Geographic and socioeconomic disparity in cardiovascular risk factors in Indonesia: analysis of the Basic Health Research 2018

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Abstract

Background: Cardiovascular diseases (CVDs) accounted for over 17 million deaths and 353 million disability-adjusted life years lost in 2016. The risk factors are also high and increasing with high blood pressure, smoking, and high body mass index contributing to up to 212 million disability-adjusted life years in 2016. To help reduce the burden, it is crucial to understand the geographic and socioeconomic disparities in CVD risk factors.

Methods: Employing both geospatial and quantitative analyses, we analyzed the disparities in the prevalence of smoking, physical inactivity, obesity, hypertension, and diabetes in Indonesia. CVD data was from Riskesdas 2018, and socioeconomic data was from the World Bank.

Results: Our findings show a very high prevalence of CVD risk factors with the prevalence of smoking, physical activity, obesity, hypertension ranged from 28 to 33%. Results also show the geographic disparity in CVD risk factors in all five Indonesian regions. Moreover, results show socioeconomic disparity with the prevalence of obesity, hypertension, and diabetes are higher among urban and the richest and most educated districts while that physical inactivity and smoking is higher among rural and the least educated districts.

Conclusion: The CVD burden is high and increasing in particularly among urban areas and districts with higher income and education levels. While the government needs to continue tackling the persistent burden from maternal mortality and infectious diseases, they need to put more effort into the prevention and control of CVDs and their risk factors.

Keywords: Cardiovascular risk factors, Geographic, Socioeconomic, Disparity, Indonesia

Background

Cardiovascular diseases (CVDs) accounted for over 17 million deaths and 353 million disability-adjusted life years (DALYs) lost with ischemic heart disease and stroke as the first and second leading causes of DALYs in 2016 [1, 2]. The burden of CVD risk factors is also high and increasing. High blood pressure, smoking, and high body mass index (BMI) contributed to over 212 million, 155 million, and 135 million DALYs in 2016, respectively. Smoking and high blood pressure were the leading risks among men, while high blood pressure and high BMI were the leading risks among women in 2016 [3].

Like many low and middle-income countries (LMICs), the burden of CVDs and risk factors is high and increasing in Indonesia, a lower-middle-income country [4]. The Global Burden of Disease study shows that stroke and ischemic heart disease are the top causes of deaths and disability in 2017 [5]. The Basic Health Research (Riskesdas), a nationally representative health survey, showed that the prevalence of diagnosed stroke among...
people aged 15 years and above increased by 56% (from 0.7 to 1.1%) during 2013–2018. The prevalence of hypertension among people aged 18 years and above also increased by 32% (from 26 to 34%), and that of obesity increased by 47% (from 15 to 22%) during 2013–2018 [6].

To achieve the Sustainable Development Goals on reducing premature deaths from non-communicable diseases, reduction in geographic and socioeconomic disparity in the burden of CVDs and risk factors is crucial [7, 8]. Evidence from high-income countries shows while the socioeconomic gap in life expectancy is narrowing, the disparity in CVD mortality and risk factors such as smoking, obesity, and hypertension are widening [9, 10]. However, current studies on geographic and socioeconomic inequality in CVD risk factors are limited in three ways. First, many studies are from high-income countries, including the United States, the United Kingdom, and South Korea [10–18]. Second, the few studies from LMICs were socioeconomic inequalities in BMI and obesity focusing among women [19–21], and lacking evidence on geographic disparity [22–24]. In this paper, we aim to address this evidence gap by examining the geographic and socioeconomic disparity in CVD risk factors in Indonesia.

Methods
Study design and sampling
This is a cross-sectional study on the geographic and socioeconomic disparity in CVD risk factors among districts in Indonesia. Data for CVD risk factors were from the district-level aggregate data of Riskesdas 2018, a nationally representative health survey conducted by the Ministry of Health. The target sample was 300,000 households from 30,000 census blocks (CBs) from the National Socioeconomic Survey (Susenas) with two-stage sampling. In the first stage, out of a total of 720,000 CBs from the 2010 population census, 180,000 CBs (25%) were selected using probability proportional to size. In each urban and rural stratum, 30,000 CBs were selected using probability proportional to size. In the second stage, 10 households were systematically selected using implicit stratification of education level of household head, to maintain variations among households. In each household, each member was interviewed, but only members meeting the criteria were selected for examination, including those 15+ years old for blood glucose and lipid profile. The interview response rate was 95% of target households at the national level, ranging from 85% in Papua to 99% in Bangka Belitung province. There were 818,507 and 713,783 individuals aged 10+ and 15+ years old, respectively [25].

Socioeconomic data were from the World Bank. In addition to the geospatial analysis, we conducted quantitative analyses on geographic disparity, including region and urbanicity. The National Planning Agency (Bappenas) divides the 34 provinces into seven regions, including Sumatera, Java, Kalimantan, Sulawesi, Nusa Tenggara, Maluku, and Papua. However, we combined the last three as one region (Papua) because they have fewer districts and similarly the least developed in the country. Moreover, we conducted quantitative analyses on socioeconomic disparity, including income and education indicators by urban/rural. We
defined cities as urban and regents as rural; we used district-level poverty rate for income with the lowest rate as quintile 5; and we used the net enrollment ratio of senior secondary for education with the highest ratio as quintile 5.

**Dependent variables**
There are five main CVD risk factors as the dependent variables, including the prevalence of smoking, physical inactivity, obesity, hypertension, and diabetes mellitus.

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*Fig. 2* Disparity of CVD risk factors by province in Indonesia, 2018

*Note: Numbers show prevalence of CVD risk factors; HPT=Hypertension, CVD=Cardiovascular Disease*
Smoking was defined as current smoking status of respondents aged 10 years and above. Physical inactivity was defined as lack of rigorous or moderate activity in the last week per the World Health Organization's Global Physical Activity Questionnaire (GPAQ) among respondents aged 10 years and above. Rigorous activity is an activity that is carried out continuously for at least 10 min for at least 3 days last week.

Table 1: Prevalence of CVD risk factors by province in Indonesia, 2018

| Province           | Poverty rates | Smoking  | Inactivity | Obesity | Hypertension | Diabetes |
|--------------------|---------------|----------|------------|---------|--------------|----------|
|                    | [1]           | [2]      | [3]        | [4]     | [5]          | [6]      |
| Bali               | 4.5%          | 22.8%    | 25.3%      | 36.3%   | 29.2%        | 1.8%     |
| South Kalimantan   | 4.8%          | 24.4%    | 33.9%      | 28.6%   | 41.6%        | 1.7%     |
| Central Kalimantan | 5.0%          | 29.8%    | 33.4%      | 24.7%   | 33.4%        | 1.5%     |
| Jakarta            | 5.0%          | 28.5%    | 46.7%      | 42.5%   | 31.9%        | 3.7%     |
| Banten             | 5.3%          | 31.4%    | 39.9%      | 30.0%   | 28.3%        | 2.2%     |
| Bangka Belitung    | 5.4%          | 28.6%    | 34.9%      | 33.4%   | 28.3%        | 2.5%     |
| West Sumatera      | 6.6%          | 30.9%    | 38.8%      | 33.4%   | 24.1%        | 1.6%     |
| North Kalimantan   | 7.0%          | 26.0%    | 41.9%      | 30.9%   | 31.8%        | 2.2%     |
| East Kalimantan    | 7.1%          | 27.1%    | 39.2%      | 35.6%   | 38.0%        | 2.9%     |
| Riau Islands       | 7.6%          | 27.1%    | 37.9%      | 31.5%   | 32.2%        | 1.8%     |
| Jambi              | 7.8%          | 25.8%    | 44.2%      | 24.6%   | 28.1%        | 1.3%     |
| North Maluku       | 7.9%          | 30.0%    | 36.0%      | 31.1%   | 22.2%        | 1.6%     |
| West Java          | 7.9%          | 32.3%    | 37.5%      | 32.0%   | 38.8%        | 1.8%     |
| West Kalimantan    | 8.1%          | 28.0%    | 30.6%      | 24.5%   | 35.7%        | 1.5%     |
| North Sulawesi     | 8.5%          | 30.1%    | 31.3%      | 40.7%   | 32.1%        | 2.7%     |
| Riau               | 8.8%          | 29.1%    | 32.0%      | 32.5%   | 27.3%        | 1.8%     |
| South Sulawesi     | 9.8%          | 26.1%    | 33.4%      | 30.7%   | 30.5%        | 1.6%     |
| West Sulawesi      | 10.3%         | 25.3%    | 30.3%      | 26.9%   | 31.8%        | 1.1%     |
| East Java          | 10.9%         | 27.8%    | 26.2%      | 30.6%   | 35.2%        | 2.7%     |
| Central Java       | 10.9%         | 27.7%    | 29.8%      | 28.9%   | 35.6%        | 2.2%     |
| North Sumatera     | 11.3%         | 26.7%    | 31.3%      | 31.1%   | 27.5%        | 1.7%     |
| Lampung            | 12.6%         | 31.9%    | 28.5%      | 25.6%   | 28.2%        | 1.3%     |
| Jogjakarta         | 12.7%         | 24.1%    | 26.8%      | 31.1%   | 31.7%        | 3.2%     |
| Southeast Sulawesi | 13.0%         | 25.6%    | 34.9%      | 29.7%   | 28.3%        | 1.3%     |
| South Sumatera     | 13.1%         | 30.6%    | 33.1%      | 26.5%   | 28.5%        | 1.1%     |
| Central Sulawesi   | 14.6%         | 31.2%    | 34.5%      | 32.7%   | 28.6%        | 2.2%     |
| West Nusa Tenggara| 14.8%         | 30.4%    | 30.1%      | 25.8%   | 24.1%        | 1.7%     |
| Bengkulu           | 15.0%         | 31.9%    | 27.3%      | 28.8%   | 26.9%        | 1.2%     |
| Aceh               | 16.4%         | 28.5%    | 34.2%      | 29.7%   | 25.3%        | 2.2%     |
| Gorontalo          | 16.8%         | 32.0%    | 35.4%      | 36.0%   | 27.4%        | 2.3%     |
| Maluku             | 21.8%         | 29.0%    | 42.0%      | 27.9%   | 26.5%        | 0.8%     |
| East Nusa Tenggara| 22.0%         | 26.7%    | 25.9%      | 18.8%   | 25.2%        | 0.8%     |
| West Papua         | 26.5%         | 27.8%    | 42.0%      | 32.1%   | 22.6%        | 1.5%     |
| Papua              | 29.4%         | 26.4%    | 35.7%      | 30.5%   | 20.7%        | 0.9%     |

**AVERAGE**

|                | 28.3% | 34.3% | 30.5% | 29.6% | 1.8% |

Note: Ordered by the average poverty rates (column 1), the provinces in the top box are richest and those in the bottom box are poorest. Shaded values show higher than the national average for each risk factor.
with a total activity duration of at least 1500 metabolic equivalent of task (MET) minute. MET minute of rigorous activity is the duration (minutes) of activities in a week multiplied by eight calories. Moderate activity including activity (e.g., sweeping, mopping, etc.) of at least 5 days with a total duration of 150 min last week. Obesity was measured by central obesity among aged 15 years and above that is abdominal circumference of more than 80 cm in women (excluding pregnant women) and of more than 90 cm in men. Hypertension was among aged 15 years and above with systolic blood pressure of at least 140 mmHg or diastolic of 90 mmHg. Diabetes mellitus was measured among respondents aged 15 years and above who have been diagnosed by a doctor.

Data analysis
We conducted geospatial analyses by dividing the CVD risk prevalence among 34 provinces and 514 districts into five quintiles in ArcMap 10. Moreover, we conducted bivariate Ordinary Least Square (OLS) regressions in STATA 15 to show associations between geographic (i.e. urban/rural and region) and socioeconomic (i.e. income and education) disparity in each CVD risk factor (smoking, physical inactivity, obesity, hypertension, and diabetes mellitus). We also calculated the absolute and relative differences between geographic and socioeconomic variation. For the region, absolute and relative differences were between Java (most developed) and Papua (least developed). For income and education, absolute and relative differences were between quintile 5 (wealthiest and most educated) and quintile 1 (poorest and least educated).

While age is an important CVD risk factor, there was only district-level age data for 2010 available from the World Bank (based on population census). We used the proportion of population aged 65+ years for each district (in quintile) in 2010, but there were fewer districts. The full regression results without \( n = 514 \) districts and with \( n = 497 \) districts controlling for age are similar, as shown in Additional file 1, respectively. Thus, we presented the former as our main results. All statistical significance was at the 5% level.

Results
Results will be in two parts: the provincial and district levels. Evidence on the disparity in CVD risk factors at the provincial level is relevant for national development planning, but the number of observations (e.g., 34 provinces) is limited for quantitative analysis. The disparity at the district level is crucial for at least two reasons. First, the decentralization policy in Indonesia that started in 2001 transferred much authority for local development planning (including the health sector) to the mayor of districts (including cities). After 2001, the district health office is accountable to the mayor (and to the Ministry of Home Affairs) instead of previously to the Ministry of Health. Also, the number of observations (e.g., 514 districts) is sufficient for further quantitative analysis.

Provincial level
Figure 1 shows the map of Indonesia, with 34 provinces distributed into five regions of Sumatera, Java (including

Table 2 Characteristics of districts and CVD risk factors

| Sample size district | 514 | All | Urban | Rural | Difference |
|----------------------|-----|-----|-------|-------|------------|
| Region
| Papua               | 95  | 18% | 9     | 9%    | -11%       |
| Java                | 128 | 25% | 35    | 36%   | 14%        |
| Sumatera            | 154 | 30% | 33    | 34%   | 5%         |
| Kalimantan          | 56  | 11% | 9     | 9%    | -2%        |
| Sulawesi            | 81  | 16% | 11%   | 11%   | -5%        |
| Income/poverty
| Q1 poor             | 102 | 20% | 3     | 3%    | -21%       |
| Q2                  | 103 | 20% | 5     | 5%    | -18%       |
| Q3                  | 103 | 20% | 13    | 13%   | -8%        |
| Q4                  | 103 | 20% | 22    | 23%   | 3%         |
| Q5 rich             | 103 | 20% | 54    | 56%   | 44%        |
| Education
| Q1 least            | 103 | 20% | 0     | 0%    | -25%       |
| Q2                  | 103 | 20% | 11    | 11%   | -11%       |
| Q3                  | 103 | 20% | 17    | 18%   | -3%        |
| Q4                  | 103 | 20% | 29    | 30%   | 12%        |
| Q5 most             | 102 | 20% | 40    | 41%   | 26%        |
| Smoking             | n/a | 28% | n/a   | 27%   | 29%        |
| Physical inactivity | n/a | 33% | n/a   | 40%   | 32%        |
| Obesity             | n/a | 30% | n/a   | 37%   | 28%        |
| Hypertension        | n/a | 30% | n/a   | 30%   | 30%        |
| Diabetes mellitus   | n/a | 2%  | n/a   | 3%    | 2%         |

CVD Cardiovascular Diseases, \( Q \) Quintile, \( n \) number, \% proportion of column total, Urban City, Rural District/Regent. Data on district characteristics are from the World Bank and data on CVD risk factors are from Basic Health Survey 2018. Bold numbers with asterisk (*) show statistically significance at 5% level – full regression results are provided in Additional file 1 panel (a)
Bali), Kalimantan, Sulawesi, and Papua (including Maluku and Nusa Tenggara). In general, provinces in the western regions (e.g., Java and Sumatera) are more developed than those in the eastern areas (e.g., Papua and Nusa Tenggara). In terms of geographic disparity, Fig. 2 shows the distribution of CVD risk factor prevalence quintiles. The prevalence of smoking ranged from 23 to 32%; that of inactivity ranged from 25 to 47%; that of obesity ranged from 19 to 43%; that of hypertension ranged from 21 to 42%; that of diabetes ranged from 0.8 to 3.7%. For

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**Fig. 2** Map showing the distribution of CVD risk factors prevalence quintiles in Indonesia.

**Fig. 3** Disparity of CVD risk factors by district in Indonesia, 2018

*Note: Numbers show prevalence of CVD risk factors; HPT=Hypertension, CVD=Cardiovascular Disease*
Table 3 Bottom ten districts with lowest prevalence of CVD risk factor in Indonesia

| Prevalence | Province     | Region     | Urban | Poverty | Education | Pop (000) |
|------------|--------------|------------|-------|---------|-----------|-----------|
| (a) Smoking                                     |              |           |       |         |           |           |
| Kab. Yahukimo 5.3% Pawau                        | Papua        | Rural     | 39%   | 12%     | 181       |           |
| Kab. Nias Selatan 8.0% North Sumatera           | Sumatera     | Rural     | 17%   | 65%     | 308       |           |
| Kab. Nias 12.1% North Sumatera                  | Sumatera     | Rural     | 16%   | 62%     | 136       |           |
| Kab. Sarolangun Bangko 13.4% Jambi               | Sumatera     | Rural     | 9%    | 59%     | 278       |           |
| Kab. Nias Barat 15.3% North Sumatera            | Sumatera     | Rural     | 27%   | 80%     | 85        |           |
| Kab. Puncak 15.6% Papua                         | Rural        | 38%       | 9%    | 103     |           |           |
| Kab. Paniayi 16.0% Papua                        | Rural        | 37%       | 25%   | 164     |           |           |
| Kab. Mambramo Tengah 16.1%                      | Papua        | Rural     | 37%   | 54%     | 46        |           |
| Kota Gunungsitoli 16.4%                         | Sumatera     | Urban     | 18%   | 76%     | 136       |           |
| Kab. Buton 16.4% Southeast Sulawesi              | Sulawesi      | Rural    | 14%   | 69%     | 98        |           |
| **AVERAGE**                                     |              |           |       |         |           | **154**   |
| (b) Inactivity                                   |              |           |       |         |           |           |
| Kab. Yahukimo 9.4% Papua                         | Papua        | Rural     | 39%   | 12%     | 181       |           |
| Sabu Raijua 10.7% East Nusa Tenggara            | Papua        | Rural     | 31%   | 69%     | 86        |           |
| Kab. Diyai 10.9% Papua                           | Papua        | Rural     | 43%   | 51%     | 69        |           |
| Kab. Bangli 12.9% Bali                           | Java         | Rural     | 5%    | 72%     | 222       |           |
| Kab. Kupang 13.0% East Nusa Tenggara             | Papua        | Rural     | 23%   | 58%     | 347       |           |
| Kab. Kulon Progo 13.1% Yogyakarta                | Java         | Rural     | 18%   | 81%     | 412       |           |
| Kab. Aceh Jaya 13.3% Aceh                        | Java         | Rural     | 14%   | 74%     | 86        |           |
| Kab. Kepahiang 13.3% Bengkulu                    | Sumatera     | Rural     | 14%   | 71%     | 132       |           |
| Kab. Pidie 13.7% Aceh                            | Sumatera     | Rural     | 20%   | 74%     | 418       |           |
| Kab Bener Meriah 14.3% Aceh                      | Sumatera     | Rural     | 20%   | 67%     | 137       |           |
| **AVERAGE**                                     |              |           |       |         |           | **209**   |
| (c) Obesity                                       |              |           |       |         |           |           |
| Kab. Nias 6.0% North Sumatera                    | Sumatera     | Rural     | 16%   | 62%     | 136       |           |
| Sumba Barat Daya 10.3% East Nusa Tenggara        | Papua        | Rural     | 29%   | 42%     | 319       |           |
| Kab. Manggarai Timur 10.5% East Nusa Tenggara    | Papua        | Rural     | 27%   | 43%     | 272       |           |
| Kab. Nias Barat 10.6% North Sumatera             | Sumatera     | Rural     | 27%   | 80%     | 85        |           |
| Sumba Tengah 11.4% East Nusa Tenggara            | Papua        | Rural     | 35%   | 44%     | 68        |           |
| Kab. Sumba Barat 12.0% East Nusa Tenggara        | Papua        | Rural     | 29%   | 55%     | 122       |           |
| Kab. Nias Selatan 12.4% North Sumatera           | Sumatera     | Rural     | 17%   | 65%     | 308       |           |
| Sabu Raijua 12.9% East Nusa Tenggara             | Papua        | Rural     | 31%   | 69%     | 86        |           |
| Kab. Timor Tengah Selatan 13.2% East Nusa Tenggara | Papua    | Rural     | 28%   | 52%     | 459       |           |
| Kab. Belu 14.6% East Nusa Tenggara               | Papua        | Rural     | 16%   | 54%     | 206       |           |
| **AVERAGE**                                     |              |           |       |         |           | **206**   |
| (d) Hypertension                                 |              |           |       |         |           |           |
| Kab. Nduga 9.6% Papua                            | Papua        | Rural     | 38%   | 9%      | 94        |           |
| Kab. Puncak Jaya 10.0% Papua                     | Papua        | Rural     | 36%   | 21%     | 115       |           |
| Kab. Tolikara 11.0% Papua                        | Papua        | Rural     | 33%   | 34%     | 131       |           |
| Kab. Mambramo Tengah 12.1% Papua                 | Papua        | Rural     | 37%   | 54%     | 46        |           |
| Kab. Asmat 12.2% Papua                           | Papua        | Rural     | 27%   | 21%     | 88        |           |
| Kab. Sorong Selatan 13.1% West Papua             | Papua        | Rural     | 19%   | 56%     | 43        |           |
| Kab. Lanny Jaya 13.2% Papua                      | Papua        | Rural     | 40%   | 46%     | 172       |           |
smoking, the prevalence was highest (quintile 5), particularly in provinces in the southern part of Sumatera (e.g., Lampung), the western part of Java (e.g., Banten), and northern part Sulawesi (e.g., Gorontalo) regions. For obesity, the prevalence was highest in the Kalimantan (e.g., East Kalimantan) and Sulawesi (e.g., North Sulawesi) regions. For hypertension, the prevalence was the highest in most provinces in the Kalimantan and Java regions.

In terms of socioeconomic disparity, Table 1 shows the prevalence of CVD risk factors by the provincial income level. The provinces in the top box (e.g., Bali) are more affluent, and those in the bottom box (e.g., West Papua) are poorer. The shaded prevalence shows higher than the national average for each risk factor. Results show more shaded prevalence among the wealthiest provinces for all risk factors but smoking. Five of the 10 wealthiest provinces have shaded smoking prevalence, while seven of the 10 poorest provinces do. Six of the 10 wealthiest provinces have the shaded hypertension prevalence, while none of the 10 poorest provinces do.

**District level**

Table 2 shows the characteristics of districts and the prevalence of CVD risk factors. In terms of district characteristics (panel a), the regions of Sumatera and Java have a lot more districts with 154 (30%) and 128 (25%) districts out of a total of 514, respectively. There are 97 urban cities (19%) and 417 rural regents (81%). By income, 79% of urban areas are in the fourth or fifth quintiles (richer) while almost half (48%) of rural areas are in the first and second quintiles (poorer). By education, 71% of the urban areas are in the fourth or fifth quintiles (most educated), while almost half (47%) of rural areas are in the first and second quintiles (least educated). In terms of CVD risk factors (panel b), the prevalence of smoking, physical activity, obesity, hypertension, and diabetes is 28, 33, 30, 30, and 2%, respectively. There is a significant disparity between urban and rural, except for the prevalence of hypertension. While smoking prevalence is lower in urban areas by 6.3% (i.e., 1.7% divided by 27% urban smoking prevalence), the prevalence of physical inactivity, obesity, and diabetes is higher in urban areas by 20.8, 22.4, and 40%, compared to rural areas.

In terms of geographic disparity, Fig. 3 shows the distribution of district-level CVD risk factor prevalence by quintile. Results show more granularity in the disparity by district, compared to that by province. Many districts in the northern part of Sumatera and several parts of Papua have the highest prevalence of all risk factors, particularly smoking, obesity, and diabetes.

In terms of socioeconomic disparity, Tables 3 and 4 provide the 10 districts with the lowest and highest prevalence. The prevalence of smoking ranged from 5.3% in Yahukimo district (Papua province) to 53.5% in Asmat district (Papua); that of inactivity ranged from 9.4% in Yahukimo district (Papua) to 93.1% in Yalimo district (Papua); that of obesity ranged from 6% in Nias district (North Sumatera) to 49.7% in Karo district

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**Table 3** Bottom ten districts with lowest prevalence of CVD risk factor in Indonesia (Continued)

| Prevalence | Province | Region | Urban | Poverty | Education | Pop (000) |
|------------|----------|--------|-------|---------|-----------|-----------|
| 13.4%      | Papua    | Papua  | Rural | 39%     | 12%       | 181       |
| 13.4%      | West Papua | Papua  | Rural | 33%     | 39%       | 30        |
| 14.2%      | North Maluku | Papua  | Rural | 14%     | 63%       | 50        |
| **AVERAGE**|          |        |       | 32%     | 36%       | 95        |

**(e) Diabetes**

| Prevalence | Province | Region | Urban | Poverty | Education | Pop (000) |
|------------|----------|--------|-------|---------|-----------|-----------|
| 0.0%       | Papua    | Papua  | Rural | 38%     | 9%        | 94        |
| 0.0%       | Papua    | Papua  | Rural | 36%     | 21%       | 115       |
| 0.0%       | Papua    | Papua  | Rural | 39%     | 12%       | 181       |
| 0.0%       | Papua    | Papua  | Rural | 33%     | 39%       | 30        |
| 0.0%       | Papua    | Papua  | Rural | 30%     | 51%       | 21        |
| 0.0%       | Papua    | Papua  | Rural | 39%     | 67%       | 206       |
| 0.0%       | Papua    | Papua  | Rural | 30%     | 39%       | 92        |
| 0.0%       | Papua    | Papua  | Rural | 43%     | 9%        | 46        |
| 0.0%       | Papua    | Papua  | Rural | 43%     | 51%       | 69        |
| 0.0%       | Southeast Sulawesi | Sulawesi | Rural | 15%     | 44%       | 77        |
| **AVERAGE**|          |        |       | 35%     | 34%       | 93        |

CVD Cardiovascular Disease, Urban City, Rural District/Regent, Pop Population. The districts are ordered by risk factor prevalence.
Table 4 Top ten districts with highest prevalence of CVD risk factor in Indonesia, 2018

| Risk Factor | Province       | Region     | Urban | Poverty | Education | Pop (000) |
|------------|----------------|------------|-------|---------|-----------|-----------|
| (a) Smoking |                |            |       |         |           |           |
| Kab. Asmat | 53.5%          | Papua      | Rural | 27%     | 21%       | 88        |
| Kab. Mappi | 42.7%          | Papua      | Rural | 26%     | 16%       | 92        |
| Kab. Boven Digul | 41.5% | Papua | Rural | 20% | 35% | 63 |
| Kab. OKU Selatan | 37.9% | South Sumatera | Sumatera | Rural | 11% | 61% | 344 |
| Kab. Garut | 37.6%          | West Java  | Rural | 9%      | 51%       | 2547      |
| Kab. Bolaang Mongo Utara | 37.3% | North Sulawesi | Sulawesi | Rural | 9% | 75% | 76 |
| Kab. Empat Lawang | 36.9% | South Sumatera | Sumatera | Rural | 12% | 62% | 238 |
| Kab. Pandeglang | 36.9% | Banten | Java | 10% | 50% | 1194 |
| Kab. Sumedang | 36.8% | West Java | Java | Rural | 10% | 43% | 1137 |
| Kab. Bolaang Mongondow | 36.8% | North Sulawesi | Sulawesi | Rural | 8% | 51% | 233 |
| **AVERAGE**    |            |            |       | **14%** | **46%**   | **601**   |
| (b) Inactivity |                |            |       |         |           |           |
| Kab. Yalimo | 93.1%          | Papua      | Rural | 35%     | 28%       | 59        |
| Kab. Sarolangun Bangko | 86.3% | Jambi | Sumatera | Rural | 9% | 59% | 278 |
| Kab. Supiori | 64.5% | Papua | Papua | Rural | 39% | 57% | 18 |
| Kab. Raja Ampat | 63.9% | West Papua | Papua | Rural | 18% | 45% | 46 |
| Kota Sungai Penuh | 62.4% | Jambi | Sumatera | Urban | 3% | 78% | 87 |
| Malaka | 62.1%          | East Nusa Tenggara | Papua | Rural | 16% | 58% | 180 |
| Kota Ternate | 61.7% | North Maluku | Papua | Urban | 3% | 63% | 213 |
| Kota Pegunungan Bintang | 61.6% | Papua | Papua | Rural | 31% | 21% | 72 |
| Kota Bukittinggi | 60.3% | West Sumatera | Sumatera | Urban | 5% | 78% | 122 |
| Kab. Maybrat | 59.5%          | West Java  | Papua | Rural | 33% | 69% | 37 |
| **AVERAGE**    |            |            |       | **19%** | **56%**   | **111**   |
| (c) Obesity |                |            |       |         |           |           |
| Kab. Karo | 49.7%          | North Sumatera | Sumatera | Rural | 9% | 74% | 389 |
| Kab. Minahasa | 48.7% | North Sulawesi | Sulawesi | Rural | 7% | 65% | 329 |
| Kota Pematang Siantar | 48.3% | North Sumatera | Sumatera | Urban | 9% | 77% | 247 |
| Kab. Minahasa Selatan | 47.8% | North Sulawesi | Sulawesi | Rural | 9% | 62% | 205 |
| Kota Jakarta Pusat | 46.9% | Jakarta | Java | Urban | 4% | 55% | 914 |
| Kota Manado | 45.6%          | North Sulawesi | Sulawesi | Urban | 5% | 66% | 425 |
| Kota Tomohon | 45.1%          | North Sulawesi | Sulawesi | Urban | 6% | 71% | 100 |
| Kota Padang Panjang | 44.5% | West Sumatera | Sumatera | Urban | 6% | 74% | 51 |
| Kota Mojokerto | 44.2%          | East Java  | Java | Urban | 6% | 80% | 126 |
| Kota Gorontalo | 44.0%          | Gorontalo  | Sulawesi | Urban | 6% | 56% | 202 |
| **AVERAGE**    |            |            |       | **7%** | **68%**   | **299**   |
| (d) Hypertension |                |            |       |         |           |           |
| Kab. Hulu Sungai Tengah | 49.2% | South Kalimantan | Kalimantan | Rural | 6% | 66% | 260 |
| Kab. Tabalong | 48.4%          | South Kalimantan | Kalimantan | Rural | 6% | 61% | 239 |
| Kab. Ciamis | 47.4%          | West Java  | Java | Rural | 7% | 51% | 1168 |
| Kab. Kutai Barat | 46.2% | East Kalimantan | Kalimantan | Rural | 9% | 60% | 146 |
| Kab. Cianjur | 45.8%          | West Java  | Java | Rural | 10% | 45% | 2243 |
| Kota Madiun | 45.2%          | East Java  | Java | Urban | 4% | 80% | 175 |
| Kota Kuningan | 45.2%          | West Java  | Java | Rural | 12% | 67% | 1055 |
Table 4 Top ten districts with highest prevalence of CVD risk factor in Indonesia, 2018 (Continued)

| Prevalence | Province       | Region    | Urban | Poverty | Education | Pop (000) |
|------------|----------------|-----------|-------|---------|-----------|-----------|
| Kota Banjarmasin | South Kalimantan | Kalimantan | Urban | 4%      | 55%       | 675       |
| Kab. Barito Kuala | South Kalimantan | Kalimantan | Rural | 5%      | 62%       | 298       |
| Melawi     | West Kalimantan | Kalimantan | Rural | 13%     | 41%       | 196       |
| **AVERAGE** |                |           |       | 8%      | 59%       | 645       |

(e) Diabetes

| Prevalence | Province       | Region    | Urban | Poverty | Education | Pop (000) |
|------------|----------------|-----------|-------|---------|-----------|-----------|
| Kota Madiun | East Java      | Java      | Urban | 4%      | 80%       | 175       |
| Kota Mojokerto | East Java    | Java      | Urban | 6%      | 80%       | 126       |
| Kota Yogyakarta | Jogjakarta  | Java      | Urban | 7%      | 73%       | 412       |
| Kab. Sidoarjo | East Java  | Java      | Rural | 6%      | 70%       | 2114      |
| Kab. Gresik  | East Java      | Java      | Rural | 12%     | 79%       | 1255      |
| Kota Probolinggo | East Java   | Java      | Urban | 7%      | 72%       | 229       |
| Kota Manado  | North Sulawesi | Sulawesi  | Urban | 5%      | 66%       | 425       |
| Kota Surabaya | East Java  | Java      | Urban | 5%      | 66%       | 2847      |
| Kep Seribu   | Jakarta        | Java      | Rural | 12%     | 71%       | 23        |
| Kota Jakarta Pusat | Jakarta   | Java      | Urban | 4%      | 55%       | 914       |
| **AVERAGE** |                |           |       | 7%      | 71%       | 852       |

CVD Cardiovascular Disease, Urban City, Rural District/Regent, Pop Population. The districts are ordered by risk factor prevalence.

Discussion

In Indonesia, we found a very high prevalence of CVD risk factors among men and women aged 10 years and above. For example, the prevalence of smoking, physical activity, obesity, hypertension ranged from 28 to 33% in 2018. We also found a huge geographic disparity in CVD risk factors. For instance, provinces and districts with the highest smoking prevalence are in the northern and southern parts of Sumatera, the western part of Kalimantan, the eastern and western parts of Java, the northern part of Sulawesi, and the southern part of Papua. We also found evidence of substantial socioeconomic disparity in CVD risk factors. The prevalence of obesity, hypertension, and diabetes is higher among urban and the richest and most educated districts, while that of physical inactivity and smoking is higher among rural and the least educated districts.

This disparity is similar to the global trend where the prevalence of obesity, hypertension, and diabetes is the largest in higher-income countries while that of smoking is largest in lower-income countries. However, our results show that obesity, hypertension, and diabetes are no longer exclusive to wealthier countries. In Indonesia, a lower-middle-income country, 40% of 514 districts have the prevalence of hypertension and obesity, ranging from 32 to 49% and 33 to 50%, respectively. This evidence highlights the need for generating similar findings in LMICs for policy evidence and national planning. Our results show that while the governments in LMICs are to continue tackling maternal mortality and infectious diseases (e.g. tuberculosis and dengue), they need to put more effort into the CVD prevention and control, especially in urban and the most developed and educated cities and regents.
| Region       | Smoking | Inactivity | Obesity | Hypertension | Diabetes | Smoking | Inactivity | Obesity | Hypertension | Diabetes | Smoking | Inactivity | Obesity | Hypertension | Diabetes | Smoking | Inactivity | Obesity | Hypertension | Diabetes |
|--------------|---------|------------|---------|-------------|----------|---------|------------|---------|-------------|----------|---------|------------|---------|-------------|----------|---------|------------|---------|-------------|----------|
| Papua        | 27.8%   | 34.5%      | 27.3%   | 23.2%       | 1.1%     | 26.8%   | 40.7%      | 35.5%   | 24.9%       | 2.2%     | 27.9%   | 33.8%      | 26.4%   | 23.0%       | 1.0%     | 0.7%    | -3.2%*     | 4.1%*   | 11.7%*      | 1.2%*    |
| Sulawesi     | 27.9%   | 33.4%      | 32.8%   | 29.9%       | 1.9%     | 26.5%   | 36.5%      | 38.8%   | 28.8%       | 2.7%     | 28.1%   | 33.0%      | 31.8%   | 30.1%       | 1.7%     | 0.7%    | 4.9%*      | 7.4%*   | 7.2%*       | 1.1%*    |
| Kalimantan   | 27.3%   | 34.6%      | 28.1%   | 36.5%       | 1.9%     | 23.5%   | 43.6%      | 35.8%   | 34.7%       | 3.1%     | 28.0%   | 32.9%      | 26.6%   | 36.9%       | 1.6%     | 0.7%    | -0.7%*     | 3.4%*   | 8.3%*       | 0.6%*    |
| Sumatera     | 29.0%   | 33.8%      | 29.8%   | 27.2%       | 1.7%     | 27.3%   | 41.3%      | 35.3%   | 26.4%       | 2.4%     | 29.5%   | 31.7%      | 28.3%   | 27.4%       | 1.5%     | 0.7%    | 1.2%       | 3.0%    | 4.0%        | 0.9%     |
| Java         | 28.5%   | 31.3%      | 31.4%   | 34.9%       | 2.3%     | 27.5%   | 39.0%      | 37.9%   | 33.8%       | 3.2%     | 28.9%   | 28.4%      | 28.9%   | 35.3%       | 2.0%     | 0.7%    | -5.4%*     | 2.5%*   | 123%*       | 1.0%*    |
| Absolute     | 0.7%    | 4.9%*      | 7.4%*   | 7.2%*       | 1.1%*    | 3.4%    | 6.1%       | 5.9%*   | 4.0%        | 0.7%    | -0.7%   | 1.2%       | 3.4%*   | 8.3%*       | 0.6%*    | 0.9%    | 1.2%        | 3.0%    | 4.0%        | 0.9%     |
| Relative     | 1.03    | 0.91       | 1.15    | 1.51        | 2.08     | 1.03    | 0.96       | 1.07    | 1.36        | 1.41     | 1.04    | 0.84       | 1.09    | 1.54        | 2.02     |

**Q Quintile, CVD Cardiovascular Diseases. Papua region includes Maluku and Nusa Tenggara. Income quintile used district-level poverty rate (e.g. Q1 = 20% of districts with highest poverty rate). Absolute (Relative) = Difference (Ratio) between Java and Papua as well as Q5 and Q1. Bold numbers with asterisk (*) show statistically significance at 5% level – full regression results are provided in Additional file 1 panels b-d.**
Moreover, our findings show that all the bottom 10 districts with the lowest prevalence of diagnosed diabetes have zero prevalence, and nine of the districts are in the most eastern and least developed Papua region. On the other hand, all the top 10 districts with the highest prevalence of diabetes have a prevalence of 4.1% and above, and nine of the districts are in the most developed Java region. In addition to the issue with a considerable disparity between the two, the zero prevalence may also indicate the lack of health system ability to diagnosed diabetes in the least developed. The future national health survey cycle should also examine the undiagnosed diabetes to help confirm this.

There are at least two recommendations to reduce the CVD risk factors in Indonesia. First, there is a need for more comprehensive tobacco control efforts (e.g. ban of outdoor tobacco advertisements and plain packaging) to help reduce smoking, particularly in rural, more deprived and less educated districts. Secondly, comprehensive policies to promote a healthy diet is needed to help reduce obesity, hypertension, and diabetes in urban, wealthier, and most educated districts. Strategies may include taxes on unhealthy foods, subsidies on healthy foods, and regulations on salt, sugar and trans-fat [4].

Our study has two limitations. First, data on CVD risk factors by sex was not available for our analysis, which limited the disparity analysis among men and women. Second, data on the prevalence of hypertension were not broken up into diagnosed and undiagnosed, and that of diabetes was only for diagnosed. All this has limited our analysis of the disparity that is due to the lack of health system efforts in diagnosing CVD risk factors. Notwithstanding these limitations, our findings have important policy implications for Indonesia and beyond.

**Conclusion**

The burden of CVD risk factors is high and increasing particularly among urban areas and districts with higher income and education levels. While the government needs to continue tackling the persistent burden from maternal mortality and infectious diseases, they need to put more effort into the prevention and control of CVDs and their risk factors.

**Supplementary information**

Supplementary information accompanies this paper at https://doi.org/10.1186/s12889-020-09099-1.

**Abbreviations**

Bappenas: National Planning Agency; BMI: Body Mass Index; CB: Census Block; CVD: Cardiovascular disease; DALY: Disability Adjusted Life Years; GPAQ: Global Physical Activity Questionnaire; LMICs: Low and middle-income countries; MET: Metabolic Equivalent of Task; OLS: Ordinary Least Square; Riskesdas: Basic Health Research

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**Authors’ contributions**

WA, VA, and DK conceived the study. VA and AA conducted data collection and DK conducted data analyses. DK drafted and WA, VA, and AA provided inputs to the manuscript. All authors approved the final version of the manuscript.

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**Availability of data and materials**

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**Competing interests**

None.

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**References**

1. Naghavi M, Abajobir AA, Abbafati C, et al. Global, regional, and national age-sex specific mortality for 264 causes of death, 1980-2016: a systematic analysis for the global burden of disease study 2016. Lancet. 2017;390:1151–210. https://doi.org/10.1016/S0140-6736(17)32152-9.
2. Hay SI, Abajobir AA, Abate KH, et al. Global, regional, and national disability-adjusted life-years (DALYs) for 333 diseases and injuries and healthy life expectancy (HALE) for 195 countries and territories, 1990-2016: a systematic analysis for the global burden of disease study 2016. Lancet. 2017;390:1260–344. https://doi.org/10.1016/S0140-6736(17)32130-X.
3. Gakidou E, Afshin A, Abajobir AA, et al. Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990-2016: a systematic analysis for the global burden of disease study 2016. Lancet. 2017;390:1345–422. https://doi.org/10.1016/S0140-6736(17)32366-8.
4. Kusuma D, Kusumawardani N, Ahsan A, Sebayang K, Amir V, Nawi N. On the verge of a chronic disease epidemic: comprehensive policies and actions are needed in Indonesia. Int Health. 2019. https://doi.org/10.1093/inthealth/ihz025.
5. Mboi N, Murty Surbakki I, Trihandini I, et al. On the road to universal health care in Indonesia, 1990–2016: a systematic analysis for the global burden of disease study 2016. Lancet. 2018;392:581–91. https://doi.org/10.1016/S0140-6736(18)30595-6.
6. National Institute of Health Research and Development. Main results of Riskesdas: Basic Health Research. Jakarta: Ministry of Health; 2018.
7. Di Cesare M, Khang YH, Asaria P, et al. Inequalities in non-communicable diseases and effective responses. Lancet. 2013;381:585–97. https://doi.org/10.1016/S0140-6736(12)61851-0.
8. Capewell S, Graham H. Will cardiovascular disease prevention widen health inequalities? PLoS Med. 2010;7. https://doi.org/10.1371/journal.pmed.1000320.

9. Mackenbach JP, Bos V, Andersen O, et al. Widening socioeconomic inequalities in mortality in six Western European countries. Int J Epidemiol. 2003;32:830–7. https://doi.org/10.1093/ije/dyg209.

10. Bleich SN, Jarlenski MP, Bell CN, et al. Health inequalities: trends, Progress, and policy. Annu Rev Public Health. 2012;33:7–40. https://doi.org/10.1146/annurev-publichealth-031811-124658.

11. Galobardes B, Costanza MC, Bernstein MS, et al. Trends in risk factors for lifestyle-related diseases by socioeconomic position in Geneva, Switzerland, 1993-2000: health inequalities persist. Am J Public Health. 2003;93:1302–9. https://doi.org/10.2105/AJPH.93.8.1302.

12. Bartley M, Fitzpatrick R, Firth D, et al. Social distribution of cardiovascular disease risk factors: change among men in England 1984-1993. J Epidemiol Community Health. 2000;54:806–14. https://doi.org/10.1136/jech.54.11.806.

13. Scholes S, Bajekal M, Love H, et al. Persistent socioeconomic inequalities in cardiovascular risk factors in England over 1994-2008: A time-trend analysis of repeated cross-sectional data. BMC Public Health. 2012;12. https://doi.org/10.1186/1471-2458-12-129.

14. Hotchkiss JW, Davies C, Gray L, et al. Trends in adult cardiovascular disease risk factors and their socio-economic patterning in the Scottish population 1995-2008: cross-sectional surveys. BMJ Open. 2011;1:e000176. https://doi.org/10.1136/bmjopen-2011-000076.

15. Ernstsen L, Strand BH, Nilsen SM, et al. Trends in absolute and relative educational inequalities in four modifiable ischaemic heart disease risk factors: repeated cross-sectional surveys from the Nord-Trøndelag health study (HUNT) 1984-2008. BMC Public Health. 2012;12. https://doi.org/10.1186/1471-2458-12-266.

16. Kanjilal S, Gregg EW, Cheng YJ, et al. Socioeconomic status and trends in disparities in 4 major risk factors for cardiovascular disease among US adults, 1971-2002. Arch Intern Med. 2006;166:2346–55. https://doi.org/10.1001/archinte.166.21.2346.

17. Stringhini S, Spencer B, Marques-Vidal P, et al. Age and gender differences in the social patterning of cardiovascular risk factors in Switzerland: the CoLaus study. PLoS One. 2012;7. https://doi.org/10.1371/journal.pone.0049443.

18. Khang YH, Cho HJ. Socioeconomic inequality in cigarette smoking: trends by gender, age, and socioeconomic position in South Korea, 1989-2003. Prev Med (Baltim). 2006;42:415–22. https://doi.org/10.1016/j.ypmed.2006.02.010.

19. Monteiro CA, Conde WL, Lu B, et al. Obesity and inequities in health in the developing world. Int J Obes. 2004;28:1181–6. https://doi.org/10.1038/sj.ijo.0802716.

20. Neuman M, Finlay JE, Smith GD, et al. The poor stay thinner: stable socioeconomic gradients in BMI among women in lower- and middle-income countries. Am J Clin Nutr. 2011;94:1346–57. https://doi.org/10.3945/ajcn.111.018127.

21. Subramanian SV, Perkins JM, Özaltin E, et al. Weight of nations: a socioeconomic analysis of women in low- to middle-income countries. Am J Clin Nutr. 2011;93:413–21. https://doi.org/10.3945/ajcn.110.004820.

22. Kinna S, Bowen LJ, Lyngdoh T, et al. Sociodemographic patterning of non-communicable disease risk factors in rural India: a cross sectional study. BMJ. 2010;341:771. https://doi.org/10.1136/bmj.c4974.

23. Hosseinpoor AR, Bergen N, Mendis S, et al. Socioeconomic inequality in the prevalence of noncommunicable diseases in low- and middle-income countries: results from the world health survey. BMC Public Health. 2012;12:474. https://doi.org/10.1186/1471-2458-12-474.

24. Fleischer NL, Roux AVD, Hubbard AE. Inequalities in body mass index and smoking behavior in 70 countries evidence for a social transition in chronic disease risk. Am J Epidemiol. 2012;175:167–76. https://doi.org/10.1093/aje/kws314.

25. National Institute of Health Research and Development. National Report of Riskesdas. Jakarta: Ministry of Health; 2018.