

นิพนธ์ต้นฉบับ

ความสัมพันธ์ระหว่างดัชนีมวลกายและความรุนแรงของโรคติดเชื้อไวรัสโคโรนา 2019
ในผู้ป่วยผู้ใหญ่ที่เข้ารับการรักษาในโรงพยาบาลนครพิงค์

พญ.วรัทม์สุดา สมุทรทัย¹, นสพ.กฤติยาภรณ์ จันทร์พรหมมินทร์, นสพ.ประภาพร พระบาลี,
นสพ.พรจิรา ศิริวัฒนา², นสพ.มณฑนาถ ศรีชุมภู², นสพ.อภิสราร ลวดเงิน², นสพ.วารสา คำประเทือง²
¹โรงพยาบาลนครพิงค์
²นิสิตแพทย์ชั้นปีที่ 4 ศูนย์แพทยศาสตรศึกษาชั้นคลินิก โรงพยาบาลนครพิงค์

บทคัดย่อ

ที่มาและความสำคัญ: ดัชนีมวลกายเป็นปัจจัยความเสี่ยงที่สัมพันธ์กับความรุนแรงของโรคติดเชื้อไวรัสโคโรนา 2019

วัตถุประสงค์: หาค่าดัชนีมวลกายของผู้ป่วยที่ส่งผลต่อความรุนแรงของโรคและศึกษาความสัมพันธ์ของปัจจัยอื่น เช่น อายุและโรคร่วมต่อความรุนแรงของการติดเชื้อไวรัสโคโรนา 2019 ในโรงพยาบาลนครพิงค์ จังหวัดเชียงใหม่

วิธีการศึกษา: ศึกษาข้อมูลแบบย้อนหลังในผู้ป่วยอายุมากกว่าหรือเท่ากับ 15 ปี ที่ได้รับการวินิจฉัยว่าติดเชื้อไวรัสโคโรนา 2019 ด้วยวิธีการตรวจหาเชื้อไวรัสโดยดูจากสารพันธุกรรม RNA ที่เข้ารับการรักษาในโรงพยาบาลนครพิงค์ในช่วงวันที่ 1 มกราคม 2563 ถึง 25 พฤษภาคม 2564

ผลการศึกษา: จากผู้ป่วยทั้งหมด 195 คน พบค่าดัชนีมวลกาย 2 ช่วง คือ ช่วง 26-29.99 กิโลกรัมต่อตารางเมตร และเกินกว่า 30 กิโลกรัมต่อตารางเมตร มีแนวโน้มติดเชื้อรุนแรงที่ 1.35 เท่า (Adj. RR 1.35, 95% CI 1.351-1.352) และ 3.03 เท่า (Adj. RR 3.03, 95% CI 2.101-4.373) เท่า เมื่อเทียบกับค่าดัชนีมวลกายน้อยกว่า 26 กิโลกรัมต่อตารางเมตรตามลำดับอย่างมีนัยสำคัญทางสถิติ และผู้ป่วยสูงอายุเกิน 60 ปีและมีโรคไตวายเรื้อรังจะมีแนวโน้มของโรคโควิด 19 แบบรุนแรงมากถึง 7.40 และ 2.86 เท่าตามลำดับอย่างมีนัยสำคัญทางสถิติ

สรุป: ค่าดัชนีมวลกายเกิน 30 กิโลกรัมต่อตารางเมตรร่วมกับอายุที่มากขึ้นและโรคไตวายเรื้อรังส่งผลต่อการติดเชื้อโควิด 19 แบบรุนแรง และเมื่อพิจารณาช่วงอายุและค่าดัชนีมวลกายพบว่าผู้ป่วยที่อายุมากกว่า 40 ปีร่วมกับค่าดัชนีมวลกายเกิน 26 กิโลกรัมต่อตารางเมตรอาจติดเชื้อรุนแรงกว่าเมื่อเปรียบเทียบกับผู้สูงอายุที่มีค่าดัชนีมวลกายเกิน 30 กิโลกรัมต่อตารางเมตรแต่ไม่มีนัยสำคัญทางสถิติ

คำสำคัญ: ดัชนีมวลกาย, COVID-19, อายุ, ความรุนแรงของโรค

ส่งบทความ: 14 ม.ค. 2567, แก้ไขบทความ: 18 มิ.ย. 2567, ตีพิมพ์บทความ: 2 ก.ค. 2567

ติดต่อบทความ

พญ.วรัทม์สุดา สมุทรทัย, กลุ่มงานเวชศาสตร์ฉุกเฉิน โรงพยาบาลนครพิงค์

E-mail: waratsamuth@gmail.com

Original Article

Exploring the correlation between body mass index and severity of COVID-19
in adult patients at Nakornping Hospital, Chiang Mai Province

Waratsuda Samutthai, M.D.¹, Krittiyaporn Chanphrommin², Praphaporn Phrabali²,
Pornjira Siri Wattana², Monthanat Srichumphu², Apisara Luadngern²,
Warasa Khamprathueng²

¹Nakornping Hospital

²4th year medical student, Medical Education Center, Nakornping hospital

ABSTRACT

Background: Body mass index (BMI) has been identified as a significant risk factor associated with the severity of coronavirus disease 2019 (COVID-19).

Objectives: This study aims to determine the BMI threshold that accurately predicts the severity of COVID-19 infection. Additionally, it explores the relationship between BMI, age, comorbidities, and disease severity at Nakornping Hospital, Chiang Mai.

Methods: A retrospective cohort study was conducted, including all COVID-19 patients aged 15 years or more, diagnosed with real-time PCR, and hospitalized between January 1, 2020, and May 25, 2021.

Results: The study comprised 195 patients, revealing that individuals with a BMI ranging from 26 to 29.99 and those with a BMI over 30 kg/m² had a higher likelihood of experiencing severe COVID-19 infection in 2019. The adjusted risk ratios for these BMI categories were 1.35 (95% CI 1.351-1.352) and 3.03 (95% CI 2.101-4.373), respectively, with a p-value of less than 0.001. Additionally, individuals with a BMI of 30 or above, along with age and chronic kidney disease, were identified as contributors to the increased severity of COVID-19.

Conclusion: Patients with a BMI of 30 kg/m² or above, advanced age, and chronic kidney disease are factors contributing to the severity of coronavirus infection. Notably, individuals with a BMI above 26 and age over 40 were found to be better predictors of severity compared to those with a BMI over 30 and age over 60.

Keywords: BMI, COVID-19, age, severity

Submitted: 2024 Jan 14, Revised: 2024 Jun 18, Published: 2024 Jul 2

Contact

Waratsuda Samutthai, M.D., Department of Emergency Medicine, Nakornping Hospital
E-mail: waratsamuth@gmail.com

Introduction

Presently, there is a widespread occurrence of coronavirus disease 2019 (COVID-19). The epidemic originated in Wuhan, China, resulting in a significant number of infected individuals and fatalities globally. According to the Department of Disease Control, as of May 25, 2021, there have been a total of 168,510,818 confirmed cases, 3,499,167 fatalities, and 150,110,076 recoveries worldwide.^[1] Thailand's Ministry of Public Health has reported a total of 135,439 confirmed cases, 832 deaths, and 89,194 recoveries. According to data from the Chiang Mai Provincial Public Health Office, Chiang Mai Province has recorded a total of 4,060 confirmed cases of illness and 20 deaths. Furthermore, a total of 3,762 individuals have successfully recuperated. The etiology of Coronavirus Disease 2019 (COVID-19) is attributed to the most recently identified strain of the coronavirus. It is the aetiology of illness in both humans and animals. In individuals, it can lead to respiratory illnesses that span from mild conditions like the common cold to more serious illnesses such as respiratory failure, shock, or organ failure. Several factors contribute to the severity of coronavirus disease 2019, such as gender^[2-5], age^[3-11], body mass index^[8-15], smoking^[16], and race.^[11] Congenital disorders^[17], high blood pressure^[18], dyslipidemia^[19], kidney disease^[4], chronic obstructive pulmonary disease^[11,13], immunological diseases such as rheumatic arthritis, lupus, and psoriasis^[11], and cancer^[20], among others.

Body mass index (BMI) is a significant determinant of the severity of coronavirus disease 2019, with obesity frequently impacting the respiratory system. A primary cause is the buildup of adipose tissue in the diaphragm, which serves as a partition between the thoracic cavities. The mediastinum and abdomen exert pressure on the chest wall, leading to a reduction in its flexibility and thus limiting the expansion of the lungs. The presence of LDL and triglyceride build-up leads to alterations in endothelial cells.^[21] Obesity leads to immune system deterioration due to an imbalance of cytokines, culminating in the failure of multiple organ systems.^[15] Furthermore, adipose tissue contains ACE2 receptors that serve as entry points for SARS-CoV-2, leading to increased infection rates. These parameters are crucial contributors to the severity of the 2019 coronavirus infection.^[5]

BMI is greater than or equivalent to 30 kilograms per square metre (kg/m^2), according to a study on the connection between BMI and the severity of the coronavirus disease in 2019 in other nations.^[11] Individuals with a body mass index (BMI) of 23 kg/m^2 or higher are at risk of mortality due to coronavirus disease 2019 (COVID-19). Consequently, there is a rise in hospitalization and mortality rates due to COVID-19 infection, and individuals with higher body weight are more likely to be admitted to an intensive care unit (ICU).^[12] According to above, this research study conducted in the United Kingdom utilizes BMI parameters

that differ from those used in Asian countries. A study conducted in Thailand revealed that patients diagnosed with coronavirus disease 2019 (COVID-19) who had a high body mass index (BMI) were more likely to experience severe pneumonia. Conversely, individuals with a BMI below 18.5 kg/m^2 had a lower incidence of severe pneumonia than BMI $\geq 25 \text{ kg/m}^2$. The occurrence of acute kidney damage (AKI) and admission to the intensive care unit (ICU) has risen.^[13]

Both local and international studies have demonstrated a correlation between BMI and the severity of coronavirus disease 2019. However, no research has been conducted on this problem specifically at Nakornping Hospital in Chiang Mai Province. This study seeks to determine the precise BMI threshold and investigate the correlation between BMI and the severity of coronavirus disease 2019. Additionally, it wants to examine the interplay between BMI, age, and comorbidities in connection to disease severity. This document provides guidance

for medical workers at Nakornping Hospital in Chiang Mai Province on the surveillance and screening of patients infected with coronavirus disease 2019. Its purpose is to help prioritize high-risk patient groups and inform future protocols for managing the disease.

Objectives

This study aims to determine the BMI threshold that accurately predicts the severity of COVID-19 infection and explore the relationship between BMI, age, comorbidities, and disease severity at Nakornping Hospital, Chiang Mai.

Methods

Conduct a prognostic study, and collect data through a retrospective study. The study comprised patients diagnosed with coronavirus 2019 using real-time PCR and aged 15 years or older who were hospitalised to Nakornping Hospital, Chiang Mai Province. It was a retrospective cohort study, spanning from January 1, 2020 to May 25, 2021 and we excluded patients lacking weight or height data. (figure 1).

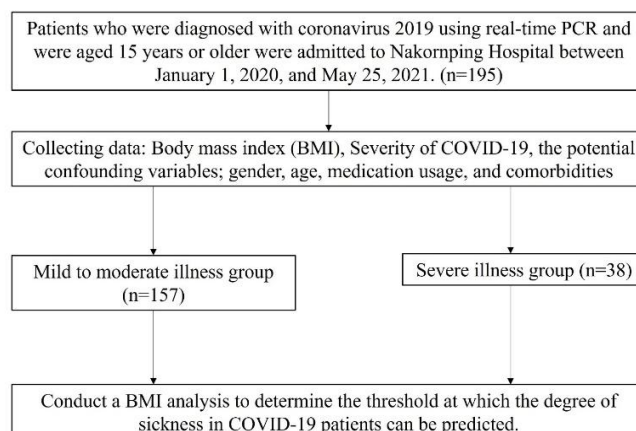


Figure 1 Study flow

Studied variables including body mass index, severity of COVID-19 were categorized into 2 group; mild to moderate for the patient who need hospitalize without oxygen support or need low flow of oxygen such as nasal cannular and severe group for the high flow oxygen or ventilator support. The potential confounding variables such as gender, age, race, medication usage, and comorbidities such as diabetes, hypertension, dyslipidemia, nephropathy, chronic obstructive pulmonary disease, autoimmune disorders, and cancer were collected. This study utilized the entirety of patient data without quantifying the study's size. Due to the continuous increase in the number of patients during the COVID-19 phase, the study period was defined as the duration in which data were stored for the largest number of patients.

The hospital's research ethics committee has been officially certified with the approved identification number 060/64.

Data analysis

The study employed descriptive statistics to analyze the fundamental characteristics of individuals diagnosed with coronavirus illness 2019, the categorical variables had been shown by number and percentages. Examining the

correlation between BMI and the severity of coronavirus disease using binary regression analysis and then reported by risk ratio, 95% confidence interval (95% CI), and p-value. The threshold for statistical significance was established at the 0.05 level.

Results

The study conducted 195 cases of coronavirus disease 2019. Of these cases, 103 (52.82%) were male, and they were distributed across three age groups: 15-39 years, 40-59 years, and 60 years or older, with 119 (61.03%), 51 (26.15%), and 25 (12.82%) cases, respectively. There was a significant difference in BMI between the mild to moderate illness group and the severe illness group (p 0.016). The median BMI for the groups was 24.22 and 26.76 kg/m^2 , with interquartile ranges (IQR) of 8.29 and 9.18, respectively. (figure 2A) The patient in the severe illness group was of advanced age compared to the mild to moderate illness group, with a statistically significant difference. The median age for the severe illness group was 53.5 years, while for the mild to moderate illness group it is 33 years. The interquartile range for the severe illness group was 22 years, whereas for the mild to moderate disease group it was 18 years. The p -value was less than 0.001. (figure 2B)

Exploring the correlation between body mass index and severity of COVID-19 in adult patients at Nakornping Hospital, Chiang Mai Province

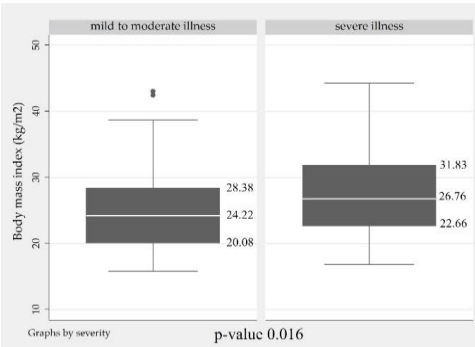


Figure 2A Body Mass Index distribution based on categorized severity of illness.

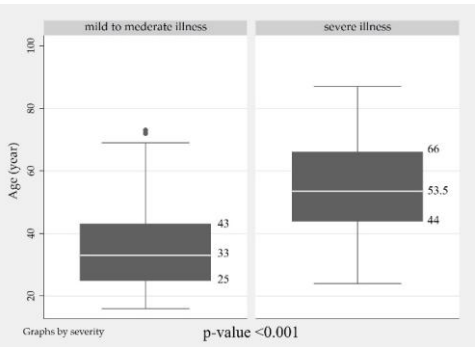


Figure 2B Age distribution based on categorized severity of illness.

*Horizontal lines within the box show the medians. The box boundaries are equal to the 25th and 75th percentiles.

The patients were further categorized based on their BMI, with 124 (63.59%) having a BMI less than 26 kg/m², 25 (12.82%) having a BMI between 26-29.99 kg/m², and 46 (23.59%) having a BMI more than 30 kg/m². The patients had underlying health conditions, with high blood pressure being the most common (21.54%), followed by type 2 diabetes (12.82%) and hypercholesterolemia (8.72%). The administration of favipiravir was the most prevalent among patients, accounting for 68.21% of cases. This was followed by dexamethasone (57.44%), prednisolone (21.54%), and remdesivir (17.44%),

respectively. The statistical analysis revealed that there were 38 individuals classified at the severe category, representing 19.49% of the total. The overall number of patients in the severe category was 38 (19.49%). When the patients were classified into three groups based on their BMI, the statistical analysis, using Fisher's exact test, revealed significant differences in severity of covid-19, age, presence of type 2 diabetes, hypertension, and the use of medications such as favipiravir, remdesivir, dexamethasone, hydrocortisone, and methylprednisolone (as indicated in table 1).

Table 1 Baseline characteristics of COVID-19 patients classified by body mass index

Characters	n (%)	Body mass index (kg/m ²)			p-value
		<26 (n=124)	26-29.99 (n=25)	≥30 (n=46)	
Gender					
male	103 (52.82)	61 (59.22)	16 (15.53)	26 (25.24)	0.341
Age (year)					
15-39	119 (61.03)	78 (65.55)	10 (8.40)	31 (26.05)	0.122
40-59	51 (26.15)	30 (58.82)	9 (17.65)	12 (23.53)	
≥60	25 (12.82)	16 (14.00)	6 (24.00)	3 (12.00)	

ความสัมพันธ์ระหว่างดัชนีมวลกายและความรุนแรงของโรคติดเชื้อไวรัสโคโรนา 2019 ในผู้ป่วยผู้ใหญ่ที่เข้ารับการรักษาในโรงพยาบาลนครพิงค์

Table 1 Baseline characteristics of COVID-19 patients classified by body mass index (Cont.)

Characters	n (%)	Body mass index (kg/m ²)			p-value
		<26 (n=124)	26-29.99 (n=25)	≥30 (n=46)	
Comorbidities					
Type 2 diabetes	25 (12.82)	11 (44.00)	5 (20.00)	9 (36.00)	0.082
Hypertension	42 (21.54)	16 (38.10)	9 (21.43)	17 (40.48)	0.001
Dyslipidemia	17 (8.72)	6 (35.29)	6 (35.29)	5 (26.41)	0.008
Chronic kidney disease	6 (3.08)	4 (66.67)	1 (16.67)	1 (16.67)	1.000
Chronic lung disease	3 (1.54)	1 (33.33)	0 (0)	2 (66.67)	0.183
Autoimmune disease	2 (1.03)	2 (100)	0 (0)	0 (0)	1.000
Cancer	2 (1.03)	1 (50)	0 (0)	1 (50)	0.597
Medication for COVID					
Favipiravir	133 (68.21)	73 (54.89)	19 (14.29)	41 (30.83)	<0.001
Remdesivir	34 (17.44)	15 (44.12)	7 (20.59)	12 (35.29)	0.029
Lopinavir/ritonavir	21 (10.77)	12 (57.14)	1 (4.76)	8 (38.10)	0.191
Dexamethasone	112 (57.44)	56 (50.00)	17 (15.18)	39 (34.82)	<0.001
Hydrocortisone	6 (3.08)	4 (66.67)	1 (16.67)	1 (16.67)	1.000
Prednisolone	42 (21.54)	26 (61.90)	8 (19.05)	8 (19.05)	0.343
Methylprednisolone	3 (1.54)	3 (100)	0 (0)	0 (0)	0.712
Severity of COVID					
Mild to moderate group	157	107 (68.15)	18 (11.46)	32 (20.38)	0.024
Severe group	38	17 (63.59)	7 (18.42)	14 (36.84)	

*Body mass index, abbreviated as BMI, is a measure of body fat based on a person's weight and height. It is calculated by dividing a person's weight in kilogrammes by the square of their height in metres.

A binary regression analysis was conducted to examine the association between body mass index and the severity of coronavirus disease 2019. Patients with a body mass index (BMI)

ranging from 26 to 29.99 kg/m² and patients with a BMI ≥ 30 kg/m² had a 2.04 (p 0.068) and 2.22 (p 0.012) times higher risk of severe COVID-19 disease, respectively (Table 2).

Table 2 Unavailable analysis between body mass index and the severity of coronavirus illness 2019.

Body mass index (kg/m ²)	Severity of COVID-19 infection		p-value
	Crude Risk Ratio	95%Confidence interval	
<26	1 (reference)	-	-
26-29.99	2.04	0.95-4.40	0.068
≥30	2.22	1.19-4.13	0.012

By analyzing the BMI and age of patients, while accounting for other factors like comorbidity and drug use, a study discovered that individuals with a BMI between 26 kg/m² and 29.99 kg/m² had a 1.35 times higher risk of severe disease. Furthermore, those with a BMI above 30 kg/m² had a 3.03 times higher risk. These findings were statistically significant (p-value<0.001). Additionally, statistical analysis revealed that patients aged 40 to 59 were 3.68 times more adversely affected, while those over 60 years old experienced a much higher impact of 7.4 times (p 0.001 and <0.001, respectively) (Table 3).

Table 3 The multivariable analysis between BMI, various ages, and the severity of COVID-19 infection.

Factors	Severity of COVID-19 infection		p-value
	Adjusted Risk Ratio	95% Confidence interval	
Body mass index (kg/m2)			
<26	reference		-
26-29.99	1.35	1.351-1.352	<0.001
≥30	3.03	2.101-4.373	<0.001
Age (year)			
15-39	reference		
40-59	3.68	1.757-7.699	0.001
≥60	7.40	3.766-14.528	<0.001
Chronic kidney disease	2.86	1.983-4.127	<0.001
Use of Favipiravir	2.59	1.796-3.738	<0.001

To determine the threshold BMI value that may accurately predict disease severity, we conducted a study using two receiver operating characteristic (ROC) curves. One curve was generated for individuals with a BMI greater than 26, and the other curve was generated for individuals with a BMI greater than 30. The cut points for BMI at 26 and 30 were selected based on the sensitivity, specificity, correct classification, positive likelihood ratio (LR+), and negative likelihood ratio (LR-) in relation to serious illness. (table 4).

Table 4 Detailed report of sensitivity, specificity, correctly classified, likelihood ratio of positive (LR+) and likelihood ratio of negative (LR-) between Body mass index and severe illness.

BMI (kg/m2) cut point	Sensitivity (%)	Specificity (%)	Correctly Classified (%)	Likelihood ratio of positive (LR+)	Likelihood ratio of negative (LR-)
16	100	1.27	20.51	1.0129	0.0000
17	97.37	4.46	22.56	1.0191	0.5902
18	97.37	9.55	26.67	1.0765	0.2754
19	94.74	17.20	32.31	1.1441	0.3060
20	89.47	22.93	35.90	1.1609	0.4591
21	89.47	28.66	40.51	1.2542	0.3673
22	84.21	33.76	43.59	1.2713	0.4677
23	73.68	41.40	47.69	1.2574	0.6356
24	65.79	49.04	52.31	1.2911	0.6975
25	55.26	57.96	57.44	1.3146	0.7718
26	55.26	68.15	65.64	1.7353	0.6564
27	50.00	71.97	67.69	1.7841	0.6947
28	44.74	73.89	68.21	1.7131	0.7480
29	44.74	76.43	70.26	1.8983	0.7230
30	36.84	79.62	71.28	1.8076	0.7933
31	31.58	81.53	71.79	1.7096	0.8392
32	23.68	83.44	71.79	1.4302	0.9146
33	18.42	85.35	72.31	1.2574	0.9558
34	15.79	89.17	74.87	1.4582	0.9444
35	13.16	92.36	76.92	1.7215	0.9403
36	13.16	94.27	78.46	2.2953	0.9212
37	13.16	95.54	79.49	2.9511	0.9089
38	7.89	97.45	80.00	3.0987	0.9451
39	7.89	98.73	81.03	6.1974	0.9329
40	5.26	98.73	80.51	4.1316	0.9596

We controlled confounding factors such as age and chronic kidney disease. The area under the ROC curve for the BMI ≥ 26 model was 0.82, while the area

under the ROC curve for the BMI ≥ 30 model was 0.81, however, there were no statistically significant findings. (figure 3).

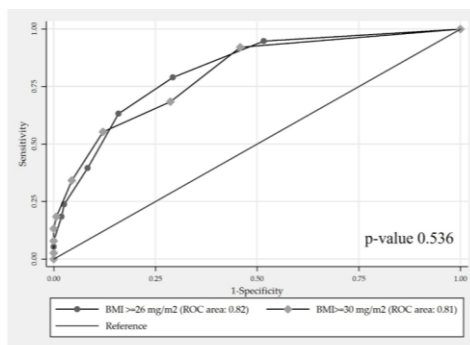


Figure 3 The receiver operating characteristic (ROC) curve demonstrates the predictive ability of a classification model for determining the severity of COVID-19 infection based on two different BMI thresholds: BMI ≥ 26 and BMI ≥ 30

Alternatively, we constructed four ROC curves to predict the severity of the disease using a BMI of 26 kg/m² or greater and a BMI of at least 30 kg/m², in conjunction with a patient's age of 40 years or older and 60 years or older. The cut points for age were selected at 40 and 60 based on sensitivity, specificity, correct classification, positive likelihood ratio (LR+), and negative likelihood ratio (LR-) with the severity of illness. (table 5).

The most reliable predictor for determining the seriousness of the illness was a BMI of 26 kg/m² or above combined

with an age of over 40, with an accuracy rate of 82%. The second category referred to those who had a BMI above 30 kg/m² and were aged 40 or above. The accuracy of this classification was 81%. The third place consisted of those with a BMI ≥ 26 kg/m² and aged ≥ 60 , with an accuracy rate of 75%. The last place included individuals BMI ≥ 30 kg/m² and aged ≥ 60 , with a precision value of 73%. Subsequently, it was discovered that there were no statistical differences between the four models. (figure 4)

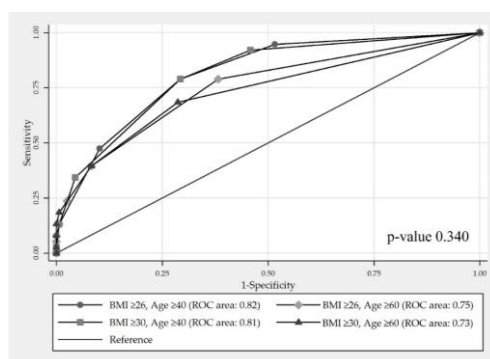


Figure 4 The receiver operating characteristic (ROC) curve illustrates the prediction performance of the classification method for prediction the severity of COVID-19 in fection using a pair of different BMI thresholds: BMI ≥ 26 and BMI ≥ 30 , in conjunction with two age boundaries: age ≥ 40 and ≥ 60

Table 5 Detailed report of sensitivity, specificity, likelihood ratio of positive (LR+) and likelihood ratio of negative (LR-) between age and severe illness.

Age (year) cut point	Sensitivity (%)	Specificity (%)	Correctly Classified (%)	Likelihood ratio of positive (LR+)	Likelihood ratio of negative (LR-)
20	100	1.91	21.03	1.0195	0.0000
30	89.47	45.86	54.36	1.6526	0.2295
40	78.95	70.70	72.31	2.6945	0.2978
50	57.89	83.44	78.46	3.4960	0.5046
60	39.47	92.36	82.05	5.1645	0.6554
70	5.26	96.82	78.97	1.6526	0.9785
80	5.26	98.09	80.00	2.7544	0.9658

Discussion:

According to this study, there was a positive correlation between higher BMI levels and increasing disease severity. Individuals BMI levels above 26 kg/m^2 and 30 kg/m^2 were found to have a statistically significant increased risk of illness severity about 1.35 and 3.03 times higher, respectively, when adjusted with advanced age, underlying of chronic kidney disease, and using Favipiravir. This study aligned with a study conducted in the United Kingdom, which examined a sample group consisting of 6.9 million individuals. Patients with a higher BMI were found to have a greater susceptibility to severe coronavirus infections. However, in Britain, a patient's BMI would need to be 23 kg/m^2 or higher to be at risk of serious sickness that may require hospitalization and have a higher death rate.^[12] Furthermore, while comparing the findings of studies conducted in Thailand, it was seen that the BMI cut-off values were quite comparable. Specifically, individuals with BMI exceeding 25 kg/m^2 were at a greater risk of experiencing serious sickness.^[13]

The incidence of pneumonia and severe pneumonia were increasing due to the impact of obesity on the respiratory system. The adipose tissue that gathers in the chest wall led to reduced elasticity and diminished lung expansion, causing hypoventilation-associated pneumonia. Additionally, an increase in LDL and triglycerides contributed to endothelial dysfunction.^[15]

Obesity could lead to a decline in the immune system's function because of abnormalities in cytokines, specifically Interleukin 6 (IL-6). The release of the excessive adipose tissue secretion, when infected with Coronavirus 2019, triggered an abnormal spread of IL-6 and led to the occurrence of cytokine storms, which in turn result in the failure of many organs. The adipose tissue possessed an ACE2 receptor which served as a receptor for SARS-CoV-2, leading to increased infections rates.^[21]

This study also discovered a significantly heightened association between ages that had a direct influence on more serious illnesses. Individuals aged 40-59 had a 3.68 times greater likelihood of

experiencing severe symptoms of the condition. For those over 60 years old, the risk was even higher, with a statistically significant increase of up to 7.4 times. The findings agreed we with other international investigations, including the work of Biswas et al.^[4], it was found that patients over the age of 50 had a 15.4 times increased risk of death, Gallo Marin et al.^[6], stated to be over 55 years of age, Suleyman et al.^[3], over 60, and Grasselli et al.^[7], over the age of 64, there's a chance of serious illness and death. Elisabeth M. discussed the impact of obesity and age on the severity of Coronavirus 2019. The presence of excess fat in the body could disrupt the metabolism system, leading to elevated insulin levels in the blood and the release of inflammatory cytokines. Moreover, there was a reduction in adiponectin levels, which was known to have a protective effect on the lungs. The process of aging adversely affected the immune system, leading to a slower response to viruses entering the body. This allowed viruses to replicate more efficiently and reduced the functioning of macrophages. Additionally, aging results in a smaller thymus gland, decreased secretion of T-cells, and ultimately increased the risk of older patients to coronavirus infection compared to younger patients.^[8]

The severity of coronavirus disease 2019 was influenced by the interaction between BMI, age, and chronic kidney disease. An analysis of the relationship

between BMI at different ages and the probability of developing the disease revealed that a BMI above 26 kg/m^2 combined with an age over 40 could accurately predict the severity of the disease with 82% accuracy. This was comparable to the study in the United States, the association between BMI and mortality or the requirement for mechanical ventilation was more pronounced in individuals who were less than 50 years old and had a BMI over 25 kg/m^2 .^[9]

This work diverged from the prior research conducted by Min Gao and colleagues, among the cohort of individuals between the ages of 20 and 39, who had a BMI exceeding 23 kg/m^2 , there was a significantly elevated likelihood of hospitalization, admission to an intensive care unit, and mortality. It was discovered that individuals aged 80 years or older did not experience any impact on the severity of their coronavirus illness.^[12] Furthermore, according to the research conducted by Satter et al., it was discovered that there was a significant correlation between the BMI of patients aged 70 or younger and their chance of having severe coronavirus disease 2019, compared to people older than them.^[10] However, a study conducted in Thailand by Kulphong Chainam et al. did not find any association between obesity and the need for a ventilator.^[13]

Conclusion

Patients with a BMI of 30 kg/m^2 or above, advanced age, and chronic kidney

disease are factors that contribute to the severity of coronavirus infection. Additionally, individuals with a BMI above 26 kg/m^2 and age over 40 are better predictors of severity compared to those with a BMI over 30 kg/m^2 and age over 60.

Limitations

The constraints of this investigation are as follows. One limitation is the tiny sample size due to the novelty of the condition. Furthermore, there is a lack of retroactive gathering of some data, such as weight, height, medical records, and treatment information for the 2019 coronavirus, from the initial hospital that admitted the patient. Furthermore, variations in the instruments employed for weighing and measuring height between hospitals can yield disparate data. Hence, conducting a prospective cohort study is imperative to gather comprehensive data and investigate

additional variables that impact the severity of the 2019 coronavirus infection. The study should also expand the population size and include various geographical regions, enhancing the research's significance and maximizing its practicality.

Acknowledgement

The study team expresses their gratitude to Kijja Jearwattanakanok M.D.,PhD., Suparat Kanjanavanit M.D., Anchalee Chainual M.D., Pharmacist Dujrudee Chinwong, Chidchanok Ruengom B.Pharm., M.P.H., Ph.D., and Akarawat Kornjirakasemsarn BSc. Pharm., and this research was endorsed by Mr. Monthian Punawat, a prominent public health specialist. Nakornping Hospital in Chiang Mai Province serves as the facilitator for data collecting in this research study.

References

1. World Health Organization. WHO COVID-19 dashboard: COVID-19 cases (datadot) [Internet].Switzerland: World Health Organization; c2024. Available from: <https://data.who.int/dashboards/covid19/cases?n=c>
2. Peckham H, de Gruijter NM, Raine C, Radziszewska A, Ciurtin C, Wedderburn LR, et al. Male sex identified by global COVID-19 meta-analysis as a risk factor for death and ICU admission. *Nat Commun.* 2020;11(1):6317. doi: 10.1038/s41467-020-19741-6.
3. Suleyman G, Fadel RA, Malette KM, Hammond C, Abdulla H, Entz A, et al. Clinical Characteristics and Morbidity Associated With Coronavirus Disease 2019 in a Series of Patients in Metropolitan Detroit. *JAMA Netw Open.* 2020;3(6):e2012270. doi: 10.1001/jamanetworkopen.2020.12270.
4. Biswas M, Rahaman S, Biswas TK, Haque Z, Ibrahim B. Association of Sex, Age, and Comorbidities with Mortality in COVID-19 Patients: A Systematic Review and Meta-Analysis. *Intervirolgy.* 2021;64(1):36-47. doi:10.1159/000512592

5. Frolidi G, Dorigo P. Endothelial dysfunction in Coronavirus disease 2019 (COVID-19): Gender and age influences. *Medical Hypotheses*. 2020;144:110015. doi:10.1016/j.mehy.2020.110015
6. Gallo Marin B, Aghagoli G, Lavine K, Yang L, Siff EJ, Chiang SS, et al. Predictors of COVID-19 severity: A literature review. *Rev Med Virol*. 2021;31(1):1-10. doi: 10.1002/rmv.2146.
7. Grasselli G, Zangrillo A, Zanella A, Antonelli M, Cabrini L, Castelli A, et al. Baseline Characteristics and Outcomes of 1591 Patients Infected With SARS-CoV-2 Admitted to ICUs of the Lombardy Region, Italy. *JAMA*. 2020;323(16):1574-81. doi:10.1001/jama.2020.5394
8. Mahase E. Covid-19: Why are age and obesity risk factors for serious disease?. *BMJ*. 2020;371:m4130. doi: 10.1136/bmj.m4130
9. Hendren NS, de Lemos JA, Ayers C, Das SR, Rao A, Carter S, et al. Association of Body Mass Index and Age With Morbidity and Mortality in Patients Hospitalized With COVID-19: Results From the American Heart Association COVID-19 Cardiovascular Disease Registry. *Circulation*. 2021;143(2):135-44. doi: 10.1161/CIRCULATIONAHA.120.051936.
10. Sattar N, Ho FK, Gill JM, Ghouri N, Gray SR, Celis-Morales CA, et al. BMI and future risk for COVID-19 infection and death across sex, age and ethnicity: Preliminary findings from UK biobank. *Diabetes Metab Syndr*. 2020;14(5):1149-51. doi: 10.1016/j.dsx.2020.06.060.
11. Williamson EJ, Walker AJ, Bhaskaran K, Bacon S, Bates C, Morton CE, et al. Factors associated with COVID-19-related death using OpenSAFELY. *Nature*. 2020;584(7821):430-6. doi: 10.1038/s41586-020-2521-4.
12. Gao M, Piernas C, Astbury NM, Hippisley-Cox J, O'Rahilly S, Aveyard P, et al. Associations between body-mass index and COVID-19 severity in 6.9 million people in England: a prospective, community-based, cohort study. *Lancet Diabetes Endocrinol*. 2021;9(6):350-9. doi: 10.1016/S2213-8587(21)00089-9.
13. Jayanama K, Srichatrapimuk S, Thammavaranucupt K, Kirdlarp S, Suppadungsuk S, Wongsinin T, et al. The association between body mass index and severity of Coronavirus Disease 2019 (COVID-19): A cohort study. *PLoS One*. 2021;16(2):e0247023. doi: 10.1371/journal.pone.0247023.
14. Simonnet A, Chetboun M, Poissy J, Raverdy V, Noulette J, Duhamel A, et al. High Prevalence of Obesity in Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) Requiring Invasive Mechanical Ventilation. *Obesity (Silver Spring)*. 2020;28(7):1195-9. doi: 10.1002/oby.22831.

15. Aghili SMM, Ebrahimpur M, Arjmand B, Shadman Z, Pejman Sani M, Qorbani M, et al. Obesity in COVID-19 era, implications for mechanisms, comorbidities, and prognosis: a review and meta-analysis. *Int J Obes (Lond)*. 2021;45(5):998-1016. doi: 10.1038/s41366-021-00776-8.
16. Patanavanich R, Glantz SA. Smoking Is Associated With COVID-19 Progression: A Meta-analysis. *Nicotine Tob Res*. 2020;22(9):1653-6. doi: 10.1093/ntr/ntaa082.
17. Mantovani A, Byrne CD, Zheng MH, Targher G. Diabetes as a risk factor for greater COVID-19 severity and in-hospital death: A meta-analysis of observational studies. *Nutr Metab Cardiovasc Dis*. 2020;30(8):1236-48. doi: 10.1016/j.numecd.2020.05.014.
18. Huang Y, Lyu X, Li D, Wang L, Wang Y, Zou W, et al. A cohort study of 676 patients indicates D-dimer is a critical risk factor for the mortality of COVID-19. *PLoS One*. 2020;15(11):e0242045. doi: 10.1371/journal.pone.0242045.
19. Atmosudigdo IS, Lim MA, Radi B, Henrina J, Yonas E, Vania R, et al. Dyslipidemia Increases the Risk of Severe COVID-19: A Systematic Review, Meta-analysis, and Meta-regression. *Clin Med Insights Endocrinol Diabetes*. 2021;14: 1179551421990675. doi: 10.1177/1179551421990675.
20. Ofori-Asenso R, Ogundipe O, Agyeman AA, Chin KL, Mazidi M, Ademi Z, et al. Cancer is associated with severe disease in COVID-19 patients: a systematic review and meta-analysis. *Ecancermedicalscience*. 2020;14:1047. doi: 10.3332/ecancer.2020.1047.
21. Kim JA, Montagnani M, Chandrasekran S, Quon MJ. Role of lipotoxicity in endothelial dysfunction. *Heart Fail Clin*. 2012;8(4):589-607. doi: 10.1016/j.hfc.2012.06.012.