 doi:10.20944/preprints202005.0166.v1

Review

Body Mass Index (BMI) and Coronavirus Disease 2019 (COVID-19): A Living Systematic Review

Jose M. Soriano[1,2,*], Aránzazu González[1,2], Carla Soler[1,2], Ana I. Catalá-Gregori[2,3] and J. Francisco Merino-Torres[2,3]

[1] Food & Health Lab, Institute of Materials Science, University of Valencia, Valencia, Spain; jose.soriano@uv.es (J.M.S.); carla.soler@uv.es (C.S.)

[2] Joint Research Unit on Endocrinology, Nutrition and Clinical Dietetics, University of Valencia-Health Research Institute La Fe, Spain; aranzazugonzalez999@gmail.com (A.G.)

[3]Department of Endocrinology and Nutrition, University and Polytechnic Hospital La Fe, Spain; catala_anagre@gva.es (A.I.C.-G.); merino_jfr@gva.es (J.F.M.-T.)
* Correspondence: jose.soriano@uv.es; Tel.: +34-963-543-056

Abstract: On March 11, 2020, coronavirus disease 2019 (COVID-19) was declared a pandemic by the World Health Organization (WHO). This review focuses on where the body mass index (BMI) value can be used as a tool to evaluate the risk of development and/or aggravation of this disease. Databases were used to search studies published up to April 18, 2020. In total, 4285 articles and other scientific literature were found, and twelve articles were included in this systematic review. The mean BMI value of severe COVID-19 patients ranged from 24.5 to 33.4 kg/m^2, versus 22.0 to 24.3 kg/m^2 for non-severe patients Articles using the terms obesity or overweight, without indicating the BMI value, in these patients were common, but this is not useful as the nutritional status, when not defined by this index, is confusing due to the classification being different in the West compared to among,, Asian and Korean criteria-based adults. Furthermore, the use of BMI is important during this pandemic, as it should be applied to nutritional support therapy during hospitalization of infected patients, as well as being considered in the home confinement population.

Keywords: BMI; COVID-19; obesity; overweight; nutrition.

1. Introduction

A new epidemic started on December 8, 2019, in Wuhan (Hubei Province, China) where several cases of severe pneumonia of undetermined etiology were reported based on fever (>38ºC), cough, fatigue, muscle pain, leukopenia, lymphopenia and radiographic imaging consistent with pneumonia, which could develop into acute respiratory distress syndrome, metabolic acidosis, septic shock, coagulation dysfunction, organ failure (such as liver, kidney and heart failure), and death [1]. This disease is caused by a new strain of coronavirus, pre-defined as novel coronavirus (2019-nCoV), which causes upper respiratory tract infections in humans [2], and which along with the severe acute respiratory syndrome coronavirus (SARS-CoV) [3] and the Middle East respiratory syndrome coronavirus (MERS-CoV) [4] evolved in the twenty-first century [5]. On February 11th, 2020, the new coronavirus was renamed "SARS-CoV-2" from "2019-nCoV" (Coronaviridae Study Group of the International Committee on Taxonomy of Viruses, 2020) and the disease caused by SARS-CoV-2 was called "coronavirus disease 2019" (COVID-19) [6]. The World Health Organization (WHO) on March 11, 2020, declared COVID-19 a pandemic [7], pointing to the over 118,000 cases of the illness, with a global death toll that had reached 4,291 people, in over 114 countries and territories around the world and sustained risk of further global spread [8]. However, history allows us to learn lessons from the past and especially with diseases of other viruses causing pneumonia in relation to the body mass index [BMI; weight/height^2 (kg/m^2)], this was used as a disease-associated factor. BMI is an anthropometric used to assess malnutrition risk, but has been observed as a risk factor in MERS-CoV

 doi:10.20944/preprints202005.0166.v1

[9], H1N1 influenza [10] and avian influenza H7N9 virus [11]. Currently, there is confusion as to whether COVID-19 has anassociation with BMI in terms of the pneumonia relationship [12-15], given this index should be considered a factor that could aggravate the disease. The aim of this systematic review was to evaluate the association of BMI with COVID-19.

2. Methods

This systematic review was developed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement [16] (Figure 1) and conducted using the WHO COVID-19 database of publications, PubMed, Scopus, Embase and Google Scholar. We included English and other languages which were translated using the freely available Web-based Google Translator (Google, Inc., Mountain View, CA) and, in cases of doubt for the manuscripts written in Asian languages, with the help of Confucius Institute from the University of Valencia, before the full papers were reviewed.

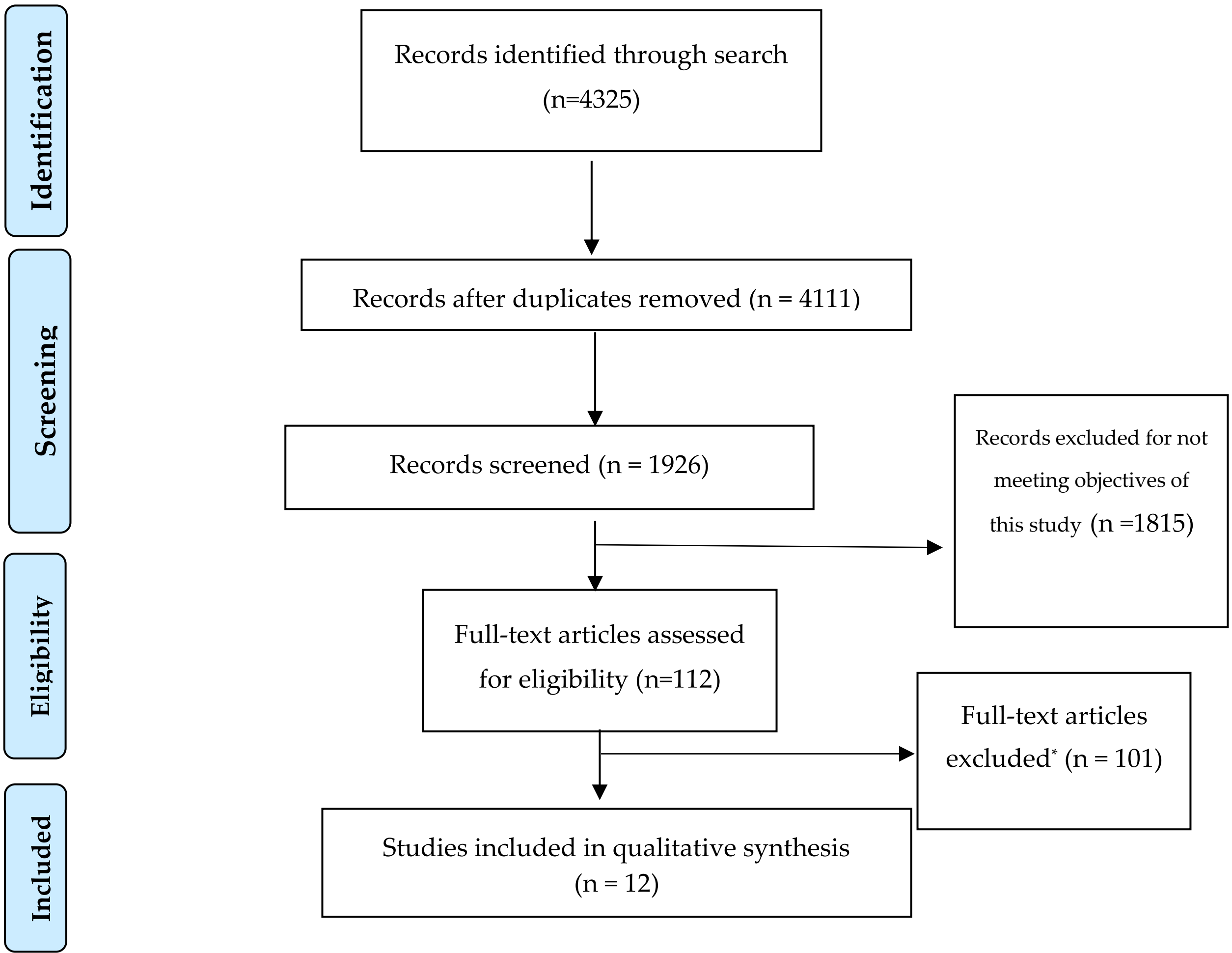

Figure 1. PRISMA flow diagram for studies retrieved through the searching and selection process. *Reasons for exclusion of articles are presented in the Methods section.

The search strategy was based on the Population, Intervention, Comparator, Outcome (PICO) framework [17] and was conducted to find studies by including two main searches based in the coronavirus, as a causal agent or disease, and an anthropometric parameter: “novel coronavirus” or “2019 Novel Coronavirus” or “2019-nCoV” or “SARS-CoV-2” or “COVID-19” or “coronavirus disease 2019” AND “body mass index” or “BMI” or “weight” or “height” or “obesity” or “obese” or

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 10 May 2020 doi:10.20944/preprints202005.0166.v1

"overweight" or "underweight" or "normal weight" or "malnutrition" or "nutritional status". The search date was up to April 18, 2020.

The classification of nutritional status was carried out, in accordance with the guidelines from the WHO [18], WHO [19] and Seo *et al.* [20] for International, Asian and Korean criteria-based adults, respectively (Table 1).

Table 1. Classification of Body Mass Index (BMI; kg/m^2) and risk of co-morbidities in International, Asian and Korean criteria-based adults according to the WHO [18], WHO [19] and Seo *et al.* [20], respectively

Nutritional status	International adults		Asian criteria-based adults		Korean criteria-based adults	
	BMI (kg/m^2)	Risk of co-morbidities	BMI (kg/m^2)	Risk of co-morbidities	BMI (kg/m^2)	Risk of co-morbidities
Underweight	<18.5	Lower (other health risk)	<18.5	Lower (other health risk)	<18.5	Low[a]/average[b]
Normal weight	18.5–24.9	Average	18.5–22.9	Average	18.5–22.9	Average[a]/increased[b]
Overweight (pre-obesity)	25.0–29.9	Increased	23.0–24.9	Increased	23.0–24.9	Increased[a]/moderate[b]
Obesity class I	30.0–34.9	Moderate	25.0–29.9	Moderate	25.0–29.9	High[a]/severe[b]
Obesity class II	35.0–39.9	Severe	≥30.0	Severe	30.0-34.9	Moderate[a]/very severe[b]
Obesity class III	≥40.0	Very severe	n.a.	n.a.	≥35	Severe[a]/very severe[b]

[a] Risk of comorbidity according to abdominal obesity < 90 cm (men) and < 85 cm (women)

[b] Risk of comorbidity according to abdominal obesity ≥ 90 cm (men) and ≥ 85 cm (women)

n.a. not applicable

As inclusion criteria, we required that the study samples were humans, and that the articles were full-textandavailable in any language. The following information was obtained: author name, type of study, number of patients, age, sex, country, anthropometric parameter or nutritional status and main outcomes.

On the other hand, as exclusion criteria, we excluded studies in which an anthropometric parameter was not used, conference abstracts, simulation studies, unpublished data and articles without full texts. Two teams of paired reviewers (J.M.S., A.G. A.I.C.-G, J.F.T-M) with expertise in medical and health evaluations and training in research methodology independently screened the titles, abstracts, and full texts for eligibility, assessed generalizability, and collected data from each eligible study using standardized pilot tested forms with detailed instructions. Any disagreements were resolved by a third researcher (C.S.).

Based on information from the National Heart, Lung and Blood Institute [21], the validity of each included study was assessed using nine items to which the answer was affirmative (+), negative (-) or other, including "cannot determine", "not applicable" and "not reported". Unclear (?) answers were classified using a rating of good (7 – 9), fair (4 – 6) or poor (≤3) for each individual study.

3. Results

For this systematic review, the quality rating of the reviewed literature, found by applying the National Heart, Lung and Blood Institute criteria, is fair (Table 2), which is similar to the study of Salehi *et al.* [34] who carried out a systematic review of imaging findings in 919 COVID-19 patients and observed that the methodologic quality of the studies was generally fair, except for the study of Simonnet *et al.* [33]. In total, we integrated twelve studies relevant to the aim of this review. All articles

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 10 May 2020 doi:10.20944/preprints202005.0166.v1

were on studies carried out in China and Korea. Table 3 shows the summary of these studies according to the term 'BMI' extracted from the reviewed articles.

Table 2. Methodological quality assessment for studies published on BMI and COVID-19 according to the criteria of the National Heart, Lung and Blood Institute [21].

Item[a]\Reference	[22]	[23]	[24]	[25]	[26]	[27]	[28]	[29]	[30]	[31]	[32]	[33]
1.	+	+	+	+	+	+	+	+	+	+	+	+
2.	+	+	+	+	+	+	+	+	+	+	+	+
3.	?	?	?	?	?	?	?	?	?	?	?	?
4.	?	?	?	?	?	?	?	?	?	?	?	?
5.	+	+	+	+	+	?	?	?	?	?	?	+
6.	+	+	+	+	+	+	+	+	+	+	+	+
7.	+	+	+	+	+	?	?	?	?	?	?	+
8.	?	?	?	+	+	+	?	?	+	-	?	+
9.	+	+	+	+	+	+	+	+	+	+	+	+
Quality Rating[b]	**6**	**6**	**6**	**6**	**6**	**5**	**4**	**4**	**5**	**4**	**4**	**7**

Affirmative (+), negative (-) or other, including "cannot determine", "not applicable" and "not reported", that is unclear (?) answers

[a]Items from the National Heart, Lung and Blood Institute [21] were; 1 = Was the study question or objective clearly stated?; 2 = Was the study population clearly and fully described, including a case definition?; 3 = Were the cases consecutive?; 4 = Were the subjects comparable?; 5 = Was the intervention clearly described?; 6 = Were the outcome measures clearly defined, valid, reliable, and implemented consistently across all study participants?; 7 = Was the length of follow-up adequate?; 8 = Were the statistical methods well-described?; 9 = Were the results well-described?

[b] Quality rating [21] was good (7 – 9), fair (4 – 6) or poor (≤3).

Table 3. Summary of articles with data on BMI in COVID-19 infected patients.

Nº of patients	**Age**	**Sex**	**Country**	**BMI (kg/m²)/Nutritional status [19,20]**	**References**
1	54	M	Korea	25.7/Obesity class I	[22]
1	35	F	Korea	33.4/Obesity class II	[23]
1	59	M	China	26.6/Obesity class I	[24]
30	21-59	F (66.7%)/ M (33.3%)	China	22.0±1.3/Normal weight[a] 27.0±2.5/Obesity class I[b]	[25]
64	35.0 (average)	F (64.0%)/ M (36.0%)	China	< 24 (89.2%)≥ 24 (10.8%)[c] < 24 (88.0%) and ≥ 24 (12.0%)[d]	[26]
149	45.11±13.35	F (45.6%)/ M (54.4%)	China	23.7±4.5/Overweight	[27]
112	62.0 (average)	F (52.7%)/ M (47.3%)	China	22.0 (22.0-24.0)/Normal weight[e] 25.5 (23.0-27.5)/Obesity class I[f]	[28]
298	33-61	F (50.0%)/ M (50.0%)	China	22.9 (20.6-25.2)/Normal weight[g] 24.5 (22.0-27.8)/Overweight[h]	[29]
60	57 (average)	F (41.7%)/ M (58.3%)	China	25.0±3.3/Obesity class I	[30]
45	56.7±15.4	F (35.6%)/ M (64.4%)	China	23.2 (21.4-25.3)/ Overweight[i] 25.2 (22.9-26.9)/Obesity class I[j]	[31]
49	43.6±17.1	F (36.7%)/	China	24.3±3.6/ Overweight[k]	[32]

124	51-70	M (63.3%) F (27.0%)/ M (73.0%)	France	26.4±2.8/Obesity class I[l] 31.1 (27.3-37.5)/Obesity class I[m] 27.0 (25.3-30.8)/Overweight I[n]	[33]

[a] common type; [b]severe cases; [c]group of patients with symptoms onset for 10 or less days; [d]group of patients with symptoms more than 10 day; [e]general group; [f]critical group; [g]non-severe patients; [h]severe patients; [i]patients with intubation; [j]patients without intubation; [k]stable non-severe; [l]progressive severe; patients admitted in intensive care who required invasive mechanical ventilation[m] and those who did no[n].

3.1. China

Li *et al.* [24] reflected on a case report of a Chinese man (59-years-old), with no history of Southern China seafood market contact, that had experienced hypertension for the past 20 years (treated using oral valsartan and bisoprolol fumarate tablets as medication), coronary heart disease for the last 6 years (treated using oral bisoprolol fumarate tablets and betaloc) and endured a long-term anti-rejection treatment (using cyclosporine and bradinine) for 5 years post right kidney transplantation. The evolution of the disease was as follows; fever (38.2ºC), dyspnea, headache, myodynia, a ground glass shadow observed in a CT scan of the lung in the upper and lower regions of the left lung, cough and expectoration (with a small amount of white sputum), nausea without vomiting, abdominal pain, diarrhea, exertional dyspnea without obvious aggravation, hemoptysis, chest pain, acid reflux, heartburn, chest distress and suffocation, progressive dyspnea, progressive deterioration of renal function while undergoing treatment, delirium (on the 5th day after admission), loss of consciousness, lowered blood pressure and heart rhythm and death. The patient had a BMI of 26.6 kg/m^2, putting him in obesity class I [19].

Furthermore, Liu *et al.* [25] studied medical workers (aged 21-59 years); from the affiliated Hospital of Jianghan University, Wuhan, in China, between January 11, 2020 and January 3, 2020, infected by COVID-19 and observed a significant difference in the BMI. It was 22.0±1.3 (normal weight) *versus* 27.0±2.5 (obesity class I) kg/m^2 among the 26 common type and 4 severe cases patients, respectively. Liu *et al.* [26] indicated that the infected medical staff, from Union Hospital, Wuhan, between 16 Jan, 2020 to 15 Feb, 2020, had a BMI of < 24 (n=33/37) and ≥24 (n=4/37) kg/m^2 among the group of patients with symptoms onset for 10 or less days; and <24 (n=22/25) and ≥ 24 (n=3/25) kg/m^2 for those with symptoms for more than 10 days, respectively, by the time of admission. However, these authors indicated that the value of ≥ 24 kg/m^2 is overweight, and this is a mistake due to the fact that the values for overweight for Asian adults, established by the WHO [19], range from 23.0 to 24.9 kg/m^2. Yang *et al.* [27] carried out at retrospective cohort study of 149 positive patients (45.6% and 54.4% of female and male, respectively, and aged 45.11±13.35) from January 17, 2020 to February 10, 2020 in three tertiary hospitals of Wenzhou, Zhejiang province (China), and found the value of the BMI was 23.75±4.54 kg/m^2 (overweight). Peng *et al.* [28] analyzed 112 patients with cardiovascular disease in the western district of Union Hospital in Wuhan, from January 20, 2020 to February 15, 2020, and found the average (first and third quartile) BMI of the critical group (n=16) was significantly higher than that of the general group (n=96), at 25.5 (23.0 and 27.5) *versus* 22.0 (20.0 and 24.0) kg/m^2. These authors observed that patients with BMI>25 kg/m^2 (obesity class I), were significantly more likely to be non-survivors (88.24%, n=15/17) *versus* survivors (18.95%, n= 18/95). Cai *et al.* [29] reviewed a study in the Third People's Hospital of Shenzhen, Guangdong province, China, from January 11, 2020 to February 6, with 298 patients (aged 33-61 years) with COVID-19 and no significant differences were found between non-severe (n=240) and severe (n=58) patients with the value of BMI being 22.9 (normal weight) and 24.5 kg/m^2 (overweight), respectively. Furthermore, these authors demonstrated that gender, BMI, and the antiviral agents lopinavir/ritonavir or favipiravir were not independent prognostic factors for virus clearance. Interestingly, Huang *et al.* [30] carried out a multicenter retrospective cohort study in twelve hospitals from Jiangsu province, China, between January 24 and February 23, 2020, detecting severe patients (n=60) out of 631 infected cases with COVID-19, with the average BMI among them being 25.0±3.3 kg/m^2, but no significant differences were found between improved (n=52) and impaired (n=8) patients in terms of the BMI (25.2±3.4 and

23.7±2.5 kg/m², respectively). The same author published other article [35] they carried out a retrospective cohort study between December 11, 2019, and January 29, 2020 but they did not include or did not have the value of the BMI. On the other hand, a multi-centered, retrospective, observational study was carried out by Xu *et al.* [31], where forty-five critically ill patients with COVID-19 (35.6% and 64.4% female and male, respectively, aged 56.7±15.4) identified in seven intensive care units in Guangdong Province, China. The average values for BMI were 23.2 (overweight) and 25.0 kg/m² (obesity class I) for patients who underwent intubation and non-intubation, respectively.

3.2. Korea

Lim *et al.* [22] reportedfor the first time the tertiary on transmission of COVID-19 outside China, to a Korean man who was living in Wuhan (China) and entered Korea on January 20, 2020. He is considered the index patient who transmitted the coronavirus at a restaurant to another person (confirmed on January 30, 2020). This patient transmitted virus to his family (spouse and son) and a friend. The index patient was 54-years-old with a BMI of 25.7 kg/m², in obesity class I [22] and lopinavir/ritonavir was used as the treatment. A reduction of viral loads and improvement of clinical symptoms during the treatment was observed. Kim *et al.* [23] described the first patient with 2019-nCoV pneumonia in Korea, a 35-year-old woman admitted to hospital on January 19, 2020, who was obese, with a BMI of 33.4 kg/m² (obesity class II [20]), but otherwise healthy.

3.3. France

Simonnet *et al.* [33] carried out a retrospective cohort study analyzing BMI and the requirement for invasive mechanical ventilation in 124 COVID-19 patients admitted into intensive care at Roger Salengro Hospital, at the "Centre Hospitalier Universitaire de Lille" (Lille, France). These authors reflected that disease severity was associated with increased BMI, and was maximal in patients with a BMI ≥35 kg/m². A higher likelihood of needing invasive mechanical ventilation was noted for this BMI, independent of age, sex, diabetes, and hypertension.

4. Discussion

To date (up to April 18, 2020), only twelve articles related to BMI and COVID-19; have been published, which indicates around 0.26% of all scientific literature. We observed that BMI values among severe COVID-19 patients ranged from 24.5 to 33.4 kg/m² *versus* those among non-severe patients, which ranged from 22.0 to 24.3 kg/m². Liu *et al.* [26] indicated that a BMI ≥24 kg/m² on admission wwas an unfavorable factors for discharge, but if a statistical difference of $p<0.005$ among BMIs is required for itto be considered as potential risk factors for predicting progression to severe disease, only three [25, 28, 29] out of studies, met this criteria. Accordingly, we proposed that a BMI ≥24.5 kg/m², which is indicative of normal weight [18] or overweight [19,20], should be the cut-off for patients to move from non-severe to severe status. Furthermore, our group thinks that the use of another relationed term such as obesity, in the bibliography, is unclear in relation to this disease as the authors indicated that some patients had this nutritional status but it was not reflected in the BMI value, according to the BMI cut-offs. This is mainly because the BMI classification for Asians [19], established from restricted numbers of prevalence studies but no from mortality data, is different from the recommended WHO-BMI cut-offs for the West [18], and even from cut-offs for Koreans [20]. Surprisingly, some studies, that our group excluded from this review mentioned obesity without a detailed specification of the BMI value. We analyzed how these articles were reflected in Table 4.

Table 4. Summary of articles with data indicating obesity, but not BMI, and patients affected by COVID-19.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 10 May 2020 doi:10.20944/preprints202005.0166.v1

Nº of patients	Age	Sex	Country	Nutritional status	References
1	73	F	USA	Obesity	[36]
33	41.8±14.1	F (48.5%)/M (51.5%)	China	9.1% obesity	[37]
46	10-24	F (47.3%)/M (52.7%)	China	8.7% underweight 52.0% normal 37.0% overweight/obesity	[38]
129	54-100[a] 22–79[b] 52–88[c]	F (65.4%)/M (34.6%)[a] F (79.4%)/M (20.6%)[b] F (28.6%)/M (71.4%)[c]	USA	33.3% obesity[a] 0% obesity[b] 3% obesity[c]	[36]

[a]resident, [b]health care personnel and [c]visitor in long-term residential care facility in Washington.

Liao *et al.* [38] observed reports of overweight/obesity, without giving BMI values, among 28.6% and 40.6% of adolescents (10-24 years of age) and young adults (25-35 years of age), respectively, who were infected with COVID-19 and hospitalized in Chongqing Three Gorges Central Hospital of Chongqing University in China, betweenJanuary 25, 2020 and February 18, 2020. In a single-center, retrospective cohort study at The Fifth Affiliated Hospital of Sun Yat-Sen University, Guangdong Province, China, between January 17, 2020, and February 13, 2020, Deng et al. [37] did not reflect the values of BMI , but indicated no significant differences in the presence of obesity. It is unknown whether they were referring to the values for the West [18] or Asian criteria-based [19] adults. This study observed obesity in two out of sixteen and one out of seventeen of combination (arbidol and lopinavir/ritonavir (LPV/r) treatment) and monotherapy (LPV/r) group, respectively.. In the USA, 33.3% of residents and 3% of visitors infected by this coronavirus in a long-term residential care facility were obese, but noinfected health care personnel had this nutritional status [36]. Among the first European cases, one was reported to be obese but they did not provide BMI values for the rest of the cases [39]. In the USA, a woman (73-years-old) with a history of obesity and other pathologies, including coronary artery disease, insulin-dependent type II diabetes mellitus, chronic kidney disease, hypertension and congestive heart failure, who resided in a long-term care facility, was infected with COVID-19 in mid-February and died on March 2 [36]. The term *obesity* is used in the primary case pre-existing condition application form entitled “Surface Sampling of COVID-19: A Practical “How To” Protocol for Health Care and Public Health Professionals” [40].Zhong *et al.* [41] described in a quick online cross-sectional questionnaire of knowledge, attitudes, and practice towards COVID-19, in the item “K4”; “Not all persons with COVID-2019 will develop to severe cases. Only those who are elderly, have chronic illnesses, and are *obese* are more likely to be severe cases”. Considering that the measurement of BMI is the usual parameter in the triage system; in hospital emergency departments [42,43], in our view, this index should be added to all studies of COVID-19 for to two reasons; the possible risk factor of the BMI in relationship with other virus diseases [8-10], and the association of pneumonia (which is a symptom in COVID-19) with BMI [11-14]. We must keep in mind that COVID-19 is spread from person to person by the same mechanism as other common cold or influenza viruses [44]. Chen *et al.* [45] and Plessa *et al.* [46] found obesity was a risk factor in influenza-like illness. Moser *et al.* [47] has suggested that being underweight or morbid obesity in adults, even with no associated chronic conditions, can increase the risk of the influenza-related complications and could influence the mortality and transmission of influenza virus [48, 49]. Dietz and Santos-Burgoa [50] emphasized the need for increased vigilance, a priority around detection and testing, and aggressive therapy for patients with obesity and COVID-19 infections. Nevertheless, the use of BMI in COVID-19 can be confusing. Jin *et al.* [51] developed a core outcome set for clinical trials on COVID-19 and included the BMI in the first round of the Delphi survey but deleted it in the second round. Arnold *et al.* [52] established a BMI value of 25 and 28 kg/m² for patients with disease caused by endemic human coronavirus and influenza virus, respectively, and observed statistically significant impacts on comorbidities based on the BMI, but not obese (BMI > 30 kg/m²).

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 10 May 2020 doi:10.20944/preprints202005.0166.v1

In terms of BMI and other factors related to the evolution of the disease, viral load, hospital discharge, and treatment of COVID-19 (the use of antiviral and vaccine immunization is hopeful in the foreseeable future), various authors have studied patients (general population and medical staff) affected with this disease. The evolution of this pandemic has been reported to beging with asymptomatic infection to mild illness, with severe or fatal illness being the last stage with the need for intensive care for respiratory support, in which; patients receive high-flow oxygen therapy, mechanical ventilation, advanced organ support with endotracheal intubation and mechanical ventilation or extracorporeal membrane oxygenation [53-55]. If focusing on patients with COVID-19 who were admitted to the intensive care unit, there is only one study [31] where BMI values were compared between intubated and non-intubated patients, but this article did not reflect the the statistical value of the differences between subjects. Cai *et al.* [29] illustrated that BMI seems to have little effect on the progress of the disease and Ji *et al.* [32] revealed statistically non-significant differences between stable non-severe and progressive severe patients. However, several authors found different results; Liu *et al.* [25] and Peng *et al.* [28] observed that the BMI of severely ill patients was significantly higher than that values of common patients. For viral load, Liu *et al.* [56] demonstrated that this analytical parameter is higher in patients with more severe disease, based one the amount of virus exposure and, known infectious dose, which increased the severity of the illness and was also linked to a higher viral load (severe cases were up to 60 times higher than mild cases). Cai *et al.* [29] documented that BMI was not an independent prognostic factor for virus clearance. On the other hand, the term of hospital discharge or release from home isolation was defined, according to the National Health Commission of the People's Republic of China [57], when three of the following applied; i) afebrile for >3 days and improved respiratory symptoms; ii) resolution of lung involvement demonstrated by computed tomography of the chest; and iii) two consecutive (with sampling intervals ≥ 24 hours) negative RT-PCR tests for respiratory tract samples. The study byLiu *et al.* [26] demonstrated that a higher BMI (≥ 24 kg/m^2) was an unfavorable factors for discharge among infected medical staff identified by the Cox model. For treatment of the disease, Louie *et al.* [10] suggested that BMI categories could be added to current high risk groups for prioritization of antiviral use and influenza vaccine immunization in times of supply shortages.

The importance of considering BMI in relation to COVID-19 has larger implications than explained above, underlying comorbidities can aggravate the disease. China [58,59] and the European Union [60] have suggested hypertension, respiratory system disease, and cardiovascular diseases are problematic; Italy [61] reflected that hypertension, diabetes, ischemic heart disease, atrial fibrillation and cancer diagnosed in the last five years complicate the disease; Ghana [62], and other tropical and sub-tropical areas, have detected cardiovascular disease, diabetes, chronic respiratory disease, hypertension, cancer and *Plasmodium falciparum* malaria as underlying conditions of concern; and Latin American countries [63] have indicated obesity, diabetes mellitus and hypertension as important. Shi *et al.* [64] observed that the mortality of diabetic patients with COVID-19 was 35.4%, due to a higher likelihood of suffering multi-organ dysfunction and, secondary infection. In fact, diabetes along with hypertension treatment with angiotensin-converting enzyme 2 (ACE2)-stimulating drugs increased the risk of developing severe and fatal COVID-19 due to both diseases being treated with ACE inhibitors and angiotensin II type-I receptor blockers (ARBs) resulting in increased expression of ACE2, which facilitates infection with COVID-19 [65-69]. Wang *et al.* [70] used a new classification of COVID-19 in severe patients which could help with individual evaluation of the disease and would provide effective triage for the treatment and management of individual patients. These authors divided patients into three groups; type A (patients with pneumonia requiring basic treatments based on antivirals, antibiotics, oxygen therapy, and glucocorticoids), type B (patients with different degrees of pneumonia, accompanied by serious comorbidities, requiring managing of the pneumonia an specific treatment plans, including antihypertensives, hypoglycaemic therapy, and continuous renal replacement therapy) and type C (patients who were critically ill with aggravation of the disease seen either in type A or type B, when early therapeutic effects for type A disease were unsatisfactory (resulting in multiple organ injuries), or when disease associated with type B became aggravated and the patient's condition deteriorated from their original comorbidities (leading to multiple organ failure), needing review of organ function and other protective measures such as mechanical ventilation, glucocorticoids, antivirals, symptomatic treatments, and anti-shock therapy). The use of our proposal of BMI ≥24.9 kg/m², as a risk factor in COVID-19 could be applied to the three groups defined by Wang *et al.* [70], with a high risk factor indicated when the BMI ≥34.9 kg/m² .

On the other hand, the use of nutritional support therapy during hospitalization is key to strengthening the patients. Li *et al.* [71] found that BMI had no effect on in-hospital mortality but may be closely correlated with prolonged intubation for patients. Xu *et al.* [72] indicated that nutritional and gastrointestinal function should be assessed for all patients. Li *et al.* [73] observed a decline of albumin, presumablyto the exuberant protein synthesis caused by infected patients' hypermetabolic state, associated with fever, malnutrition and low caloric intake, can which reduceBMI value through weight loss. Surprisingly, Rockx *et al.* [74] foundno significant weight loss in cynomolgus macaques inoculated with SARS-CoV-2, in contrast with the weight loss observed in Syrian hamsters [75], BALB/c mice [76], transgenic hACE2 mice [77] and rhesus macaques [78] inoculated with SARS-CoV-2. In humans, a case reflected a weight loss of around 8 kg at the patient discharged from the hospital [79]. Let us not forget that prolonged intensive care unit (ICU) stays for COVID-19 can directly worsen or cause malnutrition. It is worth noting that the European Society for Clinical Nutrition and Metabolism (ESPEN) has been carried out a concise guidance for nutritional management of infected patients in the ICU setting or who are of older age and polymorbidity status [80], and the French-speaking Society for Clinical Nutrition and Metabolism (SFNCM)'s Home Artificial Nutrition Committee has elaborated some recommendations for home artificial nutrition for chronic and fragile COVID-19 patients [81]. Further,Monteleone and Ardizzone [82] and Kalantar-Zadeh and Moore [83] have developed provisional guidance on nutrition and diet for managing paediatric inflammatory bowel and kidney diseases, respectively.

Finally, we noted that there are other groups to consider in relation to this disease, the home confinement population is very important in terms ofcontrolling BMI due to them being physically less active and having less favourable diets, among other factors, which may result in weight gain [84,85]..

The limitations of this study include the small number of available of studies for review, and different sample sizes (from 1 to 298 patients). A meta-analysis was not conducted due to the varied interventions in the reported studies.

5. Conclusions

In conclusions, the use of BMI value is a key tool to define the nutritional status in infected COVID-19 patients. This review explores the few published articles that consider this index, and the confusing term of obesity if the BMI was not incorporated in the manuscripts. Clinicians should keep a patient's BMI in mind when evaluating risk and deciding on a course of treatment for COVID-19, to improve both short- and long-term prognosis.

Author Contributions: All authors have read and agreed to the published version of the manuscript. J.M.S, A.G, C.S., A.I.C.-G. and J.F.M.-T. were responsible for the design and the review. A.G., A.I.C.-G. and J.M.S. wrote the manuscript. J.M.S. had primary responsibility for the final content. All authors read and approved the final manuscript.

Funding: This research received no external funding.

Acknowledgments: The authors wish to thank for their comments and suggestions to the University Clinic of Nutrition, Physical Activity and Physiotherapy (CUNAFF) from Lluís Alcanyís Foundation, Confucius Institute from University of Valencia and International Society for Anthropometry Applied to Sport and Health (ISANASHE).

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Sahin, A.R., Erdogan, A.; Agaoglu, P.M.; Dineri, Y.; Cakirci, A.Y.; Senel, M.E.; Okyay, R.A.; Tasdogan, A. M. 2019 Novel Coronavirus (COVID-19) outbreak: A review of the current literature. *EJMO*, **2020**, *4*, 1-7.
2. Sohrabi, C.; Alsafi, Z.; O'Neill, N.; Khan, M.; Kerwan, A.; Al-Jabir, A.; Iosifidis, C.; Agha, R. World Health Organization declares global emergency: A review of the 2019 novel coronavirus (COVID-19). *Int. J. Surg.*, **2020**, *76*, 71-76.
3. Vijayanand, P.; Wilkins, M.W. Severe Acute Respiratory Syndrome (SARS): a review. *Clin. Med.*, **2004**, *4*, 152-160.
4. Al-Tawfiq, J.A.; Gautret, P. Asymptomatic Middle East Respiratory Syndrome Coronavirus (MERS-CoV) infection: extent and implications for infection control: a systematic review. *Travel Med. Infect. Di.*, **2019**, *27*, 27-32.
5. Guarner, J. Three Emerging Coronaviruses in Two Decades: The Story of SARS, MERS, and Now COVID-19. *Am. J. Clin. Pathol.*, **2020**, *153*, 420–421.
6. Coronaviridae Study Group of the International Committee on Taxonomy of Viruses. The species Severe acute respiratory syndrome-related coronavirus: classifying 2019-nCoV and naming it SARS-CoV-2. *Nat. Microbiol.*, **2020**, *5*, 536–544.
7. World Health Organization. *WHO Director-General's opening remarks at the media briefing on COVID-19-11 March 2020.* Available online: https://www.who.int/csr/don/17-january-2020-novel-coronavirus-japan-ex-china/en/ (accessed on 18 April 2020).
8. Nishiura, H.; Jung, S.M.; Linton, N.M.; Kinoshita, R.; Yang, Y.; Hayashi, K.; Kobayash, T.; Yuan, B.; Akhmetzhanov, A.R. (2020). The extent of transmission of novel coronavirus in Wuhan, China, 2020. *J. Clin. Med.* **2020**, 9, 330.
9. Van den Brand, J.M.; Smits, S.L.; Haagmans, B.L. Pathogenesis of Middle East respiratory syndrome coronavirus. *J. Pathol.*, **2015**, *235*, 175-184.
10. Louie, J.K.; Acosta, M.; Samuel, M.C.; Schechter, R.; Vugia, D.J.; Harriman, K.; Matyas, B.T. A novel risk factor for a novel virus: obesity and 2009 pandemic influenza A (H1N1). *Clin. Infect. Dis.*, **2011**, *52*, 301-312.
11. Wang, X. F.; Shi, G. C.; Wan, H. Y.; Hang, S. G.; Chen, H.; Chen, W.; Qu, H.P.; Han, B.H.; Zhou, M. Clinical features of three avian influenza H7N 9 virus-infected patients in Shanghai. *Clin. Respir. J.*, **2014,** *8*, 410-416.
12. Phung, D.T.; Wang, Z.; Rutherford, S.; Huang, C.; Chu, C. Body mass index and risk of pneumonia: a systematic review and meta-analysis. *Obes. Rev.*, **2013**, *14*, 839-857.
13. Nie, W.; Zhang, Y.; Jee, S. H.; Jung, K. J.; Li, B.; Xiu, Q. Obesity survival paradox in pneumonia: a meta-analysis. *BMC Med.*, **2014**, *12*, 61.
14. Kahlon, S.; Eurich, D.T.; Padwal, R.S.; Malhotra, A.; Minhas-Sandhu, J.K.; Marrie, T.J.; Majumdar, S.R. Obesity and outcomes in patients hospitalized with pneumonia. *Clin. Microbiol. Infect.*, **2013**, *19*, 709-716.
15. Singanayagam, A.; Singanayagam, A.; Chalmers, J. D. Obesity is associated with improved survival in community-acquired pneumonia. *Eur. Respir. J.*, **2013**, *42*, 180-187.
16. Moher, D.; Liberati, A.; Tetzlaff, J.; Altman, D.G.; Group, P. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Med.* **2009**, *6*, e1000097.
17. Liberati, A.; Altman, D.G.; Tetzlaff, J.; Mulrow, C.; Gøtzsche, P.C.; Ioannidis, J.P.; Clarke, M.; Devereaux, P.J.; Kleijnen, J.; Moher, D. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *Ann. Intern. Med.*, **2009**, *151*, 65-94.

18. World Health Organization. *Obesity: preventing and managing the global epidemic.* WHO Western Pacific Region: Geneva, Switzerland, **1998**.
19. World Health Organization Western Pacific Region, International Association for the Study of Obesity, and International Obesity Task Force. *The Asian-Pacific perspective: redefining obesity and its treatment*. WHO Western Pacific Region: Geneva, Switzerland, **2000**.
20. Seo, M.H., Lee, W.Y.; Kim, S.S.; Kang, J.H.; Kang, J.H.; Kim, K.K., Kim, B.Y.; Kim, Y.H.; Kim, W.J.; Kim, E.M.; et al. 2018 Korean society for the study of obesity guideline for the management of obesity in Korea. *J. Obes. Metab. Syndr.*, **2019**, *28*, 40-45.
21. National Heart, Lung and Blood Institute. *Quality assessment tool for case series studies*. Available online: https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools (accessed on 18 April 2020).
22. Lim, J.; Jeon, S.; Shin, H. Y.; Kim, M. J.; Seong, Y. M.; Lee, W. J.; Choe, K.W.; Kang, Y.M.; Lee, B.; Park, S.J. Case of the index patient who caused tertiary transmission of Coronavirus disease 2019 in Korea: the application of lopinavir/ritonavir for the treatment of COVID-19 pneumonia monitored by quantitative RT-PCR. *J. Korean Med. Sci.*, **2020**, *35*, e79.
23. Kim, J.Y.; Choe, P.G.; Oh, Y.; Oh, K.J.; Kim, J.; Park, S.J.; Park, J.H.; Na, H.K.; Oh, M.D. The first case of 2019 novel coronavirus pneumonia imported into Korea from Wuhan, China: implication for infection prevention and control measures. *J. Korean Med. Sci.*, **2020,** *35*, e61.
24. Li, Q.; Cheng, Q.; Zhao, Z.; Zeng, L.; Zhu, L.; Guo, W.; Li, C.; Wang, J.; Li, S.; Shen, N.; Ge, Q. N Novel Coronavirus infection and acute kidney injury in two renal transplant recipients: Case report. *Preprints* **2020**, *2020030190.*
25. Liu, M.; He, P.; Liu, H.G.; Wang, X.J.; Li, F.J.; Chen, S.; Lin, J.; Chen, P.; Liu, J.H.; Li, C.H. Clinical characteristics of 30 medical workers infected with new coronavirus pneumonia. *Zhonghua Jie He He Hu Xi Za Zhi*, **2020**, *43*, 209-214.
26. Liu, J.; Ouyang, L.; Guo, P.; Wu, H.S; Fu, P.; Chen, Y.L.; Yang, D.; Han, X.Y.; Cao, Y.K.; Epidemiological, clinical characteristics and outcome of medical staff infected with COVID-19 in Wuhan, China: A retrospective case series analysis. *MedRxiv* **2020.** *03.09.20033118.*
27. Yang, W., Cao, Q., Qin, L., Wang, X., Cheng, Z., Pan, A., Dai, J.; Sun, Q:, Zhao, F.; Qu, J.; et al. Clinical characteristics and imaging manifestations of the 2019 novel coronavirus disease (COVID-19): A multi-center study in Wenzhou city, Zhejiang, China. *J. Infect.*, **2020**, *80*, 388-393.
28. Peng, Y. D.; Meng, K.; Guan, H.Q.; Leng, L.; Zhu, R.R.; Wang, B.Y.; He, M.A.; Cheng, L.X.; Huang, K.; Zeng, Q.T. Clinical characteristics and outcomes of 112 cardiovascular disease patients infected by 2019-nCoV. *Zhonghua Jie He He Hu Xi Za Zhi*, **2020**, *48*, e4
29. Cai, Q.; Huang, D.; Ou, P.; Yu, H.; Zhu, Z.; Xia, Z.; Su, Y.; Ma, Z.G.; Zhang, Y.; Li, Z.; et al. COVID-19 in a designated infectious diseases Hospital outside Hubei Province, China. Available online: https://onlinelibrary.wiley.com/doi/full/10.1111/all.14309 (accessed on 18 April 2020)..
30. Huang, M.; Yang, Y.; Futai, S.; Yishan, Z.; Wenjing, Z.; Liang, L.; Liang, L.; Xudong, H. ; Aihua, L.; Hongsheng, Z.; et al. Early and critical care in severe patients with COVID-19 in Jiangsu Province, China: A descriptive study. *Lancet*, **2020**, Available online: https://ssrn.com/abstract=3546056 (accessed on 18 April 2020).
31. Xu, Y.; Xu, Z.; Liu, X.; Cai, L.; Zheng, H.; Huang, Y.; Zhou, L.; Huang, L.; Lin, Y.; Deng, L. Clinical findings in critical ill patients infected with SARS-Cov-2 in Guangdong Province, China: a multi-center, retrospective, observational study. *MedRxiv*, **2020,** *03.03.20030668*.

 doi:10.20944/preprints202005.0166.v1

32. Ji, D.; Zhang, D.; Chen, Z.; Xu, Z.; Zhao, P.; Zhang, M.; Zhang, L.; Cheng, G.; Wang, Y.; Yang, G. Clinical characteristics predicting progression of COVID-19. *Lancet*, **2020**, Available online: https://ssrn.com/abstract=3539674 (accessed on 18 April 2020).
33. Simonnet, A.; Chetboun, M.; Poissy, J.; Raverdy, V.; Noulette, J.; Duhamel, A.; Labreuche, J.; Mathieu, D.; Pattou, F.; Jourdain, M; et al. High prevalence of obesity in severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) requiring invasive mechanical ventilation. *Obesity*, **2020** Available online: https://onlinelibrary.wiley.com/doi/epdf/10.1002/oby.22831 (accessed on 18 April 2020)
34. Salehi, S.; Abedi, A.; Balakrishnan, S.; Gholamrezanezhad, A. Coronavirus disease 2019 (COVID-19): a systematic review of imaging findings in 919 patients. *Am. J. Roentgenol*., **2020**, *215*, 1-7.
35. Huang, R.; Zhu, L.; Xue, L.; Liu, L.; Yan, X.; Wang, J.; Zhang, B.; Xu, T.; Ji, F.; Zhao, Y.; Cheng, J.; et al. Clinical findings of patients with coronavirus disease 2019 in Jiangsu Province, China: A retrospective, multi-center study. *Lancet*, **2020**, Available online: https://ssrn.com/abstract=3548785 (accessed on 18 April 2020).
36. McMichael, T.M.; Clark, S.; Pogosjans, S.; Kay, M.; Lewis, J.; Baer, A.; Kawakami, V.; Lukoff, M.D.; Ferro, J.; Brostrom-Smith, C:, et al. COVID-19 in a Long-Term Care Facility—King County, Washington, February 27–March 9, 2020. *MMWR Morb. Mortal. Wkly. Rep*., **2020**, *69*. Available online: https://www.cdc.gov/mmwr/volumes/69/wr/mm6912e1.htm (accessed on 18 April 2020).
37. Deng, S.Q.; Peng, H.J. Characteristics of and public health responses to the coronavirus disease 2019 outbreak in China. *J. Clin. Med.* **2020**, *2*, 9.
38. Liao, J.; Fan, S.; Chen, J.; Wu, J.; Xu, S.; Guo, Y.; Li, C., Zhang, X.; Wu, C.; Mou, H.; et al. Epidemiological and clinical characteristics of COVID-19 in adolescents and young adults. *MedRxiv*, **2020,** *03.10.20032136.*
39. Spiteri, G.; Fielding, J.; Diercke, M.; Campese, C.; Enouf, V.; Gaymard, A.; Bella, A.; Sognamiglio, P.; Sierra Moros, M.J.; Nicolau Riutort, A.; et al. First cases of coronavirus disease 2019 (COVID-19) in the WHO European Region, 24 January to 21 February 2020. *Euro Surveill., **2020**, 25,* pii=2000178.
40. World Health Organization. Surface sampling of coronavirus disease (COVID-19): a practical "how to" protocol for health care and public health professionals. Available online: https://apps.who.int/iris/handle/10665/331058 (accessed on 18 April 2020).
41. Zhong, B.L.; Luo, W.; Li, H.M.; Zhang, Q.Q.; Liu, X.G.; Li, W.T.; Li, Y. Knowledge, attitudes, and practices towards COVID-19 among Chinese residents during the rapid rise period of the COVID-19 outbreak: a quick online cross-sectional survey. *Int. J. Biol. Sci*., **2020**, *16*, 1745-1752.
42. Bilben, B.; Grandal, L.; Søvik, S. National Early Warning Score (NEWS) as an emergency department predictor of disease severity and 90-day survival in the acutely dyspneic patient–a prospective observational study. *Scand. J. Trauma. Resusc. Emerg. Med*., **2016**, *24*, 80.
43. Canpolat, G.; Ozgultekin, A.; Turan, G.; Iskender, A.; Adiyeke, E.; Ekinci, O. Does average volume-assured pressure support make any difference compared with BIPAP? *Crit. Care*, **2014**, *18*, P265.
44. Heymann, D.L.; Shindo, N. COVID-19: what is next for public health? *Lancet*, **2020**, *395*, 542-545.
45. Chen, W.H.; Lu, C.Y.; Shao, P.L.; Lee, P.I.; Kao, C.L.; Chung, M.Y.; Chang, L.Y.; Huang, L.M. Risk factors of severe novel influenza A (H1N1) infections in hospitalized children. *J. Formos. Med. Assoc.* **2012**, *111*, 421-426.
46. Plessa, E.; Diakakis, P.; Gardelis, J.; Thirios, A.; Koletsi, P.; Falagas, M.E. Clinical features, risk factors, and complications among pediatric patients with pandemic influenza A (H1N1). *Clin Pediatr (Phila),* **2010**, *49*, 777-781.

47. Moser, J.S.; Galindo-Fraga, A.; Ortiz-Hernández, A.A.; Gu, W.; Hunsberger, S.; Galán-Herrera, J.F.; Guerrero, M.L.; Ruiz-Palacios, G.M.; Beigel, J.H.; La Red ILI 002 Study Group. Underweight, overweight, and obesity as independent risk factors for hospitalization in adults and children from influenza and other respiratory viruses. *Influenza Other Respir. Viruses*, **2019**, *13*, 3–9.
48. Milner, J.J.; Rebeles, J.; Dhungana, S.; Stewart ,D.A.; Sumner, S.C.; Meyers, M.H.; Mancuso, P.; Beck, M.A. Obesity increases mortality and modulates the lung metabolome during Pandemic H1N1 Influenza virus infection in mice. *J. Immunol.*, **2015,** *194*, 4846-4859.
49. Maier, H.E.; Lopez, R.; Sanchez, N.; Ng, S.; Gresh, L.; Ojeda, S.; Burger-Calderon, R.; Kuan, G.; Harris, E.; Balmaseda, A. Obesity increases the duration of Influenza A virus shedding in adults. *J. Infect. Dis.*, **2018**, 218, 1378-1382.
50. Dietz, W.; Santos-Burgoa, C. Obesity and its implications for COVID-19 mortality. *Obesity*, **2020**, Available online: https://onlinelibrary.wiley.com/doi/epdf/10.1002/oby.22818 (accessed on 18 April 2020).
51. Jin, X.; Pang, B.; Zhang, J.; Liu, Q.; Yang, Z.; Feng, J.; Liu, X.; Zhang, L.; Wang, B.; Huang, Y. et al. Core outcome set for clinical trials on Coronavirus Disease 2019 (COS-COVID). *Engineering,* **2020,** Available online: https://www.sciencedirect.com/science/article/pii/S2095809920300424 (accessed on 18 April 2020).
52. Arnold, F.W.; Burns, M.V.; Mahmood, K.; Aden, D.; Furmanek, S.P.; Tella, M.A.; . Glick, C.; Raghuram, A.; Beavin, L.; Cavallazzi, R.; et al. Endemic human coronaviruses in hospitalized adults with community-acquired pneumonia: Results from the Louisville Pneumonia Study. *Univ. Louisville J. Respir. Infect.*, **2020,** *4*, 1-11.
53. Wang, D.; Hu, B.; Hu, C.; Zhu, F.; Liu, X.; Zhang, J.; Wang, B.; Xiang, H.; Cheng, Z.; Xiong, Y. et al. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. *JAMA*, **2020**, *323*, 1061–1069.
54. Chen, N.; Zhou, M.; Dong, X.; Qu, J.; Gong, F. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. *Lancet*, **2020**, *395*, 507-513.
55. Novel, C.P.E.R.E. The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19) in China. *Zhonghua Liu Xing Bing Xue Za Zhi*, **2020**, *41*, 145-151.
56. Liu, Y.; Yan, L.M.; Wan, L.; Xiang, T.X.; Le, A.; Liu, J.M., Peiris, M.; Poon, L.L.M.; Zhang, W. Viral dynamics in mild and severe cases of COVID-19. *Lancet Infect Dis.*, **2020**, Available online: https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(20)30232-2/fulltext (accessed on 18 April 2020).
57. National Health Commission of the People's Republic of China. New coronavirus pneumonia diagnosis and treatment program (trial version 5, revised version). Available online: http://www.nhc.gov.cn/yzygj/s7652m/202002/41c3142b38b84ec4a748e60773cf9d4f.shtml (accessed on 18 April 2020).
58. Guan, W.J.; Liang, W.H.; Zhao, Y.; Liang, H.R.; Chen, Z.S.; Li, Y.M.; Liu, X.Q.; Chen, R.C.; Tang, C.L.; Wang, T.; et al. Comorbidity and its impact on 1590 patients with Covid-19 in China: A Nationwide Analysis. *Eur. Respir. J.*, **2020**, Available online: https://erj.ersjournals.com/content/erj/early/2020/03/17/13993003.00547-2020.full.pdf (accessed on 18 April 2020).
59. Yang, J.; Zheng, Y.; Gou, X.; Pu, K.; Chen, Z.; Guo, Q.; Guo, Q.; Ji, R.; Wang, H.; Wang, Y.; Zhou, Y. Prevalence of comorbidities in the novel Wuhan coronavirus (COVID-19) infection: a systematic review

and meta-analysis. *Int J Infect Dis.*, **2020,** Available online: https://www.ijidonline.com/article/S1201-9712(20)30136-3/pdf (accessed on 18 April 2020).
60. Johnson, H.C.; Gossner, C.M.; Colzani, E.; Kinsman, J.; Alexakis, L.; Beauté, J.; Würz, A.; Tsolova, S.; Bundle, N.; Ekdahl, K. Potential scenarios for the progression of a COVID-19 epidemic in the European Union and the European Economic Area, March 2020. *Euro Surveill.*, ***2020,*** *25*, pii=2000202.
61. Istituto Superiore di Sanità. Characteristics of COVID-19 patients dying in Italy Report based on available data on March 20th, 2020. **2020,** Available online: https://www.epicentro.iss.it/coronavirus/bollettino/Report-COVID-2019_20_marzo_eng.pdf (accessed on 18 April 2020).
62. Addo, L. Of the COVID-19 in Ghana - Preparedness, demographics and comorbidity (March 27, 2020). Available online: https://ssrn.com/abstract=3562720 (accessed on 18 April 2020).
63. Comité Internacional para la Elaboración de Consensos y Estandarización en Nutriología (CIENUT). *Posición de expertos sobre el manejo nutricional del coronavirus COVID-19.* Available online: https://www.cienut.org/comite_internacional/declaraciones/pdf/declaracion2.pdf (accessed on 18 April 2020).
64. Shi, Q.; Zhang, X.; Jiang, F.; Tao, J.; Zhang, X.; Hu, N.; Feng, J.; Bimu, J.; Yan, S.; Guan, Y.; et al. Diabetic patients with COVID-19, Characteristics and outcome: A two-centre, retrospective, case control study. AwesomeCapital. Available online: https://awesomecapital.blogspot.com/2020/03/diabetic-patients-with-covid-19.html (accessed on 18 April 2020).
65. Fang, L.; Karakiulakis, G.; Roth, M. Are patients with hypertension and diabetes mellitus at increased risk for COVID-19 infection? *Lancet Respir. Med.*, **2020,** *8*, e21.
66. Zhou, F.; Yu, T.; Du, R.; Fan, G.; Liu, Y.; Liu, Z.; Xiang, J.; Wang, Y.; Song, B.; Gu, X.; et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. *Lancet*, **2020,** *395*, 1054-1062.
67. Wan, Y.; Shang, J.; Graham, R.; Baric, R.S.; Li, F. Receptor recognition by novel coronavirus from Wuhan: an analysis based on decade-long structural studies of SARS. *J. Virol.*, **2020**, *94*, e00127-20.
68. Guo, Y.R.; Cao, Q.D.; Hong, Z.S.; Tan, Y.Y.; Chen, S.D.; Jin, H.J.; Tan, K.S.; Wang, D.Y.; Yan, Y. The origin, transmission and clinical therapies on coronavirus disease 2019 (COVID-19) outbreak-an update on the status. *Mil. Med. Res.*, **2020**, *7*, 11.
69. Zhang, H.; Penninger, J.M.; Li, Y.; Zhong, N.; Slutsky, A.S. Angiotensin-converting enzyme 2 (ACE2) as a SARS-CoV-2 receptor: molecular mechanisms and potential therapeutic target. *Intensive Care Med.*, **2020,** *46*, 586-590.
70. Wang, T.; Du, Z.; Zhu, F.; Cao, Z.; An, Y.; Gao, Y.; Jiang, B. Comorbidities and multi-organ injuries in the treatment of COVID-19. *Lancet*, **2020**, *395*, e52.
71. Li, Y.; Jiang, H.; Xu, H.; Li, N.; Zhang, Y.; Wang, G.; Xu, Z. Impact of a higher body mass index on prolonged intubation in patients undergoing surgery for acute thoracic aortic dissection. *Heart Lung Circ.*, **2020**, Available online: https://www.heartlungcirc.org/article/S1443-9506(20)30072-X/pdf (accessed on 18 April 2020).
72. Xu, K.; Cai, H.; Shen, Y.; Ni, Q.; Chen, Y.; Hu, S.; Li, J.; Wang, H.; Yu, L.; Huang, H.; Qiu, Y. Management of corona virus disease-19 (COVID-19): the Zhejiang experience. *Zhejiang Da Xue Xue Bao Yi Xue Ban.*, **2020**, *49*, 0.

 doi:10.20944/preprints202005.0166.v1

73. Li, L.; Li, S.; Xu, M.; Zheng, S.; Duan, Z.; Chen, Y.; Li, J. The level of plasma C-reactive protein is closely related to the liver injury in patients with COVID-19. *MedRxiv* **2020.** Available online: https://www.medrxiv.org/content/10.1101/2020.02.28.20028514v1.full.pdf (accessed on 18 April 2020).
74. Rockx, B.; Kuiken, T.; Herfst, S.; Bestebroer, T.; Lamers, M.M.; de Meulder, D.; van Amerongen, G.; van den Brand, J.; Okba, N.M.A; Schipper, D.; et al. Comparative pathogenesis of COVID-19, MERS And SARS in a non-human primate model. *bioRxiv,* **2020,** *2020.03.17.995639*
75. Chan, J.F.W.; Zhang, A.J.; Yuan, S.; Poon, V.K.M.; Chan, C.C.S.; Lee, A.C.Y.; Chan, W.M.; Fan, Z.; Tsoi, H.W.; Wen, L.; et al. Simulation of the clinical and pathological manifestations of Coronavirus Disease 2019 (COVID-19) in golden Syrian hamster model: implications for disease pathogenesis and transmissibility. *Clin. Infect. Dis.,* **2020,** *ciaa325.*
76. Xiong, R.; Zhang, L.; Li, S.; Sun, Y.; Ding, M.; Wang, Y.; Zhao, Y.; Wu, Y.; Shang, W.; Jiang, X. Novel and potent inhibitors targeting DHODH, a rate-limiting enzyme in de novo pyrimidine biosynthesis, are broad-spectrum antiviral against RNA viruses including newly emerged coronavirus SARS-CoV-2. *bioRxiv,* **2020,** *2020.02.07.939389.*
77. Bao, L.; Deng, W.; Huang, B.; Gao, H.; Liu, J.; Ren, L.; Wei, Q.; Yu, P.; Xu, Y.; Qi, F.; et al., The pathogenicity of SARS-CoV-2 in hACE2 transgenic mice. *bioRxiv,* **2020,** *2020.03.11.983056.*
78. Munster, V.J.; Feldmann, F.; Williamson, B.N.; van Doremalen, N.; Pérez-Pérez, L.; Schultz, J.; Kimberly Meade-White, M.; Okumura, A.; Callison, J.; Brumbaugh, B.; et al. Respiratory disease and virus shedding in rhesus macaques inoculated with SARS-CoV-2. *bioRxiv,* **2020,** 2020.03.21.001628.
79. Baos, V.; A medical account from my own experience. **2020.** Available online: https://www.vozpopuli.com/altavoz/next/Covid-19-relato-medico-propia-experiencia_0_1341767497.html (accessed on 18 April 2020).
80. Barazzoni, R.; Bischoff, S.C.; Krznaric, Z.; Pirlich, M.; Singer, P. ESPEN expert statements and practical guidance for nutritional management of individuals with SARS-CoV-2 infection. *Clin. Nutr.* **2020.** Available online: https://www.sciencedirect.com/science/article/pii/S0261561420301400 (accessed on 18 April 2020).
81. Schneider, S.M.; Albert, V.; Barbier, N.; Barnoud, D.; Bouteloup, C.; Chambrier, C.; Fayemendy, P.; Flori, N.; Goulet, O.; Guimber, D. Adaptations de la prise en charge des patients en Nutrition Artificielle à Domicile au cours de l'épidémie virale COVID-19 en France: avis du Comité de Nutrition à Domicile de la Société Francophone de Nutrition Clinique et Métabolisme (SFNCM). *Nutr. Clin. Métab*. **2020.** Available online: https://www.sciencedirect.com/science/article/pii/S098505622030354X (accessed on 18 April 2020).
82. Monteleone, G.; Ardizzone, S. Are patients with inflammatory bowel disease at increased risk for Covid-19 infection? *J. Crohns Colitis*, **2020,** *jjaa061*, 1-3.
83. Kalantar-Zadeh, K.; Moore, L.W. Impact of nutrition and diet on COVID-19 infection and implications for kidney health and kidney disease management. *J. Ren. Nutr.,* **2020.** Available online: https://www.jrnjournal.org/article/S1051-2276(20)30083-2/pdf (accessed on 18 April 2020).
84. Rundle, A G.; Park, Y.; Herbstman, J.B.; Kinsey, E.W.; Wang, Y.C. COVID-19 related school closings and risk of weight gain among children. *Obesity,* **2020.** Available online: https://onlinelibrary.wiley.com/doi/epdf/10.1002/oby.22813 (accessed on 18 April 2020).
85. Wang, G.; Zhang, Y.; Zhao, J.; Zhang, J.; Jiang, F. Mitigate the effects of home confinement on children during the COVID-19 outbreak. *Lancet,* **2020,** *395,* 945-947.