Program. 2004. A Strategic Approach to Anaemia Control Program. Arlington, Virginia, USA.

Niehof A. 2010. Food, Diversity, Vulnerability and Social Change. The Netherlands: Wageningen Academic Publishers.

Notoatmodjo S. 2003. Public Health Science (*Ilmu Kesehatan Masyaraka*t). Jakarta: Rineka Cipta.

[NHLBI] Nutitional Heart, Lung, and Blood Institute. 2014. Who Is at Risk for Iron-Deficiency Anaemia?. https://www.nhlbi.nih.gov/health/health-topics/topics/ida/atrisk.

Nuttall FQ. 2015. Body mass index. Nutr Today. 2015;50(3):117-128. DOI:10.1097/ NT.0000000000000092.

Pasricha SR, Low M, Thompson J, Farrell A, and De-Regil LM. 2014. Iron Supplementation Benefits Physical Performance in Women of Reproductive Age : A Systematic Review and Meta-Analysis. J. Nutr. 144: 906–914, 2014.

Pawlowski ZS, Schad GA, Stott GJ. 1991. Hookworm Infection and Anaemia: Approaches to Prevention and Control. Geneva: WHO. http://apps.who.int/iris/bitstream/10665/ 40857/1/9241544155.pdf.

Perkebunan Nusantara VIII. 2017. Nusantara Plantation VIII (*Perkebunan Nusantara VIII*). Sumber: http://www.pn8.co.id. [cited in 2017 Mei].

Plowman SA & Smith DL. 2014. Exercise physiology for health, fitness, and performance. Fourth edition. Baltimore : Lippincott Williams & Wilkins.

Power ML, Schulkin J. 2008. Sex differences in fat storage, fat metabolism, and the health risks from obesity: possible evolutionary origins. British Journal of Nutrition (2008), 99, 931–940. doi: 10.1017/S0007114507853347.

Rasmaliah. 2004. Iron Deficiency Anaemia in Conjunction with Worm Infection on Pregnant Women (*Anaemia Kurang Besi Dalam Hubungannya Dengan Infeksi Cacing Pada Ibu Hamil*). Fakultas Kesehatan Masyakat, Universitas Sumatera Utara. Sumber: .

Rhee JY. 2012. The Effect of Iron Deficiency on Worker Productivity: Evidence from a Field Experiment in India. Thesis. Ithaca, NY : Department of Policy Analysis and Management, Cornell University.

Riyadi H. 2007. Book of Sport Science Subject (*Diktat Mata Kuliah Gizi Olahraga*). Bogor: Institut Pertanian Bogor.

Sacher RA, MC Pherson RA. 2000. Widman's Clinical Interpretation of Laboratory Tests. Philadelphia: FA Davis Company.

Sahyoun NR, Pratt CA, Anderson A. 2004. Evaluation of Nutrition Education Intervensions for Older Adults: a Proposed Framework. J. Am. Diet Assoc.104(1):58-69.

Santoso A. 2011. Dietary Fiber and it's function for health (*Serat Pangan dan Manfaatnya bagi Kesehatan*). Magistra: No. 75 Th. XXIII Maret 2011, p:35-40.

Sarwa. 2003. Effect of Nutition Education on Iron Consumption and Hemoglobin Status (*Pengaruh Intensifikasi Penyuluhan Gizi dalam Pemberian Tablet Besi pada Ibu Hamil terhadap Kepatuhan Mengkonsumsi dan Pencapaian nilai Hemoglobin Harapan*). Thesis. Universitas Diponegoro Semarang.

Setyawati, 2010. Glimpses of Work Fatigue (*Selintas tentang Kelelahan Kerja*). Yogyakarta: Amara Books.

Sharkey BJ. 1991. New Dimension in Aerobic Fitness. Champaign, Illinois: Human Kinetics Books.

Rolfes SR, Pinna K, Whitney E. 2008. Understanding Normal and Clinical Nutrition 8th Ed -Brooks_Cole.

Soehardjo. 1986. The influence of iron intervention to work productivity of tea picker (*Pengaruh intervensi besi terhadap produktivitas kerja pemetik teh*). [disertasi]. Bogor: Fakultas Pascasarjana, Institut Pertanian Bogor.

Soekirman. 2000. Nutrition Science and Its Application for Family and Community (I*lmu Gizi dan Aplikasinya untuk Keluarga dan Masyarakat*). Jakarta: Direktorat Jenderal Pendidikan Tinggi, Departemen Pendidikan Nasional.

Souganidis E S, Sun K, Pee S D, Kraemer K, Rah J H, Pfanner R M, Sari M, Bloem M W, and Semba R D. 2012. Determinants of Anaemia Clustering Among Mothers and Children in Indonesia JOURNAL OF TROPICAL PEDIATRICS, VOL. 58, NO. 3, 2012.

Stevens GA, Finucane MM, De-Regil LM, Paciorek CJ, Flaxman SR, Branca F, Pena-Rosas JP, Bhutta ZA, Ezzati M. 2013. Nutrition Impact Model Study Kelompok. Global, regional, and national trends in haemoglobin concentration and prevalence of total and severe anaemia in children and pregnant and non-pregnant women for 1995–2011: A systematic analysis of population-representative data. Lancet Glob. Health 2013, 1, e16–e25. [PubMed] .

Stoltzfus RJ and Dreyfuss ML. 1998. Guidelines for the Use of Iron Supplements to Prevent and Treat Iron Deficiency Anaemia. Washington DC: International Nutritional Anaemia Consultative Group (INACG). Sumber: http://www.who.int/nutrition/ publications/micronutrients/ guidelines_for_Iron_supplementation.pdf?ua=1.

Stopler T. Medical Nutrition Therapy for Anaemia. In Mahan LK and Escott-Stump S. 2008. Krause's Food and Nutrition Therapy. 12th Edition. USA: Saunders Elsevier.

Strain JJ, Cashman KD. 2002. Minerals and Trace Elements. Di dalam : Gibney MJ, Vorster HH, Kok FJ, editor. *Introduction to Human Nutrition*. USA : Blackwell Publishing.

Sudikno, Syarief H, Dwiriani CM, dan Riyadi H. 2015. Risk factor of central obesity in adults 25-65 years old in Indonesia (data analysis of basic health research 2013) (*Faktor risiko obesitas sentral pada orang dewasa umur 25-65 tahun di indonesia (analisis data riset kesehatan dasar 2013)*). Penelitian Gizi dan Makanan 38(2):111-120.

Suhardjo. 1989. Various Ways of Nutrition Education (*Berbagai Cara Pendidikan Gizi*). Petunjuk Laboratorium Pusat Antar Universitas Pangan dan Gizi. Bogor: PAU-IPB.

Suhardjo. 1996. Food and Nutrition Planning (*Perencanaan Pangan dan Gizi*). Jakarta: Bumi Aksara.

Sunarti E, Roosita K, Herawati T. 2008. A Study of Plantation Women Workers: Soci-economic, Family Strength, Food Consumption, and Children Growth and Development. Department of Family and Consumer Sciences, Bogor Agricultural University and Neys-Van Hoogstraten Foundation.

SPRING. 2016. Understanding Anaemia: Guidance for Conducting a Landscape Analysis. Arlington, VA: Strengthening Partnerships, Results, and Innovations in Nutrition Globally (SPRING) project.

Syarief O. 1994. Factors related to nutrition anaemia on pregnant women in Serang District and Tangerang West Java (*Faktor-faktor yang berhubungan dengan kejadian anaemia gizi pada ibu hamil di Kabupaten Serang dan Tangerang Jawa Barat*). [Tesis]. Depok: Program Pascasarjana, Program Studi Ilmu Kesehatan Masyarakat, Universitas Indonesia.

Tang AM, Dong K, Deitchler M, Chung M, Maalouf-Manasseh Z, Tumilowicz A, Wanke C. 2013. Use of Cutoffs for Mid-Upper Arm Circumference (MUAC) as an Indicator or Predictor of Nutritional and Health-Related Outcomes in Adolescents and Adults: A Systematic Review. Washington, DC: FHI 360/FANTA.

Thankachan P, Walczyk T, Muthayya S, Kurpad AV, Hurrell RF. 2008. Iron absorption in young Indian women: the interaction of iron status with the influence of tea and ascorbic acid. *Am J Clin Nutr*,87:881–6.

UNICEF. 1998. Preventing Iron Deficiency in Woman and Children: Backgrond and Consensus on Key Technical Issues and Resources for Advocacy, Planning, and Implementing National Programs. Canada: International Nutritional Foundation (INF).

UNICEF. 1992. Strategy for improve nutrition of children and women in developing countries. New York : Unicef.

UNICEF/WHO/UNU. 1999. Composition of a multi-micronutrient supplement to be used in pilot programmes among preg- nant women in developing countries. Report of a Unicef, WHO, UNU workshop UNICEF/WHO/UNU, New York.

[UNICEF/UNU/WHO] United Nations Children's Fund, United Nations University, World Health Organization. 2001. Iron Deficiency Anaemia Assessment, Prevention, and Control: A guide for programme managers. Geneva: World Health Organization.

Wirakusumah ES. 1998. Diet Planning for Iron Deficiency Anaemia (*Perencanaan Menu Anaemia Gizi Besi*). Jakarta: Trubus Agriwidya.

World Bank. 2006. Repositioning Nutrition as Central to Development a Strategy for Large Scale Action. Washington DC:The World Bank.

[WHO] World Health Organization. 2001. Iron Deficiency Anaemia Assessment, Prevention, and Control: A guide for programme managers. Geneva: World Health Organization. Available from: http://www.who.int/nutrition/publications/en/ida_assessment_ prevention_control.pdf. [cited in 2015 September 30].

[WHO] World Health Organization. 2008. Worldwide prevalence of anaemia1993-2005: WHO global database on anaemia. Benoist B, McLean E, Egli I, Cogswell M, editors. Geneva: World Health Organization. Available from: Error! Hyperlink reference not valid.. [cited in 2015 September 30].

[WHO] World Health Organization. 2011[a]. Guideline: Intermittent Iron and Folic Acid Supplementation in Menstruating Women. Geneva, Switzerland: World Health Organization.

[WHO] World Health Organization. 2011[b]. Guidelines for Drinking-water Quality – 4th ed. ISBN 978 92 4 154815 1. http://www.who.int/water_sanitation_health/publications/ dwq-guidelines-4/en/. [cited in 2017 April 4].

[WHO] World Health Organization. 2011[c]. Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity. Vitamin and Mineral Nutrition Information System (WHO/NMH/NHD/MNM/11.1). Geneva, Switzerland: World Health Organization. http://www.who.int/vmnis/indicators/haemoglobin. pdf. [cited in 2017 Maret 3]

[WHO] World Health Organization. 2011[d]. Waist circumference and waist–hip ratio: report of a WHO expert consultation, Geneva, 8–11 December 2008. Geneva : WHO.

[WHO] World Health Organization. 2014. Global Nutrition Targets 2025: Anaemia Policy Brief. Geneva, Switzerland: World Health Organization. http://apps.who.int/iris/ bitstream/10665/148556/1/WHO_NMH_NHD_14.4_eng.pdf.

[WHO] World Health Organization. 2015. The global prevalence of anaemia in 2011. Geneva: World Health Organization. Available from: http://apps.who.int/iris/ bitstream/10665/177094/1/9789241564 960_eng.pdf. [cited in 2015 September 28].

[WHO] World Health Organization. 2016. Guideline: Daily iron supplementation in adult women and adolescent girls. Geneva: World Health Organization.

[WHO] World Health Organization. 2017[a]. Housing and health. http://www.who.int/hia/ housing/en/. [cited in 2017 April 4]

[WHO] World Health Organization. 2017[b]. Water. http://www.who.int/topics/water/en/. [cited in 2017 April 4

Yosephin B, Riyadi H, Anwar F, Khomsan A, Elly N, Diana D. 2016. Is vitamin D deficiency associated with using veil in female garment workers?. Asian Pac J Trop Dis 6(6):930-934.

Yulianasari AI. 2007. Factors Affected Anaemia among Adolescents and Adults in Jakarta, (*2007 Faktor-Faktor yang Mempengaruhi Kejadian Anaemia pada Remaja dan Dewasa di DKI Jakarta Tahun 2007*) [Skripsi]. Bogor: Departemen Gizi Masyarakat Fakultas Ekologi Manusia Institut Pertanian Bogor.

Figure 3. Tea plantation

Figure 4. Housing at tea plantation

Figure 5. Research team and women tea workers

Figure 6. Blood sample collection

Figure 7. Blood pressure measurement

Figure 8. Anthropometry measurement

Figure 9. Body composition measurement

Figure 10. Interviewing woman tea worker

Figure 11. Fitness measurement

Figure 12. Interactive nutrition education

About Authors

Name	:	**Prof. Faisal Anwar**
Place/Date of Birth	:	**Padangpanjang, April 13th 1952**
Education	:	**PhD in Community Nutrition, Bogor Agricultural University, 2002**
Office	:	**Dept. of Community Nutrition, IPB**
Email	:	**faisalanwar_gmipb@yahoo.com**

Name	:	**Prof. Ali Khomsan**
Place/Date of Birth	:	**Ambarawa, February 2nd 1960**
Education	:	**PhD in Home Economics Education, Iowa State University, USA, 1991**
Office	:	**Dept. of Community Nutrition, IPB**
Email	:	**erlangga259@yahoo.com**

Name	:	**Hadi Riyadi, PhD**
Place/Date of Birth	:	**Hulu Sungai Selatan, June 15th 1961**
Education	:	**PhD in Community Nutrition, Bogor Agricultural University, 2002**
Office	:	**Dept. of Community Nutrition, IPB**
Email	:	**hadiriyadi@yahoo.com**

Name : **Betty Yosephin, PhD**
Place/Date of Birth : **Medan, September 26th 1973**
Education : **PhD in Community Nutrition, Bogor Agricultural University, 2014**
Office : **Health Polytechnic of Bengkulu**
Email : **patricknmom@yahoo.co.id**

Name : **dr. Karina R Ekawidyani, MGizi**
Place/Date of Birth : **Bogor, December 10th 1986**
Education : **- Medical Doctor, University of Indonesia, 2010**
- Master of Science in Community Nutrition, University of Indonesia, 2012
Office : **Dept. of Community Nutrition, IPB**
Email : **karinare@apps.ipb.ac.id**

Name : **Rian Diana, MSi**
Place/Date of Birth : **Bogor, May 05th 1984**
Education : **MSi in Community Nutrition, Bogor Agricultural University, 2014**
Office : **Dept. of Health & Nutrition, Faculty of Public Health, Airlangga University, Surabaya**
Email : **riandiana2013@gmail.com**