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Prevalence of Obesity and Overweight Stratified by Age Group of the 34 Provinces in Indonesia: Local Empirical Bayesian Estimation

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Abstract

Background: Indonesia is one of the countries most affected by a high prevalence of obesity and overweight among other lower-middle-income countries. Most studies, however, are not concerned with the geographical dependence of the obesity and prevalence of overweight. The purpose of this study was to describe the prevalence of obesity and overweight stratified by age group among 34 provinces in Indonesia. **Methods:** This study used data from the Report on Basic Health Research 2018 of the Indonesian Ministry of Health. We calculated data to find the estimated prevalence of obesity and overweight in each age group across 34 provinces (n=427,675) by using the local empirical Bayesian estimation. The mapping was used to show the phenomenon of obesity and overweight in different age groups and areas. **Results:** In each group, the overweight prevalence was much higher than the obesity prevalence. Age group 18+ had the highest prevalence of obesity and overweight (obesity: 10.4–30.1%, overweight: 19.2–46.3%) followed by the age group of 5–12 years (obesity: 2.4–15.0%, overweight: 6.1–30.3%). The province with the highest prevalence of obesity among the age group of 5–12 years was Papua province and for the 18+ age group it was North Sulawesi province. The province with the largest number of obesity and overweight was West Java province for each group. **Conclusion:** Prevalence of obesity and overweight differed by age group and by 34 provinces.

Keywords: obesity; overweight; lower-middle-income country; local empirical Bayesian estimation

1. Introduction

Globally, the prevalence of obesity and overweight from childhood to adulthood has increased significantly in high- and low-income countries, with variation between countries over the last 4-decade (World Health Organization, n.d.). A study revealed that these cases have risen at alarming rates in some regions (Afshin et al., 2017). This study found that since 1980, the prevalence of obese children and adults has increased twofold in 73 countries, followed by other countries with considerable increases. Indonesia has become one of the countries with more distressing figures; doubled growth of overweight adults (17.1 to 33.0%) between 1993 and 2014. In a cohort of children aged between 6 and 12 years and 13–18 years in Indonesia, the prevalence had increased threefold from 5.1 to 15.6% and had doubled from 7.1 to 14.1%, respectively, during the same period (Oddo, et al., 2019). Compared to other lower-

middle-income countries (LMICs), the obesity prevalence in Indonesia is relatively high. The World Health Organization (WHO) reveals that 8.5% of children aged between 5 and 9 years old in Indonesia were obese in 2016, which is 3.4 % higher than in other LMICs. Meanwhile, the obesity prevalence among adults was 6.9% in Indonesia, while it was 7.6% in other LMICs in 2016 (World Health Organization, n.d.).

Adult overweight is defined according to the body mass index (BMI), which is a person's weight in kilograms divided by the square of the height in meters (kg/m^2). Greater than or equal to 25 is considered overweight, whereas greater than or equal to 30 for adults is classed as obese (World Health Organization, 2021). Broadly, studies have identified that both obesity and overweight result in some adverse health consequences. A high BMI in adults becomes a risk factor for expanding numbers of chronic diseases. It includes cardiovascular diseases (Wormser et al., 2011; Azizi et al., 2004.; Rabkin et al., 1977), many types of cancer (Lauby-Secretan, 2016), obstructive sleep apnea (Jehan et al., 2017), and recent finding indicates that high BMI is associated with severe COVID-19 outcomes (Gao et al., 2021). A similar effect has been found due to childhood obesity and overweight. Childhood obesity is defined as a BMI-for-age z-score more than 2 standard deviations (SDs), whereas overweight is a BMI-for-age z-score more than 1 SD (World Health Organization, n.d.). Obesity and overweight among children lead to short-term health problems such as cardiovascular symptoms (Kollias et al., 2011), asthma symptoms (Tantisira et al., 2003), and long-term health problems (for an adult who was obese during childhood) such as the increased risk of death from endocrine, nutritional, and metabolic diseases, and circulatory system diseases (Bjorge et al., 2008).

An increasing number of obesity-related studies have revealed a growing trend of obesity within countries and on a global level. The majority of studies focused on modifiable determinants and the driving factors of obesity and overweight. Most studies, however, are not concerned with the effect of the geographical location on the obesity rate (Qin et al., 2019). Geospatial data is a potentially evidence-based tool that enables researchers to identify the incidence of obesity and overweight in a specific location on the Earth's surface. This tool allows researchers or policymakers to identify the targeted area for providing obesity intervention. However, spatial data for an innovative study of obesity and overweight generally employs large geographical units (Afshin et al., 2017), or it is conducted in a high-income country (Penney et al., 2013). This study will be conducted in Indonesia to map childhood and adult obesity prevalence. Indonesia is an archipelago country that is geographically different from other major world countries. Geographical differences followed by differences in culture and ethnicity could affect the prevalence of childhood and adult obesity and overweight in Indonesia compared to elsewhere. It is essential to focus on the targeted area and age group to implement obesity prevention in lower-middle-income countries with increasing rates of obesity like Indonesia.

The purpose of this study was to describe the prevalence of obesity and overweight stratified by age group in each of the 34 provinces in Indonesia. This study aimed to examine the following research questions: 1) In each group, does obesity and overweight prevalence differ according to geographical distribution? 2) Does obesity and overweight prevalence differ according to age group as well as by geographical distribution? 3) Is the number of obesity and overweight in each age group different among provinces?

2. Method

2.1. Data source and data collection

This study was conducted using collected data on September 30, 2021, from the Laporan Hasil Riset Kesehatan Dasar (Report on Basic Health Research) 2018 from 34 provinces in Indonesia organized by the Indonesian Ministry of Health (Indonesia Ministry of Health, 2018). The data used were the number and prevalence of overweight and obesity by province, which were categorized into four different age groups: age 5–12 years, 13–15, 16–18, and 18+. Geospatial data on provincial boundaries and the capital city of each province were collected from the website of the United Nations Office for the Coordination of Humanitarian Affairs (United Nations Office for the Coordination of Humanitarian Affairs, n.d.). The data are publicly available, it is provincial-level open data without any information to be able to identify individuals, therefore this study does not require ethical clearance.

2.2. Data analysis and visualization

In order to adjust unstable rates over provinces and avoid the so-called 'small number problem' (Bailey & Gatrell, 1995), we used local empirical Bayesian estimation using a k-nearest neighbor approach (Bivand, et. al, 2013) based on provincial capital cities to calculate the estimated prevalence of obesity and overweight of each age group among 34 provinces. Data visualization is used to give an in-depth understanding of the phenomenon of obesity and overweight in different ages and areas. Meanwhile, a bar chart is used to present the number of obesity and overweight of each age group among 34 provinces. All the statistical analyses and visualization were performed using R version 4.1.1 (R Core Team, 2021), which is an open-source programming language for statistical computing and graphics.

3. Results

3.1. Obesity and overweight prevalence in each age group

Table 1 presents the estimated prevalence using local empirical Bayesian approach on obesity and overweight for the 4 different age groups among the 34 provinces in Indonesia. The prevalence was geographically mapped to each province (Figure 1). In each group, the overweight prevalence was higher than the obesity prevalence. For the age group 5–12 years, the obesity prevalence ranged from 2.4–15%, while the overweight prevalence ranged from 6.1–30.3%. For the age group 13–15 years, the obesity prevalence ranged from 1.0–9.5%, while the overweight prevalence ranged from 4.7–24.4%. For the age group 16–18 years, the obesity prevalence ranged from 1.1–7.8%, while the overweight prevalence ranged from 4.6–20.4%. For the age group 18+, the obesity prevalence ranged from 10.4–30.1%, while the overweight prevalence ranged from 19.2–46.3%.

3.2. Obesity and overweight prevalence by age group

The 18+ age group had the highest prevalence of obesity and overweight, it ranged from 10.4–30.1% and 19.2–46.3%, respectively. The second highest prevalence of overweight and obesity was in the age group 5–12 years with obesity ranging from 2.4–15% and overweight 6.1–30.3%. The third position was the age group 13–15 years, obesity range 1.0–9.5%, while overweight prevalence was 4.7–24.4%. The age group 16–18 years became the last group in terms of obesity/overweight prevalence, with the lowest rate of obesity ranging from only 1.1–7.8%, and overweight from 4.6–20.4%.

The highest prevalence of obesity and overweight among the 18+ age group was observed in Sulawesi Utara (North Sulawesi) province (30.1% and 46.3%, respectively), followed by DKI Jakarta (Jakarta Special Capital Region) and Kalimantan Timur (East Kalimantan) province. Among the age group of 5–12 years, Papua province had the highest prevalence of overweight and obesity (15.0% and 30.3%, respectively), followed by Jakarta Special Capital Region. The highest prevalence of overweight and obesity for the age group of 13–15 years and 16–18 years was recorded in Jakarta Special Capital Region. Meanwhile, Nusa Tenggara Timur (East Nusa Tenggara) province had the lowest prevalence of overweight and obesity for all age groups.

Table 1. Estimated prevalence of obesity and overweight using local empirical Bayesian approach in each of the 34 provinces (%)

Province	Age 5–12		Age 13–15		Age 16–18		Age 18+	
	Obesity	Overweight	Obesity	Overweight	Obesity	Overweight	Obesity	Overweight
Aceh	10.0	20.7	4.4	17.5	3.4	14.0	24.4	38.2
Bali	10.5	23.5	8.5	21.2	5.2	16.9	23.2	38.6
Banten	10.0	20.2	4.3	14.0	3.7	13.5	22.1	35.3
Bengkulu	10.1	21.0	3.9	16.1	3.0	10.9	19.9	33.1
Daerah Istimewa Yogyakarta	10.2	21.3	7.2	19.8	5.6	14.5	21.4	34.8
Dki Jakarta	13.7	28.8	9.5	24.4	7.8	20.4	29.7	45.3
Gorontalo	6.7	15.5	4.2	15.0	3.5	12.9	24.3	39.0
Jambi	11.1	23.1	4.2	14.9	3.1	11.4	17.7	31.0
Jawa Barat	9.6	21.3	4.9	16.9	4.5	15.4	23.0	36.7
Jawa Tengah	9.1	20.2	4.5	14.7	3.7	11.7	20.4	33.4
Jawa Timur	11.1	24.3	6.0	19.3	5.1	16.4	22.4	36.1
Kalimantan Barat	9.0	19.5	4.2	13.1	3.5	11.3	17.0	30.2
Kalimantan Selatan	9.1	19.1	4.5	14.8	3.9	12.7	19.6	33.0
Kalimantan Tengah	9.6	22.4	4.8	14.8	4.5	12.5	18.9	32.1
Kalimantan Timur	11.2	23.7	6.6	18.4	4.9	17.7	28.6	44.0
Kalimantan Utara	9.2	19.1	5.7	17.3	4.1	13.5	25.9	40.0
Kepulauan Bangka Belitung	9.9	20.7	4.8	17.9	5.5	14.2	23.6	37.3
Kepulauan Riau	11.8	22.3	4.6	18.5	4.0	12.3	26.1	39.7
Lampung	8.5	19.0	3.2	12.2	2.4	12.0	17.4	29.7
Maluku	5.0	10.9	3.8	11.2	3.5	9.0	20.6	33.7
Maluku Utara	6.5	13.7	4.1	14.1	3.5	10.7	24.6	38.2
Nusa Tenggara Barat	4.3	9.7	2.8	10.3	2.2	8.8	15.2	27.0
Nusa Tenggara Timur	2.4	6.1	1.0	4.7	1.1	4.6	10.4	19.2
Papua	15.0	30.3	5.7	21.2	3.8	16.9	20.4	35.3
Papua Barat	7.0	16.2	4.8	16.0	3.8	14.4	26.1	39.5
Riau	8.4	17.6	3.9	15.9	4.2	11.2	24.1	38.0
Sulawesi Barat	5.9	13.5	4.0	12.8	3.0	12.7	18.9	31.7
Sulawesi Selatan	6.5	14.3	4.1	14.5	2.7	10.5	19.1	32.1
Sulawesi Tengah	4.2	10.9	3.5	11.9	3.1	11.4	20.7	34.5
Sulawesi Tenggara	5.4	12.6	3.2	10.7	2.7	8.4	19.4	32.5
Sulawesi Utara	9.5	21.3	6.0	18.8	4.6	15.4	30.1	46.3
Sumatera Barat	6.1	14.0	3.9	14.9	3.6	11.1	20.4	33.5
Sumatera Selatan	9.1	19.3	3.9	14.7	2.2	9.6	17.4	30.3
Sumatera Utara	9.1	19.7	4.7	17.6	3.5	14.8	25.8	40.6

Figure 1. Estimated prevalence of obesity and overweight using local empirical Bayesian approach in the 34 provinces by the 4 different age groups (%).

3.3. age group

Figure 2 shows the number of obesity and overweight for the 4 different age groups. The highest number of overweight and obesity among the 4 different age groups was observed in Jawa Barat (West Java) province. For the 18+ age group, West Java province had the highest number of obesity and overweight (26,376 and 42,087 people, respectively), followed by Jawa Timur (East Java) province and Jawa Tengah (Central Java) province. For the age group 5–12 years, West Java province had the highest number of obesity and overweight (2,847 and 6,317, respectively), followed by East Java province and then Central Java province.

Figure 2. Numbers of obesity and overweight in each of the 34 provinces by the 4 different age groups.

4. Discussion

This study described the prevalence of obesity and overweight by age group among the 34 provinces in Indonesia. It applied a geographical technique to draw a provincial-level map to identify the area to be focused on based on the prevalence. The results showed that the prevalence of overweight was higher than obesity for each age group. Even though the rate of child (age 5–12 years old) obesity (8.7%) and adult (age 18+ years old) obesity (21.7%) was significantly low compared with other countries where childhood obesity has been observed (12.7% in the United States and adult obesity 35.3% in Egypt in 2015 (Afshin, et al., 2017), without any prevention strategies, potentially the overweight will become the obese. This seems proven by the fact that in the last 3 decades, the WHO reported that there has been a steady upward trend in obesity cases for many low-income to high-income countries (World Health Organization, n.d.). Meanwhile, applying prevention strategies in some studies has been verified to reduce BMI increases (World Health Organization, 2007). A systematic review and meta-analysis study showed that obesity prevention by combining nutrition and physical activity interventions effectively reduces weight in school settings (Katz, , 2008). The positive results of obesity prevention strategies provide a promising development to reduce the increasing rate of obesity at a global level. It is also essential for Indonesia to apply obesity prevention.

Among all the age groups, Indonesia's risk population for obesity and overweight cases was the age-group 18 and over and the age-group 5–12 years. These findings potentially indicate that the senior population in this study could become the influential group for the younger population in Indonesia. Previous studies have confirmed how parents have an essential role in developing obesity in children in several ways. A result from a 12-country study showed a negative relationship between parental education and childhood obesity in wealthy countries. In comparison, children who were raised in lower economic status countries showed a positive association. Well-educated parents in high-income countries have a better understanding of how to maintain a healthy body weight (Muthuri, et al., 2016). Another study confirmed that social norms could be the critical factor that leads parents to raise an obese child. In some developing countries, including Indonesia, a "healthy child" has been described as overweight (Leonita & Nopriadi, 2010). The way parents raise their children will be affected by how they interpret obesity and overweight. With the highest cases of overweight in the oldest group and the

youngest group, future studies need to clarify how both groups correlate with each other. According to the exciting fact that social norms have a pivotal role in raising obese children in Indonesia, future studies need to focus on parents' perceptions of obesity or food intake.

This study revealed that there are several provinces with high overweight and obesity prevalence. The highest prevalence of overweight and obesity for the 18+ age group was observed in North Sulawesi province and for the age group 5–12 years it was Papua province. Meanwhile, East Nusa Tenggara province had the lowest prevalence of obesity and overweight for all age groups. In cases of obesity and overweight by numbers, West Java province becomes the overriding province for each group with the highest prevalence of obesity. There are many factors that lead to obesity (energy intake, energy expenditure, genetics, psychosocial, behavioral settings, food and agriculture, education, media, government, public health, health care, land use and transportation, leisure, recreation, social norms, and values) (Jeffrey, et al., 2005). These provinces have become the priority provinces in which to conduct further research in order to clarify the most affected factors related to obesity and overweight.

This study has two limitations. First, it was a secondary data analysis using provincial-level data. Further studies are needed to identify obesity and overweight prevalence and the factors using individual-level data. Second, as a variety of definitions of 'the neighborhood' are proposed, there might be another approach which may alter our results using the local empirical Bayesian estimates.

5. Conclusion

Overweight prevalence was higher than obesity prevalence in each age group. Age group 18+ had the highest obesity and overweight prevalence followed by age group 5–12 years. The province with the highest prevalence of obesity among the age group 5–12 years was Papua province and for the age group 18+, it was North Sulawesi province. West Java province had the highest numbers for overweight and obesity. In order to develop obesity and overweight prevention program effectively and efficiently, further studies are needed to target those age groups and areas and to explore the factors leading to obesity and overweight.

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