https://doi.org/10.31689/rmm.2024.31.2.135

ORIGINAL PAPERS

# A Path Model of Factors Associated with Hypertension and Disease: Analysis of Indonesian Basic Health Survey Year 2018

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## Abstract

Non-communicable diseases are estimated to account for 73% of all deaths in Indonesia, and cardiovascular disease contributes 35%. Unhealthy dietary behavior leads to several NCDs, such as Diabetes Mellitus, obesity, hypertension, cardiovascular disease, and stroke. This cross-sectional study used secondary data from the Indonesian Basic Health Survey Year 2018. The study selected 10,171 samples aged ≥15 years from West Borneo Province. The dependent variable was coronary disease. The independent variables were hypertension, age, gender, education, smoking, vegetables, fruit consumption, fat intake, alcohol consumption, instant noodles consumption, soft drink consumption, physical activity, and residence. A path analysis was conducted data analysis. The coronary disease was directly increased by hypertension (b=1.19; 95% CI=0.90 to 1.48; p<0.001), age ≥43 years (b=0.88; 95% CI=0.55 to 1.21; p<0.001), and high physical activity (b= -0.49; 95% CI= -0.81 to -0.17; p=0.003). It was directly decreased by alcohol consumption, but it was statistically non-significant (b=-0.71; 95% CI=-1.54 to 0.11; p=0.088). Coronary disease was indirectly affected by males, smoking, vegetable consumption, fruit consumption, fat intake, grilled food consumption, energy drink consumption, instant noodles consumption, soft drink consumption, residence, and education.

**Keywords:** Heart disease, Hypertension, Path analysis

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## INTRODUCTION

Cardiovascular diseases account for most NCD deaths worldwide (17.9 million people) annually. Tobacco use, physical inactivity, the harmful use of alcohol and unhealthy diets all increase the risk of dying from a NCD.[1] In Indonesia, coronary heart disease (CHD) and stroke are estimated to cause more than 470 000 deaths annually.[2] Cardiovascular diseases account for 37% of deaths in Indonesia. The burden of disease for 2012 was approximately 18,000 disability-adjusted life years (DALYS), of which 17,500 were years of life lost due to premature mortality (YLL) and the remainder due to years of healthy life lost due to disability (YLD).[3] The George Institute for Global Health (2017) suggests there is substantial variation in the frequency of ischemic heart disease and other competing causes of death between urban and rural settings in Indonesia.

Evidence from previous scientific studies reported that reducing these risk factors decreases the chance of having a heart attack or experiencing another cardiac event, such as a stroke, and reduces the possibility of needing a coronary revascularization procedure. Regular exercise has a favourable effect on many of the established risk factors for cardiovascular disease.[4] Many cardiometabolic risk factors are known to be modified by lifestyle behaviors including diet. Among many diet-related behaviors, avoiding instant foods and/or fast food and increasing the intake of basic and unprocessed foods, is considered a simple but pivotal strategy.[5]

Reducing the incidence of hypertension by implementing population-wide policies to reduce behavioral risk factors, including harmful use of alcohol, physical inactivity, overweight, obesity and high salt intake, is essential to attaining this target. A total-risk approach needs to be adopted for early detection and cost-effective management of hypertension in order to prevent heart attacks, strokes and other complications.

The purpose of this study was to describe and examine factors associated with hypertension and coronary disease using path analysis model.

## MATERIAL AND METHODS

This was a cross-sectional study using Indonesian Family Life Survey year 2018. The study selected 10,171 samples aged ≥15 years from West Borneo Province. The dependent variable was coronary disease. The independent variables were hypertension, age, gender, education, smoking, vegetables consumption, fruit consumption, fat intake, alcohol consumption, instant noodles consumption, soft drink consumption, physical activity, and residence. Data analysis was conducted by a path analysis run on Stata 13 (Figure 1).

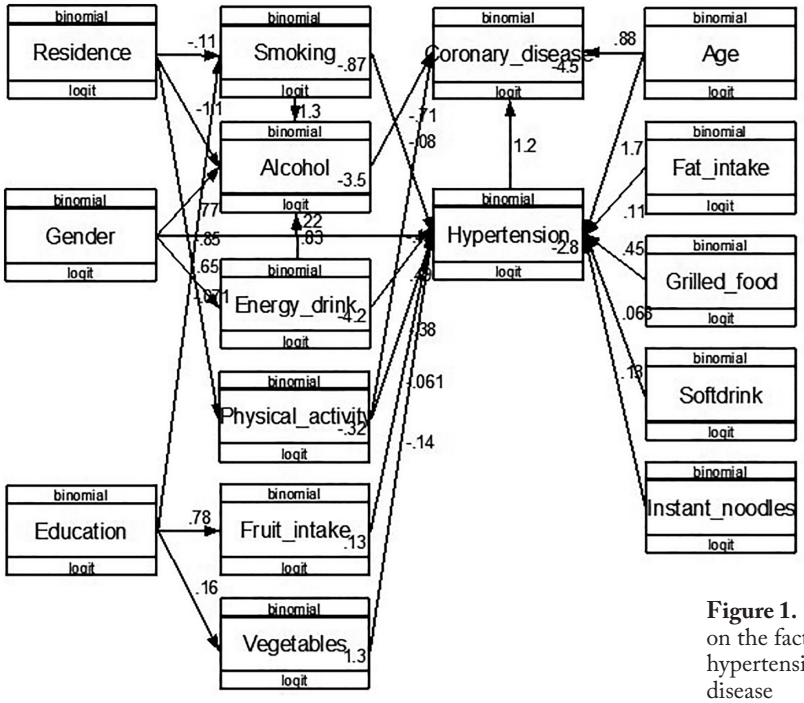


**Figure 1.** Path analysis model on the factors associated with hypertension and coronary disease

## RESULTS

### Univariate analysis

Table 1 reported sample characteristics of continuous data. Table 1 showed that the average age of the samples were 43 years (Mean= 43.12; SD= 15.39). The average of fruits consumption was 2 times a week (Mean=2.32; SD=2.10). The average of vegetables consumption was 5 times a week (Mean=5.96; SD=1.84). The average of instant noodle consumption was 4 times a week (Mean=4.18; SD=1.19). The average of soft drink consumption was 5 times a week (Mean=5.53; SD=0.95). The average of preserved food intake was 5 times a week (Mean=5.17; SD=1.07). The average of fat intake was 3 times a week (Mean=3.42; SD=1.37). The average of grilled food consumption was 5 times a week (Mean=5.04; SD=1.00). The average of energy drink consumption was 5 time a week (Mean= 5.60; SD= 0.91).

**Table 1. Sample characteristics (continuous data)**

| Variables | n | Mean | SD | Minimum | Maximum |
|---|---|---|---|---|---|
| Age (year) | 10171 | 43.12 | 15.39 | 15 | 97 |
| Fruits consumption (days in a week) | 10171 | 2.32 | 2.10 | 0 | 7 |
| Vegetables consumption (days in a week) | 10171 | 5.96 | 1.84 | 0 | 7 |
| Instant noodles consumption (per weeks) | 10171 | 4.18 | 1.19 | 1 | 6 |
| Soft drink consumption (per weeks) | 10171 | 5.53 | 0.95 | 1 | 6 |
| Preservative food consumption (per week) | 10171 | 5.17 | 1.07 | 1 | 6 |
| Fat intake (per week) | 10171 | 3.42 | 1.37 | 1 | 6 |
| Grilled food consumption (per week) | 10171 | 5.04 | 1.00 | 1 | 6 |
| Energy drink intake (per week) | 10171 | 5.60 | 0.91 | 1 | 6 |

Table 2 reported the sample characteristics of dichotomous data. Table 2 showed that most of sample never been diagnosed coronary disease by doctor (97.85%), did not experience hypertension (83.55%), no alcohol consumption (93.44%), energy drink consumption <5 times a week (97.3%), and soft drink consumption 5 times a week (97.70%). Half of samples were at age <43 years (51.38%). A third of samples consumed instant noodles ≥5 times per weeks (38.06%) and had high physical activity (36.56%).

**Table 2. Sample characteristics (dichotomous data)**

| Variables | n | % |
|---|---|---|
| Coronary disease | | |
| No | 9,952 | 97.85 |
| Yes | 219 | 2.15 |
| Hypertension | | |
| No | 8,498 | 83.55 |
| Yes | 1,673 | 16.45 |
| Residence | | |
| Rural | 7,136 | 70.16 |
| Urban | 3,035 | 29.84 |
| Gender | | |
| Female | 6,223 | 61.18 |
| Male | 3,948 | 38.82 |
| Age | | |
| <43 years | 5,226 | 51.38 |
| ≥43 years | 4,945 | 48.62 |
| Education | | |
| <Senior high school | 7,350 | 72.26 |
| ≥Senior high school | 2,821 | 27.74 |
| Smoking | | |
| No | 7,276 | 71.54 |
| Yes | 2,895 | 28.46 |
| Alcohol consumption | | |
| No | 9,504 | 93.44 |
| Yes | 667 | 6.56 |
| Fruits consumption per weeks | | |
| Non-daily consumption | 6,311 | 62.05 |
| Daily consumption | 3,860 | 37.95 |
| Vegetables consumption per weeks | | |
| Non-daily consumption | 2,025 | 19.91 |
| Daily consumption | 8,146 | 80.09 |
| Fat intake | | |
| <3 times per week | 7,620 | 74.92 |
| ≥3 times per week | 2,551 | 25.08 |
| Grilled food consumption | | |
| <5 times per week | 9,966 | 97.98 |
| ≥5 times per week | 205 | 2.02 |
| Instant noodles consumption | | |
| <5 times per week | 6,300 | 61.94 |
| ≥5 times per week | 3,871 | 38.06 |
| Soft drink intake | | |
| <5 times per week | 9,937 | 97.70 |
| ≥5 times per week | 234 | 230 |
| Energy drink intake | | |
| <5 times per week | 9,960 | 97.93 |
| ≥5 times per week | 211 | 207 |
| Physical activity | | |
| Low | 6,452 | 63.44 |
| High | 3,719 | 36.56 |

**Bivariate analysis**

Table 3 reported crosstab analysis on the relationships of hypertension, age, gender, smoking alcohol consumption, fat intake, grilled food consumption, soft drink consumption, and coronary disease. Table 3 showed that hypertensive person (6.10%) had higher possibility to experience coronary disease that those with normotension (1.38%), with p<0.001.

**Table 3. Crosstab analysis on the relationships of hypertension, age, gender, smoking, alcohol consumption, fat intake, soft drink consumption, and coronary disease**

| Independent variables | Coronary disease | | | | P |
|---|---|---|---|---|---|
| | No | | Yes | | |
| | n | % | n | % | |
| Hypertension | | | | | |
| No | 8.381 | 98.62 | 117 | 1.38 | <0.001 |
| Yes | 1,571 | 93.90 | 102 | 6.10 | |
| Smoking | | | | | |
| No | 7,123 | 97.90 | 153 | 2.10 | 0.579 |
| Yes | 2,829 | 97.72 | 66 | 2.28 | |
| Age | | | | | |
| <43 years | 5,174 | 99.00 | 52 | 1.00 | <0.001 |
| ≥43 years | 4,778 | 96.62 | 167 | 3.38 | |
| Gender | | | | | |
| Female | 6,099 | 98.01 | 124 | 1.99 | 0.161 |
| Male | 3,853 | 97.59 | 95 | 2.41 | |
| Alcohol consumption | | | | | |
| No | 9,291 | 97.76 | 213 | 2.24 | 0.021 |
| Yes | 661 | 99.10 | 6 | 0.90 | |
| Fat intake | | | | | |
| <3 times a weeks | 7,458 | 97.87 | 162 | 2.13 | 0.744 |
| ≥3 times a weeks | 2,494 | 97.77 | 57 | 2.23 | |
| Grilled food consumtion | | | | | |
| <5 times a weeks | 9,750 | 97.83 | 216 | 2.17 | 0.492 |
| ≥5 times a weeks | 202 | 98.54 | 3 | 1.46 | |
| Soft drink consumption | | | | | |
| <5 times a weeks | 9,725 | 97.87 | 212 | 2.13 | 0.371 |
| ≥5 times a weeks | 227 | 97.01 | 7 | 2.99 | |

Sample who had age ≥43 years (3.38%) had higher possibility to experience coronary disease than those with age <43 years (1.00%), with p<0.001. Sampel who consume alcohol (0.90%) had lower possibility to experience coronary disease than those who did not consume alcohol (2.24%), with p= 0.021. There was no difference between female (1.99%) and male (2.11%) to experience coronary disease, with p= 0.161. There was no difference between smokers (2.99%) and non-smokers (2.11%) to experience coronary disease, with p=0.607. There was no difference of fat consumption <3 times a week (2.13%) and fat consumption ≥3 times a week (2.23%) to experience coronary disease, with p= 0.744. There was no difference between people who consume grilled food <5 times per week (2.17%) and those who consume grilled food ≥5 times per week (1.46%) to experience coronary disease (p= 0.492). There was no difference between sample who consume soft drink <5 times a week (2.13%) and those who consume soft drink ≥5 times a week (2.99%) to experience coronary disease (p= 0.371).

Table 4 showed that coronary disease was directly affected by hypertension, age ≥43 years, alcohol consumption, and high physical activity.

Hypertension was directly increased logodd (possibility) to experience coronary disease 1.19 units (b=1.19; 95% CI=0.90 to 1.48; p<0.001). Age ≥43 years was directly increased logodd (possibility) to experience coronary disease 0.88 units (b= 0.88; 95% CI=0.55 to 1.21; p<0.001). High physical activity directly decreased logodd (possibility) to experience coronary disease 0.49 units (b= -0.49; 95% CI= -0.81 to -0.17; p=0.003). Alcohol consumption directly decreased logodd (possibility) to experience coronary disease 0.71 units, but it was statistically non-significant (b=-0.71; 95% CI=-1.54 to 0.11; p=0.088). Table 4 showed that coronary disease was indirectly affected by male, vegetables consumption, fruits consumption, fat intake, grilled food consumption, energy drink consumption, instant noodles consumption, smoking, soft drink consumption, residence, and education. Age ≥43 years increased logodd (possibility) to experience hypertension 1.76 units (b=1.76; 95% CI= 1.63 to 1.90; p<0.001). Grilled food consumption ≥5 times a week increased logodd (possibility) to experience hypertension 0.42 unit (b=0.42; 95% CI=0.05 to 0.80; p=0.027). Instant noodle consumption ≥5 times a week increased logodd (possibility) to experience hypertension 0.15 unit (b=0.15; 95% CI=0.04 to 0.26; p=0.010). Soft drink consumption ≥5 times a week increased logodd (possibility) to experience hypertension 0.15 unit, but it was statistically non-significant (b=0.15; 95% CI=-0.28 to 0.59; p=0.495).

Energy drink consumption ≥5 times a week increased logodd (possibility) to experience hypertension 0.27 units, but it was statistically non-significant

**Table 4.** reported path analysis of factors associated with hypertension and coronary disease.

| Dependent variables | | Independent variables | Path analysis coefficient (b) | 95% CI | | P |
|---|---|---|---|---|---|---|
| | | | | **Lower limit** | **Upper limit** | |
| Direct effect | | | | | | |
| Coronary disease | ← | Hypertension | 1.19 | 0.90 | 1.48 | <0.001 |
| | ← | Age ≥43 years | 0.88 | 0.55 | 1.21 | <0.001 |
| | ← | Alcohol consumption | -0.71 | -1.54 | 0.11 | 0.088 |
| | ← | High physical activity | -0.49 | -0.81 | -0.17 | 0.003 |
| Hypertension | ← | Male | -0.22 | -0.37 | -0.08 | 0.003 |
| | ← | Age ≥43 years | 1.76 | 1.63 | 1.90 | <0.001 |
| | ← | Vegetables consumption (every day) | -0.14 | -0.28 | -0.01 | 0.040 |
| | ← | Fruits consumption (every day) | -0.06 | -0.18 | 0.05 | 0.267 |
| | ← | Fat intake ≥3 times a week | 0.10 | -0.02 | 0.23 | 0.111 |
| | ← | Grilled food consumption ≥5 times a week | 0.42 | 0.05 | 0.80 | 0.027 |
| | ← | Energy drink consumption ≥5 times a week | 0.27 | -0.19 | 0.74 | 0.253 |
| | ← | Instants noodle consumption ≥5 times a week | 0.15 | 0.04 | 0.26 | 0.010 |
| | ← | Smoking | -0.08 | -0.24 | 0.07 | 0.292 |
| | ← | Soft drink consumption ≥5 times a week | 0.15 | -0.28 | 0.59 | 0.495 |
| | ← | High physical activity | -0.38 | -0.59 | -0.26 | <0.001 |
| Alcohol consumption | ← | Male | 0.77 | 0.54 | 1.00 | <0.001 |
| | ← | Smoking | 1.27 | 1.06 | 1.49 | <0.001 |
| | ← | Urban resident | -1.11 | -1.35 | -0.88 | <0.001 |
| | ← | Energy drink consumption ≥5 times a week | 0.83 | 0.44 | 1.23 | <0.001 |
| Energy drink consumption ≥5 times a week | ← | Male | 0.65 | 0.38 | 0.92 | <0.001 |
| Smoking | ← | Urban resident | -0.11 | -0.21 | -0.01 | 0.027 |
| | ← | Education ≥Senior high school | -0.07 | -0.17 | -0.03 | 0.170 |
| High physical activity | ← | Urban resident | -0.85 | -0.94 | -0.75 | <0.001 |
| Fruits consumption (every day) | ← | Education ≥Senior high school | 0.78 | 0.68 | 0.87 | <0.001 |
| Vegetables consumption (every day) | ← | Education ≥Senior high school | 0.16 | 0.05 | 0.27 | 0.005 |
| N observation= 10,171 | | | | | | |
| Log likelihood = -32636.925 | | | | | | |

(b=0.27; 95% CI=-0.19 to 0.74; p=0.253). Fat intake ≥3 times a week increased logodd (possibility) to experience hypertension 0.10 units, but it was statistically non-significant (b=0.10; 95% CI= -0.02 to 0.23; p= 0.111). Vegetables consumption (everyday) decreased logodd (possibility) to experience hypertension 0.14 units (b=-0.14; 95% CI=-0.28 to -0.01; p=0.040). Male decreased logodd (possibility) to experience hypertension 0.22 units (b=-0.22; 95% CI=-0.37 to -0.08; p=0.003). High physical activity decreased logodd (possibility) to experience hypertension 0.38 unit (b=-0.38; 95% CI=-0.59 to -0.26; p<0.001). Fruits consumption (everyday) decreased logodd (possibility) to experience hypertension 0.06 units, but it was statistically non-significant (b=-0.06; 95% CI=-0.18 to 0.05; p=0.267). Smoking decreased logodd (possibility) to experience hypertension 0.08 units, but it was statistically non-significant (b=-0.08; 95% CI=-0.24 to 0.07; p=0.292). Male increased logodd (possibility) to consume alcohol 0.77 units (b=0.77; 95% CI=0.54 to 1.00; p <0.001).

Smoking increased logodd (possibility) to consume alcohol 1.27 units (b= 1.27; 95% CI= 1.06 to 1.49; p <0.001). Energy drink consumption ≥5 times a week increased logodd (possibility) to consume alcohol 0.83 units (b=0.83; 95% CI=0.44 to 1.23; p<0.001). Urban resident decreased logodd (possibility) to consume alcohol 1.11 units (b=-1.11; CI 95%=-1.35 to -0.88; p <0.001). Male increased logodd (possibility) to consume energy drink ≥5 times a week 0.65 units (b=0.65; 95% CI=0.38 to 0.92; p<0.001). Urban resident decreased logodd (possibility) to smoke 0.11 units (b=-0.11; 95% CI=-0.21 to -0.01; p= 0.027). Education ≥Senior high school decreased logodd (possibility) to smoke 0.07 units, but it was statistically non-significant (b= -0.07; 95% CI=-0.17 to -0.03; p=0.170). Urban resident decreased logodd (possibility) of high physical activity 0.85 units (b= -0.85; 95% CI= -0.94 to -0.75; p <0.001). Education ≥Senior high school increased logodd (possibility) of fruits consumption (everyday) 0.78 units (b=0.78; 95% CI=0.68 to 0.87; p<0.001). Education ≥Senior high school increased logodd (possibility) to eat vegetables everyday 0.16 units (b=0.16; 95% CI=0.05 to 0.27; p=0.005).

## DISCUSSION

Hypertension has a negative impact on mortality and on the development of cardiovascular diseases and other NCDs.[6–8] Regular physical activity is a determinant of energy expenditure and, along with healthy dietary behavior, can impact cardio-respiratory and metabolic health.[9,10] The reduction in blood pressure with physical activity is thought to be due to attenuation in peripheral vascular resistance, which may be due to neurohormonal and structural responses with reductions in sympathetic nerve activity and an increase in arterial lumen diameters, respectively.[11] Other proposed mechanisms for blood pressure reduction include favorable changes in oxidative stress, inflammation, endothelial function, arterial compliance, body mass, renin-angiotensin system activity, parasympathetic activity, renal function, and insulin sensitivity.[12]

Female sex is associated with a longer life expectancy than male sex, women constitute a larger proportion of the elderly population in which the prevalence of CVD is greatest.[13] The higher mortality rate among women appears to be limited primarily to ST-segment–elevation MI.[14] Although women with acute coronary syndromes may have similar benefits from antiplatelet pharmacotherapy as men, they are more likely to have bleeding problems, possibly as a result of excess dosing.[15] Previous study reported that women and men overall have nearly equal percentages of hypertension (1 in 3 adults). Data from the National Health and Nutrition Examination Survey (NHANES) showed that the prevalence of high blood pressure is greater in women >65 years.

Alcohol drinking is an inseparable part of the indigenous culture in many local communities across Indonesia, where it often plays a large role in religious festivals and social gatherings[16]. In 2018, the alcohol consumption per capita in Indonesia amounted to approximately 0.48 liters annually[17]. The relationship between alcohol and hypertension is well known, and a reduction in the alcohol intake is widely recommended in the management of hypertension.[18,19] Previous studies reported several mechanisms that may underlie alcohol's effects on blood pressure. High alcohol consumption caused impairments in cells that lead to buildup of plaque in arteries (i.e., through alterations in endothelial cell function and nitric oxide availability), and disruptions in arterial-vascular function (i.e., through myogenic mechanisms and changes in baroreceptor function), and hormonal imbalances that control the body's fluid and BP regulation (through the renin–angiotensin–aldosterone system [RAAS]).[20,21]

A cross-sectional study in Chinese men examined the associations between alcohol intake and blood

pressure. Men with the highest alcohol intake category (≥30 drinks/week) were twice as likely as non-drinkers to have hypertension.[22] The type, quantity, and pattern of drinking are all highly correlated with socioeconomic and other lifestyle behaviors.[23] Among drinkers, those living in accessible small towns had higher odds of weekly drinking and drunkenness compared to urban areas. Higher odds of drunkenness were also found in remote rural areas. Those residing in the least deprived areas had lower odds of weekly drinking.[24]

Smoking and consuming alcohol are both related to increased mortality risk.[25] Drinking and smoking together is strongly socially patterned, being normative behavior in pubs, bars and clubs worldwide until the recent introduction in some countries of smoking restrictions in public places. The neurochemical mechanisms of action of nicotine and alcohol appear to be mutually reinforcing.[25,26]

Another drink often consumed daily by the community is soft drink and sweet beverages. Soft drink and sweetened beverages have little nutritional value (Malik and Hu, 2019). A meta-analysis study conducted by Narain (2016) reported that soft drink intake suggests a significant increase in stroke (RR=1.13; 95% CI=1.02 to 1.24, and coronary heart disease (RR=1.22; 95% CI=1.14 to 1.30).

Instant noodle is one the most popular processed foods and practically every Indonesians have ever consumed. While instant noodle might be considered as unhealthy food, millions of people consume it due to the cheap price, tasty flavors, and easy-to-prepare. In 2018, approximately 12.5 billion servings of instant noodles were consumed in Indonesia.[27] Previous study reported that increased consumption of instant noodles has recently been reported to be positively associated with obesity and cardiometabolic syndrome in South Korea. The study subjects with a higher frequency of instant noodle consumption were more likely to have multiple cardiometabolic risk factors.[5]

Instant noodles are generally high in refined carbohydrates but low in fiber. Most instant noodles are deep-fried, so they are high in calories, refined carbohydrates, saturated fat, and sodium. Several studies have suggested that the high energy density, glycemic load (due to the refined carbohydrates), saturated fat content, and sodium content of instant noodles, may contribute to increase the risk of heart disease.[5,28]

Fruits and vegetables have long been regarded as essential to a healthy diet. A recent WHO/FAO expert consultation report on diet, nutrition and prevention of chronic diseases, sets population nutrient goals and recommends intake of a minimum of 400 g of fruits and vegetables per day for the prevention of chronic diseases such as heart diseases, cancer, diabetes and obesity. Worldwide, low intake of fruits and vegetables is estimated to cause about 19% of gastrointestinal cancer, about 31% of ischemic heart disease and 11% of stroke.[29] Previous study reported that fruits and vegetables consumption 200 g/day reduced the risk of cardiovascular disease.[30,31]

## CONCLUSION

A path model can describe the correlations of factors associated with hypertension and coronary disease. Coronary disease is directly increased by hypertension, age ≥43 years, and high physical activity. It is directly decreased by alcohol consumption, but it was statistically non-significant. The coronary disease was indirectly affected by male vegetable consumption, fruit consumption, fat intake, grilled food consumption, energy drink consumption, instant noodles consumption, smoking, soft drink consumption, residence, and education.

### Ethical Approval

Ethical approval for the study was obtained from the ethics committee of Poltekkes Kemenkes Pontianak (094.A/KEKP-PK.PKP/III/2020).

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