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Micronutrient Status and Dietary Intake - A Cross Sectional Study in Women Married to Smokers among Poor Households in Indonesia

DISSERTATION

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I declare that the dissertation here submitted is entirely my own work, written without any illegitimate help by any third party and solely with materials as indicated in the dissertation. I have indicated in the text where I have used texts from already published sources, either word for word or in substance, and where I have made statements based on oral information given to me. At all times during the investigations carried out by me and described in the dissertation, I have followed the principles of good scientific practice as defined in the “Statutes of the Justus Liebig University Giessen for the Safeguarding of Good Scientific Practice.”

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Abbreviation

AGP	α-1-acid glycoprotein
BMI	Body mass index
°C	Celcius
CI	Confidence interval
Cm	Centimeter
CRP	C-reactive protein
DDS	Dietary diversity score
EAR	Estimated average requirement
FANTA	Food and Nutrition Technical Assistance
FAO	Food and Agriculture Organization of the United Nations
FCT	Food composition table
G	Gram
g/L	Gram per liter
HAZ	Height-for-age Z-score
Hb	Haemoglobin
Hcy	Homocysteine
ID	Iron deficiency
IDA	Iron deficiency anaemia
IDR	Indonesian rupiah
kJ	Kilojoule
Kg	Kilogram
kg/m^2	Kilogram-meter squared
µg/d	Microgram per day
µg/L	Microgram per liter
µL	Microliter
µmol/L	Micromoles per liter
mg/d	Milligram per day
mg/kg	Milligram per kilogram
mg/L	Milligram per liter
mL	Milliliter
Na-EDTA	Natrium Ethylene-Diamine-Tetra-Acetic acid
NCD	Non-communicable diseases
OR	Odds ratio
PUFA	Poliunsaturated fatty acids
RBP	Retinol-binding protein
RE/d	Retinol equivalent per day
SD	Standard deviation
SFA	Saturated fatty acids
sTfR	Transferrin receptor
UN	United Nations
US	United States
USDA	United States Department of Agriculture
WAZ	Weight-for-age Z-score
WHO	World Health Organization
WHZ	Weight-for-height Z-score
24HR	24-hour dietary recalls

1 INTRODUCTION

Tobacco use is the leading cause of preventable death in the world and alone accounts for one in six of all deaths resulting from chronic non-communicable diseases (NCD). Southeast Asia (includes Indonesia) faces an epidemic of NCD, now responsible for 60% of deaths in the region. Further, NCD contribute to ongoing poverty and are a major barrier to development goals including poverty reduction, health equity, economic stability, and human security (Beaglehole *et al*., 2011). These problems stem from environmental factors which promote tobacco use, unhealthy diet, and inadequate physical activity (Beaglehole *et al*., 2011).

In 2011, the United Nations (UN) high-level meeting on NCD highlighted priority actions to reduce the global NCD crisis and identified tobacco control as the most urgent and immediate priority intervention. A goal was proposed to achieve a world relatively free from tobacco by 2040—i.e., a prevalence of less than 5% (Beaglehole *et al*., 2011).

Over recent decades, tobacco use has indeed fallen in many high-income countries, at least in men, but is now rising rapidly in many low-income and middle-income countries (Beaglehole *et al*., 2011; de Beyer & Brigden, 2003), with a prevalence of more than 25% in adolescents in some countries (Beaglehole *et al*., 2011). This trend is exacerbated by the efforts of cigarette companies to expand sales in developing countries, where many people are still poorly informed about the harm to health that tobacco causes and many governments have not yet adopted or implemented policies strong enough to discourage tobacco use (de Beyer & Brigden, 2003).

1.1 Background and Rationale of the Study

In Indonesia, tobacco companies are politically and financially powerful because, after oil, timber and gas, they are the largest source of government revenue (Nichter *et al*., 2009). As a result, there are only a few restrictions on tobacco marketing and advertising in place—suggesting that it is a challenging country in which to introduce tobacco cessation (Nichter *et al*., 2009). Factors such as the relatively cheap cigarette price in the country (the lowest in the South East Asian region) (Thabrany, 2012), weak public policies coupled with a lack of access to information on living healthily, aggressive marketing of tobacco industries and, ultimately, addiction to nicotine - all contribute, to the fact that people who are living on low income are spending their money on tobacco rather than on essential needs (GATS, 2011; WHO, 2011). To date, the country has not yet signed the World Health Organization (WHO) Framework Convention on Tobacco Control, which would require the implementation of price controls and the introduction of a tax on tobacco which would lead to a reduction in demand as well as to initiate an awareness of and protection from exposure to tobacco smoke along with the regulation and restriction of tobacco advertising etc. (WHO, 2013). Based on the Indonesian Global Adult Tobacco Survey in 2011, a nationally representative household survey of persons aged 15 years and above, the percentage of smoking among men is 67% (57.6 million) (GATS, 2011), which identifies Indonesia's as the highest male smoking rate among the fifteen 'low and middle-income countries' surveyed to date (GTC Updates, 2012). However, smoking is not distributed equally across all sectors of society. Rather, it is becoming increasingly concentrated among individuals with the lowest levels of income, education, and occupational status (LEGACY, 2010). In Indonesia, smoking prevalence among those living in poverty or of low educational attainment is about twice that of the general population (GATS, 2011), in which prevalence in the poorest quintile (35.8%) was higher than that in the richest quintile (31.5%) (Thabrany, 2012). This creates a burden on the already scarce financial resources of low-income families. As a result, in low income families with smoking parents or adults, fewer financial resources are available for food, shelter, transportation, education, and other necessities (LEGACY, 2010). A recent systematic review reported an inverse relationship between income levels and the prevalence of tobacco use: although money is spent on cigarettes by people on low income, this sector smokes more than those people on a high income (OR 1.48, 95% CI 1.38-1.59) (WHO, 2011).

Deficiencies in essential micronutrients are prevalent among women of childbearing age which are common due to physiologically higher micronutrient requirements during the reproductive life stage (FAO/WHO, 2001). The consequences of micronutrient deficiencies among women are profound and far reaching; they affect not only the health and survival of women but also have irreversible, long-term effects on their offspring (Ruel, Deitchler & Arimond, 2010). A previous study in rural Indonesia reported more than 50% of the women being anaemic and 18% being marginally deficient in vitamin A (Dijkhuizen *et al.,* 2001). Moreover, several cross sectional studies showed the relation between dietary intakes of B vitamins and plasma homocysteine (Hcy) concentration (Selhub *et al.,* 1993; Bree *et al.,* 2001; Konstantinova *et al.,* 2007). Homocysteine is an intermediate amino acid in the metabolism of the essential amino acid methionine (Konstantinova *et al.,* 2007). Elevated Hcy levels are typically caused by either genetic defects in the enzymes involved in Hcy metabolism or by nutritional deficiencies in vitamin cofactors (Milani, 2008). Several B vitamins are involved in Hcy metabolism that deficiencies of folate, vitamin B_2, vitamin B_6, or vitamin B_{12} are associated with higher plasma Hcy concentration (Allen, 2005). In addition to its possible role in cardiovascular disease, hyperhomocysteinemia has been implicated in the pregnancy complications (preeclampsia, prematurity, very low birth weight, stillbirth, and placental abruption) and birth defects (neural tube defects) (Refsum *et al*., 2006). Yet, there is a lack of current data on hyperhomocysteinemia in women of childbearing age in Indonesia.

One of the most important factors responsible for maternal micronutrient deficiency is poor diet which lacks diversity, characterized by high intakes of food staples but low consumption of animal source foods, fruits, lentils, and vegetables — foods that are rich sources of bioavailable vitamins and minerals (Ruel, Deitchler & Arimond, 2010; Bouis *et al.,* 2011).

In poor households, the diet of the women is often inadequate because of economic constraints. Studies have revealed that food costs are a barrier to the adoption of nutrient-dense diets by the lower income groups (Darmon & Drewnowski, 2008). These disadvantaged groups consume foods that are cheap, energy-dense and nutrient-poor (Novaković *et al.,* 2013). The problem being more severe in low-income households, where a significant portion of income is devoted to food and therefore expenditures on tobacco can mean the difference between an adequate diet and malnutrition (WHO, 2011). Even in very poor households, increased food expenditure is associated with increased quantity and quality of the diet (Swindale & Bilinsky, 2006). An earlier study conducted in urban Indonesian households reported that the proportion of weekly per capita household expenditures on quality foods - such as eggs, fish, fruits and vegetables – was lower in households in which the father was a smoker (24% vs 32% for households where the father was a non-smoker) (Semba *et al*., 2007), hence, paternal smoking exacerbated child malnutrition (Efroymson *et al*., 2001; Semba *et al*., 2007; Best *et al*., 2008).

Prevalence of smoking among men is high, and women of reproductive age are vulnerable to micronutrient deficiency, however, until now, no study has been done in Indonesia to investigate the effect of smoking husbands on the micronutrient status and diet quality of their wives among low income strata.

1.2 Study Objectives

A smoking husband can be expected to exacerbate the problem of deficiencies in essential micronutrients for his wife as some household income is diverted to be spent on cigarettes and consequently less is spent on food compared to women whose husbands are non-smokers.

- The main objective is to assess the micronutrient status (iron, vitamin A, and homocysteine) and the prevalence of anaemia, of iron and vitamin A deficiencies, and of hyperhomocysteinemia in women of reproductive age from low income households comparing smoker to non-smoker husbands.
- The second objective is to examine diet quality (measures of dietary diversity, micronutrient intake, and diet-related chronic disease prevention (prevention here being based on WHO/FAO dietary guidelines, i.e., cut-offs for intake of food and nutrient-for more detail see 'Methods') in women comparing smoker to non-smoker husbands in 2 study areas (coastal and inland). How inadequate the women’s diet is, relative to current dietary recommendations, is also assessed.
- In a subsample of the women we studied the association between maternal and child nutritional status with reference to paternal smoking.

2 METHODS

2.1 Study Location

The study was carried out during 2010-2011 in two provinces, Gorontalo, a coastal area and East Java a rural area of Indonesia. The areas were selected based on the wealth index, i.e., percentage of men using cigarettes according to the local province survey information (CBS, Macro-International, 2008a), and the regional minimum wage in 2010 (UMP, 2011). In Gorontalo province (Fig. 2.1 no. 26), the study was conducted in two districts (Bone Bolango and Gorontalo) and in one municipality (Kota Gorontalo) from December 2010 to March 2011. This province is mainly coastal and has an elevation of 5-25 m above sea level (DRASA, 2012). The total population registered in Gorontalo province in 2011 was 1,062,883 with approximately 249,323 households in an area of 12,435 km^2 (DRASA, 2012).

In East Java province (Fig. 2.1 no. 16), the study was conducted in one district (Jember) from July to September 2011. The district is mostly an inland area with its average elevation of 83 m above sea level (DPPJT, 2012). The population in Jember district in 2011 was 2,345,851, living in an area of 3,349 km^2 (DPPJT, 2012). The climate of Indonesia is tropical with 2 seasons: a dry season (May to October) and a rainy season (November to April).

The location of the study areas and the study profile are shown in **Fig. 2.1** and **Fig. 2.2**, respectively.

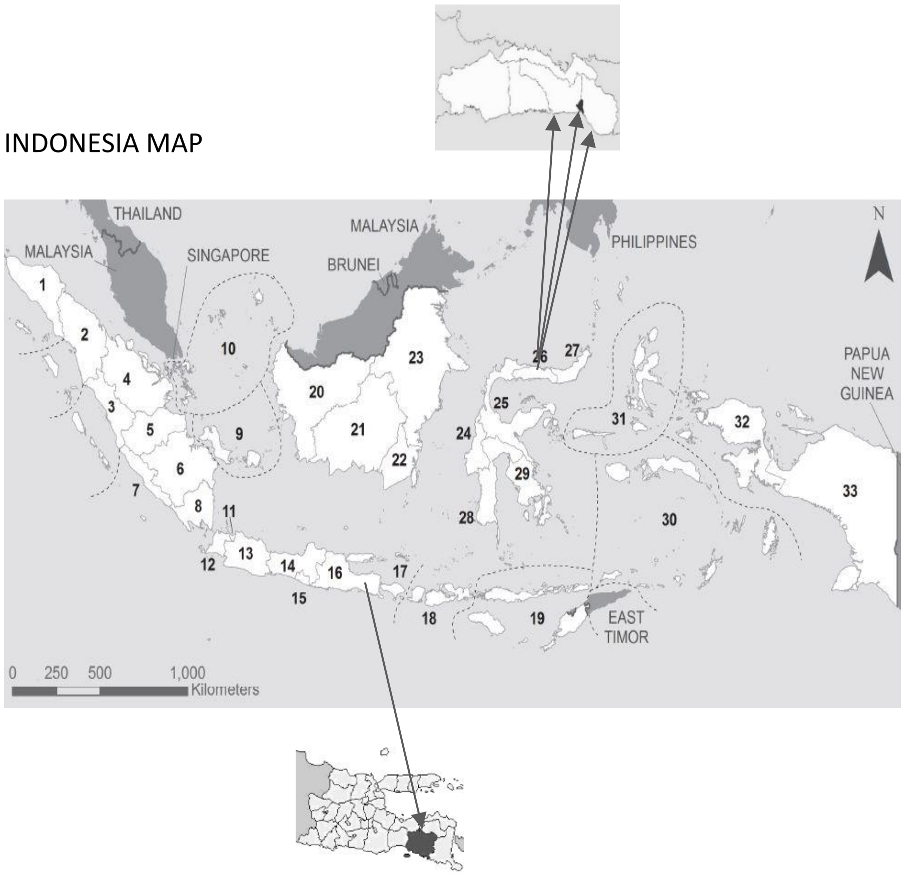

Fig. 2.1 Location of the study area.

2.2 Sample Size Calculation

The study power calculation was based on a comparison of 2 means of Hcy concentration, with the assumption of a mean (±SD) of 10 (±3) µmol/L in the non-smoking group (Panagiotakos *et al.,* 2004); a significance level of 5%, a power of 90%, and a ratio sample size (smokers group/non-smokers group) of 2. A minimum sample size of 537 women was required to detect a difference in Hcy concentration of 1 µmol/L and an SD of 1 µmol/L between the groups (Panagiotakos *et al.,* 2004). Anticipating a 10% dropout per group because of incomplete data, a total of 588 non-smoking women of fertile age were recruited. Women were categorized into 2 groups: the husband was a non-smoker (n=202) and the husband was a smoker (n=386).

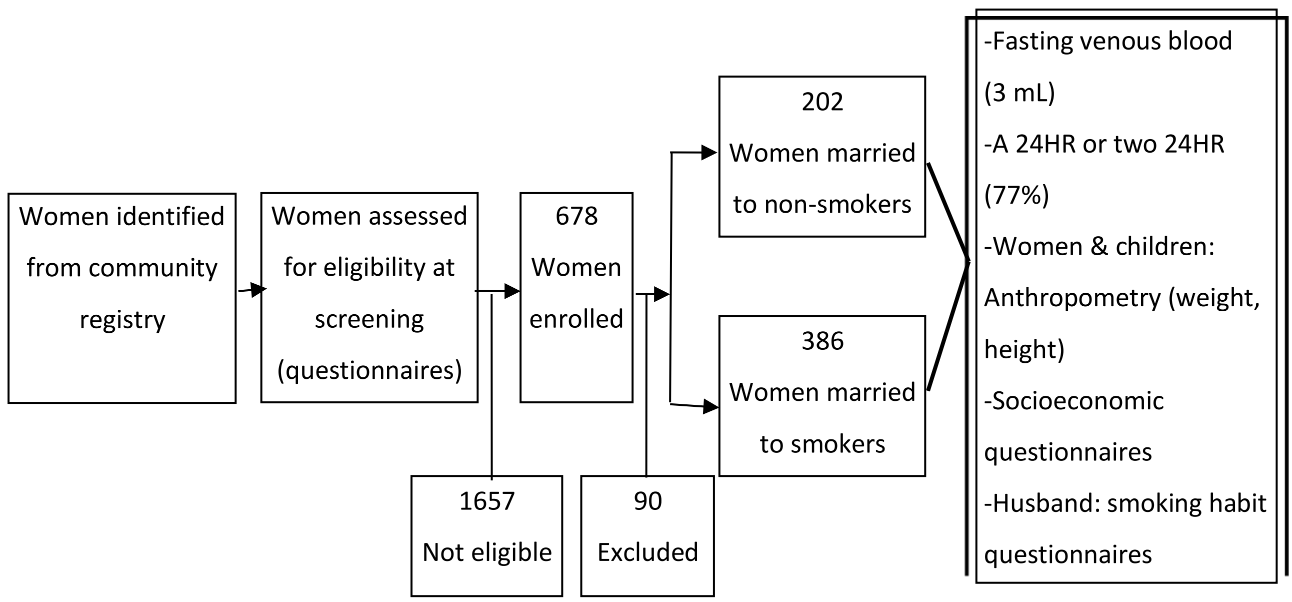

Fig. 2.2 The study profile. NB: Data were not calculated for the first two groups during data collection, therefore there are no 'number of participants' for these groups.

2.3 Subjects

A cross sectional study was conducted among women (19-44 years old), who were purposely selected from the community registry. They were recruited from poor rural and peri-urban households in the community for screening through questionnaires. The questionnaires then applied the enrolment criteria: apparently healthy, not pregnant, not lactating, non-smoking, having a smoking or non-smoking husband, and not consuming drugs/vitamin supplements regularly for the last 3 months which could influence the nutrition status regarding iron, vitamin A, and Hcy.

Poor households were defined by a 'monthly income below the regional minimum wage of Indonesian rupiah' which was identified as (IDR) 710,000 (≈US$ 80.7) for Gorontalo province and IDR 630,000 (≈US$ 71.6) for East Java province (UMP, 2011).

2.4 Ethical Consideration

Before the study, women were informed by their assigned 'investigator' about the protocol of the study. Eligible women were enrolled only when they had signed a written informed consent. Assurance was given to participants that participation was voluntary and that all subjects were free to withdraw at any stage of the data collection. The study was approved by the Ethics Committee of the Faculty of Medicine at University of Indonesia (No. 243/PT02.FK/ETIK/2010) and from the Faculty of Medicine at University of Giessen (AZ.: 165/10).

2.5 Data Collection

During data collection, the women received socioeconomic, biochemical, dietary intake, and anthropometric assessments.

2.5.1 Socioeconomic and Smoking Behaviour Questionnaires

Two enumerators in each study area interviewed and observed the participating women at home through visits also recording their socioeconomic status. A structured questionnaire was used to obtain information on socioeconomic indicators, household income, other cash resources (such as cash benefits) and food expenditures. For assessing smoking behaviour and expenditures for cigarettes a separate questionnaire was administered to each smoking husband. Household income, other cash resources, and expenditure variables were collected in terms of Indonesian Rupiah (IDR). These variables were collected by recalling the average daily or weekly cash resources and expenses over the previous 3 months. All cash resources and expenses were recalculated by the enumerators as monthly household income as well as food and cigarette expenditures. Based on the exchange rate on 1 March 2011, US$ 1 was equivalent to IDR 8,802.8 (Oanda, 2011).

2.5.2 Blood Sampling

Via venipuncture, samples of 3 mL venous blood were collected once by phlebotomists from each woman after an overnight fasting in the sitting position. A total of 586 women provided blood samples. Approximately 0.5 mL blood was drawn into Na-EDTA vacuettes for measuring haemoglobin (Hb) concentration in blood samples. The remaining 2.5 mL was drawn into vacuette heparin tubes for analysis of plasma Hcy, ferritin, transferrin receptor (sTfR), retinol binding protein (RBP), C-reactive protein (CRP), and α-1-acid glycoprotein (AGP). In the field, the tubes were immediately manually centrifuged for ~4 minutes to separate plasma at room temperature. The plasma was then transferred into two 500 µL Eppendorf Safe Lock vials (at least 300 µL in the first one). The second vials were intended as backups from which an adequate plasma could only be obtained from 430 women. EDTA-full blood and heparinized plasma samples were stored at -7°C initially and then at -70°C until further analyses. Frozen samples were then transported on dry ice to Germany.

Hb was determined using the cyano-methemoglobin method (INACG, 1984), and measured by a standard photometer. Plasma ferritin, sTfR, RBP, CRP, and AGP concentrations were measured with an in-house sandwich enzyme-linked immunosorbent assay technique (Erhardt *et al.,* 2004) in 2012. Originally, plasma Hcy had to be measured in all 586 women; however, the remaining funds were not sufficient and the primary plasma samples were accidentally lost in the laboratory. Therefore, plasma Hcy was then analysed in 2013 from 430 backups of the primary plasma samples. Plasma Hcy was assessed in duplicate with an enzyme immunoassay kit (Axis Homocysteine EIA; IBL International, Hamburg, Germany).

To identify the prevalence of micronutrient deficiency within this study; anaemia was defined as an Hb-level <120 g/L (WHO/CDC, 2007); iron deficiency (ID) as plasma ferritin concentration of <15 µg/L (WHO, 2011); and IDA as concurrent anaemia and ID. Tissue ID was defined as plasma sTfR concentration of >8.3 mg/L (Engle-Stone *et al.,* 2013). Body iron stores were estimated by using the following equation (Cook *et al.,* 2003):

Body iron (mg/kg) = -[log(sTfR/ferritin ratio)-2.8229]/0.1207. Body iron >0 indicates the amount of iron in stores, body iron <0 indicates the deficit in tissue iron. Marginal vitamin A status was defined as plasma RBP <1.17 µmol/L (Engle-Stone *et al.,* 2011) and hyperhomocysteinemia as plasma Hcy concentration of ≥15 µmol/L (Refsum *et al.,* 2004). Inflammation was indicated when the CRP concentration was >5 mg/L and/or AGP concentration was >1 g/L (Thurnham & McCabe, 2012). Data of women with inflammation were excluded from statistical analyses of ferritin, body iron stores, and RBP concentrations.

2.5.3 Dietary Intake Assessment

For dietary intake assessment, in each study area 3 highly-trained enumerators interviewed the women to obtain information about the usual food intake on the previous day using a quantitative 24-hour diet recall (24HR). Training for the 24HR included standardized probes for all the ingredients used, portion size estimation, cooking methods and local recipes. These representative recipes were used for all subjects who reported those foods.

Women were asked to recall each food they had eaten the previous day (yesterday) from the time they woke up to the time they went to bed. Meals and snacks eaten outside of the home were also recalled and then recorded by the interviewer. Household measurements (spoons/cups) and 3 dimensional food models were used to assist women in recalling the amount of all food consumed. Repeated 24HR non-consecutive were obtained from 453 (77%) of the subjects and were performed with a median interval of 7 days between the first and the second 24HR. If over the preceding 24 hours, there was a celebration/feast day where the women ate special or more/less than usual foods, the enumerators postponed their visit and in that time visited the other subjects on those days-asking the women to recall the previous 24 hours food eaten. A single 24HR of 482 children aged 2-6 years was also provided by the women. However, in regard to women who were not able to observe exactly what their child ate, particularly outside of the home, data on child food intake might therefore be unreliable and for this reason were not presented in the results part of this thesis (**Appendix Table A.4**).

Data from the 24HR of women were analysed for food groups intake, micronutrient intake, diet-related chronic disease prevention, and diet quality scores.

<u>Food Groups Intake</u>

In order to record food items from the 24HR records, foods were grouped into 10 groups following the FAO/FANTA guidelines (FAO/USAID/FANTA, 2014). This study's food groups were modified from the FAO/FANTA guidelines to make them more suitable to the geographical study areas (inland and coastal). The modified food groups are consistent throughout this study, all groups and all areas. The guideline definition separates a 'beans and peas' group from a 'nuts and seeds' group, however this study combined these two food groups into one, namely, 'legumes and nuts'. Flesh foods appears as one food group in the guidelines and this has been separated into two food groups in this study, namely, meat and fish. **Table 3.5** shows the food groups used in this study: (1) grains, roots and tubers; (2) legumes and nuts; (3) dairy; (4) fishes and seafood; (5) meat; (6) eggs; (7) vitamin A rich dark green leafy vegetables; (8) other vitamin A-rich vegetables and fruits; (9) other vegetables; and (10) other fruits. Vitamin A-rich food was defined as those with ≥120 RE/100 g (Daniels, 2009). All food groups contained in a mixed dish were counted separately. A food group was counted as eaten if the woman consumed the food 'yesterday' with a minimum intake requirement of 15 g (FAO/USAID/FANTA, 2014). The food group ‘‘other,’’ consisting of sweets, snacks, fat and oil, soft drinks, and condiments, was not included in this study but was used for the calculation of energy.

Micronutrient Intake

Daily total intake for each micronutrient for each woman was assessed by taking a 24HR or two 24HR obtained on non-consecutive days. To estimate adequacy for 12 micronutrients, this study computed cut-offs of WHO/FAO (2004) based on the Estimated Average Requirement (EAR) for vitamin A, folate, and vitamin B_{12} intakes. For thiamine (vitamin B_1), riboflavin (vitamin B_2), niacin, vitamin B_6, vitamin C, calcium, iron, magnesium, and zinc, which there is no information of EAR from WHO/FAO, the EAR of these nutrients were evaluated from the US Institute of Medicine of the National Academies (IOM, 2012). These micronutrients were selected because of their public health relevance (**Table 3.7**).

Diet-related Chronic Disease Prevention

The cut-offs of diet-related chronic disease prevention were based on WHO/FAO dietary guidelines (2003) for the intake of major nutrients and foods (i.e., carbohydrates, fat, protein), unsaturated and saturated fat, added sugar, cholesterol, fruits and vegetables, and dietary fiber (**Table 3.8**).

Diet Quality Scores

For scoring within this study, zero or one were assigned (Kant *et al*., 1993; Ponce, Ramirez & Delisle, 2006) to all variables contributing to diet quality. Dietary diversity scores (DDS) were calculated by summing the 10 categorized food groups. The maximum DDS was 10 as one point was counted for each food group with a minimum intake of 15 g. The maximum micronutrient adequacy score was 12: one point was given for each micronutrient if a woman met the EAR. The maximum score of diet-related chronic diseases prevention was 9: one point was given for each major nutrient/food if a woman met the WHO/FAO recommendations (**Table 3.9**).

2.5.4 Women's and Children's Anthropometry

In each study area, two enumerators who also interviewed socioeconomic characteristics of women, were rigorously trained to perform anthropometry. The software for Emergency Nutrition Assessment was used to calculate the precision and accuracy for the training measurements. The average results of all measurements of all enumerators was taken as a ‘reference’, to evaluate the quality of all anthropometric results of the enumerators. Body weight of each woman was recorded to the nearest 0.1 kg with an electronic scale (Soehnle 63166) which was kept on a firm horizontal surface. Height was recorded using a roll-up measuring tape to the nearest 0.1 cm. The woman was requested to stand upright without shoes with her back against the wall and heels together, looking forward. The BMI (body mass index; kg/m^2) classification was defined for underweight, normal, overweight, and obese (WHO, 2003). Of 588 mothers who were measured for weight and height, anthropometry of 482 children aged 2-6 years were also recorded. If one family had more than one child that fulfilled the study requirements, one child was randomly selected for anthropometry. Child body weight was recorded to the nearest 0.1 kg, with the child minimally clothed and without shoes, and height was measured to the nearest 0.1 cm. Mothers’ and children’s anthropometry were performed using the same calibrated equipment and standardized techniques. Three indices were used in assessing the nutritional status of children: weight-for-age Z-score (WAZ), height-for-age Z-score (HAZ), and weight-for-height Z-score (WHZ), which were calculated by using the WHO growth reference standard (WHO, 2006).

2.6 Limitations on Data Collection

Based on the study protocol, 200 women of non-smoking husbands and 400 women of smoking husbands from low-income families had to be recruited from urban and rural areas of Indonesia. With the prevalence of smoking among men in rural areas being more than 70% (Semba *et al.*, 2008), it was quite challenging for this study to find a sufficient number of non-smoking husbands. In addition to this situation, women of non-smoking husbands had to come from condition as similarly poor as those of smoking husbands i.e., monthly income below regional minimum wages. This was an important concern of the study design with subjects being purposely selected during fieldwork. Long distances and a scattered population in rural Gorontalo resulted in increased workload, time, and costs. Therefore, fieldwork could not have been more effective at selecting subjects in this rural area or elsewhere in neighbouring rural areas.

Another key factor of concern was the availability of human resources in this province. This study was highly dependent on a specific key skill i.e., phlebotomy. Blood samples of women had to be taken in the morning after a long night of fasting and the phlebotomist, having taken the sample, could not assist anymore during working day. At the same time, other phlebotomists were both private and government employees who already had their jobs descriptions. The “field-friendly” methods (such as collection of capillary blood samples) had to be taken into consideration. The investigator was capable of performing the sampling her/himself or of training a person to be able to take capillary blood sampling with a few days of support.

Because of these practical difficulties, the investigator decided to move to a rural area in another province, East Java, with a higher population density. In the first rural study area (Gorontalo), the study had 67 women of non-smoker husbands and 189 women of smoker husbands from 52 villages. To fulfil the total (n=600) and the ratio of sample size (smoker : non-smoker = 2 : 1), in the second study area (Jember district), the study tried to collect more subjects of non-smoker husbands. The study attained 135 women of non-smoker husbands and 197 women of smoker husbands from 42 villages.

2.7 Statistical Analyses

Descriptive data of the *socioeconomic status* of women, husbands, households, and children were compared between non-smoker and smoker husband groups using independent *t* test for continuously distributed variables and expressed as mean (±SD). The Pearson’s chi-square test was used to examine differences in proportions. Descriptive statistics were also used for describing the nutritional status of women (BMI) and children’s age, sex, weight, and height. Data on the socioeconomic status for each study area (coastal, inland) and both areas of subjects were presented.

The study outcome variables were the micronutrient status and dietary intakes of women and the nutritional status of children. The ANCOVA was used as the main analysis for all outcomes of continuous variables as the dependent variable. The independent variable included 2 groups: non-smoker and smoker husbands. Preliminary checks were done to ensure that there was no violation of the assumption of normality, homogeneity of variances, homogeneity of regression slopes, and reliable measurement of the covariate. Plotting of regression standardized residual was used to check if the assumption that the residuals are approximately normally distributed was met. Covariates were retained or dropped depending on *p*-values (<.2). Adjusted mean and 95^{th} confidence interval (CI) were calculated for retained variables.

Observed means and medians are provided in the tables of results. In addition to the main effects, interactions between husbands' smoker status and covariates were assessed to determine whether the effect of covariates appeared to differ between non-smoker and smoker husbands. Partial *eta* squared was used to determine the effect size for group mean differences: small (.02), medium (.13), and large (.26) (Cohen, 1992).

For the *micronutrient status of women*, continuous data of plasma ferritin, sTfR, RBP, and Hcy concentrations were logarithmically transformed by natural log (ln) to normalize their distributions and expressed as a geometric means (95% CI); meanwhile Hb and body iron concentrations were expressed as an arithmetic mean (SD). In each study area, the ANCOVA with daily energy intake (kilojoule/day) as a covariate was used to estimate the adjusted mean micronutrient status as dependent variables. While, daily energy intake and study area were included as covariates for analysing the total sample of women (both study areas), the Linear Probability Model was used to estimate the likelihood of prevalence of anaemia and micronutrient deficiencies (dichotomous outcomes) as the dependent variables. The relation between micronutrient status (Hb, ferritin, sTfR, body iron, RBP, and Hcy) and corresponding micronutrient intakes (iron, vitamin A, and vitamins B_2, B_6, folate and B_{12}), controlling for energy intake and study area, were examined by linear regression with micronutrient status as dependent variables.

For *dietary intake of women*, the Nutrisurvey software program (Nutrisurvey™) was used for entering dietary intake and for converting this information into energy and nutrient intakes based on the USDA Release 23 and the FAO Minilist food composition tables (FCT). Additionally, the Indonesian FCT (Nio, 1992; Persagi, 2009) was used for food items found neither in the USDA database nor in the FAO Minilist.

Data on food group intake, micronutrient intake and diet-related chronic disease prevention (except for energy, protein, fat, and carbohydrate) were logarithmically transformed to normalize their distributions and expressed as log-adjusted means (95% CI). The dependent variables were 10 food group intakes, 12 micronutrient intakes, 9 diet-related chronic disease prevention, and 3 scores on diet quality. To account for differences in socioeconomic status which might confound the association between dependent variables and husbands' smoker status, several indices of socioeconomic status were adjusted for. Potential covariates were determined when socioeconomic status in each study area was $p<.05$, as appropriate. The covariates were age and occupation of husbands in the coastal area (Gorontalo), while age, education level, marriage age of women; and age, education level, occupation of husbands were the covariates in the inland area (Jember).

The *child Z-scores*, WAZ, HAZ, and WHZ, were the dependent variables in ANCOVA. The analysis was controlled for potential covariates which showed a *p*-value <.05. In the coastal area (Gorontalo), covariates that might have affected the child Z-scores included age and occupation of fathers and age of children. In the inland area (Jember), covariates included schooling and mother's age at marriage; schooling and occupation of fathers; family size of households. For the total sample of children, covariates in mother's age at marriage, schooling, and occupation of fathers; age of children; and study area were included. The procedure 'generalized linear models with robust standard errors (GENLIN) ' was used to run a linear probability model comparing the likelihood of child malnutrition (Mood, 2010). The dichotomous outcomes: underweight, stunting, and wasting were the dependent variables.

The SPSS software package was used for all statistical analyses. A result was considered significant when *p*<.05 (two-tailed). The *p*-value was not corrected for multiple comparison (such as the Bonferroni-correction).

3 RESULTS

3.1 Socioeconomic Characteristics

The sociodemographic characteristics and nutritional status of women are shown in **Table 3.1**.

Coastal Area (Gorontalo)

The average age and age at first marriage were 30.7 years and 20 years, respectively. The average BMI of the women was 24.5 kg/m^2, with a larger proportion being overweight (34.3%) and obese (9.8%), and a smaller proportion (7.9%) being underweight. Husbands and wives had similar educational levels (6 years of schooling). There were no significant differences in average household size (5 persons; range: 3-18), with nearly one-third of both groups (32%) living as a part of an extended family. Households with a smoker husband spent an average of 11.6% of their monthly income on cigarettes; but in both groups, households spent similar proportions of their incomes on food, an average of 46% of their monthly total income.

Compared to women with non-smoking husbands, those with smoking husbands had older spouses and a higher number of husbands worked as fishermen or farmers (both $p<.05$).

Inland Area (Jember)

Compared to women married to non-smokers, those married to smokers were younger (30 vs. 31 years), as well as having married at a younger age (18 vs. 20 years), and they also had a lower education level (6.4 vs. 7.8 years) (all $p<.05$). They were also more likely to have a younger spouse (35 vs. 37 years), have a less educated husband (6.6 vs. 8.2 years), and a higher percentage of these smoker husbands worked as farmers (40.6 vs. 20%) (all $p<.05$). In both groups, the average BMI 23.7 kg/m^2 was similar ($p=.86$), with 27.4% being overweight, 7.5% obese, and 7.8% underweight. There were no significant differences between smoker and non-smoker husband groups with respect to: the average household size of 5 members (range: 2-10), more than half (53.9%) living in nuclear family structure, and their average total monthly income of 70 US$ in which 55% of their income was spent on food (all $p>.05$). The average household with a smoker husband spent 22% of their monthly income on cigarettes.

Both Study Areas (Total Subjects)

The average age of women and their husbands were 30.4 years and 35 years, respectively. All were Moslems by religion and had a mean BMI of 24 kg/m^2. About 30.4% of the women were overweighed and 8.5% obese, whilst 7.8% were underweight. Compared to women with non-smoker husbands, those with smoker husbands were married at a younger age and more likely to be less educated (both $p<.01$). They were also more likely to be married to a less educated spouse. A higher rate of husband’s occupation was fishermen and farmers (both $p<.001$). No significant differences were observed between groups with respect to the average household size of 5 members and the average total income of 67.5 US$ per month. The average total monthly household income spent on food as a percentage of total expenditure differed across groups accordingly: non-smoker husband family households, 53.2%, smoker husband family households 49.8% ($p=.08$). Households with smoker husbands spent 16.9% of their monthly income on cigarettes.

Regarding the proliferation of smoker husbands within the study areas there was a significant difference as to the percentage of non-smoker husbands in the inland area (Jember) which was twice that of the coastal area (Gorontalo).

Table 3.1 Characteristics of women related to husbands' smoker status[1]

Characteristics	Coastal (Gorontalo)			Inland (Jember)			Total subjects		
	W(NS)	W(S)		W(NS)	W(S)		W(NS)	W(S)	
	Mean ± SD or n (%)	Mean ± SD or n (%)	*p*[2]	Mean ± SD or n (%)	Mean ± SD or n (%)	*p*	Mean ± SD or n (%)	Mean ± SD or n (%)	*p*
Women									
Age (years)	30 ± 5.7 (n=67)	31 ± 5.8 (n=189)	.10	31 ± 6.7 (n=135)	30 ± 6.8 (n=197)	.02	31 ± 6.4 (n=202)	30 ± 6.4 (n=386)	.41
Schooling (years)	6.1 ± 3.0 (n=65)	6.3 ± 2.8 (n=186)	.62	7.8 ± 3.2 (n=135)	6.4 ± 2.4 (n=197)	<.001	7.2 ± 3.2 (n=200)	6.4 ± 2.6 (n=383)	.001
Marriage age (years)	20 ± 2.4 (n=65)	20 ± 2.8 (n=187)	.15	20 ± 4.2 (n=135)	18 ± 2.9 (n=197)	<.001	20 ± 3.7 (n=200)	19 ± 3.0 (n=384)	<.001
BMI (kg/m^2)	23.8 ± 3.9 (n=66)	24.7 ± 4.5 (n=188)	.11	23.5 ± 4.1 (n=135)	23.8 ± 4.2 (n=197)	.54	23.6 ± 4.0 (n=201)	24.3 ± 4.3 (n=385)	.07
Underweight (<18.5)	7 (10.6)	13 (6.9)	.16	12 (8.9)	14 (7.1)	.86	19 (9.5)	27 (7.0)	.33
Normal (18.5-24.9)	33 (50.0)	89 (47.3)		74 (54.8)	116 (58.9)		107 (53.2)	205 (53.2)	
Overweight (25-29.9)	24 (36.4)	63 (33.5)		39 (28.9)	52 (26.4)		63 (31.3)	115 (29.9)	
Obese (≥30)	2 (3.0)	23 (12.2)		10 (7.4)	15 (7.6)		12 (6.0)	38 (9.9)	
Husbands									
Age (years)	33 ± 5.3 (n=67)	35 ± 6.6 (n=186)	.01	37 ± 7.2 (n=135)	35 ± 7.9 (n=197)	.02	35 ± 6.8 (n=202)	35 ± 7.3 (n=383)	.48
Schooling (years)	6.5 ± 3.1 (n=65)	6.0 ± 2.6 (n=187)	.24	8.2 ± 3.4 (n=135)	6.6 ± 2.7 (n=197)	<.001	7.6 ± 3.4 (n=200)	6.3 ± 2.7 (n=384)	<.001

Table 3.1 Continued[1]

	Coastal (Gorontalo)			Inland (Jember)			Total subjects		
	W(NS)	W(S)		W(NS)	W(S)		W(NS)	W(S)	
	Mean ± SD or n (%)	Mean ± SD or n (%)	p^2	Mean ± SD or n (%)	Mean ± SD or n (%)	*p*	Mean ± SD or n (%)	Mean ± SD or n (%)	*p*
Occupation (%)			<.001			<.001			<.001
Fisherman	5 (7.7)	27 (14.4)		-	-		5 (2.5)	27 (7.0)	
Farming	11 (16.9)	49 (26.2)		27 (20.0)	80 (40.6)		38 (19.0)	129 (33.6)	
Waged labour	41 (63.1)	67 (35.8)		56 (41.5)	74 (37.6)		97 (48.5)	141 (36.7)	
Salaried	1 (1.5)	29 (15.5)		25 (18.5)	15 (7.6)		26 (13.0)	44 (11.5)	
Entrepreneur	7 (10.8)	15 (8.0)		27 (20.0)	28 (14.2)		34 (17.0)	43 (11.2)	
% cigarette expenditure per month	-	11.6 ± 8.5 (n=187)	-	-	21.9 ± 14.2 (n=197)	-	-	16.9 ± 12.8 (n=384)	-
Households									
Family size	5 ± 2.4 (n=65)	5.5 ± 2.2 (n=187)	.09	4.8 ± 1.6 (n=135)	4.6 ± 1.3 (n=197)	.15	4.9 ± 1.9 (n=200)	5 ± 1.8 (n=384)	.29
Family type			.52			.13			.04
Nuclear	42 (64.6)	129 (69.0)		66 (48.9)	113 (57.4)		108 (54)	242 (63)	
Extended	23 (35.4)	58 (31.0)		69 (51.1)	84 (42.6)		92 (46)	142 (37)	
Total income per month (US$)[3]	60.1 ± 20.6 (n=65)	65.6 ± 23.6 (n=187)	.07	69.2 ± 20.7 (n=135)	70.7 ± 32.0 (n=197)	.61	66.2 ± 21.1 (n=200)	68.2 ± 28.3 (n=384)	.34
% food expenditure per month	45 ± 19.3 (n=65)	46 ± 20.6 (n=187)	.76	57 ± 19.7 (n=135)	53 ± 25.1 (n=197)	.14	53.2 ± 20.3 (n=200)	49.8 ± 23.3 (n=384)	.08
Study area									<.001
Gorontalo (coastal)							67 (33.2)	189 (49.0)	
Jember (inland)							135 (66.8)	197 (51.0)	

[1] *W(NS)* women with non-smoking husbands; *W(S)* women with smoking husbands; *n* number of participants; *BMI* body mass index.

[2] Calculated using the chi-square test for categorical variables and the *t* test for continuous variables.

[3] US$ 1 was equivalent to 8,802.8 IDR (Oanda, 2011).

3.2 Micronutrient Status of Women

Of the 678 women screened, 90 could not be enrolled due to a number of reasons. Most exclusion were due to the women's refusal to provide a blood sample and on the following the day on which blood was taken, 2 more women did not return for their blood sample collection. In total, 586 women contributed a blood sample. During analysis, the samples from 6 women were excluded with regard to the Hb indicator (5 were considered severe outliers and 1 because of broken tube), leaving 580 women with Hb samples and 586 with plasma samples for indicators of iron- and vitamin A status. Results of two women with extremely high Hcy values (38.7 and 42.8 µmol/L) were excluded, leaving 428 women with plasma Hcy samples. Eighty-five women had plasma CRP concentrations >5 mg/L and/or AGP concentrations >1 g/L, which indicated inflammation or infection; data from these women were excluded from the statistical analysis for ferritin, body iron stores, and RBP.

Table 3.2 shows the indicators of iron, vitamin A and Hcy status in 2 study areas.

Coastal Area (Gorontalo)

The average Hb, ferritin, sTfR and body iron, RBP, and Hcy concentrations were within the normal range in both groups. The ANCOVA for non-smoker compared to smoker husbands on Hb, ferritin, sTfR, body iron, and RBP concentrations were found to have no significant main effects, covariates, or interactions. Though the differences were not significant, expected direction of associations between micronutrient status and groups were seen in 4 of the 5 indicators. Except for RBP concentration, there was a tendency in women with smoker husbands to present lower Hb, ferritin, and body iron concentrations and to present higher sTfR concentration than did those with non-smoker husbands.

Adjusted for energy intake, ANCOVA revealed that there was a significant effect for smoker status of husbands, with women married to smokers having higher Hcy concentration, by 0.8 µmol/L on average (adjusted ln-mean: 0.1 µmol/L, 95% CI: 0.003, 0.201 µmol/L, p=.04), than in those women married to non-smokers.

In both groups, the prevalence of anaemia was 19.6%. The prevalence of iron deficiency (ferritin <15 µg/L) and iron deficiency anaemia (Hb <120 g/L and ferritin <15 µg/L) were 5% and 3.2%, respectively, in women with non-smoker husbands, and there was an 11.2% rate of iron deficiency and a 7.1% iron deficiency anaemia in the smoker counterparts. The prevalence of tissue iron deficiency (sTfR >8.3 mg/L) was 3.6% in the 2 groups. The prevalence of a deficit in tissue iron (body iron <0 mg/kg) was 3.5% (1.7% in the women with non-smoker husbands compared to 4.1% in the women with smoker husbands). About one-fourth (25.2%) of the women had marginal vitamin A status (RBP <1.17 µmol/L), and 5% had hyperhomocysteinemia (Hcy ≥15 µmol/L). Linear Probability Model revealed that prevalence of anaemia (*p*=.90), tissue iron deficiency (*p*=.62), iron deficiency anaemia (*p*=.22), deficit in tissue iron (*p*=.28), marginal vitamin A status (*p*=.25), and hyperhomocysteinemia (*p*=.60) of women were not associated with their husbands' smoker status. Similarly, adjusted for energy intake and smoker groups*energy intake (*p*=.09 for tests of interaction), the model showed that there was no significant effect of husbands' smoker status on the iron deficiency prevalence of the women (*p*=.11) (**Table 3.3**).

Inland Area (Jember)

In both groups, mean Hb, ferritin, sTfR and body iron, RBP, and Hcy concentrations showed normal value. The ANCOVA for non-smoker to smoker husbands on Hb, ferritin, sTfR, body iron, and Hcy concentrations were found to have no significant main effects, covariates, or interactions. The differences were not significant, however, there was a tendency in women with smoker husbands to have lower plasma concentrations of ferritin and body iron, and to have higher concentration of Hcy than did those with non-smoker husbands. Meanwhile, the unexpected direction of associations between Hb and sTfR concentrations of women and smoker groups were noted.

Adjusted for energy intake, ANCOVA revealed that there was a significant effect for husbands' smoking, with women married to smokers having lower RBP concentration, by 0.1 µmol/L on average (adjusted ln-mean: 0.07 µmol/L, 95% CI: -0.15, -0.003 µmol/L, *p*=.04), than those with non-smoker husbands.

Approximately 16.1% of women were anaemic (17.2% in the group of women with non-smoker husbands compared to 15.3% in the women with smoker husbands). The prevalence of iron deficiency (ferritin <15 µg/L) was 1.8% in women married to non-smokers which was double (3.7%) in those with smoker husbands. The prevalence of tissue iron deficiency (sTfR >8.3 mg/L) was equally low (0.9%) in both groups. The prevalence of deficit in tissue iron (body iron <0 mg/kg) was zero in women with non-smoker husbands and almost 2% in those with smoker husbands. The prevalence of iron deficiency anaemia (Hb <120 g/L and ferritin <15 µg/L) was almost zero (0.8%) in women with non-smoker husbands but nearly four times (3.1%) in those with smoker husbands. The prevalence of marginal vitamin A status (RBP <1.17 µmol/L) was 32.7% in the women with non-smoker husbands and 40.4% in their smoker counterparts, and the prevalence of hyperhomocysteinemia (Hcy ≥15 µmol/L) was 14.4% in both groups. Linear Probability Model showed that prevalence of anaemia (*p*=.67) and hyperhomocysteinemia (*p*=.47) of women were not associated with husbands' smoking status. The model was found to have no significant covariates, or interactions. Adjusted for energy intake and smoking groups*energy intake (*p*=.17 for tests of interaction), there was no association between prevalence of marginal vitamin A status of women and husbands' smoker status (*p*=.47). For women who had iron deficiency, tissue iron deficiency, deficit in tissue iron, or iron deficiency anaemia, Linear Probability Model was not performed because of the smaller number of cases (**Table 3.3)**.

Both Study Areas (Total Subjects)

Mean Hb, ferritin, sTfR and body iron, RBP, and Hcy concentrations were in the normal range.

There was no significant difference in Hb-levels between the 2 groups (*p* =.63), after adjusting for study area and smoker groups*study area (*p*=.04 for tests of interaction). In Gorontalo, the mean Hb concentration was 129 g/L (95% CI: 126, 132 g/L) vs. 126 g/L (95% CI: 124, 128 g/L) (*p*=.11) in non-smoker and smoker husbands, respectively. In Jember, mean Hb concentration was 129 g/L (95% CI: 126, 131 g/L) vs. 130 g/L (95% CI: 129, 132 g/L) (*p*=.21), respectively.

Controlling for study area, there were no significant differences on ferritin, sTfR, and body iron concentrations of the 2 groups (all *p*>.05). Similarly, there was no significant difference between the 2 groups on RBP concentration (*p* =.23), after adjusting for study area and smoking groups*study area (*p*=.17 for tests of interaction).

Although, no significant differences were observed, however, women with smoker husbands compared to those with non-smoker husbands tended to have lower Hb, ferritin, body iron, and RBP and to have higher sTfR concentrations.

Controlling for energy intake and study area, women with smoker husbands had significantly higher Hcy concentration, by 0.08 µmol/L (adjusted ln-mean; 95% CI: 0.02, 0.15 µmol/L, *p* =.01) than those with non-smoker husbands (**Table 3.4)**.

The prevalence of anaemia was 17.6% in the 2 groups. The prevalence of iron deficiency (ferritin <15 µg/L), iron deficiency anaemia (Hb <120 g/L and ferritin <15 µg/L), and deficit in tissue iron (body iron <0 mg/kg) were 2.6-fold, 3.1-fold, and 5.5-fold, respectively, higher in women married to smokers than those married to non-smokers. Few women (2%) had tissue iron deficiency (sTfR >8.3 mg/L).

Low plasma RBP (<1.17 µmol/L) was found in 31.3% of the women and 10% had elevated plasma Hcy levels (≥15 µmol/L) in both groups. The Linear Probability Model showed that a prevalence of anaemia (p=.95) and tissue iron deficiency (p=.95) were not associated with smoking status of husbands. Less than half of the anaemic women were iron deficient (**Appendix Fig. A.2**) which showed that their anaemia was not caused by iron deficiency. Adjusted for energy intake, study area, smoking groups*energy intake (p=.08 for tests of interaction), and smoking groups*study area (p=.12 for tests of interaction), there was a significantly lower prevalence of iron deficiency (p=.04) in women married to non-smokers than their smoke exposed counterparts. Women married to non-smokers had a lower rate of iron deficiency anaemia (p=.04) than those women with smoker husbands, after controlling for energy intake and study area. The wives of non-smokers also had a lower deficit in tissue iron (p=.04) than those women with smoking husbands, after controlling for energy intake. Adjusted for study area, there were no significant differences for groups, with regard to prevalence of marginal vitamin A status (p=.10) and hyperhomocysteinemia (p=.38) **(Table 3.3).**

Table 3.2 Iron, vitamin A, and homocysteine status of women in coastal (Gorontalo) area and inland (Jember) area, related to husbands' smoking status[1]

	Coastal (Gorontalo)						Inland (Jember)					
	W(NS)		W(S)				W(NS)		W(S)			
	Mean (95% CI)	Adjusted mean[2] (95% CI)	Mean (95% CI)	Adjusted mean (95% CI)	Partial Eta Squared	*p*[3]	Mean (95% CI)	Adjusted mean (95% CI)	Mean (95% CI)	Adjusted mean (95% CI)	Partial Eta Squared	*p*
Hb[4] (g/L)	129 ± 13 (n=63)	129 (126, 132)	126 ± 13 (n=187)	126 (124, 128)	.008	.15	129 ± 12 (n=134)	128 (127, 130)	130 ± 11 (n=196)	130 (129, 132)	.006	.17
Ferritin[5,6] (µg/L)	52.1 (42.2, 64.4) (n=60)	4.0 (3.7, 4.2)	47.3 (41.7, 53.7) (n=170)	3.9 (3.7, 4.0)	.003	.44	62.9 (55.3, 71.6) (n=110)	4.1 (4.0, 4.3)	59.1 (53.6, 65.1) (n=161)	4.1 (4.0, 4.2)	.003	.43
sTfR[5] (mg/L)	3.6 (3.3, 4.0) (n=65)	1.3 (1.2, 1.4)	3.8 (3.6, 4.0) (n=188)	1.3 (1.3, 1.4)	.002	.45	3.5 (3.3, 3.7) (n=135)	1.3 (1.2, 1.3)	3.4 (3.3, 3.6) (n=198)	1.2 (1.2, 1.3)	.001	.57
Body iron[4,6] (mg/kg)	8.1 ± 3.9 (n=60)	8.1 (7.1, 9.1)	7.6 ± 3.9 (n=170)	7.6 (7.0, 8.2)	.003	.38	9.0 ± 2.9 (n=110)	9.0 (8.5, 9.5)	8.7 ± 2.8 (n=161)	8.7 (8.3, 9.1)	.002	.42
RBP[5,6] (µmol/L)	1.4 (1.3, 1.5) (n=60)	0.3 (0.3, 0.4)	1.4 (1.4, 1.5) (n=170)	0.4 (0.3, 0.4)	.000	.92	1.3 (1.2, 1.4) (n=110)	0.3 (0.2, 0.3)	1.2 (1.2, 1.3) (n=161)	0.2 (0.2, 0.2)	.02	.04
Hcy[5] (µmol/L)	7.9 (7.2, 8.7) (n=53)	2.1 (2.0, 2.1)	8.7 (8.3, 9.2) (n=146)	2.2 (2.1, 2.2)	.02	.04	10.7 (10.0, 11.4) (n=117)	2.3 (2.3, 2.4)	11.2 (10.5, 11.9) (n=112)	2.4 (2.4, 2.5)	.01	.11

[1] *W(NS)* women with non-smoker husbands; *W(S)* women with smoker husbands; *n* number of participants, *Hb* haemoglobin, *sTfR* soluble transferrin receptor, *RBP* retinol binding protein, *Hcy* homocysteine.
[2] Adjusted mean: adjusted for covariate (energy intake), natural log transformed dependent variable.
[3] *p*-value for comparison between micronutrient status of women married to non-smokers and women married to smokers (ANCOVA).
[4] Arithmetic mean ± SD.
[5] Geometric mean (95% CI).
[6] Women with plasma CRP concentration >5 mg/L and/or AGP concentration >1 g/L were excluded.

Table 3.3 Prevalence of women with anaemia, low iron stores, marginal vitamin A status and hyperhomocysteinemia, related to husbands' smoker status[1]

	Coastal (Gorontalo)		Inland (Jember)		Total subjects	
	W(NS)	W(S)	W(NS)	W(S)	W(NS)	W(S)
	%		%		%	
Anaemia, Hb <120 g/L	19.0 (n=63)	19.8 (n=187)	17.2 (n=134)	15.3 (n=196)	17.8 (n=197)	17.5 (n=383)
Iron deficiency, ferritin <15 µg/L[2]	5.0 (n=60)	11.2 (n=170)	1.8 (n=110)	3.7 (n=161)	2.9 (n=170)	7.6 (n=331)
Tissue iron deficiency, sTfR >8.3 mg/L	4.6 (n=65)	3.2 (n=188)	0.7 (n=135)	1.0 (n=198)	2.0 (n=200)	2.1 (n=386)
Deficit in tissue iron, body iron <0 mg/kg[2]	1.7 (n=60)	4.1 (n=170)	0.0 (n=110)	1.9 (n=161)	0.6 (n=170)	3.3 (n=331)
Iron deficiency anaemia, Hb <120 g/L and ferritin <15 µg/L[2]	3.2 (n=63)	7.1 (n=184)	0.8 (n=129)	3.1 (n=195)	1.6 (n=192)	5.0 (n=379)
Marginal vitamin A status, RBP <1.17 µmol/L[2]	20.0 (n=60)	27.1 (n=170)	32.7 (n=110)	40.4 (n=161)	28.2 (n=170)	32.9 (n=331)
Hyperhomocysteinemia, Hcy ≥15 µmol/L	3.8 (n=53)	5.5 (n=146)	12.8 (n=117)	16.1 (n=112)	10.0 (n=170)	10.1 (n=258)

[1] *W(NS)* women with non-smoking husbands; *W(S)* women with smoking husbands; *n* number of participants, *Hb* haemoglobin, *sTfR* soluble transferrin receptor, *RBP* retinol binding protein, *Hcy* homocysteine.
[2] Women with plasma CRP concentration >5 mg/L and/or AGP concentration >1 g/L were excluded.

Table 3.4 Iron, vitamin A, and homocysteine status of total sample of women, related to husbands' smoking status[1]

		W(NS)			W(S)			
	N	Mean (95% CI)	Adjusted mean[2] (95% CI)	n	Mean (95% CI)	Adjusted mean (95% CI)	Partial Eta Squared	*p*[3]
Hb[4] (g/L)	197	128.7 ± 12.3	129 (127, 131)	383	128.3 ± 12.0	128 (127, 129)	.000	.63
Ferritin[5,6] (µg/L)	170	58.9 (52.6, 65.8)	4.0 (3.9, 4.2)	331	52.7 (48.6, 57.2)	4.0 (3.9, 4.0)	.002	.28
sTfR[5] (mg/L)	200	3.5 (3.4, 3.7)	1.3 (1.2, 1.3)	386	3.6 (3.5, 3.7)	1.3 (1.2, 1.3)	.000	.88
Body iron[4,6] (mg/kg)	170	8.7 ± 3.3	8.5 (8.0, 9.0)	331	8.1 ± 3.4	8.1 (7.8, 8.5)	.003	.24
RBP[5,6] (µmol/L)	170	1.3 (1.3, 1.4)	0.3 (0.3, 0.4)	331	1.3 (1.3, 1.4)	0.3 (0.2, 0.3)	.003	.23
Hcy[5] (µmol/L)	170	9.7 (9.2, 10.3)	2.2 (2.2, 2.3)	258	9.7 (9.3, 10.1)	2.3 (2.3, 2.3)	.014	.01

[1] *W(NS)* women with non-smoker husbands; *W(S)* women with smoker husbands; *n* number of participants, *Hb* haemoglobin, *sTfR* soluble transferrin receptor, *RBP* retinol binding protein, *Hcy* homocysteine.
[2] Adjusted mean: adjusted for covariates (energy intake, study area), natural log transformed dependent variable.
[3] *p*-value for comparison between micronutrient status of women married to non-smokers and women married to smokers (ANCOVA).
[4] Arithmetic mean ± SD.
[5] Geometric mean (95% CI).
[6] Eighty-five women had plasma CRP concentration >5 mg/L and/or AGP concentration >1 g/L were excluded.

3.3 Dietary Intake of Women

The 24HR dietary recall were obtained for 588 women and repeated 24HR non-consecutive were obtained from 453 (77%) of the subjects. As food consumption patterns between the two study areas were very different, the comparisons of women's diet related to husbands' smoker status from each study area are presented separately.

<u>Food Groups Intake</u>

Results of food groups intake were not shown for all women. This study classified a food group as 'eaten' with a minimum intake requirement of 15 g which was consumed by women during observation days. **Tables 3.5** and **3.6** show descriptions of 10 food groups, by study area and median intake according to husbands' smoking status and two study areas, respectively.

Coastal Area (Gorontalo)

In both groups, women's diet included white rice and ground corn as main staple foods with median total intake of 400 g. Fish were commonly consumed with median intake of 50 g. More than half of the women consumed other provitamin A-rich vegetables and fruits with a median daily intake of 40 g. Consumption of other food groups was rare with less than 10% of women consuming legumes, eggs, vitamin A rich dark green leafy vegetables, other vegetables and fruits. Neither group of women consumed meat nor dairy products.

Consumption of food groups were (in descending order): all women ate grains, 73.4% ate fish, 59% ate other provitamin A-rich vegetables and fruits, 9.8% ate provitamin A rich dark green leafy vegetables, 7.8% ate legumes, 3.1% ate other fruits, 1.6% ate other vegetables, and 1.6% ate eggs.

After adjusting for occupation of husbands, there was neither a significant difference between the two groups on *grain* consumption (p=.30) nor between the two groups on *fish* consumption of women (p=.43), after adjusting for covariate (occupation of husbands) and interaction (smoker groups*occupation of husbands, p=.27).

The ANCOVA for non-smoker compared to smoker husbands on *other provitamin A-rich vegetables and fruits* consumption of women detected no significant effects, covariates, or interactions.

Inland Area (Jember)

Women's diet included white rice as main staple food with a median intake of 425 g. Legumes were often consumed with median intake of 200 g. Other vegetables with median intake of 74 g were more frequently consumed than other provitamin A-rich vegetables and fruits with median intake of 50 g. About 15% of women consumed provitamin A-rich dark green leafy vegetables with a median intake of 46 g, and less than 10% consumed other fruits with a median intake of 86 g. Less than one-fifth of the women consumed fish with a median intake of 40 g and eggs with a median intake of 44 g. Meat (median intake: 68 g) was infrequently consumed. Neither group of women consumed dairy products.

Consumption of food groups was as follows in descending order: all women ate grains, 67.8% ate legumes, 44.6% ate other vegetables, 38.3% ate other provitamin A-rich vegetables and fruits, 18.7% ate fishes, 15.1% ate provitamin A-rich dark green leafy vegetables, 12% ate eggs, 9.6% ate other fruits, and 6% ate meat.

There was no significant difference between the two groups on *grains* consumption (*p*=.73), after adjusting for covariates (marriage age and occupation of husbands) and interaction (smoker groups*occupation of husbands, *p*=.14). No significant differences were found between the two groups on *fish* consumption (*p*=.67) after adjusting for occupation of husbands and on *eggs* consumption (*p*=.54) after controlling for age, mother's age at marriage, education level of women and occupation of husbands. There was no significant effect of husbands' smoker status on *meat* consumption of women (*p*=.40) after adjusting for covariates (women: age, age of marriage, and education level; husbands: occupation) and interaction (smoker groups*age of women, *p*=.01). The ANCOVA for non-smoker compared to smoker husbands on *legumes* and pro*vitamin A-rich dark green leafy vegetables* consumption of women found no statistically significant effect. In addition, there were no significant effects of the smoker status of husbands on the consumption of *other provitamin A-rich vegetables and fruits* (*p*=.20) after adjusting for age. No significant difference was observed between the two groups on *other fruits* consumption of women (*p*=.23) after adjusting for husband's and wife's education. After adjusting for the educational level of the women and the occupation of husbands, wives with non-smoker husbands were found to consume more *other vegetables* than those with smoking husbands (*p*=.01).

Table 3.5 Food groups descriptions, related to study areas[1]

Food groups	Representative foods	Coastal (Gorontalo)		Inland (Jember)	
		%	No[2]	%	No
Grains	Rice, ground corn, noodles, rice noodles, rice flour, wheat flour, glutinous rice, glutinous rice flour Root and tubers: cassava, potato, tapioca starch, sago, fermented cassava	100.0	1	100.0	1
Legumes and nuts	Peanuts, mung beans, coconut meat, coconut milk, soya bean, fermented soya bean, tofu, cowpeas	7.8	5	67.8	2
Dairy					
Fishes and seafood	Tilapia, tuna, milkfish, catfish, squid, salted fish, small shrimp, anchovy	73.4	2	18.7	5
Meat	Chicken, goat, beef, meatball, sausage, beef liver			6.0	9
Eggs	Chicken egg, quail egg	1.6	8	12.0	7
Vitamin A rich dark green leafy vegetables	Spinach, swamp cabbage, cassava leaves, papaya leaves, winged bean leaves, watercress, taro leaves, horseradish-tree leafy tips	9.8	4	15.1	6
Other vitamin A rich vegetables and fruits	Carrot, tomato, sweet potato, pumpkin, papaya, mango	59.0	3	38.3	4
Other vegetables	Yardlong bean, snap green bean, cabbage, cauliflower, bean sprouted, spring onions, eggplant, towel gourd, chayote, celery, cucumber	1.6	7	44.6	3
Other fruits	Banana, watermelon, pineapple, rose-apple, apple, jackfruit, star fruit, snake fruit	3.1	6	9.6	8

[1]"Vitamin A-rich" is defined as ≥120 RE/100 g.
[2] Consumption of food group ≥15 g in descending order

Table 3.6 Median intakes of women, who consumed food group ≥15 gram, in coastal area (Gorontalo) and inland area (Jember), related to husbands' smoker status[1]

	Coastal (Gorontalo)						Inland (Jember)					
	W(NS)		W(S)				W(NS)		W(S)			
Food groups	Median[2]	Adjusted mean[3] (95% CI)	Median	Adjusted mean (95% CI)	Partial Eta Squared	*p*[4]	Median	Adjusted mean (95% CI)	Median	Adjusted mean (95% CI)	Partial Eta Squared	*p*
Grains	400 (n=65)	2.6 (2.6, 2.6)	400 (n=187)	2.6 (2.6, 2.6)	.004	.30	427 (n=135)	2.6 (2.6, 2.7)	420 (n=197)	2.6 (2.6, 2.6)	.000	.73
Legumes and nuts	133 (n=7)	2.2 ± 0.2	104 (n=13)	1.9 ± 0.4			200 (n=88)	2.3 (2.2, 2.3)	209 (n=137)	2.3 (2.3, 2.4)	.002	.56
Dairy												
Fishes	50 (n=42)	1.7 (1.7, 1.8)	50 (n=143)	1.7 (1.7, 1.7)	.004	.43	46 (n=20)	1.7 (1.5, 1.8)	40 (n=42)	1.7 (1.6, 1.8)	.003	.67
Meat							47 (n=8)	1.9 (1.7, 2.1)	77 (n=12)	2.0 (1.9, 2.1)	.065	.40
Eggs	55 (n=1)	1.7	55 (n=3)	1.8 ± 0.1			43 (n=22)	1.6 (1.6, 1.7)	46 (n=18)	1.6 (1.5, 1.7)	.011	.54
Vitamin A rich dark green leafy vegetables	21 (n=7)	1.3 ± 0.1	20 (n=18)	1.3 ± 0.1			71 (n=19)	1.8 (1.7, 2.0)	100 (n=31)	1.9 (1.8, 2.0)	.02	.27
Other vitamin A-rich vegetables and fruits	46 (n=40)	1.7 (1.6, 1.7)	38 (n=111)	1.6 (1.6, 1.7)	.002	.60	50 (n=47)	1.8 (1.7, 1.8)	50 (n=80)	1.7 (1.6, 1.8)	.013	.20
Other vegetables	160 (n=1)	2.2	18 (n=3)	1.3 ± 0.1			82 (n=59)	1.9 (1.8, 2.0)	55 (n=89)	1.8 (1.7, 1.8)	.042	.01
Other fruits	43 (n=1)	1.6	134 (n=7)	2.0 ± 0.2			98 (n=14)	2.0 (1.8, 2.2)	74 (n=18)	1.8 (1.7, 2.0)	.051	.23

[1] *W(NS)*, women with non-smoker husbands; *W(S)*, women with smoker husbands.
[2] Median values were calculated using descriptive statistics.
[3] Adjusted mean: adjusted for covariates, log10 transformed dependent variables.
[4] *p*-value for comparison between food group intake of women married to non-smokers and women married to smokers (ANCOVA).

Micronutrient Intake

Table 3.7 shows the micronutrient intake of women according to husbands' smoker status and the two study areas.

Coastal Area (Gorontalo)

In both groups, median intakes for all micronutrients was well below the recommended EAR. Expected direction of associations between micronutrient intakes and groups were seen in eight (vitamins B_1, B_6, folate, C as well as mineral calcium, magnesium, iron, zinc) of the 12 micronutrients. Women with non-smoker husbands compared to those with smoker husbands tended to have higher intakes of these eight micronutrients.

Adjusting for occupation of husbands, there was no significant effect of smoker status of husbands on vitamins A, niacin, C as well as on mineral iron and zinc intakes of women (all p>.05). Similarly, there was no significant difference between the two groups on folate intake of women after adjusting for age of husbands (p=.71).

Adjusting for age and occupation of husbands, there was no significant difference between the two groups on vitamins B_1 and B_{12} intakes of women (both p>.05).

There was no significant effect of smoker status of husbands on vitamin B_2 intake of women (p=.62); after adjusting for covariates (husbands: age and occupation) and interaction (smoking groups*age of husbands, p=.12).

Adjusting for occupation of husbands (p=.001), there was no significant interaction effect (smoker groups*occupation of husbands, p=.07). The main effect of smoker status of husbands on vitamin B_6 intake of women was not significant (p=.64).

The ANCOVA for non-smoker compared to smoker husbands on calcium and magnesium intakes of women was found to have no significant main effects, covariates, or interactions.

Inland Area (Jember)

Median micronutrient intake was in most cases lower than the EAR, with the exception of vitamin A (299 RE/d) and iron (10.3 mg/d) for women with non-smoker husbands. Meanwhile, those with smoker husbands met the recommended EAR for median intakes of iron (10.8 mg/d) and zinc (7.1 mg/d). Intakes of vitamins B_1, B_2, niacin, B_6, and magnesium were slightly below the EAR and were well below the EAR for folate, vitamins B_{12}, C and calcium for both groups of women. Women with non-smoker husbands compared to those with smoker husbands tended to have higher intakes of the eight micronutrients (vitamins A, B_1, niacin, B_6, folate, B_{12}, C as well as magnesium).

The ANCOVA for non-smoker compared to smoker husbands on vitamins A, B_1, B_2, folate, B_{12}, and mineral magnesium intakes of women controlling for occupation of husbands was found to have no significant main effect or interaction.

Adjusting for education of husbands (p=.01), there was no significant interaction effect (smoker groups*education of husbands, p=.09). The main effect of smoker status of husbands on vitamin B_6 intake of women was not significant (p=.64).

There was no significant difference between the two groups of niacin intake of women (p=.59), after adjusting for occupation and education level of husbands; age and education level of women; smoking groups*education levels of husbands (p=.02) and smoking groups*age of women (p=.18).

There was no significant effect of husbands' smoker status on vitamin C intake of women (p=.91), after adjusting for covariates (husbands: occupation; women: age, age of marriage, education level) and interactions (smoking groups*marriage age of women (p=.10) and smoking groups*education level of women (p=.20)).

The ANCOVA, adjusting for occupation of husbands and age of woman at marriage (both p>.05), indicated that there was no significant effect of husbands' smoking status on intakes of iron and zinc.

Adjusting for covariates (husbands: occupation and education level; women: age and age of marriage), there was no significant difference between the 2 groups on calcium intake of women (p=.63).

Table 3.7 Micronutrient intakes of women in coastal area (Gorontalo) and inland area (Jember), related to husbands' smoker status[1]

		Coastal (Gorontalo)						Inland (Jember)					
		W(NS) n=67		W(S) n=189				W(NS) n=135		W(S) n=197			
	EAR	Median (unit/d)	Adjusted mean[2] (95% CI)	Median (unit/d)	Adjusted mean (95% CI)	Partial Eta Squared	*p*[3]	Median (unit/d)	Adjusted mean (95% CI)	Median (unit/d)	Adjusted mean (95% CI)	Partial Eta Squared	*p*
Thiamin	0.9 mg	0.3	-0.5 (-0.6,-0.4)	0.3	-0.5 (-0.6, -0.5)	.000	.83	0.6	-0.2 (-0.3,-0.2)	0.5	-0.3 (-0.3,-0.2)	.000	.14
Riboflavin	0.9 mg	0.2	-0.6 (-0.7,-0.6)	0.2	-0.6 (-0.7, -0.6)	.001	.62	0.6	-0.2 (-0.3,-0.2)	0.7	-0.2 (-0.3,-0.2)	.001	.69
Niacin	11 mg	5.1	0.7 (0.7, 0.8)	4.9	0.7 (0.7, 0.8)	.001	.57	8.1	0.9 (0.8, 0.9)	7.7	0.9 (0.9, 0.9)	.001	.59
Vitamin B_6	1.1 mg	0.4	-0.1 (-0.1,-0.1)	0.4	-0.1 (-0.1, -0.1)	.001	.64	0.8	-0.1 (-0.1,-0.1)	0.8	-0.1 (-0.1,-0.1)	.001	.64
Folate	320 µg	57	1.7 (1.7, 1.8)	53	1.8 (1.7, 1.8)	.001	.71	168	2.2 (2.2, 2.3)	156	2.2 (2.2, 2.2)	.004	.23
Vitamin B_{12}	2 µg	1.2	0.4 (0.3, 0.4)	1.2	0.4 (0.3, 0.4)	.000	.90	0.5	0.3 (0.3, 0.4)	0.4	0.3 (0.3, 0.4)	.001	.59
Vitamin C	60 mg	12	1.1 (1.0, 1.2)	10	1.1 (1.0, 1.1)	.000	.91	25	1.4 (1.3, 1.4)	23	1.4 (1.3, 1.4)	.000	.91
Vitamin A	270 RE	143	2.1 (2.1, 2.2)	138	2.2 (2.1, 2.2)	.000	.98	299	2.4 (2.4, 2.5)	257	2.4 (2.3, 2.4)	.005	.19
Calcium	800 mg	84	2.0 (1.9, 2.1)	77	1.9 (1.9, 2.0)	.004	.33	426	2.6 (2.6, 2.7)	501	2.6 (2.6, 2.7)	.001	.63
Magnesium	255-265 mg	75	1.9 (1.8, 1.9)	63	1.8 (1.8, 1.9)	.002	.51	210	2.3 (2.3, 2.4)	220	2.3 (2.3, 2.3)	.000	.92
Iron	8.1 mg	6.1	0.8 (0.7, 0.9)	6.2	0.8 (0.7, 0.8)	.002	.48	10.3	1.0 (1.0, 1.1)	10.8	1.0 (1.0, 1.1)	.000	.83
Zinc	6.8 mg	3.7	0.6 (0.5, 0.6)	3.3	0.5 (0.5, 0.6)	.006	.24	6.7	0.8 (0.8, 0.9)	7.1	0.8 (0.8, 0.9)	.000	.92

[1] *W(NS)*, women with non-smoker husbands; *W(S)*, women with smoker husbands; *EAR*, Estimated Average Requirement [taken from WHO/FAO (2004) or IOM (2011)].
[2] Adjusted mean: adjusted for covariates, log10 transformed dependent variables.
[3] *p*-value for comparison between micronutrient intakes (unit/day) of women married to non-smokers and women married to smokers (ANCOVA).

Diet-related Chronic Disease Prevention

Table 3.8 shows intake in women for prevention of diet-related chronic disease according to husbands' smoking status and 2 study areas.

Coastal Area (Gorontalo)

Median total energy intake was low (4,767 kilojoule/day) in both smoker and non-smoker groups. However, diet of women met WHO/FAO recommendations for the distribution of the total energy from protein (11%), total (24.5%) and saturated fat (SFA), and carbohydrates (65%). Still, about 19.5%, 10.2%, and 13.7% of women had below the recommendations for the proportion of energy from protein, total fat, and carbohydrate, respectively. While, 43.8% had exceeded the limit of the recommendations for proportion of energy from SFA. In both groups, the contribution from polyunsaturated fatty acids (PUFA) to the total energy intake was below the recommended level; with only 4.7% of women meeting the recommendations.

Proportion of energy from sugar and median intake of cholesterol reflected the recommendations. The consumption of fruits, vegetables, 'legumes and nuts' along with dietary fiber were generally well below the recommendations. The expected tendency in the correlation between diet-related chronic disease prevention and groups (smoker and non-smoker) were seen in six of the nine recommendations (distribution of total energy from protein, PUFA, sugar; median intake of cholesterol, vegetables, fiber). Women with non-smoker husbands compared to those with smoker husbands tended to have higher vegetables, fruits and fiber intakes; lower cholesterol intake, higher proportion of energy from protein, PUFA; a lower proportion of energy from sugar.

After adjusting for occupation of husbands, there was no significant difference between the two groups on energy intakes or the proportion of energy from SFA of either groups of women (both p>.05). Similarly, there was no significant difference between the two groups on proportion of energy from fat of women (p=.42) after adjusting for the age of husbands.

There was no significant effect of husbands' smoker status on cholesterol intake of women (p=.39), after adjusting for covariates (age and occupation of husbands) and interaction (smoker groups*age of husbands, p=.20).

Women with non-smoker husbands were associated with a lower 'proportion of energy intake from sugar' compared to those with smoking husbands (*p*=.01). The ANCOVA was found to have no significant covariates or interactions.

The ANCOVA for non-smoker husbands compared to smoker husbands on proportion of energy from protein, PUFA, carbohydrate, intakes of vegetables and fiber of women was found to have no significant main effects, covariates, or interactions.

Inland Area (Jember)

Both groups had median energy intake of 6,010 kilojoule/day, with 15.5% from protein, 26.8% from fat, and 57.5% from carbohydrates. Diet of women met WHO/FAO recommendations for the distribution of the total energy from protein, total fat, SFA, PUFA; carbohydrates and sugar. About 2.1% of women had below the recommendations for the proportion of energy from protein, 7.8% below the recommendations for proportion of total fat, and 37.7% of women had below the recommendations for proportion of carbohydrates. Meanwhile, 21.1% exceeded the limit of recommendations for proportion of energy from SFA and 45.5% had below the recommendations for proportion of energy from PUFA. Only 1.8% of women exceeded the limit of recommendations for proportion of energy from sugar.

Intakes of cholesterol followed the recommendations. The consumption of fruits and vegetables as well as fiber were generally well below the recommendations. Among women with non-smoking husbands, proportion of energy from SFA was lower, but from carbohydrate was higher than among their smoking counterparts. The expected tendency in the correlation between diet-related chronic disease prevention and groups were met in four of the nine recommendations (distribution of total energy from carbohydrate, fat, and SFA; median intake of fiber). Women with non-smoker husbands compared to those with smoker husbands tended to have higher fiber intake; higher proportion of energy from carbohydrate; lower proportion of energy from fat and SFA.

There was no significant difference between the two groups on energy intake of women (*p*=.60), after adjusting for covariates (marriage age of women and education level of husbands) and interaction (smoker groups*education level of husbands, *p*=.16).

After adjusting for education of husbands, there was a marginally lower proportion of energy from fat intake and marginally higher proportions of energy from carbohydrate intake in women who were married to non-smoker husbands than those women who were married to smokers (both *p*=.08).

After adjusting for age of women and occupation of husbands, there were no significant effect of husbands' smoker status on the proportion of energy from PUFA intake of women (*p*= .55).

There was no significant effect of husbands' smoker status on the proportion of energy from protein intake of women (*p*=.66), after adjusting for covariate (education level of women) and interaction (smoker groups*education level of women, *p*=.04) or on proportion of energy from SFA intake of women (*p*=.10), after controlling for education level of husbands and smoker groups*education level of husbands (*p*=.14).

The ANCOVA for non-smoker compared to smoker husbands on cholesterol intake of women after adjustment for occupation of husbands was found to be of no significant difference (*p*=.98).

There were no significant effect of husbands' smoking status on proportion of energy from sugar intake of women (*p*=.17), after adjusting for covariates (husbands: occupation and education level, women: age of marriage) and interactions (smoker groups*occupation of husbands (*p*=.05), smoker groups*education level of husbands (*p*=.03), smoker groups* marriage age of women (*p*=.13).

No significant association between smoking status of husbands and fruits and vegetables intake of women (*p*=.13) was observed, after adjusting for covariates (husbands: occupation and education level, women: age of marriage) and interactions (smoker groups*occupation of husbands (*p*=.04), smoker groups*education level of husbands (*p*=.001)).

Adjusting for age of women, education level and occupation of husbands, no difference in fiber intake of women was found between non-smoker and smoker husband groups.

Due to a few cases and inconsistent interactions, further analysis to check interactions between factors was not carried out (which was therefore less reliable for interpretation).

Table 3.8 Diet-related chronic disease prevention of women in coastal area (Gorontalo) and inland area (Jember), related to husbands' smoker status[1]

		Coastal (Gorontalo)						Inland (Jember)					
		W(NS) n=67		W(S) n=189				W(NS) n=135		W(S) n=197			
	WHO/ FAO[2]	Median[3]	Adjusted mean[4] (95% CI)	Median	Adjusted mean (95% CI)	Partial Eta Squared	p[5]	Median	Adjusted mean (95% CI)	Median	Adjusted mean (95% CI)	Partial Eta Squared	p
Energy (kJ)		5006	5101 (4690, 5511)	4748	4895 (4657, 5132)	.003	.36	5808	6270 (5851, 6689)	6101	6417 (6072, 6762)	.001	.60
Protein	10-15%	11.5	11.5 (11.0, 12.0)	11.0	11.3 (11.0, 11.6)	.001	.57	15.0	15.4 (14.8, 15.9)	15.5	15.5 (15.1, 16.0)	.001	.66
Total fat	15-30%	24.5	25.3 (23.3, 27.2)	24.0	24.3 (23.2, 25.5)	.003	.42	26.0	25.9 (24.3, 27.5)	28.0	27.8 (26.5, 29.1)	.009	.08
SFA	<10%	9.3	0.9 (0.9, 1.0)	9.4	1.0 (0.9, 1.0)	.000	.94	6.6	0.8 (0.8, 0.9)	7.5	0.9 (0.8, 0.9)	.008	.10
PUFA	6-10%	2.9	0.5 (0.4, 0.5)	2.4	0.4 (0.4, 0.5)	.005	.31	6.4	0.8 (0.7, 0.9)	8.0	0.8 (0.8, 0.9)	.001	.55
CHO	55-75%	63.5	63 (61, 65)	65.0	64 (63, 66)	.006	.22	58.5	59 (57, 61)	57.0	57 (55, 58)	.01	.08
Free sugars	<10%	0.03	0.2 (0.1, 0.3)	0.9	0.3 (0.3, 0.4)	.023	.01	0.8	0.3 (0.3, 0.4)	1.0	0.4 (0.4, 0.5)	.006	.17
Cholesterol	<300 mg	34.0	1.6 (1.5, 1.7)	42.0	1.7 (1.6, 1.8)	.003	.39	25.5	1.2 (1.1, 1.4)	16.5	1.2 (1.1, 1.3)	.000	.98
Fruits and vegetables[6]	≥400 g	33.4	1.3 (1.1, 1.5)	26.7	1.3 (1.2, 1.4)	.001	.69	202.9	2.0 (1.9, 2.1)	237.5	2.1 (2.0, 2.3)	.007	.13
Dietary fiber	>25 g	6.7	0.8 (0.7, 0.8)	5.7	0.8 (0.7, 0.8)	.002	.47	11.7	1.1 (1.0, 1.1)	11.7	1.0 (1.0, 1.1)	.005	.19

[1] *W(NS)*, women with non-smoker husbands; *W(S)*, women with smoker husbands.
[2] WHO/FAO recommendations/day intake (2003).
[3] Median values were calculated using descriptive statistics.
[4] Adjusted mean: adjusted for covariates, log10 transformed dependent variables.
[5] *p*-value for comparison between % energy intake or intake (unit/day) of women married to non-smokers and women married to smokers (ANCOVA).
[6] Including legumes and nuts (as part of the 400 g of fruit and vegetables).

Diet Quality Scores

Three diet quality scores in women according to the husbands' smoker status and the two study locations are shown in **Table 3.9**.

Coastal Area (Gorontalo)

The dietary diversity score was similar in both groups, with an average consumption of 2.6 from 10 food group intakes. Both groups had comparable micronutrient adequacy scores, with a mean intake of 0.8 from 12 micronutrients. Diet-related chronic disease prevention scores of the two groups did not differ with mean adherence of 4.8 out of a maximum of 9.

There was no significant effect of husbands' smoker status on dietary diversity score of women (*p*=.22), after adjusting for occupation of husbands. No differences were observed for non-smoker and smoker husbands on micronutrient adequacy score of women (*p*=.46). The ANCOVA was found to have no significant covariates or interactions. There was no significant effect of husbands' smoker status on the diet-related chronic disease prevention score of women (*p*=.70), after controlling for the age of the husbands.

Inland Area (Jember)

Both groups had similar dietary diversity with an average consumption of 3.1 from 10 food groups and micronutrient adequacy scores with a mean intake of 3.6 from 12 micronutrients. Women with non-smoker husbands, as compared to their smoker counterparts, had a higher diet-related chronic disease prevention score (mean adherence: 5.0 vs. 4.7 out of a maximum of 9).

There was no significant effect of the husbands' smoker status on the dietary diversity score of women (*p*=.57), after adjusting for: covariates (marriage age of women, occupation and education level of husbands) or interactions (smoking groups*marriage age of women (*p*=.08), or smoking groups*education level of husbands (*p*=.002)). No inter-group differences were noted in relation to the micronutrient adequacy score of women (*p*=.53), controlling for occupation of husbands or smoker groups*education level of husbands (*p*=.03). Women with non-smoker husbands had a significantly higher diet-related chronic disease prevention score than those with smoker husbands (*p*=.04). The ANCOVA was found to have no significant covariates or interactions.

Table 3.9 Diet quality indices of women in coastal area (Gorontalo) and inland area (Jember), in relation to husbands' smoker status[1]

Indices	Coastal (Gorontalo)						Inland (Jember)					
	W(NS) n=67		W(S) n=189				W(NS) n=135		W(S) n=197			
	Mean ± SD	Adjusted mean[2] (95% CI)	Mean ± SD	Adjusted mean (95% CI)	Partial Eta Squared	p^3	Mean ± SD	Adjusted mean (95% CI)	Mean ± SD	Adjusted mean (95% CI)	Partial Eta Squared	p
Dietary diversity score (maximum 10)	2.5 ± 0.94	2.5 (2.2, 2.7)	2.6 ± 0.88	2.6 (2.5, 2.8)	.006	.22	3.1 ± 1.32	3.0 (2.8, 3.2)	3.2 ± 1.16	3.1 (2.9, 3.2)	.001	.57
Micronutrient adequacy score (maximum 12)	0.9 ± 1.05	0.9 (0.7, 1.2)	0.8 ± 1.06	0.8 (0.7, 1.0)	.002	.46	3.6 ± 2.84	3.3 (2.8, 3.9)	3.6 ± 2.81	3.6 (3.1, 4.0)	.001	.53
Diet-related chronic disease prevention score (maximum 9)	4.8 ± 1.36	4.9 (4.6, 5.2)	4.8 ± 1.18	4.8 (4.6, 5.0)	.001	.70	5.0 ± 1.33	4.9 (4.7, 5.2)	4.7 ± 1.24	4.7 (4.5, 4.8)	.012	.04

[1] *W(NS)*, women with non-smoker husbands; *W(S)*, women with smoker husbands.
[2] Adjusted mean: adjusted for covariates.
[3] *p*-value for comparison between diet quality score of women married to non-smokers and women married to smokers (ANCOVA).

3.4 Nutritional Status of Children

Of the 482 children who contributed their anthropometric measurements, 4 were excluded (3 with extreme data of WHZ <-5.00 or a WHZ >+3.00 (SMART Methodology, 2006) and 1 with low-birth- weight history), leaving 478 children who were analysed.

Coastal Area (Gorontalo)

Around half (50.4%) of the sample were males. Children with smoker fathers (3.9 years) were on average 3 months older (p=.05) than children with non-smoker fathers (3.6 years). Adjusted for father's age, WAZ and WHZ of children did not differ between either group, smoker or non-smoker, the mean WAZ and WHZ were within normal range in these groups. Although both groups of children had an average HAZ below the normal range, with no significant differences between groups; the HAZ in the non-smoker group was 0.24 Z-score greater than that in smoker group (**Table 3.10**).

One-third (35.5%) of children (32.8% of children of the non-smoker fathers and 36.4% of the children of the smoker fathers) were underweight (WAZ <-2 SD). Two-thirds of the children (of non-smoker fathers: 56.3%; of smoker fathers: 63.6%) were stunted (HAZ <-2 SD), and 21.8% were severely stunted (HAZ <-3 SD). Wasting amongst children was less prevalent: the weight-for-height Z score was <-2 for <8% of the children in both groups (**Fig. 3.1**). Linear Probability Model revealed that neither a prevalence of child underweight (p=.60) nor of stunting (p=.30) was associated with the smoking status of the father.

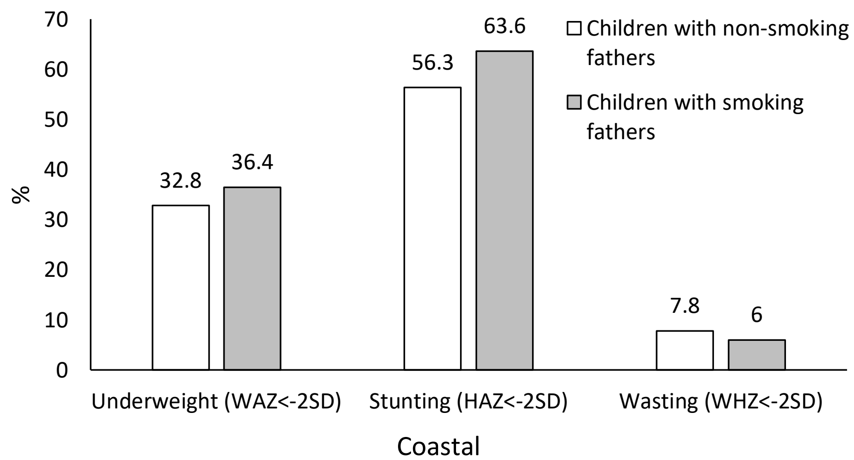

Fig. 3.1 Prevalence of children with underweight, stunting and wasting in coastal (Gorontalo), by fathers' smoking status

Table 3.10 Nutritional status of children, aged 2-6 years, in coastal area (Gorontalo) and inland area (Jember), related to fathers' smoker status[1]

	Coastal area (Gorontalo)					Inland area (Jember)				
	C(NS) n=64		C(S) n=184			C(NS) n=74		C(S) n=156		
	Mean±SD	Adjusted mean[2] (95% CI)	Mean±SD	Adjusted mean (95% CI)	p^3	Mean±SD	Adjusted mean (95% CI)	Mean±SD	Adjusted mean (95% CI)	*p*
Male, n (%)	34 (53.1)		91 (49.5)		-	39 (52.7)		87 (55.8)		-
Age (years)	3.6±1.1		3.9±1.1*		-	3.8±1.3		4.0±1.1		-
Weight (kg)	12.6±2.2		12.9±2.4		-	13.4±3.0		13.3±2.5		-
Height (cm)	91.3±7.8		92.3±8.6		-	93.7±10.1 (n=73)		93.5±8.9 (n=155)		-
WAZ score	-1.60±1.09	-1.6 (-1.8,-1.3)	-1.72±0.91	-1.7 (-1.9,-1.6)	.32	-1.34±1.01	-1.5 (-1.7,-1.2)	-1.60±0.94	-1.6 (-1.7,-1.4)	.42
HAZ score	-2.08±1.20	-2.1 (-2.4,-1.8)	-2.32±1.08	-2.3 (-2.5,-2.2)	.14	-1.85±1.08 (n=73)	-2.2 (-2.4,-1.9)	-2.21±1.01 (n=155)	-2.2 (-2.4,-2.1)	.61
WHZ score	-0.55±0.96	-0.5 (-0.7,-0.3)	-0.48±0.92	-0.5 (-0.6,-0.4)	.75	-0.37±0.95 (n=73)	-0.4 (-0.7,-0.2)	-0.41±0.94 (n=155)	-0.4 (-0.6,-0.3)	.98

[1] *C(NS)* children with non-smoker fathers; *C(S)* children with smoker fathers; *n* number of participants; *WAZ* weight-for-age Z-score; *HAZ* height-for-age Z-score; *WHZ* weight-for-height Z-score.
[2] Adjusted mean: adjusted for covariates.
[3] *p*-value for comparison between nutritional status of children with non-smoking fathers and children with smoking fathers (ANCOVA).
[*] Calculated using the *t* test.

Inland Area (Jember)

More than half (54.8%) of children were males and children's mean age was 3.9 years, ranging from 1.9 to 6.2 years. Adjusted for maternal schooling, age of mother at marriage, and smoker groups*age of maternal marriage (*p*=.06 for tests of interaction), WAZ of children did not differ between the two groups, even though the WAZ in the non-smoker group was 0.26 Z-score greater than that in smoker group. Adjusted for age of maternal marriage and smoking groups*age of maternal marriage (*p*=.06 for tests of interaction), no significant difference in WHZ of children was noted between the groups, with the mean WHZ showing a normal value.

Mean HAZ (-1.85) was within normal range in children with non-smoking fathers and -2.21 was below normal range in those with smoker fathers (**Table 3.10**). The interaction between maternal schooling and fathers' smoker status was significant in child HAZ (*p*=.03), which suggests that the association between child HAZ and fathers' smoker status differs according to the mother's schooling. **Fig. 3.2** showed that among children whose mothers had completed schooling in 4 years (*p*=.51) nor in 6 years (*p*=.61), child HAZ did not differ between groups of smoking fathers' status. But, mothers with a schooling of 9 years, children with non-smoker fathers were associated with a 0.43 Z-score (adjusted mean; 95% CI: 0.10, 0.76 Z-scores, *p*=.01) greater in HAZ. Further, relating to women with a schooling of 12 years, their children with non-smoker fathers was associated with a 0.78 Z-score (adjusted mean; 95% CI: 0.22, 1.33 Z-scores, *p*=.006) greater in HAZ compared to their 'smoker father' child counterparts.

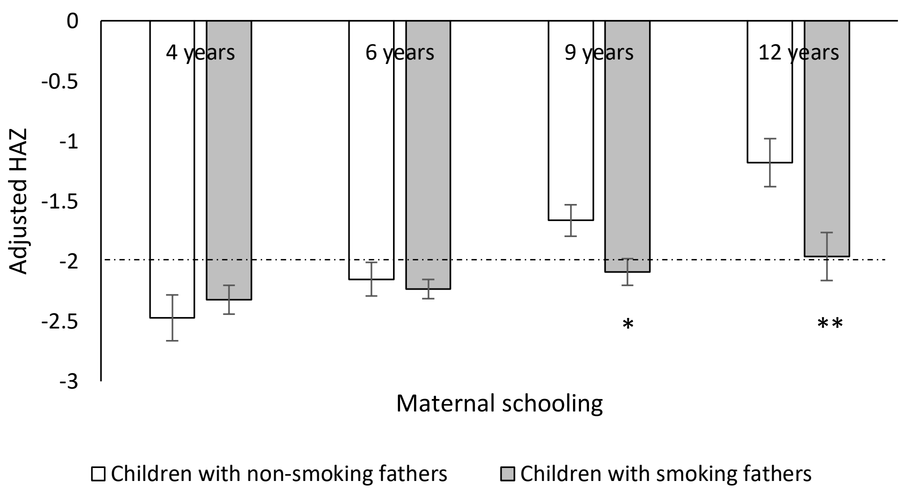

Fig. 3.2 Adjusted height-for-age Z-score (HAZ) of children aged 2-6 years in non-smoker and smoker fathers, related to maternal schooling

The prevalence of underweight (WAZ <-2 SD) was lower in children with non-smoking fathers (24.3%) than in those with smoking fathers (34.6%). Similarly, the prevalence of child stunting (HAZ <-2 SD) was lower in the non-smoker group (43.8%) than in those of their smoker father counterparts (60.6%). Wasting (WHZ <-2 SD) was present in only 1.4% of the children with non-smoker fathers (only one child was wasted) but in 3.2% of the children with smoker fathers (**Fig. 3.3**). Adjusted for maternal schooling and smoking groups*maternal schooling, Linear Probability Model showed that the prevalence of child underweight was not associated with smoker status of the fathers (p=.31). Similarly, adjusted for maternal schooling, there was no significant effect of father' smoker status on the prevalence of child stunting (p=.11).

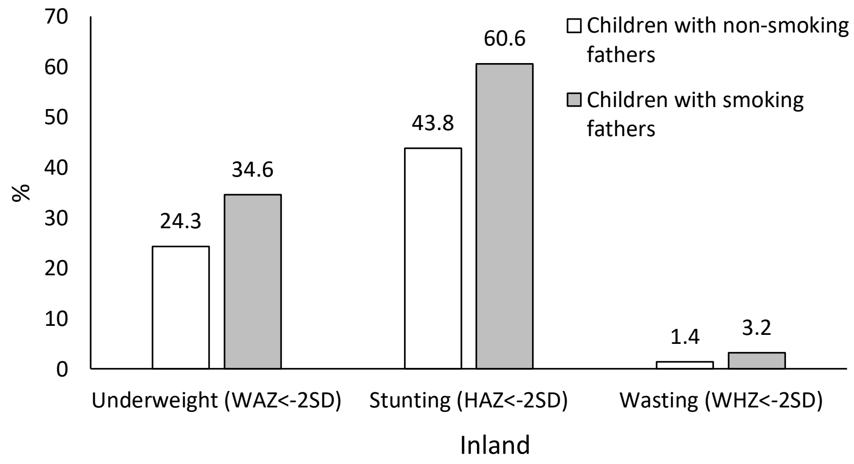

Fig. 3.3 Prevalence of children with underweight, stunting and wasting in inland area (Jember), related to fathers' smoker status

Both Study Areas (Total Children)

Of the total number of children, 52.5% were male and 47.5% were female. Children with smoking fathers (4 years) were older, by 2.6 months on average (p=.03), than those with non-smoker fathers (3.7 years). Adjusted for age of maternal marriage and study area, both groups of children had similar normal values of mean WAZ (-1.61), even though the WAZ in the non-smoker group was 0.20 Z-score greater than that in the smoker group. Mean HAZ (-1.96) of children with non-smoker fathers showed normal value, whereas those with smoker fathers (-2.27) was below the cut-off value for normal HAZ. Even after being adjusted for age of maternal marriage, paternal schooling, children's age, and study area, HAZ of children with smoker fathers was -0.25 Z-scores lower (adjusted mean; 95% CI: -0.47, -0.04 Z-scores; p=.02) than those with non-smoker fathers. There was no significant difference in WHZ of children between the groups, with mean WHZ (-0.45) which was within the normal range (**Table 3.11**).

About 28.3% of children with non-smoker fathers and 35.6% of children with smoker fathers were underweight. Stunting was high in both smoker and non-smoker groups across both geographical areas. Nearly half of the children with non-smoker fathers (49.6%) and two-thirds of the children with smoker fathers (62.2%) were stunted, and 17.5% of the children of non-smoker fathers and 20.4% of children of smoker fathers were severely stunted. Of all the children, less than 5% were wasted, whereas none were indicated as overweight (WHZ >+2 SD) (**Fig. 3.4**).The Linear Probability Model revealed that the prevalence of child underweight did not differ by fathers' smoker status (p=.11). After adjustment for mother's age at marriage, paternal schooling, children's age, and smoking groups*age of mother at marriage (p=.11 for tests of interaction), the prevalence of child stunting in children whose fathers did not smoke, was marginally lower than in those children whose fathers were smokers (p=.07). For children who were wasted (WHZ <-2 SD), Linear Probability Model was not performed because of the smaller number of cases.

Table 3.11 Nutritional status of total sample of children, aged 2-6 years, related to fathers' smoking status[1]

	Total children					
	C(NS) n=138		C(S) n=340			
	Mean ± SD	Adjusted mean[2] (95% CI)	Mean ± SD	Adjusted mean (95% CI)	Partial Eta Squared	p^3
Male, n (%)	73 (52.9)		178 (52.4)			-
Age (years)	3.7 ± 1.2		4.0 ± 1.1*			-
Weight (kg)	13.1 ± 2.7		13.1 ± 2.4			-
Height (cm)	92.6 ± 9.1 (n=137)		92.9 ± 8.8 (n=339)			-
WAZ score	-1.46 ± 1.05	-1.49 (-1.65, -1.33)	-1.66 ± 0.92	-1.64 (-1.74, -1.54)	.005	.13
HAZ score	-1.96 ± 1.14 (n=137)	-1.99 (-2.17, -1.81)	-2.27 ± 1.05 (n=339)	-2.25 (-2.36, -2.13)	.011	.02
WHZ score	-0.46 ± 0.95 (n=137)	-0.46 (-0.61, -0.30)	-0.45 ± 0.93 (n=339)	-0.45 (-0.55, -0.35)	.000	.93

[1] *C(NS)* children with non-smoker fathers; *C(S)* children with smoker fathers; *n* number of participants; *WAZ* weight-for-age Z-score; *HAZ* height-for-age Z-score; *WHZ* weight-for-height Z-score.
[2] Adjusted mean: adjusted for covariates.
[3] *p*-value for comparison between nutritional status (Z-score) of children with non-smoker fathers and children with smoker fathers (ANCOVA).
[*] Calculated using the *t* test.

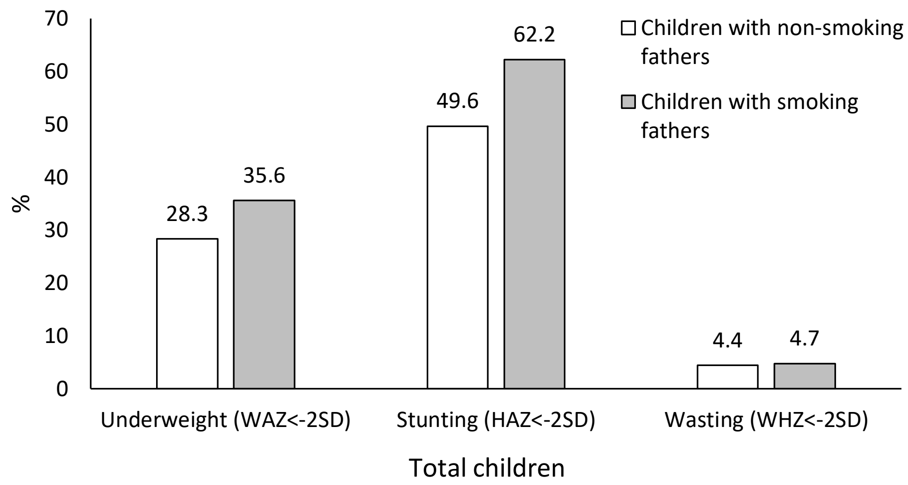

Fig. 3.4 Prevalence of children with underweight, stunting and wasting from two study areas, related to fathers' smoker status

The main findings of this study are summarized in **Table 4.1.**

Table 4.1 Overview of the main findings

Objective	**Main findings for wives with smoker husbands compared to those with non-smoker husbands**
Micronutrient status of women Association of iron, vitamin A, and homocysteine status of women and husbands' smoker status	*Both study areas (total women)* Hb, ferritin, body iron, and RBP concentrations tended to be lower and sTfR concentration tended to be higher. Significantly higher Hcy concentration. No significant differences in prevalence of anaemia (Hb <120 g/L), tissue iron deficiency (sTfR >8.3 mg/L), marginal vitamin A status (RBP <1.17 µmol/L), and hyperhomocysteinemia (Hcy ≥15 µmol/L). Significantly higher prevalence of iron deficiency (ferritin <15 µg/L), iron deficiency anaemia (Hb <120 g/L and ferritin <15 µg/L), and deficit in tissue iron (body iron <0 mg/kg).
Diet quality of women Association of dietary diversity, micronutrient intakes, and diet-related chronic disease prevention of women and husbands' smoker status in coastal and inland areas	*Coastal area (Gorontalo)* <u>Food group intakes</u> No significant differences in grains, fishes, and other vitamin A-rich vegetables and fruits consumption. No significant differences in dietary diversity score. <u>Micronutrient intakes</u> No significant differences in vitamins and mineral intakes. No significant differences in micronutrient intake score. <u>Diet-related chronic disease prevention</u> No significant differences in energy intake, proportion energy intake from carbohydrate, protein, total fat, SFA, and PUFA; intakes of cholesterol, fruits and vegetables, and fiber. Significantly higher proportion energy intake from sugar. No significant differences in diet-related chronic disease prevention score.

Table 4.1 Continued

Objective	Main findings for wives with smoker husbands compared to those with non-smoker husbands
	<u>Household income and % food expenditure</u> No significant differences in monthly household income. No significant differences in percentage of income spent on food. *Inland area (Gorontalo)* <u>Food group intakes</u> No significant differences in grains, legumes, fishes, meat, eggs, and vitamin A rich dark green leafy vegetables, other vitamin A-rich vegetables and fruits, and other fruits consumption. Significantly lower other vegetables consumption. No significant differences in dietary diversity score. <u>Micronutrient intakes</u> No significant differences in vitamins and mineral intakes. No significant differences in micronutrient intake score. <u>Diet-related chronic disease prevention</u> No significant differences in energy intake, proportion energy intake from carbohydrate, protein, total fat, SFA, PUFA, and sugar; intakes of cholesterol, fruits and vegetables, and fiber. Significantly lower diet-related chronic disease prevention score. <u>Household income and % food expenditure</u> No significant differences in monthly household income. No significant differences in percentage of income spent on food.

Table 4.1 Continued

Objective	Main findings for children with smoker fathers compared to those with non-smoker fathers
Nutritional status of children aged 2-6 years Association of Z-scores for weight for age, height for age, and weight for height of children and fathers' smoker status	*Both study areas (total children)* No significant differences in WAZ and WHZ scores. Significantly lower HAZ score. No significant differences in prevalence of underweight (WAZ <-2 SD) and stunting (HAZ <-2 SD).

4 DISCUSSION

This cross sectional study, involving 588 Indonesian women of reproductive age, who were stratified by non-smoking and smoking husbands, revealed mixed results. The hypotheses of the present study, that in households where the husband/father is a smoker: (1) women have lower micronutrient status and higher prevalence of anaemia and micronutrient deficiencies, (2) in households with similarly restricted income where the husband is a non-smoker, women have a poorer diet quality, and (3) children aged 2-6 years have a lower nutritional status and a higher prevalence of underweight, stunting, and wasting.

Micronutrient Status of Women

The findings of this study showed that plasma Hcy concentration was significantly lower in women with non-smoking husbands than in those with smoking husbands, suggesting a better vitamin B-status. Hcy concentration depends largely on folate, vitamin B_6, vitamin B_{12}, and riboflavin status, and is elevated if any one of these is limited. This is in agreement with a population-based sample of adult men and women, The Hordaland (Norway) Homocysteine Study, which has indicated that the lower levels of circulating Hcy were related to a good folate or vitamin B_{12} status (Refsum *et al.,* 2006). While iron and vitamin A status were within expectations to an extent of higher Hb, ferritin, body iron, and RBP concentrations and lower sTfR concentration in wives with non-smoking husbands; these indicators are not statistically significant. The lack of group differences in iron and vitamin A status is unclear since a number of factors may affect iron and vitamin A status.

For instance, several studies revealed that although no significant differences were noted in plasma retinol concentrations of smokers and non-smokers (Pamuk *et al.,* 1994; Paiva *et al.,* 1996; Hallfrisch, Muller & Singh, 1994), serum concentrations of β-carotene, α-carotene, cryptoxanthin, and lycopene were lower in smokers when compared to non-smokers (Pamuk *et al*., 1994; Paiva *et al*., 1996; Albanes *et al.,* 1997). More recent research findings were unfortunately unavailable up to the time of publishing.

The negative effect of household tobacco use are identifiable mainly through the measurement of two determinants, i.e. direct effect and indirect effect. Direct effect is defined as 'environmental exposure to passive smoking', while indirect effect is defined as 'a proportion of the disposable household income being diverted to buy tobacco products'. It has been difficult, however, to distinguish between the causes of the measurable indicators of these two determinants and establish whether differences in indicators such as levels in plasma antioxidants between smokers and non-smokers are actually due to the effect of cigarette smoke exposure or are due instead to differences in dietary antioxidant intakes or in other covariates (Dietrich *et al*., 2003).

This study hypothesized that wives with smoking husbands suffer more from micronutrient deficiencies compared to those with non-smokers husbands because of their lower diet quality. An association between husband smoker status and micronutrient deficiency of the women was due to dietary differences rather than to non-smoking women being exposed to environmental tobacco smoke in the home because their husbands smoked. As a tropical country, the climate is mild all year round in Indonesia, which allows for an open environment of maximum ventilation in the home and therefore the diluting of cigarette smoke.

Studies have indicated that women whose spouses smoke have poorer diets than those married to non-smokers, however, no significant association has been observed between women married to non-smoker husbands and their micronutrient status. An epidemiologic study in women from four Italian areas reported that non-smoking women married to a smoker were significantly less likely to eat vegetables than those married to a non-smoker. The study identified serum concentration of L-ascorbic acid in women as its determining indicator. However, in the study referred to here, despite marginally lower (p=.08) serum concentration of L-ascorbic acid in women with smoking husbands than in those with non-smoking husbands, no differences were found for most serum levels of vitamins (such as α-, β-carotene, retinol, α-tocopherol, and lycopene) (Forastiere *et al*., 2000).

Another reason of no-difference findings in this study is that the categories of participant groups of women did not provide enough variety of contrast in smoking status. If the study had included an additional target group i.e., smoking women married to smokers this may have been more helpful in showing the differences to a gradual decrease from non-smoking women married to non-smokers and to smokers groups. And with particular regard to the purpose of this current study, when husbands and wives are spending household income on cigarettes.

Although conducted in a rather different context, Alberg *et al.* (2000)'s cross sectional study of 1590 subjects living in Washington County, MD, U.S., concluded that even when differences were not significant; a consistent pattern of associations was observed; that among non-smokers living with smokers there was a tendency to have lower serum total carotenoids, α-carotene, β-carotene, and cryptoxanthin concentrations than in non-smokers living in households with non-smokers. As expected, the differences between those exposed and those not exposed tended to be smaller for passive smoking than for active smoking. The consistency of the associations observed for active and passive smoking indicates that exposure to passive smoking may result in decreased circulating concentrations of selected carotenoids.

Tribble *et al.* (1993), in a study of women aged 25-45 years, found that plasma ascorbic acid concentrations in passive smokers were intermediate between non-smokers (p=.01) and active smokers (p=.0001), despite similar dietary vitamin C intakes.

Dietrich *et al.* (2003) conducted a study in the Kaiser Permanente system in California, U.S., found that after adjustment for dietary antioxidant intakes and other covariates, smokers and passive smokers had significantly lower plasma β-carotene concentrations than did non-smokers (0.15, 0.17, and 0.24 μmol/L, respectively) and significantly higher γ-tocopherol concentrations (7.8, 7.8, and 6.5 μmol/L, respectively: no explanation why plasma γ-tocopherol concentrations were significantly higher in smokers and passive smokers than in non-smokers). Smokers had significantly lower plasma ascorbic acid and β-cryptoxanthin concentrations than did non-smokers and passive smokers (ascorbic acid: 43.6, 54.5, and 54.6 μmol/L, respectively; β-cryptoxanthin: 0.12, 0.16, and 0.16 μmol/L, respectively). No significant differences in plasma concentrations of α-tocopherol, α-carotene, total carotenoids, lycopene, or retinol were observed.

Tröbs *et al*. (2002), in a study of 817 adults in Germany, described that there was a decreasing trend of daily fiber and micronutrient intakes from Groups 1 to 4 (Group 1: non-smokers from non-smoker households, Group 2: non-smokers living with a smoker, Group 3: smokers living with a non-smoker, and Group 4: smokers living with a smoker); but, no significant differences in lycopene, all-*trans*-retinol, selenium, ascorbic acid, folate, and cobalamin concentrations across 4 groups were seen. Group 4 had significantly lower α-tocopherol and β-carotene concentrations than did Group 1 or Group 2, and significantly higher Hcy concentrations than Group 2. No significant differences in all plasma concentrations described above were observed between Group 1 and Group 2, still, there was a gradient to unfavourable levels from Groups 1 to 4 for the concentrations of ascorbic acid, folate, and cobalamin.

Despite the finding that the overall micronutrient status assessed was in normal range, a substantially higher proportion of women married to a smoker exhibited iron deficiency (ferritin <15 µg/L), iron deficiency anaemia (Hb <120 g/L and ferritin <15 µg/L), and deficit in tissue iron (body iron <0 mg/kg). Whereas, there was no significant difference between groups in increased frequency of lower plasma RBP or higher plasma Hcy concentrations. Tribble *et al*., (1993) had previously reported for other micronutrient status indicator that an increased frequency of lower plasma ascorbic acid concentration (hypovitaminosis C), which are considered to be marginal or at risk for clinical deficiency symptoms, which the study observed for 12% of passive smokers but not in non-exposed non-smokers.

Regardless of group differences, nutritional anaemia is an important public health problem in developing countries, including Indonesia. An earlier study done in 1998, 23.8% of Indonesian women were anaemic (Jus'at *et al*., 2000), indicating moderate public health problem (20%-39.9%) (UNICEF/UNU/WHO, 2001). This study found 17.1% of the women having low Hb concentrations falling in the range of mild public health significance as defined by WHO at 5-19.9% (UNICEF/UNU/WHO, 2001). Between 1995 and 2011, mean Hb improved slightly and anaemia prevalence decreased globally; in some regions including East and Southeast Asia, women's Hb concentrations improved the most (Stevens *et al.,* 2013). In particular, because of large improvements, women's Hb concentrations in East and Southeast Asia in 2011 were among the highest in the world, similar to or higher than those for Latin America and Caribbean or high-income regions (Stevens *et al.,* 2013). In Indonesia, the prevalence of anaemia among non-pregnant women aged 15-49 years was 22.2% in 2011 (its lowest value) and was 39.2% in 1990 (its highest value over the past 21 years) (Stevens *et al.,* 2013).

Iron deficiency is the top ranking cause of anaemia globally, although its importance has varied by region (Kassebaum *et al.,* 2014). About two-third of anaemic women in this study were not iron deficient (**Appendix Fig. A.2**). High rates of non–iron deficiency anaemia in this population might be due to deficiencies of other micronutrients, particularly vitamin A: 44.9% of the anaemic women had a plasma RBP concentration below the normal range. Using cut-offs RBP <1.17 µmol/L (corresponding to plasma retinol <1.05 µmol/L) (Engle-Stone *et al.,* 2011), almost one-third (31%, **Table 3.3**) of the women were marginally deficient in their vitamin A status. The results found in this study were in line with that found in previous report, in which anaemia in developing countries is multifactorial (WHO, 2010). Anaemia can result from vitamin A deficiency, likely due to multiple apparent roles of vitamin A in supporting iron mobilization and transport, and hematopoiesis (WHO, 2009). Additionally, anaemia can result from indicators unmeasured in this study, such as infections and/or other micronutrient deficiencies.

In this resource-poor settings, the relatively good iron status and the low prevalence of iron deficiency in our study population might not have been expected. Less than 20% of women had a low plasma ferritin and less than 10% had a high sTfR concentrations, both indicating iron deficiency was not highly prevalent in this population (WHO/CDC, 2007). Low prevalence of iron deficiency in this study might also be due to good iron absorption mediated by co-factors obtained from meals containing meat and/or fish, and fruit and/or vegetables containing ascorbic acid (Garcia *et al*., 2003), and fermented food (FAO/WHO, 2001). Further, low iron deficiency might be achieved by taking advantage of unusual sources of iron not assessed in this study, like iron cooking vessels, soil or dust contamination (FAO/WHO, 2001), or high iron content in ground water (Merril *et al*., 2012). Iron contamination is more frequent in developing countries where the amount of such contamination in the meal may be several times greater than the amount of food iron) (Geerligs *et al*., 2003). The absorption of contaminant iron is influenced by the same factors as the native to the food substance (FAO/WHO, 2001). Iron contamination of food is sometimes found in large amounts which may become nutritionally important, especially if it is ingested together with absorption enhancing factors (FAO/WHO, 2001).

Vitamin A deficiency, on a public health scale, is a disorder of the poor and undernourished, reflecting population groups on margins who will be most vulnerable to economic downturn (West & Mehra, 2010). To assess vitamin A status in a population, the WHO serum retinol threshold of <0.70 µmol/L was used to classify those at risk for biochemical vitamin A deficiency (WHO, 2009). Based on data obtained by WHO between 1995 and 2005, about half of the global populations of both preschool-age children and pregnant women are considered to be at risk (WHO, 2009). The current WHO global report, however, does not address vitamin A deficiency as a public health problem in all other age groups due to lack of adequate data and understanding of the public health importance of vitamin A deficiency at other ages (a research priority) (WHO, 2009). Indonesia had no nationally representative data of the prevalence of biochemical vitamin A deficiency, country estimates (regression-based estimates) of the prevalence of serum retinol <0.70 µmol/L in pregnant women 1995-2005: 17.1% 95% CI (2.4-63.3): moderate public health problem, while in preschool-age children: 19.6% (moderate). Africa and Southeast Asia are the 2 regions having the highest risk of vitamin A deficiency affecting preschool-age children and pregnant women (WHO, 2009).

Like retinol, RBP may not accurately identify the true vitamin A status under all conditions, because the acute phase response and protein malnutrition depress RBP concentrations. However, RBP is a simple and inexpensive tool for the assessment of vitamin A deficiency in population studies (Baeten *et al*., 2004). Baeten *et al.* (2004) reported that in healthy people, concentrations of RBP were found highly correlated with those of retinol (r = 0.88) and this remained so, in the presence of HIV-1 infection, protein malnutrition, or acute phase response.

Mean Hcy of 9.65 µmol/L in our subjects was rather like those results from other developing countries. Naik *et al*. (2011) reported a median Hcy of 9.5 µmol/L in 146 Indian women with median ages 34 years. Also, Scorsatto *et al*. (2011) reported that before the fortification of flour with folic acid and iron, mean Hcy of 9.5 µmol/L was found among 38 Brazilian women with average age of 48 years. Although that study found a significant positive correlation between the consumption of folate, pyridoxine, and dietary fiber; a significant inverse correlation between the consumption of folate, pyridoxine, cobalamin and Hcy concentration could not be observed (Scorsatto *et al*., 2011). The authors suggested that because of the lower bioavailability of folic acid from food, it is unlikely that only a diet could be sufficient to reduce the concentration of Hcy (Scorsatto *et al.,* 2011). There is no consensus regarding the definition of hyperhomocysteinemia (Selhub *et al.*, 1993). However, an expert review, suggesting 15 µmol/L as upper reference limits for Hcy in adults 15-65 years adults who are not supplemented and do not eat folic acid-fortified food (Refsum *et al*., 2004). In this study, two women were found had Hcy levels higher than 30 µmol/L, being excluded from statistical analyses. The common probable causes of the Hcy level of 30-100 µmol/L are moderate/severe cobalamin, folate deficiencies or renal failure (Refsum *et al*., 2004).

Dietary Intake of Women

In the current study, living with a smoker seemed to have no effect on diet quality of the wives in the coastal or in the inland study areas. Only a few significant differences appeared: in the coastal area, wives with smoking husbands consumed a proportionately higher rate of free sugar in proportion to their food energy intake; in the inland district these women consumed less vegetables and had a lower score on diet-related chronic disease prevention than their counterparts married to non-smoking husbands. With similarly restricted monthly income between non-smoking and smoking groups (US$ 64 in the coastal and US$ 70 in the inland), it might be assumed that the household with non-smoking husband would not have much greater possibility to buy nutrient-dense, expensive food such as meat, dairy products or fruits.

The participant group selection aimed to simplify and optimise the comparability of the results. It was restricted to poor households, because this single socioeconomic group presented less deviations and less variety than groups from socioeconomically diverse backgrounds. However, it may be argued that the group selection, 'poor households', which by definition presented more dietary deficits than economically wealthier households, reduced the dietary differences presented in the results between wives with smoker compared to non-smoker husbands.

The relationship between environmental tobacco smoke exposure and cancer or cardiovascular diseases may be confounded by social class or diet because women exposed to smoke by their smoking spouse belong to lower social classes and have an unhealthy diet (Curtin *et al*., 1999). However, studies comparing characteristics of spouses, i.e. non-smoking women compared with their smoking or non-smoking male partners have yielded inconclusive or controversial results. Several reports have compared dietary and/or lifestyle differences of non-smokers living in smoking and non-smoking households. A study of dietary habits among 2,142 non-smokers living in smoking households in the San Francisco Bay Area, U.S.A, associated with lower dietary intake of carotenoids but higher intake of alcohol (Sidney *et al*., 1989). Koo *et al*. (1997) showed that wives who had never smoked, together with smoking husbands had a tendency to eat more fried food and less fruit in all four study sites (Hong Kong, Japan, Sweden, and the U.S.A). However, Kawachi and Colditz's (1996) study detected a more hazardous pattern of risk factors for cardiovascular diseases (hypertension, diabetes, hypercholesterolemia, higher body mass index, saturated fat intake) between non-smoking nurses, enrolled in the Nurses' Health Study, and therefore defined as exposed to environmental tobacco smoke at home, in comparison to nurses who lived with a non-smoking spouse. In contrast to these findings, carried out by Sidney *et al.,* 1989; Koo *et al*., 1997; Kawachi & Colditz, 1996, which highlighted a correlation between an unhealthy diet and a risk of cardiovascular diseases, another study reported, after adjustment for age and education, that wives with smoking husbands had worse diets than wives with non-smoking husbands, but few of these differences were statistically significant in the First National Health and Nutrition Examination Survey (NHANES I) in the U. S (Matanoski *et al*., 1995). In the study of a representative sample of U.S. participants who had never smoked from the NHANES III, the only significant difference identified among 13 risk factors for cardiovascular disease between two groups of women, i.e. those reporting 'smoking exposed' (at home or at work) and those reporting 'smoking unexposed', after adjustment for demographic covariates, was for dietary carotene intake, which was lower among 'smoking exposed' subjects (Steenland *et al.,* 1998). Similarly, a report from Switzerland did not find that the diet (daily energy sources, food, and nutrient intakes) of women, living for a substantial period of time with a smoker, differed from the diet of those unexposed at home (Curtin *et al*., 1999). With reference to this finding, the authors concluded that: as unhealthy lifestyle and diets are not universally associated with living with a smoker, confounding factors of the association of exposure tobacco smoke and disease vary according to site and populations and therefore should not be invoked as a systematic source of bias in all studies (Curtin *et al*., 1999). Further evidence of a minimal correlation between exposure to tobacco smoke and dietary status is evident in a study in Italy which found a lower intake of vegetables among non-smoking women married to smokers in comparison to those married to non- smokers, however, as in the Swiss study (Curtin *et al*., 1999), it seems that the dietary pattern in the Italian population did not differ to a large extent between women married to smokers and to non-smokers. Likewise, no significant association has been found for most of the items in the food-frequency questionnaire (Forastiere *et al*., 2000). Forastiere and his colleagues, suggested that the results regarding socio-demographic factors are easily explained by the social class distribution of smoking in Italy. Women married to smokers were more likely to be either, less educated, to be married to a less educated husband, or to live in more crowded dwellings than women married to non-smokers. However, once socio-economic differences are taken into account, the possibility of confounding in studies on the health effects of environmental tobacco smoke is minimal (Forastiere *et al*., 2000).

Poor households have scarce cash resources resulting in a low consumption of animal-source foods, legumes, vegetables, and fruits which are good sources of many micronutrients

(Darmon & Drewnowski, 2008). Cigarette consumption of the husbands could worsen the poor diet quality of the women by diversion of income to cigarette purchase. In Indonesia, cigarettes are affordable for everyone due to their relatively cheap price of cigarette. Indonesia has the lowest cigarette price in the South East Asian region where they can also be bought individually from kiosks and vendors. (Thabrany, 2012).

Our findings showed that in households where the husband was a smoker, cigarette purchase diverted a mean of 11.6% of the total monthly household income in coastal areas and 21.9% in inland areas. Surprisingly, the proportion of the total monthly household income spent in the household on food was the same, both for women with smoking husbands as it was for women with non smoking husbands, which raises the question as to where the money was raised within the limited household budget for cigarette purchase. Several explanations could be considered for the lack of significant food expenditure differences which in turn might predict wives' lower diet quality: first, some of the bias related to under and over reporting are associated with self-reports, such as recall or socially desirable responding. Subsample analysis in the smoking households revealed, however, there was no inverse relationship between (%) food expenditure which was answered by the wives and (%) cigarette expenditure reported by the husbands. Also, it should be noted that household food expenditure which was described by the women, therefore the unit of analysis in this study was household, whereas tobacco expenditure was made at the individual level of husband. Unfortunately, the women were not interviewed about other expenditures in which possible altered household income may have been spent on other goods apart from tobacco. Participating in socio-economic and dietary intake interviews might be time consuming for women, and longer interviews cannot be expected to ensure substantial data more accurately. Since data on individual food consumption are lacking in Indonesia, our objective was to probe the quantity of dietary intakes rather than household expenditures on some basic needs in addition to food. Additionally, earlier studies found that smoking households spent proportionally less on food as well as on education, medical care, and other commodities (Semba *et al*., 2007; Best *et al*., 2008) in comparison with non-smoking households. Second, 32.1% the coastal areas and 46.1% the inland areas were characterized by extended family members living in the same household. This family type might be more likely to share basic needs amongst its household members; it is then possible that the nuclear family was not exclusively responsible for their own family's food expenditure and that members from the wider, extended family took some responsibility for expenditure decisions. Third, more detailed interviews about expenditures on food items such as staples, rice, flesh meat, eggs, vegetables, oil and sugar, etc. might help to find a greater difference in the results. For example, Best *et al*. (2008) reported that in rural Indonesia, the amount of money spent on all types of foods, i.e., animal foods, plant foods, and other foods, was less in smoking households than in non-smoking households. Another study in rural India showed that even though the difference in budget share on food is not significant between tobacco consuming and non-consuming households, it is observed that tobacco consumers allocate more of their budget to cereals/cereal substitutes in comparison to their non-tobacco consumer counterparts. In contrast, milk/milk products (an item mostly consumed by children), is a highly compromised item among tobacco consuming households. Consumption of fruits and beverages is also compromised in a similar way (John, 2008). Fourth, besides food expenditure, other determinant factors might be involved, acting in different ways on the outcome, on the measurable indicators present in the women's diet. Maternal nutrition knowledge and intra-household food allocation, which were not observed in this study, could further explain this missing relationship between food expenditure and diet quality. A study conducted in Indonesia found that mothers with greater nutrition knowledge, independent of maternal education, allocated a larger share of their food budget to foods that were rich in micronutrients, including fruits and vegetables (Block, 2003). Furthermore, Rasyid *et al*., (2006) reported other factors that could play important roles in improving dietary quality, which are: income, education, occupation, household size, food prices, gender of the household head, and household age-sex composition.

Although this study was unable to detect a significantly lower proportion spent on food among smoking households, a bigger difference in proportion of income spent on food is possible in some other target groups and in other situations. For instance, in urban poor areas where the cigarette prices is higher (GATS, 2011), and where households spent more money on tobacco (22% of weekly per capita cigarette expenditure (Semba *et al*., 2007)). Also, urban populations are usually dependent on cash resources to purchase food, whereas rural populations are more likely to own/rent land and be directly involved in crop production (Best CM *et al*., 2008).

In both study areas (in the coastal and in the inland), the husbands' smoking habit did not affect their wives' nutritional status, BMI, showing similar percentage of overweight and obese women with smoking vs. non-smoking husbands, though in the coastal area, the percentage of obese women with smoking husbands (12.2%) was four times higher than those of their non-smoking counterparts (3%). The identical BMI among wives with smoking vs. non-smoking husbands may reflect an actual similar intake of fat and/or total calories. The trend of nutrition transition has already been observed in Indonesia affecting poor households. In this study, dietary pattern were coupled with lack of physical activity (most women were housewives and all were Moslem who faced many barriers to do sports and exercise). In addition, all women had children which might relate to difficulties in reducing their body weight after delivery. Likewise, the average BMI of women living with a smoker at home did not differ from that of women living with a non-smoker either in Geneva (Curtin *et al.,* 1999), Italy (Forastiere *et al*., 2000), or the U.S.A (Koo *et al*. 1997); but lower BMI were found for Hong Kong and in Japanese wives with non-smoking husbands (Koo *et al*. 1997).

In addition to examining the relations between husbands' smoking husbands and women's diet, as shown in **Table 3.9** the diet was characterized by a limited diversity (as indicated by mean score on 10 food groups). Different food group categories used in this present study and in the study of non-pregnant non-lactating women in resource-poor settings of another Southeast Asian site, the Philippines, the mean dietary diversity scores was 4.6 of 13 food groups (Daniels, 2009). Very low micronutrient adequacy (max. score 12) was observed, which illustrates that inadequate micronutrient intake was being the foremost problem among women in this study. In agreement with the women's diet in the urban Cebu sample, from the Philippines, of 11 micronutrients measured, median micronutrient intake was in most cases lower than the corresponding EAR, with the exception of niacin and vitamin B_{12} (Daniels, 2009). These findings reflect a monotonous diet low in fruits, vegetables, and animal-derived foods (Torheim *et al*., 2010). The systematic literature review by Torheim *et al.* (2010) shows a consistent pattern of generally low micronutrient intakes among women in Africa, Asia, and Latin America, regardless of the methods used to assess dietary intake. The authors conclude that low dietary intakes of thiamine, riboflavin, vitamin B_6, folate, vitamin B_{12}, iron, and zinc are likely to be common among poor women in most developing regions of the world (Torheim *et al*., 2010).

Adequate diet quality is defined as a diet that has a high probability of delivering adequate amounts of selected micronutrients, to meet the needs of women of reproductive age. This definition of diet quality also includes other dimensions, such as moderation (e.g., in intakes of energy, saturated/trans fat, cholesterol, sodium, refined sugars) and balance (Daniels, 2009). High intakes of these nutrients drive the 'nutrition transition' and increase the risk of nutrition-related NCD (Ponce, Ramirez & Delisle, 2006). In this study population, relatively moderate diet-related chronic diseases prevention (average score was 5 out of a maximum 9) was noted. Our study showed that women had low adherence to fruits and vegetables, and fiber intake (**Table 3.8**), although we found a regular consumption of vegetables. These findings are consistent with the fact that fruit and vegetables tend to be a more expensive source of energy for low income families who prioritize the fulfilment of their basic energy needs to avoid hunger (Ruel, Minot & Smith, 2004).

Nutritional Status of Children

The results of this study revealed that the degree of height growth faltering was less in children with non-smoking fathers compared to children with smoking fathers. The differences between the two weight-dependent indicators (WAZ and WHZ) did not reach statistical significance, although a higher WAZ (0.20 Z-score) was found among children with non-smoking fathers. Although a lower WHZ-score (-0.008) was observed among children with non-smoking fathers this study indicates that the effect of father's smoking was more pronounced regarding chronic undernutrition (low height-for-age) and less associated with acute malnutrition (low weight-for-age). Stunting continues to be the major nutritional problem in Indonesia compared to underweight and wasting (Sandjaja *et al*., 2013). Furthermore, stunting has been related to wealth because protein, especially animal source protein, is relatively expensive (Sandjaja *et al*., 2013).

In addition to economic pressure, it was also necessary for the duration of cigarette expenditures diversion, away from the basic necessities, to be short, as the length of the fathers' smoking behaviour was on median ≥ 10 years (**Appendix Table A.1**). This longterm behaviour might influence chronic effects of child malnutrition. The lack of effect of the fathers' smoking on child acute malnutrition differs from results of other studies where paternal smoking is associated with not only an increased risk of children being underweight (Best *et al*., 2008), and wasted (Semba *et al*. 2007), but also being stunted (Best *et al*., 2008; Semba *et al*. 2007).

In addition, in our sample of children living in Jember, the association of child HAZ with fathers' smoking status varies with maternal schooling. Among less-educated mothers, child HAZ did not differ with fathers' smoking status. However, among more educated mothers, a much more positive pattern was found: non-smoking fathers were associated with higher HAZ in children. The positive effect of non-smoking fathers on child linear growth was larger in households with a more educated mother. Accordingly, maternal schooling can help lessen a further decrease in child HAZ.

Even though stunting was marginally lower in children with a non-smoking father (12.6% lower), stunting (average rate of >58 %) was the most prevalent child malnutrition noted. Very high prevalence of stunting is of concern, suggesting that the majority of children had poor nutritional history or growth failure. Also, the percentages of children underweight (33.5%) was high in this study. These findings are higher than those reported by nationally representative data which has found that among children 2.0-4.9 years old who lived in rural areas, there was 47.3% stunting and 26.9% underweight (Sandjaja *et al*., 2013). One explanation for the differences could be the different target populations. The present study was conducted among low income households, while the latter study represented the general population of children in the country. The latter study also reported that the older the children, the higher the deviation from the WHO standard curves. Compared to children 2.0-4.9 years old, stunting (28.9%) and underweight (16.5%) were less prevalent among children 0.5-1.9 years old (Sandjaja *et al*., 2013). In agreement with these results, a study among infants living in rural Vietnam reported that growth faltering often starts when the child is 5-6 months old (around the time of the introduction of complementary feeding). The prevalence of stunting rapidly rises to ~20-30% by 12 months and reaches a maximum of ~30-40% when children are 15-20 months old (Pham *et al*., 2012).

The prevalence of malnutrition, especially wasting, is decreasing in the world (das Neves *et al.,* 2006). In the current study, 6.5% of children were wasted in the coastal area. The use of -2 Z-scores as a cut-off implies that 2.3% of the reference population will be classified as malnourished even if they are truly “healthy” individuals with no growth impairment (WHO, 2016). The low prevalence of wasting (average rate of 2.3%; after a subtraction of 2.3% regarded as the expected prevalence) was confirmed by WHO guidelines which suggested that, provided there is no severe food storage, the prevalence of wasting is usually below 5%, even in poor countries (WHO, 2016).

Methodological Issues

Selection of Study Population and Study Areas

The women were purposively selected on the basis of a number of criteria, such as an identified poor household. A list from the local administration of all village households was used to compile a new list of selected women for the study. This approach may introduce a bias in the selection of subjects as well as in the selection of study areas. Hence, they may not be representative of the general Indonesian areas and women. At the same time, however, in developing countries, where people in general are relatively constrained by money, poverty does not limit tobacco consumption, which identifies tobacco as belonging to the budget of basic needs. Poor households are worst affected as smoking is often more prevalent among men of lower social class, education, or income (MOH & ICF, 2013; Jha *et al*., 2006).

In this study, most women were living in rural areas; where poverty is higher (rural: 16.6% vs. urban: 9.9%) (IFAD, 2013) and smoking is more prevalent (37.7% vs. 31.9%) (GATS, 2011) and a larger proportion (44.5%) of farmers/fishermen/labourers smoke actively on a daily basis as compared to other groups (Balitbangkes, 2013). Additionally, in areas where families remain impoverished and heavily reliant on staple food, the poor diet quality and low nutrient adequacy, characteristic features which define this group, are likely to dominate. As in another Asian country such as Cambodia, higher levels of nutrient deficiency were observed in people with low incomes and in rural areas with women being mostly affected (In *et al.,* 2015).

The relatively good micronutrient status and the lower than expected prevalence of anaemia and micronutrient deficiencies might be due to the selection criteria of specific subjects in this study. The subjects were limited to women of reproductive age with micronutrient status as the main measurable indicator. Using a wider population target subgroup may have resulted in different outcomes. Women of reproductive age were generally considered less vulnerable to severe deficiency. For instance, other target groups such as infants 6–71 months of age were considered to be the most useful for surveillance as they are highly vulnerable to vitamin A deficiency; however, it was a problem to gain access to these participating subjects. Preschool-age children and pregnant women are considered to be populations most at-risk of vitamin A as well as of iron deficiency due to their increased demands for vitamin A and the potential health consequences associated with vitamin A deficiency during these life stages (WHO, 2009). Two other groups are also especially susceptible to vitamin A deficiency, namely lactating women as their needs increase due to daily losses of vitamin A in breast milk (WHO, 2004) and school-age children (McLaren & Kraemer, 2012) .

Study Design and Implementation

The study design of this research project was based on a cross-sectional study, which may have weaknesses that could affect the validity of these findings. A primary limitation of this design is that exposure (smoking husbands) and outcomes (dietary intake and micronutrient status of women and nutritional status of children) were assessed at the same moment in time, however, there is generally no evidence of a temporal relationship between exposure and outcome. That is, although the investigator may determine that there is an association between an exposure and an outcome, there is generally no evidence that the exposure caused the outcome (Carlson & Morrison, 2009). Second, the measured association in the cross-sectional study was between exposure and having the outcome as opposed to exposure and developing the outcome (Carlson & Morrison, 2009). As such, this study did not account for changes over time between the effect of smoking by husbands at the time the data were collected, and the conditions that originally led to the development of maternal micronutrient deficiencies or child undernutrition.

Strengths of the Study

Objective measures (biomarkers of iron, vitamin A, and Hcy status) assessed by laboratory analysis were used to determine the outcome. Laboratory personnel was blind to the identity of the groups. For assessment of the iron status of populations, the concentration of Hb was measured, and that measurement of ferritin and sTfR provided the best approach to measuring the iron status of populations (WHO, 2010). In addition, body iron was also calculated; the ratio of sTfR to ferritin is a more sensitive and specific indicator of iron status than is either of the measurements alone (Cook *et al.,* 2003). Further, the concentration of both of the acute phase proteins, CRP and AGP, were measured to account for a high plasma ferritin or a low RBP caused by inflammation. A depression in retinol concentrations (this study used RBP) will result in an overestimate of vitamin A deficiency. In contrast, where the biomarker is increased due to infection as in the case of plasma ferritin concentrations, inflammation will result in an underestimate of iron deficiency (WHO, 2010).

The fact that data were collected about the food quantity or serving sizes that women consumed from a particular food group was a strength of the 24HR used in this study.

Recalls have the advantage of providing more specific information regarding intake than do food frequency questionnaires, including the ability to more accurately quantify intake of food groups and to describe intake patterns (Thomson *et al*., 2003). To our knowledge, there are no data on assessing the quantity of food consumption and presenting a relatively complete picture of diet (i.e., food group intakes, micronutrient intakes, and diet-related chronic disease prevention) among women of reproductive age in both smoking and non-smoking husbands in Indonesia. This approach is advantageous because important and specific information about diet and nutrients are not missed. The dietary diversity indicator is used as a proxy measure of the nutritional quality of an individual's diet (Swindale & Bilinsky, 2006). At the same time, this study provides a quantity measure of diet from micronutrient and macronutrient analyses. Moreover, connected to the recent concern in countries in transition, such as Indonesia, a common shift in dietary and activity patterns applies not only to micronutrient deficiencies but also to over nutrition problems, such as the amount of fat, SFA, cholesterol, and refined sugars. The 31 single variables are also presented as a summary score reflecting diet quality indices of identified women with respect to diet variety, micronutrient adequacy, moderation, and balance.

The collection of height and weight data through extensive training of enumerators, standardization of measurements, adequate equipment, and daily calibration of scales, ensured that the measurements were in accordance with predetermined procedures. The quality of the anthropometric data was assessed by observing the SD of the Z-score distribution (WHO, 2016). The SDs of the observed height-for-age, weight-for-age, and weight-for-height Z-score distributions should be relatively constant and close to the expected value of 1.0 for the reference distribution; any SD of the Z-scores above 1.3 suggests inaccurate data due to measurement error or incorrect age reporting (WHO, 2016). In this study, the SD values obtained were highly acceptable. These values are either lower than, or within, those considered to be acceptable internationally. The expected ranges of SD of the Z-score distribution for the 3 anthropometric indicators: weight-for-age Z-score 1.00 to 1.20, height-for-age Z-score 1.10 to 1.30, and weight-for-height Z-score 0.85 to 1.10 (WHO, 2016). While, the SD within groups in this study was 0.91-1.09 for the weight-for-age, 1.01-1.14 for the height-for-age, and 0.92-0.96 for the weight-for-height Z-score.

Limitations of the Study

Several limitations of this study should be noted.

Determination sample size was made to detect a mean difference of 1 µmol/L in Hcy with a power of 80% (Panagiotakos *et al*., 2004) which resulted in a sample size of 444 women. However, the magnitude of the difference between groups is considered small (effect size was 0.28, using Cohen's d (1992)).

A second limitation is that there is no consensus regarding Hcy threshold. According to expert recommendations about Hcy determinations that upper reference limits for fasting Hcy in non-supplemented adults 15-65 years is 15 µmol/L, corresponding to the 95^{th}-97.5^{th} percentiles in a presumed healthy population (Refsum *et al.,* 2004).

Likewise, the RBP threshold is not yet as validated as it is for retinol. RBP was measured as a proxy indicator of vitamin A status, as retinol is released from the liver in the form of a 1:1 complex of retinol and RBP (Gibson, 2005). The WHO serum retinol threshold of <0.70 µmol/L was used to classify those at risk for biochemical vitamin A deficiency (WHO, 2009). For this present study, the cut-offs of <1.17 RBP µmol/L for women (corresponding to 1.05 retinol µmol/L as marginal vitamin A status) was used that were derived from a nationally representative sample of Cameroonian women of childbearing age (Engle-Stone *et al*., 2011).

This present study could not reveal associations between intake of iron with plasma ferritin nor with other iron status indicators and, intake of vitamin A was not related to RBP concentrations. Intake of the B vitamins, riboflavin, folate, B_6, and $B_{12,}$ were not as well associated with Hcy concentrations in all subjects investigated (**Appendix Table A.2**). In contrast with these findings, earlier studies showed the relation between iron intake and plasma ferritin (Backstrand *et al*., 2002), and the effect of vitamin A intake on plasma RBP (Koo *et al*., 1995). Backstrand *et al.* (2002) repeatedly assessed data over a period of more than 10 days combining dietary recalls, food weighing, and food diaries among non-pregnant women in Mexico. They revealed a positive association between intake of non-heme iron and plasma ferritin concentrations. Some large population-based studies have shown that dietary intakes of folate (Selhub *et al*., 1993; Bree *et al*., 2001; Konstantinova *et al*., 2007), riboflavin (Konstantinova *et al.*, 2007), vitamin B_6 (Selhub *et al*., 1993; Konstantinova *et al*., 2007), and vitamin B_{12} (Konstantinova *et al*., 2007) were inversely associated with plasma Hcy concentrations. However, some recent studies in developing countries observed, for example, that no association was found between folate intake and red blood cell folate deficiency among tribal Indian adolescents (Jani *et al*., 2015), between dietary iron intake and Hb concentration among Nepali women (Henjum *et al*., 2014). Also, while it is likely that an inadequate dietary intake of vitamin A or beta-carotene reveals an important and preventable cause of vitamin A deficiency in a population, it is not an indicator of vitamin A status (WHO, 2009). Recall methods may be the reason why we could not observe a significant relationship between micronutrient intakes and micronutrient status. Nutrient intakes in this study were based on one or two days of reported 24HR which were used specifically to measure the amounts actually consumed by an individual, which might not have affected maternal micronutrient status. This method leads to distributions with too large a variance, and, consequently, the prevalence of nutrient inadequacy in a group may be significantly biased (Ribas-Barba *et al.*, 2009). Variability in dietary intake influences the number of days required to estimate food and nutrients accurately (Ribas-Barba *et al.*, 2009). A larger number of 24HR replications during a longer period is needed to obtain estimates of absolute average daily intakes and a consistent pattern in food consumption instead of classifying subjects according to levels of energy and nutrients intake (Pereira *et al.,* 2010). However, although we are aware that more dietary records are needed from each person, when no other information is available, their application could become common practice. Because 24HR are expensive, sampling strategies in studies often limits the number of days of information collected to 2 or 3 to capture both energy and nutrient variability of the diet (Yunsheng *et al.,* 2009).

Underreporting food intake, particularly among women in the coastal area with median total energy intake of 4,767 kilojoule/day, was also found in this study population. The recall method has been found to underestimate food intake in most groups (Rutishauser, 2000; Johansson *et al.,* 2001; Harrison *et al.,* 2000; Poslusna *et al.,* 2009). Women were asked questions by trained interviewers with similar methods applied to each study site. Intensive training and pre-testing for enumerators and field supervision were done in order to minimize some potential biases in interviewing the women. In addition, to reduce potential misclassifications associated with one-time events (such as weddings or funerals), we did not interview the women as consumption patterns can be atypical during festive periods (FAO, 2010). In this study, all respondents were Muslim, for that reason, interview of dietary intake was not done during periods of Ramadan and Eid celebrations, in which it is likely that food consumption does not reflect a typical diet (FAO, 2010). Low energy intake in the current study is rather similar to an earlier study of non-pregnant non-lactating women in resource-poor settings of other Southeast-Asian site, Philippines, showing mean total energy intake of 5,430 kilojoule/day (Daniels, 2009). Less variety of food intake among women in the coastal areas than those in the inland areas might have lead to lower energy intake estimates. When data were analysed in two study areas, there were similarities and differences of food consumption between women in Jember and those in Gorontalo. With regard to food groups, except for fish, consumption of legumes, vegetables, fruits, meat, and eggs was higher in women living in Jember. While, consumption of grains and absence of milk consumption were similar in both study areas.

Moreover, total income, food and cigarette expenditures as a measure of poverty is more likely to be affected by current situation and shorter-term influences which may not present child growth development and which may not reveal the long-term behaviour of a fathers' smoking. Similarly, our study used questionnaires and interviews to draw "true" socio-economic conditions from participants. 'Socially desirable responding' is the tendency for participants to present a favourable image of themselves and is most likely to occur in response to socially sensitive questions, which affects the validity of a questionnaire (van de Mortel, 2008).

Recommendations for Future Studies

Although there are several limitations, further studies could still be carried out:

- The results of this study justify further studies with a more refined/effective study design, such as longitudinal cohort studies or an intervention trial for smoking cessation to provide more conclusive practical evidence on the potential causal relationship between paternal smoking in the household and health outcomes of women, children, and the husbands themselves. Findings, such as those from the previous cross-sectional study, which was performed in a representative sample of the Iranian population, suggest that lifestyle habits can be improved by a community-based intervention programme on smoking behaviour, diet, and physical activity even in a developing country setting (Sarrafzadegan *et al.,* 2009). Any change that affects the prevalence of smoking in a community is also likely to affect community norms, which will in turn lead to even greater change in the community. These results serve to underscore the additive properties of nicotine and suggest that long-term behavioural intervention and ongoing counselling may be required to influence cessation. As little evidence exists to support the effectiveness of any specific intervention on long-term cessation rates, further studies are needed to advance this field (Sarrafzadegan *et al.,* 2009).

- The firm results in the present study show that a non-smoking father decreases the risk of child malnutrition, specifically chronic under-nutrition (stunting). In the Indonesian setting, where paternal smoking is highly prevalent: 70.8% in urban areas and 73.2% in rural areas (Semba *et al.,* 2008), the positive deviance intervention among the community could be applied to address tobacco control, which in turn has been associated with positive outcomes of fathers' behaviour change and fewer children are malnourished. The idea being that there are a few non-smoking fathers who deviate from the norm and exhibit unusual but positive behaviour that protects them and their families from certain health problems, despite sharing the same limited resources, having the same socio-economic status and challenges with their smoking neighbours-(the sense that, "if they can do it, why can't I"). Positive deviant behaviours are thus affordable, acceptable and sustainable by the people at risk because they are already being practiced by others in a similar situation (Shafique *et al.,* 2016). Identifying individuals from within the communities to act as role models can result in greater engagement from the community and the ability to better relate to messages than if they were delivered by outside experts or organizations (Shafique *et al.,* 2016). This latter approach often results in failure because local populations are unable to maintain the practices or behaviour that were identified as lacking once the outside intervention is taken away (Shafique *et al.,* 2016). Positive deviance is an asset-based, community-driven approach to behaviour change which has successfully been applied to address many health and social problems (Shafique *et al.,* 2016), such as positive deviance methodology which is used in childhood nutrition studies, involving project teams weighing children or pregnant women to identify those with healthier weights (Ahrari *et al.,* 2006; Zeitlin 1991), and then interviewing their families to find out which behaviours were being exhibited which were out of the norm.
- To confirm the results, repeating a study using the same methods but with different subjects, age groups, areas, or any other variables is feasible, such as replicating a study on more vulnerable groups (children, pregnant or lactating women) living in poor urban areas. Unlike the rural poor, the urban poor are generally more vulnerable i.e.,

(they are generally net food buyers, rely on cash income for their food security, spend a large proportion of their total budget on food, and have little access to agriculture or land for their food supply) (Ruel *et al*., 2010).

- Connected with the long-term smoking behaviour of husbands, several repeated 24HR during a longer period is essential to collect estimates of usual intakes and a regular pattern in food consumption.
- Regardless of smoking status, currently accurate information on women's diets and micronutrient intakes is extremely scant due, primarily, to the challenge and cost of collecting and analysing dietary data. Without data on women's dietary, and more specifically, micronutrient intake, however, progress in designing, targeting, and evaluating effective programs to improve women's micronutrient nutrition will continue to be hampered (Ruel, Deitchler & Arimond, 2010). The present study contributes descriptive information on dietary patterns and levels of micronutrient and macronutrient intakes for women of reproductive age in a poor setting. These findings can be used to further the development of indicators of dietary diversity and to improve micronutrient intakes of women.

Implication for Public Health

Tobacco control policies, enhancing nutrition program (such as dietary diversification, homestead food production, nutrition education) especially in low-income groups must be strengthened and should be included in strategies aimed at the reduction of poverty and in the improvement of the well-being of women and children in Indonesia. Full participation in the implementation of the tobacco control movement i.e., the Framework Convention on Tobacco Control is essential to the country. These population-wide approaches are not only highly feasible and cost effective, but they will also have an immediate and positive effect in the short term as well as being cheap to implement (Beaglehole *et al.,* 2011). Political will at the highest levels of government is a must to make possible the enactment and enforcement of effective legislation, as well as to counter the inevitable opposition from the tobacco industry (WHO, 2013). Transition economies suffer, for example in Indonesia, where the investments to promote economic growth is the priority and there is a necessity to increase incomes of poor households (including cash benefits/cash transfer program from local government). However, unconditional cash transfer programs might have unplanned negative consequences on women and children malnutrition when poorly targeted i.e., providing greater spending power for cigarettes instead of for household food purchases. Parallel to cash benefits, in the short term, smoking prevention behaviour changes communication in the form of direct transfer health and nutrition relevant information and an improvement in the quality and quantity of interactions with health care professionals is necessary to prevent a further decrease in child linear growth and health correlations for husbands and wives. Moreover, the results of this study also showed that mothers with higher levels of education potentially protect children from chronic under-nutrition. Accordingly, in the long term, investing in women's education has a promising impact to make programs more effective in improving the growth of children.

CONCLUSION

In summary, despite the fact that we did not find that households with smoking husbands in our study settings were not spending less of their income on food and influencing the poorer diet quality of women, unfavourable effects on other outcomes could be observed. Though, the overall micronutrient status assessed was in normal range, women with non-smoking husbands had lower plasma Hcy levels (indicating better B vitamin status), had a lower rate of iron deficiency, lower rate of iron deficiency anaemia, and a deficit in tissue iron relative to those with smoking husbands. Women with smoking husbands tended to have less favourable iron and vitamin A status. In these poor households, the negative effect of fathers' smoking was the most pronounced in child malnutrition, particularly chronic undernutrition, indicating that the economic hardship of tobacco exacerbates addiction, further decreasing child linear growth.

Summary

Prevalence of male smoking is high in Indonesia especially among those living in poverty which diverts money from basic necessities to cigarettes. However, information on whether micronutrient status and women's diet are associated with the smoking status of husbands in low income households in Indonesia is generally lacking. For this purpose, we conducted a cross-sectional study among poor rural and peri-urban households.

A total of 588 non-smoking women, aged 19 – 44 years, stratified by smoking (n=386) or non-smoking (n=200) husbands, was purposely selected and, data regarding socio-economic, micronutrient status, and dietary intake were collected from 2 study areas in Indonesia. Venous blood samples were obtained, and haemoglobin (Hb), ferritin, soluble transferrin receptor (sTfR), body iron, retinol binding protein (RBP), and homocysteine (Hcy) concentrations were measured. 24-hour dietary recall were used to examine the nutritional quality of women's diet. During the study, the women with their children received anthropometric assessments. The nutritional status of 482 children aged 2-6 years old were defined based on weight and height measurements: weight-for-age, height-for-age and weight-for-height.

The results of this study showed that women with non-smoking husbands, in comparison to those married to smokers, had significantly lower Hcy concentration (by 0.08 µmol/L on average), after adjustment for energy intake and study area. No significant differences in Hb, ferritin, sTfR, body iron, and RBP concentrations were observed; however, expected direction of associations between micronutrient status and groups could be seen in all indicators. Women with non-smoking husbands had significantly lower prevalence of iron deficiency (ferritin <15 µg/L; 2.9 vs. 7.6%), iron deficiency anaemia (Hb <120 g/L and ferritin <15 µg/L; 1.6 vs. 5%), and deficit in tissue iron (body iron <0 mg/kg; 0.6 vs. 3.3%) than women with smoking husbands.

In general there were no significant differences found in food group intakes and micronutrient intakes between the 2 groups. Inadequate micronutrient intake was the foremost problem in both areas, with reported median values of almost all micronutrients assessed being below the recommended requirements.

Households with smoking husbands had similar economic constraints and a similar percentage of monthly income spent on food, to households with non-smoking husbands.

Children whose fathers did not smoke were associated with higher child height-for-age Z-score (-1.99 vs. -2.25 Z-score, p=.02) than children whose fathers smoked. This resulted in a marginally lower prevalence of child stunting (49.6% vs. 62.2%, p=.07, respectively). For weight for age and weight for height no significant differences were found.

Despite the found differences in micronutrient status and child growth we could not establish that households with smoking husbands spent less of their income on food or negatively influenced women's diet quality. Future studies with methodologies to better measure socio-economic status and diet and in other settings and target groups would be useful.

The findings of this study support tobacco control policies in Indonesia to reduce tobacco use, circumvent further unfavourable micronutrient status of women and faltering linear growth of children living in households with smoking fathers.

Zusammenfassung

Die Prävalenz von Rauchen bei Männern in Indonesien ist sehr hoch insbesondere unter der ärmeren Bevölkerung welches einen negativen Einfluss auf das verfügbare Einkommen hat um essentielle Dinge zu kaufen. Da es noch kaum untersucht wurde ob dies auch den Lebensmittelverzehr und die Versorgung mit Mikronährstoffen bei Frauen negativ beeinflusst haben wir eine Querschnittsstudie unter armen ländlichen und halbstädtischen Haushalten durchgeführt.

Insgesamt 588 nicht rauchende Frauen im Alter von 19-44 Jahren wurden abhängig vom Rauchverhalten des Mannes in eine rauchende (n=386) und eine nicht rauchende (n=200) Gruppe eingeteilt und in 2 Studienregionen in Indonesien sozioökonomische Daten, der Mikronährstoffstatus und der Lebensmittelverzehr erfasst. Venöse Blutproben wurde gesammelt und Hämoglobin (Hb), Ferritin, der lösliche Transferrinrezeptor (sTfR), Körpereisenspeicher, Retinol bindendes Protein (RBP) und Homocystein (Hcy) gemessen. 24 Stunden Recalls wurden verwendet um die Qualität der Ernährung der Frauen zu beurteilen. Während der Studie wurde das Gewicht und die Größe der Frauen und deren Kindern erfasst. Der Ernährungsstatus der 482 Kinder im Alter von 2-6 Jahren wurde mit Hilfe von anthropometrischen Indizes (Gewicht für Alter, Größe für Alter und Gewicht für Größe) bestimmt.

Die Ergebnisse dieser Studie zeigten dass Frauen mit einem nicht rauchenden Ehemann nach Berücksichtigung der Energiezufuhr und Studienregion einen signifikant niedrigeren Homocysteinspiegel hatten (im Mittel um 0.08 umol/L). Keine signifikanten Unterschiede wurden gefunden bei Hämoglobin, Ferritin, sTfR, Körpereisenspeicher und RBP. Eine Tendenz für einen besseren Status bei Frauen mit nicht rauchenden Männern konnte allerdings bei allen gemessenen Parametern gefunden werden. Frauen mit einem nicht rauchenden Ehemann hatten gegenüber den Frauen mit rauchendem Ehemann eine signifikant niedrigere Prävalenz von Eisenmangel (Ferritin < 15 ug/L, 2.9% vs. 7.6%), Eisenmangelanämie (Hb < 120 g/L und Ferritin < 15 ug/L; 1.6% vs. 5%) und Defizit in Körpereisenspeicher (Körpereisenspeicher < 0 mg/kg; 0.6% vs. 3.3%).

Im allgemeinen konnte beim Konsum von Lebensmittelgruppen und der Mikronährstoffzufuhr keine signifikanten Differenzen zwischen den beiden Gruppen gefunden werden. Eine unzureichende Mikronährstoffzufuhr die im Nichterfüllen der Empfehlungen bei fast allen Mikronährstoffen gefunden werden konnte war das größte Problem in beiden Regionen.

Haushalte mit einem rauchenden Ehemann hatten im Vergleich zu Haushalten mit einem nicht rauchenden Ehemann ähnliche ökonomische Begrenzungen und Ausgaben für Lebensmittel.

Kinder deren Vater nicht rauchte hatten im Vergleich zu Kinder deren Vater rauchte einen besseren Z-score für Größe für Alter (-1.99 vs. -2.25 Z-score, p=.02) das sich in einer geringeren Prävalenz von Kleinwuchs zeigte (49.6% vs. 62.2%, p=.07). Beim Gewicht für Alter und Gewicht für Größe gab es keinen signifikanten Unterschied.

Obwohl das Rauchen des Ehemanns das Risiko für einen Mikronährstoffmangel bei den Frauen erhöht und einen negativen Effekt auf das Wachstum der Kinder hat, wurde in dieser Studie keine signifikant geringeren Ausgaben für Lebensmittel oder negative Auswirkung auf die Lebensmittelqualität in den untersuchten Haushalten gefunden. In zukünftige Studien müssten deshalb genauere Erhebungsmethoden verwendet werden um die Ernährung und den soziökonomischen Status besser zu erfassen und zusätzlich andere Regionen und Gruppen einschließen wie z.B. die städtische Bevölkerung, die für den Kauf von Lebensmittel vollständig vom Haushaltseinkommen abhängig ist.

Die Befunde dieser Studie unterstützen die Notwendigkeit, dass die Reduzierung des Tabakkonsums auch hinsichtlich des Einflusses auf die Mikronährstoffversorgung der Frauen und der Prävention von Wachstumshemmung von Kindern in Indonesien verbessert werden muss.

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Appendix

Table A.1 Smoking behaviour of husbands in coastal area (Gorontalo) and inland area (Jember)

Characteristics	Coastal (Gorontalo)		Inland (Jember)	
	Median (IQR)[1]	Min, Max	Median (IQR)	Min, Max
Length of smoking (year)	10 (5, 17) n=184	1, 33	15 (11, 21) n=197	<1, 47
Average daily cigarette consumption	5 (4, 7) n=187	1, 34	12 (10, 14) n=197	1, 24

[1] Median and interquartile range (IQR) values were calculated using descriptive statistics.

Table A.2 Summary of linear regression analysis for micronutrient status of women related to their corresponding micronutrient intake[1]

	Unstandardized Coefficient (B)	*p*	95% CI
Hb (g/L)			
Iron intake	-.43	.84	-4.5, 3.7
Study area	2.77	.02	0.5, 5.0
Ferritin (µg/L)			
Iron intake	.03	.79	-0.2, 0.3
sTfR (mg/L)			
Iron intake	.09	.37	-0.1, 0.3
Energy intake	-9.1E-6	.49	-3.5E-5, 1.6E-5
Study area	-.11	.002	-0.2, -0.04
Energy intake*iron intake	4.2E-5	.08	-4.8E-6, 8.9E-5
Study area*iron intake	-.22	.14	-0.5, 0.1
Body iron (mg/kg)			
Iron intake	-.89	.14	-2.1, 0.3
Study area	1.32	<.001	0.7, 2.0
RBP (µmol/L)			
Vitamin A intake	-.05	.12	-0.1, 0.01
Study area	-.11	<.001	-0.2, -0.1
Hcy (µmol/L)			
Vitamin B_2 intake	-.07	.51	-0.3, 0.1
Vitamin B_6 intake	-.03	.80	-0.3, 0.2
Folate intake	.07	.49	-0.1, 0.3
Vitamin B_{12} intake	.05	.48	-0.1, 0.2
Energy intake	1.5E-5	.17	-6.1E, 3.6E-5
Study area	.23	<.001	0.1, 0.3
Energy intake*vitamin B_{12} Intake	-7.7E-5	.01	0.0, -1.6-5

[1] *Hb* haemoglobin, *sTfR* soluble transferrin receptor, *RBP* retinol binding protein, *Hcy* homocysteine.

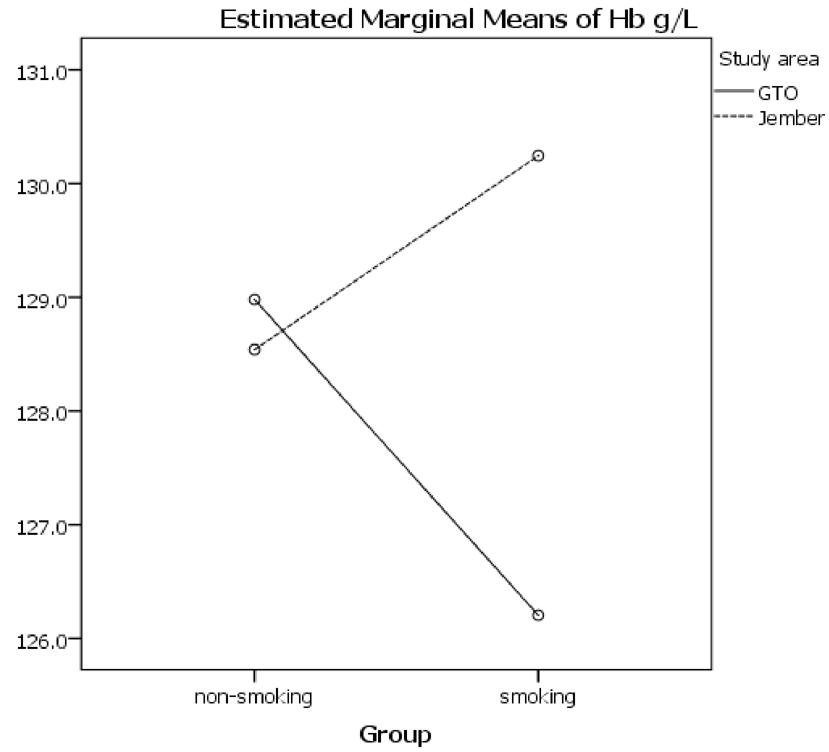

Fig. A.1 Adjusted haemoglobin concentration of women in coastal and inland areas, in relation to husbands' smoking status

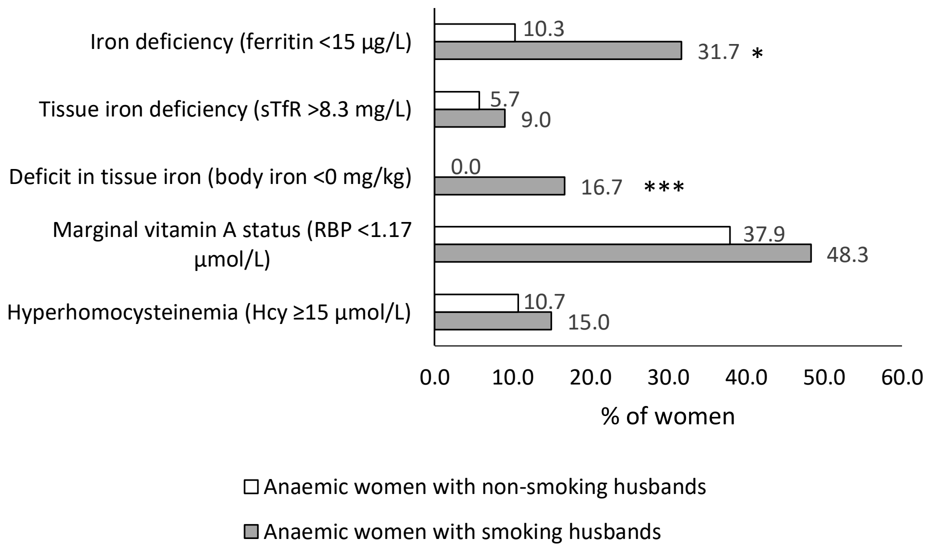

Fig. A.2 Prevalence of anaemic women (Hb <120 g/L) with low iron stores, marginal vitamin A status and hyperhomocysteinemia, in relation to husbands' smoking status

Table A.3 Characteristics of children, aged 2-6 years, in relation to fathers' smoking status[1]

Characteristics	Coastal (Gorontalo) C(NS) Mean ± SD or n (%)	Coastal (Gorontalo) C(S) Mean ± SD or n (%)	p^2	Inland (Jember) C(NS) Mean ± SD or n (%)	Inland (Jember) C(S) Mean ± SD or n (%)	p^2	Total children C(NS) Mean ± SD or n (%)	Total children C(S) Mean ± SD or n (%)	p^2
Mothers									
Age (years)	30 ± 5.7 (n=64)	31 ± 5.8 (n=184)	.11	29 ± 6.0 (n=74)	28 ± 6.2 (n=156)	.66	29 ± 5.8 (n=138)	30 ± 6.1 (n=340)	.30
Schooling (years)	5.9 ± 2.9 (n=63)	6.4 ± 2.8 (n=182)	.33	7.8 ± 2.9 (n=74)	6.5 ± 2.4 (n=156)	.001	6.9 ± 3.1 (n=137)	6.4 ± 2.7 (n=338)	.09
Marriage age (years)	20.3 ± 2.3 (n=63)	19.9 ± 2.8 (n=183)	.23	20.0 ± 3.9 (n=74)	17.8 ± 2.9 (n=156)	<.001	20.1 ± 3.2 (n=137)	18.9 ± 3.0 (n=339)	<.001
Fathers									
Age (years)	33 ± 5.3 (n=64)	35 ± 6.3 (n=181)	.02	35 ± 6.7 (n=74)	34 ± 7.5 (n=156)	.21	34 ± 6.1 (n=138)	35 ± 6.9 (n=337)	.58
Schooling (years)	6.5 ± 3.2 (n=63)	6.0 ± 2.6 (n=183)	.27	8.3 ± 3.2 (n=74)	6.6 ± 2.8 (n=156)	<.001	7.5 ± 3.3 (n=137)	6.3 ± 2.7 (n=339)	<.001
Occupation (%)			.001			<.001			.001
Fisherman	5 (7.9)	25 (13.7)		-	-		5 (3.6)	25 (7.4)	
Farming	10 (15.9)	48 (26.2)		16 (21.6)	68 (43.6)		26 (19.0)	116 (34.2)	
Waged labour	40 (63.5)	66 (36.1)		26 (35.1)	60 (38.5)		66 (48.2)	126 (37.2)	
Salaried	1 (1.6)	29 (15.8)		14 (18.9)	9 (5.8)		15 (10.9)	38 (11.2)	
Entrepreneur	7 (11.1)	15 (8.2)		18 (24.3)	19 (12.2)		25 (18.2)	34 (10.0)	
% cigarette expenditure per month	-	11.7 ± 8.5 (n=183)	-	-	22.4 ± 15.0 (n=156)	-	-	16.6 ± 13.1 (n=339)	-

Table A.3 Continued[1]

	Coastal (Gorontalo)			Inland (Jember)			Total subjects		
	C(NS)	C(S)		C(NS)	C(S)		C(NS)	C(S)	
	Mean ± SD or n (%)	Mean ± SD or n (%)	p^2	Mean ± SD or n (%)	Mean ± SD or n (%)	p^2	Mean ± SD or n (%)	Mean ± SD or n (%)	p^2
Households									
Family size	5.0 ± 2.4 (n=63)	5.5 ± 2.2 (n=183)	.11	5.0 ± 1.6 (n=74)	4.5 ± 1.3 (n=156)	.03	5.0 ± 2.0 (n=137)	5.1 ± 1.9 (n=339)	.66
Family type			.43			.14			.07
Nuclear	40 (63.5)	126 (68.9)		36 (48.6)	92 (59.0)		76 (55.5)	218 (64.3)	
Extended	23 (36.5)	57 (31.1)		38 (51.4)	64 (41.0)		61 (44.5)	121 (35.7)	
Total income per month (US$)[3]	59.9 ± 20.8 (n=63)	65.6 ± 23.7 (n=183)	.07	66.4 ± 20.3 (n=74)	67.6 ± 29.5 (n=156)	.73	63.4 ± 20.7 (n=137)	66.5 ± 26.5 (n=338)	.17
% food expenditure per month	45.1 ± 19.5 (n=63)	46.1 ± 20.7 (n=183)	.73	56.2 ± 20.5 (n=74)	53.7 ± 25.9 (n=156)	.48	51.1 ± 20.7 (n=137)	49.6 ± 23.5 (n=339)	.53
Study area									.13
Gorontalo (coastal)							64 (46.4)	184 (54.1)	
Jember (inland)							74 (53.6)	156 (45.9)	

[1] *C(NS)* children with non-smoking fathers; *C(S)* children with smoking fathers; *n* number of participants.
[2] Calculated using the chi-square test for categorical variables and the *t* test for continuous variables.
[3] US$ 1 was equivalent to 8,802.8 IDR (Oanda, 2011).

Fig. A.3 Adjusted weight-for-age Z-score (WAZ) of children aged 2-6 years in non-smoking and smoking fathers, in relation to mother's age of marriage

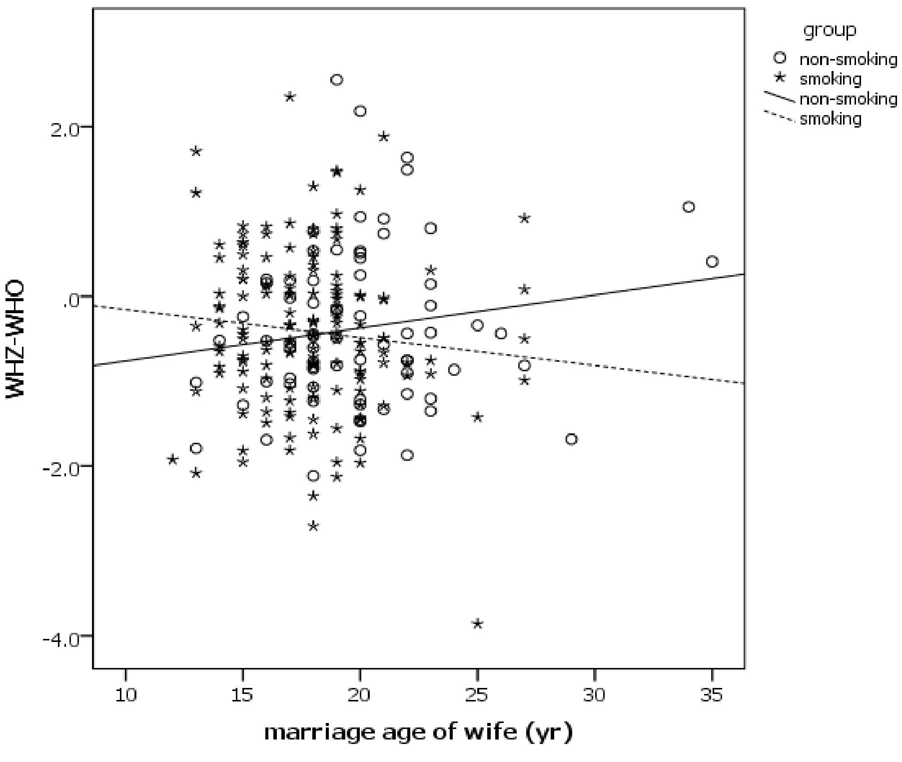

Fig. A.4 Adjusted weight-for-height Z-score (WHZ) of children aged 2-6 years in non-smoking and smoking fathers, in relation to mother's age of marriage

Table A.4 Median intakes of children, who consumed food ≥10 gram, in coastal area (Gorontalo) and inland area (Jember), in relation to fathers' smoking status[1]

Food group	Age group (year)	Coastal (Gorontalo)		Inland (Jember)	
		C(NS)	C(S)	C(NS)	C(S)
		Median (IQR)[2]	Median (IQR)	Median (IQR)	Median (IQR)
Grains	< 4	201 (153, 302) n=44	217 (150, 302) n=93	225 (110, 304) n=41	275 (150, 364) n=79
	≥ 4	213 (150, 288) n=20	206 (200, 314) n=91	300 (203, 422) n=32	308 (208, 439) n=76
Legumes and nuts	< 4	50 (44, 163) n=14	50 (25, 100) n=28	150 (88, 200) n=25	121 (56, 211) n=64
	≥ 4	50 (25, 75) n=7	50 (25, 63) n=26	100 (85, 263) n=18	200 (100, 300) n=59
Dairy	< 4	10 (10) n=3	10 (10, 19) n=16	50 (25, 70) n=15	55 (20, 88) n=18
	≥ 4	10 (10, 10) n=4	10 (10, 10) n=14	60 (18, 83) n=9	70 (40, 140) n=13
Flesh meat	< 4	35 (20, 45) n=26	40 (20, 40) n=65	50 (48, 80) n=19	47 (21, 83) n=36
	≥ 4	37 (20, 41) n=14	40 (27, 40) n=59	51 (29, 81) n=18	40 (20, 82) n=33
Eggs	< 4	55 (34, 55) n=8	28 (28, 55) n=15	55 (28, 110) n=11	55 (28, 58) n=23
	≥ 4	28 (28) n=3	55 (28, 55) n=15	55 (55, 93) n=10	55 (55, 110) n=20
Vitamin A rich fruits and vegetables	< 4	21 (21) n=2	17 (13, 21) n=10	50 (25, 75) n=19	50 (25, 75) n=35
	≥ 4	15 (13, 17) n=4	17 (16, 27) n=10	75 (50, 100) n=11	50 (25, 100) n=31
Other vegetables	< 4	25 (20, 40) n=20	33 (20, 48) n=44	50 (25, 100) n=9	34 (25, 50) n=20
	≥ 4	50 (27, 67) n=13	33 (20, 50) n=49	43 (19, 74) n=10	50 (33, 100) n=32
Other fruits	< 4	68 (37, 105) n=6	108 (48, 173) n=10	43 (29, 133) n=5	51 (43, 99) n=12
	≥ 4	59 (24, 116) n=4	61 (43, 103) n=10	95 (38, 150) n=5	88 (51, 136) n=14

[1] *C(NS)*, children with non-smoking fathers *C(S)*, children with smoking fathers.
[2] Median and interquartile range (IQR) values were calculated using descriptive statistics.