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COVID 19 AND OBESITY AS A RISK FACTOR: A SYSTEMATIC REVIEW

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Abstract:
Although an increasing number of studies have reported unhealthy nutrition and its relationship to COVID 19 worldwide, there is a dearth of studies on obesity and its relationship with COVID 19, especially in Iraq. The study aimed to determine the relationship between obesity factor for Iraqi adults of both sexes and of different ages and its relationship to infection with Covid 19, where random samples were selected, and the total number of people was (384) patients infected with Covid 19 virus who were diagnosed by a specialist doctor, and Microbiologically and molecularly, the cases were divided according to the severity of the injury into three categories, severe (37)moderate (160) and mild (187). Patients with any form of obesity were also identified into three degrees (obesity 1 (50)). Obesity 2 (5) and obesity 3The study also revealed a direct link between the risk of Covid 19 and aging, and because this virus requires treatment, vitamin D3 is the most important drug for us. Furthermore, with the COVID 19 outbreak in Iraq, this study explored the differences between males (31%) and females (69%).

Keywords: COVID 19, obesity, ACE2, Vitamin D.

Introduction:

The virus SARS-CoV-2, which is the reasons extremely contagious disease known as COVID-19, was originally discovered in Wuhan, Hubei Province, China, and swiftly spread to other nearby cities and nations (Zhu et al., 2020). CoVs their genome is RNA that cause moderate to severe respirational illnesses in both humans and domestic and companion animals' respiratory tracts (Su et al., 2016).

The educational system is being threatened by the coronavirus (Daniel, 2020). The outbreak started in China (Wuhan) in December 2019 and expanded to all other nations (Jin et al., 2020). Up till March 25, 2020, Covid-19 had resulted in 414 179 infections and 18440 fatalities (Verity et al., 2020). A group of viruses known as coroviruses can cause everything from a common cold to life-threatening pneumonias like SARS and Middle East Respiratory Syndrome (Zaki et al., 2012). (Drosten et al., 2003). The chance of hospitalization and treatment for those with coronavirus disease 2019 (covid-19), which is brought on by the severe acute respiratory syndrome (SARS-

cov-2), appears to be correlated with pre-obesity or obesity (Lighter et al., 2020; Popkin et al., 2020).

It has been found that obesity has a significant relation to many health problems, including cardiovascular disease, cancer, diabetes, and hypertension. There were almost 900,000 adult Covid-19 hospitalizations. Obesity was discovered in 30.2 percent of hospitalizations in the United States between the early epidemic and November 18, 2020 (O'Hearn et al., 2021; CDC, 2021).

Coronavirus (CoV):

In 1965, Tyrrell became the first person to isolate the coronavirus (CoV) from male children's nasal washes. The number of coronavirus strains has drastically risen since 1965, when the common cold and mild upper respiratory illness first appeared. HCoV-NL63 and HCoV-229E, HCoV-OC43, HCoV-HKU1, SARS-CoV, and MERS-CoV are the six (HCoVs) that have been discovered thus far. The most typical pneumonia viruses are SARS-CoV and MERS-CoV. SARS-CoV2 infections in humans are related. A CoV was connected to the SARS (Tyrrell and Bynoe, 1965).

Acute pneumonia was among the outbreak's symptoms when the illness was discovered in 2002; it later expanded to (29). The SARS-CoV epidemic in 2003 resulted in significant morbidity and mortality by June 2003. The Middle East Respiratory Syndrome Coronavirus, which was discovered in June 2012 in Saudi Arabia, followed this (MERS-CoV). Peninsula has had several epidemics. SARS-CoV and MERS-CoV are endemic viruses that cause pneumonia in between 0.6% and 2.5% of cases (Anand et al., 2020).

In 2019, Wuhan saw a sudden onset of an inexplicable pneumonia. The majority of the early cases, which are unique from SARS-CoV and MERS-CoV, were connected to the wholesale seafood industry. COVID-19 has a 14-day incubation period and produces fever and pneumonia (Page et al., 2021).

2.1.1. General Characteristics of COVID_19:

Coronaviruses are large, positive single strand RNA, enveloped, infecting humans and a wide range of animals (Dhuaif, 2021). Coronaviruses have four sub families, the first two alpha coronaviruses and beta coronaviruses originated from mammals, in particular from bats. The last two coronaviruses gamma and delta viruses originate from pigs and birds (Page et al., 2021).

Spikes (S), Membrane (M), Covering protein (E), and Hemagglutinin-Esterases (HEs) are the four main structural proteins that the viral genome encodes and are crucial for the formation of intracellular particles (Rezabakhsh et al., 2020). The M-protein is

most prevalent on the viral surface and is thought to be the primary organizer for coronavirus assembly. The thesis-protein, which is incorporated into the surface of the virus, facilitates membrane fusion between the viral and host cell membranes as well as the knobs of the hosts cells that bind to virus. With (76–109) amino acids, the E-protein is a very small protein. On the surface, hemagglutinin-esterase dimer protein was discovered. HE lied about the virus's introduction have important in the natural host cell (Boopathi et al., 2020).

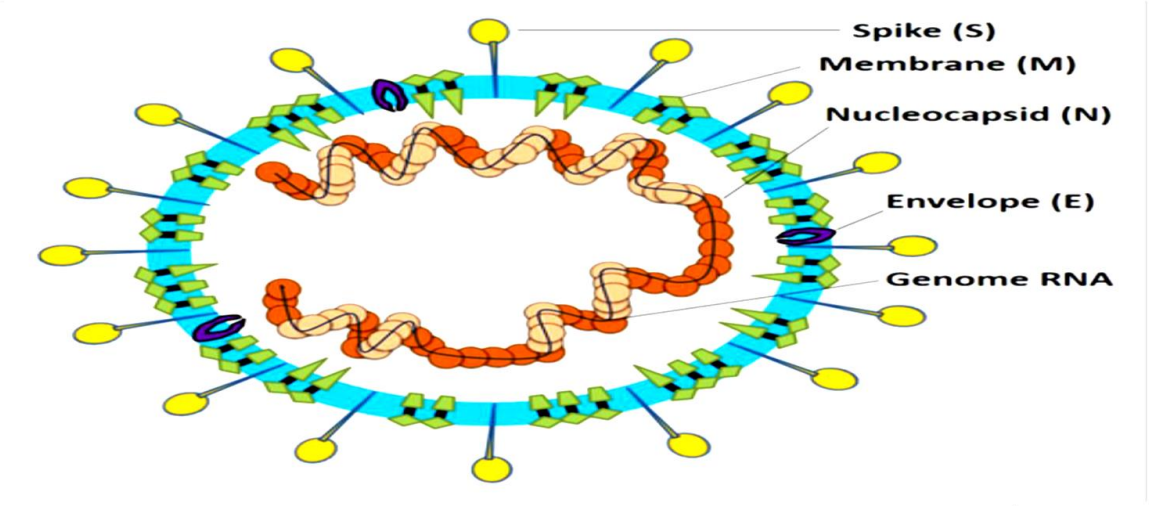

Fig 1: General structure of 1): General structure of Corona virus Corona virus ((Li et al., 2020)

Epidemiology of COVID 19:

The first recording of the (COVID-19) in Wuhan, COVID-19 has spread rapidly across China. Despite the global effort to prevent its spread, it transmitted into many countries. (WHO) shows 84,503 patients in 57 countries have COVID-19, causing 2,924 deaths by February, 2020 (Lai et al., 2020).

The respiratory system is the route via which a virus is spread when a person is exposed to polluted air containing virus droplets and tiny particles. Close quarters increase the likelihood of infection (Wang et al., 2021). Transmission can also happen if infected fluids are sprayed in the eyes, mouth, or nose, and extremely rarely through contaminated surfaces (Wang et al., 2021).

2.1.3. Mechanism of SARS CoV 2 Invasion and Replication:

The life cycle of virus with host include 5 stages:

1. Affection. 2. Infiltration Biosynthesis 3. 4. Development. 5. Release (Bosch et al., 2003; Channappanavar et al., 2014).

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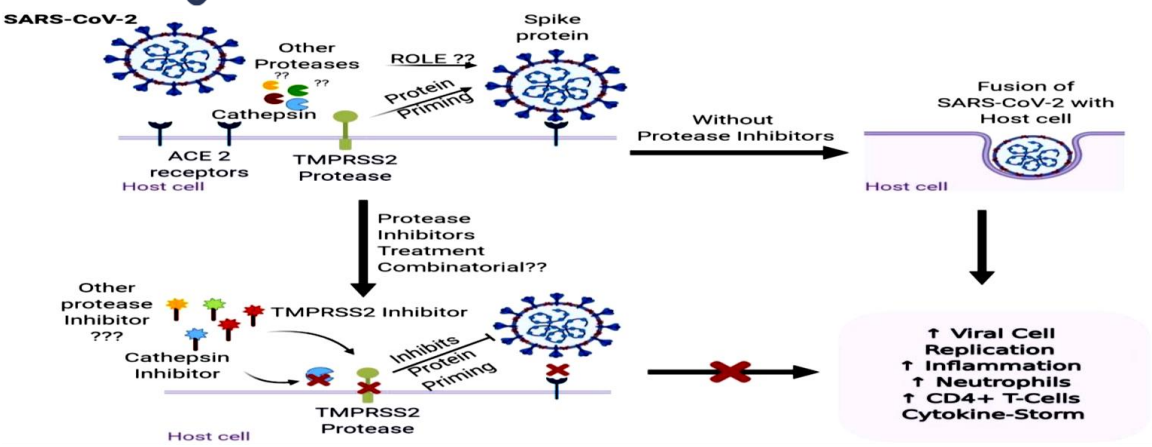

Fig 2: Mechanism m of SARS CoV 2 Invasion and Replication (Seth et al., 2020).

2.1.4. Pathogenesis:

Numerous body systems and cells may be infected by SARS-CoV-2. The upper and lower respiratory systems are impacted by COVID-19 (Harrison et al., 2020). Because COVID-19 enters the body through the ACE2 receptor, which is most frequently found on type II alveolar cells, the lungs are affected (Verdecchia et al., 2020). A "spike" glycoprotein is used by the virus to attach to ACE2 and enter the host cell (Letko et al.; 2020).

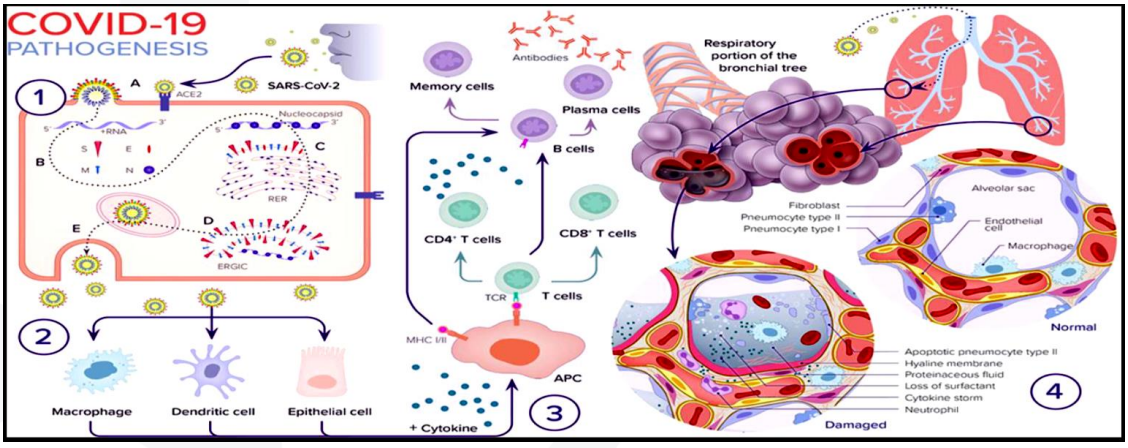

Fig 3: Pathogenicity of Corona virus (Covid 19) (Harrison et al., 2020).

2.1.5. Symptoms of COVID 19:

After 5 days, COVID-19 symptoms appear (Cassaniti et al., 2020). The median time between COVID-19 symptoms and death was 14 days. This depends on age and immune system health. It was shorter for patients > 70 than < 70 (Chan et al., 2020). Sputum, hemoptysis, headache, lymphopenia, and dyspnea are other symptoms. On chest CT scans, the majority of patients with fever, dry cough, and dyspnea revealed bilateral ground-glass opacities (Chen et al., 2020). Fever and dyspnea are two COVID-19 signs and symptoms (Huang et al., 2020). Upper respiratory symptoms as

rhinorrhea, sore throat, and sneezing were caused by COVID-19, which targeted the lower airway (Rothan and Byrareddy, 2020). Previous SARS studies have connected GI cells to SARS-CoV-1. Testing for bacteria in the stomach, especially in hospitalized patients, may explain why some illnesses return and how they spread (Gu et al., 2020). COVID-19 symptoms might range from little discomfort to serious illness. Many folks don't show any symptoms. The following symptoms, which may manifest two to 14 days after exposure: Fever, Chest pain, and Cough; Additional signs and symptoms include a headache, pains, diarrhea, and vomiting, Loss of smell or taste, Tiredness, Sore throat, Runny nose (Sheikhi and Shirzadfar, 2020).

2.1. 6. Severity of COVID 19:

The 2019 coronavirus illness (COVID-19) presents with a wide range of symptoms. Asymptomatic people are those who show no symptoms, whereas unwell people have severe symptoms. The likelihood of developing COVID-19 symptoms and ultimately passing away might increase. Males and females have similar rates of infection, but males die on average 1.7 times more frequently than females (Rychter et al., 2020; CDC, 2021). Another important variable that has a substantial impact on COVID-19 severity is:

1. Older age: Coronaviruses can affect people of any age, but they most frequently affect people aged 85 and older.
2. Lung issue Lung issues include cystic fibrosis, lung cancer, chronic obstructive pulmonary disease, and pulmonary fibrosis.
3. Weakened immune system: Can be caused by a variety of medical conditions and treatments, such as HIV/AIDS, chemotherapy, and organ transplantation
4. Chronic diseases: Such as Diabetes and hypertension are examples of such diseases.

In addition to these factors, new research suggests obesity is one of important risk factors in patients with covied-19.

Obesity: Is a medical state in which fat accumulates in the body and causes a negative effect on health (WHO, 2015).

Body Mass Index (BMI): Is an amount derived from the height and mass (weight) of a person. The most common used by (WHO) that published in 2000. To convert pounds per inch squared multiplied by 703(kg/m) (Ib/sq in), BMI is used kilograms of mass per meter squared of height. The BMI can provide many categories according the range of value in adult include: Value founder weight, Value for normal weight, value for being overweight and Value for obesity. There has been an increase in the

overweight rate in most world countries in 2016 (2 billion) were overweight (Alberca et al., 2020).

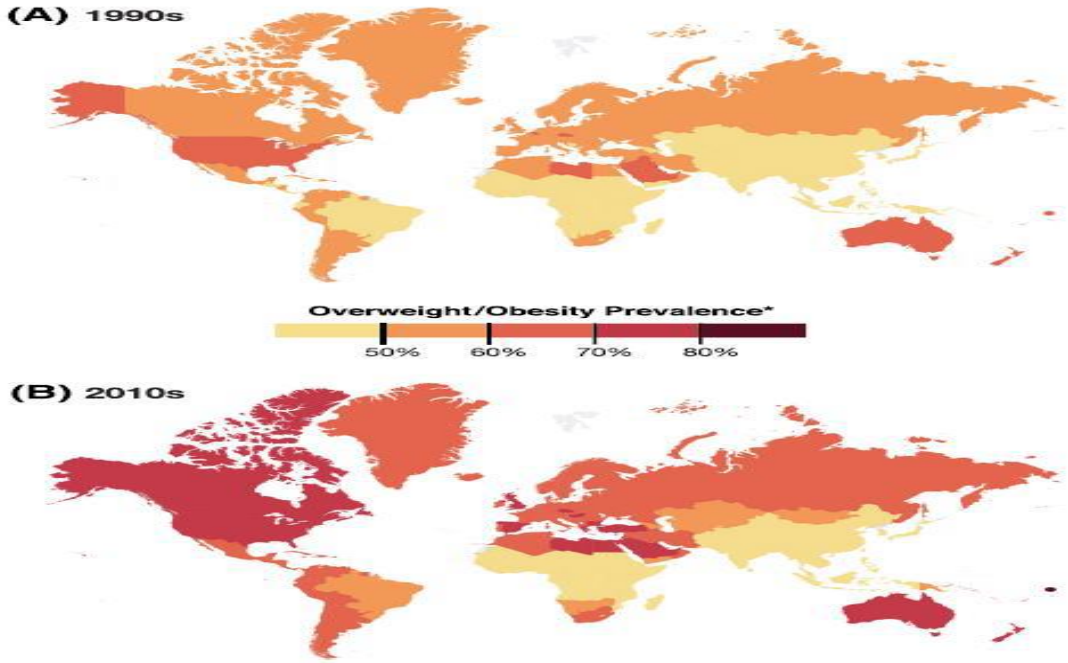

Fig 5: Prevalence of overweight and obesity based on 1990s and late2010s weight and height data (Popkin et al.,2020).

2.1.7. Obesity and Respiratory viruses:

Obesity is related to Respiratory viruses such as influenza, parainfluenza, coronavirus and rhinovirus (Van Kerkhove et al., 2011; Moser et al., 2019). Obesity has been found to be increased in both lower respiratory tract infection and upper respiratory tract infection .In 2009 with influenza pandemic observed the mortality rate was higher especially in those with severe obesity ($BMI>40kgm2$) (Rello et al., 2009; Fuhrman et al., 2011; Cocoros et al., 2014).

2.1.8. Relationship between obesity and Covid 19:

Obesity increases covid-19 symptoms, severity, and death (Gao et al., 2020). Obesity triples covid-19 risk (Petrakis et al., 2020). Any increase in BMI increased serious illness risk by 12%. Obesity increases the probability of hospitalisation and critical care (Lighter et al., 2020). Obesity was linked to a poorer illness outcome and mortality in 2009 2010 Influenza A (H1N1) infections (Tsatsanis et al., 2010).

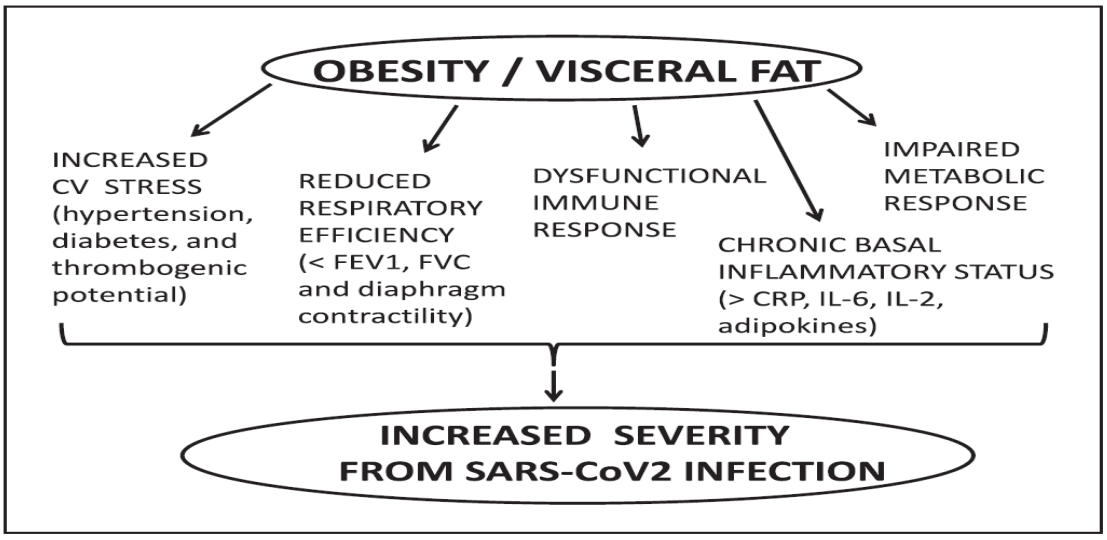

Fig 6: Relationship between Covid 19 and the obesity (Gammone and D'Orazio).

2.1.9. Gender and Older Age Differences in Patients with Covid19:
According to research, men die from Covid-19 at a far higher rate than women over the world, up to 50% more often. Biological differences and higher smoking rates are two reasons that may render males more vulnerable to serious illness (Gerdeman, 2020). Another reason for the increased risk, according to the current study, is that males don't take viruses as seriously as women do, and they don't wear masks or follow other healthy practices. This helps us understand not only who gets the disease, but also who spreads it more widely (Gerdeman, 2020). COVID-19 may infect youngsters. Middle-aged and elderly people are more susceptible. 85-year-olds have the greatest chance of getting serious symptoms (CDC, 2021). In the U.S., persons 65 and older account for 81% of illness deaths. Healthy elderly persons have increased risks (CDC, 2021).

2.1.10. Effect of Vitamin D on Obese Individual:
Something to remember is that cholesterols (vit.D3), a kind of vitamin D produced by the skin when exposed to sunshine, is a common connection between obesity and covid-19 (Coulston et al., 2013). Obese adults have reduced vitamin D levels, according to numerous studies (Savastano et al., 2017; Feghaly et al., 2020; Palaniswamy et al., 2020; de Oliveira et al., 2020). Obesity has been linked to a loss of immune competence, Helper T lymphocytes, cytotoxic lymphocytes, B lymphocytes, and natural killer cells all have decreased activity, as well as a decrease in antibody production (Frasca et al., 2017; Honce and Schultz-Cherry, 2019; O'Shea and Hogan, 2019) , and reduce antibody (Grant et al., 2020).

This means that, when compared to people of normal weight, obese people are more susceptible to bacterial, viral, and fungal illnesses, as well as having a poorer response to immunizations (Milner and Beck, 2012; Huttunen and Syrjanen, 2013; Dobner and Kaser, 2018; Frasca and Blomberg, 2020), and poorer response to vaccinations (Honce and Schultz-Cherry, 2019; Frasca and Blomberg, 2020; Carter et al., 2020). Obesity's impact on influenza infection and immunization against influenza has been widely researched. B lymphocytes, natural killer cells, cytotoxic lymphocytes, helper T lymphocytes, and all have decreased activity, and they recovered from sickness at a slower rate than healthy people (Honce and Schultz-Cherry, 2019). When covid-19 became pandemic in December 2019, a hospital treatment plan was devised that included ten medications, one of which being vitamin D (Alpert and Shaikh, 2007; Pereira-Santos et al., 2015).Methylprednisolone, Ascorbic, Thiamine, Heparin, Vitamin D, Atorvastatin, Melatonin, Zinc, famotidine and Therapeutic plasma (Sabetta et al.; 2010).

Materials & Methods

3. Materials

3.1. Electronic statistics:

Electronic statistics was made for the paper studying Covid-19 and obesity as a risk factor in patients, collected 384 papers of patients with covid-19 with different Ages and Gender in different spaces in Iraq in during October 2021.

This statistics have many indicators include:

1. Age
2. Gender
3. Weight
4. Height
5. Data of infection
6. Severity of infection
7. And any healthy complication

3.2. Weight & Height (BMI):

From weight & height we get body mass index according to this mathematical equation: METRIC UNITS (BMI =weight (Kg), *height* (m^2)),

IMPERIAL UNITS (BMI =weight [Ib]*height* 2[*in*]2 x703

In this research calculation was used to classified patients to:

☐ Underweight = 18.5

☐ Normal weight =18.5_24.9

☐ Pre obesity =25-29.3
Obesity from 30 to greater as
☐ Obesity I = 30-35
☐ Obesity II =35-40
☐ Obesity III=>40

3.3. Statics analytics:

Microsoft Excel 2020 and the Statistical Package for Social Sciences (SPSS) software program (version 25.0) were used to statistically analyze all of the study's findings. The statistical difference between groups was determined using two analyses of variance and the Chi-square test. To investigate the correlation between various factors, the person correlation coefficient was performed. P values under 0.05 were taken to signify statistical significance.

Results & Discussion:

4.1. Distribution of severity groups of Covid 19 according to weight

Covid-19 is a relatively new condition, and research on fat people is still rare. However, according to the research, Patients who are overweight or obese have a higher rate of being in a serious state and requiring hospital care (Alberca et al., 2020; Finer et al., 2020; CDC, 2021).

Table (4-1): Distribution of severity groups of patients with Covid 19 and according to weight

Characteristic c	Mild n = 187	Moderate n = 160	Severe n = 37	P
Weight				
Mean ±SD	67.72 ± 17.09	70.68 ± 15.04	79.24 ± 21.23	P= 0.001 † S
Range	12.00 - 162.00	40.00 – 141.00	50.00 – 141.00	

n: cases number; **SD**: standard deviation; **S**: significant

4.2. Distribution of severity groups of patients with Covid-19 according to obesity classification

When looking to Table (4-2), we can see the distribution of severity group of patient, the patient with Normal BMI is the higher percentage in all groups then overweight and obesity

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Table (4-2): Frequency distribution of severity groups of patients with Covid-19 and according to classification of obesity

Characteristic	Mild n = 187	Moderate n = 160	Severe n = 37	P
Classification of obesity				
Under weight , n(%)	8 (4.3%)	6 (4.3 %)	1 (2.7 %)	P = 0.001 ¥ S
Normal, n (%)	85 (45.5 %)	68 (42.2 %)	9 (24.3 %)	
Pre-Obesity (%)	70 (37.4%)	59 (36.6 %)	13 (35.1 %)	
Obesity I , n (%)	19 (10.2 %)	24 (14.9 %)	7 (18.9 %)	
Obesity II, n (%)	2 (1.1%)	1 (0.6 %)	2 (5.4 %)	
Obesity III, n (%)	3 (1.6 %)	2 (1.2 %)	5 (13.5 %)	

n: cases number; ¥: Chi-square test; **S**: significant

4.3. Distribution of patients with Covid-19 who need hospitalization according to classification of obesity

Our results showed that 38 patients require hospital care, with a percentage of overweight and obese people of more than half (57.9%). The results is similar to the finding of (AHA) Covid-19 heart disease, which found that classes I to III obesity were associated with higher risks of in-hospital death, with severe obesity (BMI>40kg/m2) linked with an increased death risk under 50 years old patients (Hendren et al., 2021).

Table (4-3): Frequency distribution of patients with Covid-19 who need to hospital and according toclassification of obesity

Characteristi	Under weight	Normal	Pre- Obesity	Obesity I	Obesity II	Obesity III	P
Classification of obesity							
Number	2	14	14	3	3	2	P = 0.001 ¥ S
(%)	(5.3%)	(36.8%)	(36.8%)	(7.9 %)	(7.9%)	(5.3%)	
Age							
Mean ± SD	35.00 ± 25.45	34.35 ± 21.28	29.14 ± 7.69	33.33 ± 10.4	32.33 ± 10.9	62.00 ± 2.82	P = 0.197 † NS
Range	17.00 - 53.00	18.00 –80.00	20.00 -46.00	25.00 –45.00	26.00–45.00	60.00 -64.00	
Weight							
Mean ± SD	47.00 ± 8.48	59.64 ± 7.04	70.7 ± 11.1	75.0 ± 18.02	83.3 ± 10.4	130.5 ± 14.8	P = 0.001 † S
Range	41.00 - 53.00	50.00 –70.00	50.0 -85.00	55.00 -90.00	75.00 -95.00	120.0-141.0	
Height							
Mean ± SD	167.7 ± 24.7	161.71 ± 8.08	160.0 ± 15.1	160.3± 2.5	162.6± 6.4	144.0 ± 48.0	P = 0.674 † NS
Range	150.0 - 185.00	152.0 –183.0	130.0-180.0	158.0 - 168.0	158.0-170.0	110.0-178.0	

n: cases number; **SD**: standard deviation; **S**: significant

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4. Distribution of severity groups of patients with Covid-19 according to demographic characteristics

When looking at age in Table (4-4), we can see a link between being over50 and being in a severe state. This finding is similar to a survey on 4103 patients with covid-19 illness in New Work City, which found that age > 65 years and obesity were more common clinical characteristics leading to hospitalization than diabetes, hypertension, or cardiovascular disease (Petrilliet al., 2020).

Table (4-4): Distribution of severity groups of patients with Covid-19 and according todemographic characteristics

Characteristic	Mild n = 187	Moderate n = 160	Severe n = 37	P
Age groups				
> 50, n (%)	178 (95.2%)	147 (91.9 %)	28 (75.7 %)	P = 0.001 ¥ S
≥ 50, n (%)	9 (4.8 %)	13 (8.1 %)	9 (24.3 %)	
Gender				
Male	53 (28.3%)	53 (33.1 %)	13 (35.1 %)	P = 0.535 ¥ NS
Female	134 (71.7 %)	107 (66.9 %)	24 (64.9 %)	
M:F ratio	1:2.52	1:2.01	1:1.84	

n: number of cases; ¥: Chi-square test; **S**: significant at P > 0.05

Infected females were 265(69) % and males were 119(31), on average. When focusing on each group separately, the proportion of female infection is twice in each group, which varies from previous studies outside of Iraq, such as a study in Latin America that indicated a larger male-to-female disease ratio (Undurraga et al., 2021).
In another study of 140 patients, 50.7% were men (Chen et al., 2020). A research in Kirkuk, Diyala, and Sulaminiyah found that women had less knowledge about covid-19 than men and are less equipped to fight them against the illness. Coronavirus affects women's income and livelihoods more than men's; 15-30% of interviewed women were economically active before the pandemic. Most couldn't stop the epidemic (Oxfam, 2020).

4.5. Distribution of hospitalized patients with Covid-19 according to vitamin D3 level and weight

The comparison of vitamin D3 levels between Covid-19 patients with different weight has been carried out and the results were demonstrated in table (4-5**).**

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Table (4-5): Frequency distribution of hosibitilized patients with Covid-19 according tovitamin D3 levels.

Characteristic	Under weight	Normal	Pre-Obesity	Obesity I	Obesity II	Obesity III	P
Vitamin D3							
Mean ± SD	66.30 ± 23.43	73.2 ± 33.23	43.20 ± 15.1	33.43± 12.3	13.6± 6.4	11.7 ± 3.2	P = 0.001 † S
Range	8.00 - 90.30	28.34 –95.34	20.38-85.40	9.80 – 67.00	8.00-39.50	8.00 - 25.00	

n: number of cases; **SD**: standard deviation; †: independent samples t-test; **S**: significant at P > 0.05

Normal weight Covid-19 patients had significantly greater vitamin D3 levels than underweight, pre-obese, obese I, obese II, and obese III patients (73.2 33.23 against 66.30 23.43, 43.20 15.1, 33.43 12.3, 13.6 6.4, and 11.7 3.2). (P 0.001). Adiposity lowers vitamin D3 levels. The COVID-19 pandemic has highlighted obesity as a risk factor for an acute infectious sickness that has killed over 3 million people and left more with long-term COVID. Overweight or obese people do badly with some infections, but the new COVID-19-obesity data, together with an increasing understanding of obesity's role in many chronic diseases, gives an opportunity to enhance obesity prevention and treatment. Multimorbidity risk factor obesity (Sattar and Valabhji., 2021). A BMI of 35 to 40 may increase a person's chance of dying from covid-19 by 40%, while a BMI above 40 may increase the risk by 90%. (2020)

Conclusions

This study concludes the relationship of obesity as a risk factor in covid-19 patients in Iraq .We found that there is:

1. A direct relationship between overweight or obesity with COVID-19.
2. An increase in incidence and severity, in addition to the affecter of people with obesity and covid-19 by other factors such as age and gender and level of vitamin D3.

References:

1. Alberca R.W.; Oliveira L.D.M.; Branco A.C.C.C.; Pereira N.Z. & Sato M.N. (2020). Obesity as a risk factor for COVID-19: an overview, Critical Reviews in Food Science and Nutrition, ISSN: 1040-8398; Pp. 1549-7852 https://www.tandfonline.com/loi/bfsn20.
2. Alpert P.T. and Shaikh U. (2007). "The effects of vitamin D deficiency and insufficiency on the endocrine and paracrine systems". Biological Research for Nursing. 9 (2): 117–29.

3. Anand K.; Karade S.; Sen S. and Gupta R. (2020). SARS-CoV-2: camazotz's curse. Medical Journal, Armed Forces India, 76, 136.
4. Aquino L.A. (2021). COVID-19 signs and symptoms. National, News, https://mb.com.ph/2021/03/16/covid-19-signs-and-symptoms/.
5. Boopathi S.; Poma A.B.; Kolandaivel P. (2020). Novel 2019 coronavirus structure, mechanism of action, antiviral drug promises and rule outagainst its treatment. Journal of Biomolecular Structure and Dynamics, 1-10.
6. Bosch BJ..; van der Zee R.; de Haan C.A. and Rottier P.J. (2003). The coronavirus spike protein is a class I virus fusion protein: structural and functional characterization of the fusion core complex. Journal.77:8801-11.
7. Carter S.J.; Baranauskas M.N.; Fly A.D. (2020). Considerations for obesity, vitamin D, and physical activity amidst the COVID-19 pandemic. Obesity. Published online April 16; 1-2, e22838. https://doi.org/10.1002/oby.22838.
8. Cassaniti I.; Novazzi F.; Giardina F.; Salinaro F.; Sachs M.; Perlini S.; Bruno R.; Mojoli F.; Baldanti F. (2020). Performance of VivaDiagCOVID-19 IgM/IgG Rapid Test is inadequate for diagnosis of COVID-19 in acute patients referring to emergency room department. Journal of medical virology.
9. CDC (2021). COVID-19 Risks and Vaccine Information for Older Adults. Older Adults Risks and Vaccine Information | cdc.
10. Chan J.F.W.; Kok K.H.; Zhu Z.; Chu H.; To K.K.-W.; Yuan S. & Yuen K.-Y. (2020). Genomic characterization of the 2019 novel human- pathogenic coronavirus isolated from a patient with atypical pneumonia after visiting Wuhan. Emerging microbes & infections, 9, 221-236.
11. Channappanavar R.; Zhao J.; Perlman S. (2014). T cell-mediated immuneresponse to respiratory coronaviruses. Journal 59:118-28.
12. Chen X.; Ling J.; Mo P.; Zhang Y.; Jiang Q.; Ma Z.; Cao Q.; Hu W.; ZouS.; Chen L.; Yao L.; Luo M.; Chen T.; Deng L.; Liang K.; SongS.; Yang R.; Zheng R.; Gao S.; Gui X.; Ke H.; Hou W.; Lundkvist Å.; Xiong Y. (2020). Restoration of leukomonocyte counts is associated with viral clearance in COVID-19 hospitalized patients. https://doi.org/10.1101/2020.03.03.20030437 .
13. Cocoros N.M.; Lash T.L.; DeMaria A. Jr.; Klompas M. (2014). Obesity as a risk factor for severe influenza-like illness. Influenza Other Respi Viruses.; 8(1):25-32.
14. Coulston A.M.; Boushey C.; Ferruzzi M. (2013). Nutrition in the Prevention and Treatment of Disease. Academic Press. ISBN: 9780123918840 p. 818.
15. Daniel S.J. (2020). Education and the COVID-19 pandemic. © UNESCO IBE2020. P.1-6.

16. de Oliveira L.F.; de Azevedo L.G.; da Mota S.J.; de Sales L.P.C.; Pereira-Santos M. (2020). Obesity and overweight decreases the effect of vitamin D supplementation in adults: systematic review and meta- analysis of randomized controlled trials. Rev Endocr Metab Disord.; 21(1):67-76. https://doi.org/10.1007/s11154-019-09527-7.
17. Dhuaif S.Q. (2021). TLR3 – 4 Gene Expression and Blood Biomarkers Associated with SARS-COV-2 Patients in Basrah, Southern-Iraq. Thesis Master, College of science in Basrah in Biology (Immunology). P. 1-203.
18. Dobner J. and Kaser S. (2018). Body mass index and the risk of infection - from underweight to obesity. Clinical Microbiology and Infection ; 24:24–8.
19. Drosten C.; Gunther S.; Preiser W.; van der Werf S.; Brodt H.R.; Becker S.; Rabenau H.; Panning M.; Kolesnikova L.; Fouchier R.A.M.; Berger A.; Burguière A.-M.; Cinatl J.; Eickmann M.; Escriou N.; Grywna K.; Kramme S.; Manuguerra J.-C.; Müller S.; Rickerts V.; Stürmer M.; Vieth S.; Klenk H.-D.; Osterhaus A.D.M.E.; Doerr H.W. (2003). Identification of a novel coronavirus in patients with severe acute respiratory syndrome. N Engl. J Med. 348:1967–76.
20. Feghaly J.; Johnson P.; Kalhan A. (2020). Vitamin D and obesity in adults: a pathophysiological and clinical update. Br J Hosp Med.; 81(1):1-5. https://doi.org/10.12968/hmed.2019.0291.
21. Finer N.; Garnett S.P.; Bruun J.M. (2020). COVID-19 and obesity. Clin Obes.; World Obesity Federation; 1–2.
22. Frasca D. and Blomberg B.B. (2020). The impact of obesity and metabolic syndrome on vaccination success. Interdiscip. Top. Gerontol. Geriatr; 43:86–97.
23. Frasca D.; Diaz A.; Romero M.; Blomberg B.B. (2017). Ageing and obesity similarly impair antibody responses. Clin Exp Immunol ; 187:64–70.
24. Fuhrman C.; Bonmarin I.; Bitar D.; Cardoso T.; Duport N.; Herida M.; Isnard H.; Guidet B.; Mimoz O.; Richard J.C.M.; Brun-Buisson C.; Brochard L.; Mailles A.; Paty A.C.; Saura C.; Lévy-Bruhl D. (2011). Adult intensive-care patients with 2009 pandemic influenza A (H1N1) infection. Epidemiol Infect.; 139:1202-1209.
25. Gammone M.A. and D'Orazio N. (2021). COVID-19 and Obesity: Overlapping of Two Pandemics. Obes Facts ; 14:579–585.
26. Gao F.; Zheng K.I.; Wang X.B.; Sun Q.-F.; Pan K.-H.; Wang T.-Y.; Chen Y.-P.; Targher G.; Byrne C.D.; George J.; Zheng M.-H. (2020). Obesity is a risk factor for greater COVID-19 severity. Diabetes Care. 43:e72–4. doi: 10.2337/dc20-0682.
27. Gerdeman D. (2020). The COVID Gender Gap: Why Fewer Women Are Dying. Harvard Business School (HBS) Working Knowledge.

https://hbswk.hbs.edu/item/the-covid-gender-gap-why-fewer- women-are-dying.

28. Grant W.B.; Lahore H.; McDonnell S.L.; Carole A. Baggerly C.A.; French C.B.; Aliano J.L.; Bhattoa H.P. (2020). Evidence that vitamin D supplementation could reduce risk of influenza and COVID-19 infections and deaths. Nutrients.; 12(4):988–1007. https://doi.org/10.3390/nu12040988.
29. Gu J.; Han B.; Wang J. (2020). COVID-19: gastrointestinal manifestations and potential fecal–oral transmission. Gastroenterology, 158, 1518- 1519.
30. Harrison A.G; Lin T.; Wang P. (2020). "Mechanisms of SARS-CoV-2 Transmission and Pathogenesis". Trends in Immunology. 41 (12): 1100-1115.
31. Hendren N.S.; de Lemos J.A.; Ayers C.; Das S.R.; Rao A.; Carter S.; Rosenblatt A.; Walchok J.; Omar W.; Khera R.; Hegde A.A.; Drazner M.H.; Neeland I.J.; Grodin J.L. (2021). 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.;143 :135–144.
32. Honce R. and Schultz-Cherry S. (2019). Impact of obesity on influenza A virus pathogenesis, immune response, and evolution. Front Immunol; 10:1071.
33. Huang C.; Wang Y.; Li X.; Ren L.; Zhao J.; Hu Y.; Zhang L.; Fan G.; Xu J.; Gu X.; Cheng Z.; Yu T.; Xia J.; Wei Y.; Wu W.; Xie X.; Yin W.; Li H.; Liu M.; Xiao Y.; Gao H.; Guo L.; Xie J.; Wang G.; Jiang R.; Gao Z.; Jin Q.; Wang J.; Ca B. (2020). Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. The lancet, 395, 497-506.
34. Huttunen R. and Syrjanen J. (2013). Obesity and the risk and outcome of infection. Int J Obes; 37:333–40.
35. Jin J.M; Bai P.; He W.; Wu F.; Liu X.F.; Han D.M.; Liu S.; and Yang J.K. (2020). Gender Differences in Patients With COVID-19: Focus on Severity and Mortality. Frontiers in Public Health , Vol. 8 , Article 152, p. 1-6. www.frontiersin.org.
36. Lai C.-C.; Wang C.Y.; Wang Y.-H.; Hsueh S.-C.; Ko W.-C.; Hsueh P.-R. (2020). Global epidemiology of coronavirus disease 2019: disease incidence, daily cumulative index, mortality, and their association with country healthcare resources and economic status. International journal of antimicrobial agents, 105946.
37. Letko M.; Marzi A.; Munster V. (2020). "Functional assessment of cell entry and receptor usage for SARS-CoV-2 and other lineage B betacoronaviruses". Nature Microbiology. 5 (4): 562–569.

38. Li G.; Fan Y.; Lai Y.; Han T.; Li Z.; Zhou P.; Pan P.; Wang W.; Hu D.; Liu X.; Zhang Q.; Wu J. (2020). Coronavirus infections and immune responses. J Med Virol.; 92:424–432.
39. Lighter J.; Phillips M.; Hochman S.; Johnson D.; Francois F.; Stachel A. (2020). Obesity in patients younger than 60 years is a risk factor for Covid-19 hospital admission. Clin Infect Dis.; 71(15):896-897.
40. Mahase E. (2020). Covid-19: England's obesity strategy will fail without tackling social factors, warn doctors. BMJ, 370:m2994.
41. Milner J.J. and Beck M.A. (2012). The impact of obesity on the immune response to infection. Proc Nutr Soc.; 71:298–306.
42. 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. (2019). Underweight, overweight, and obesity as independent risk factors for hospitalization in adults and children from influenza and other respiratory viruses. Influenza Other Respi Viruses.; 13(1):3-9.
43. O'Hearn M.; Liu J.; Cudhea F.; Micha R.; Mozaffarian D. (2021). Coronavirus Disease 2019 Hospitalizations Attributable to Cardiometabolic Conditions in the United States: A Comparative Risk Assessment Analysis. Journal of the American Heart Association; 10(5):e019259.
44. O'Shea D. and Hogan A.E. (2019). Dysregulation of natural killer cells in obesity.
45. Oxfam (2020). Gender Analysis of the COVID-19 Pandemic in Iraq. Oxfam Research Reports. P. 1-48. www.oxfam.org.
46. Page J.; Hinshaw D.; McKay B. (2021). "In Hunt for Covid-19 Origin, Patient Zero Points to Second Wuhan Market – The man with the first confirmed infection of the new coronavirus told the WHO teamthat his parents had shopped there". The Wall Street Journal.
47. Palaniswamy S.; Gill D.; De Silva N.M.; Lowry E.; Jokelainen J.; KarhuT.; Mutt S.J.; Dehghan A.; Sliz E.; Chasman D.I.; Timonen M.;Viinamäki H.; Keinänen-Kiukaanniemi S.; Hyppönen E.; HerzigK.-H.; Sebert S.; Järvelin M.-R. (2020). Could vitamin D reduce obesity-associated inflammation? Observational and Mendelian randomization study. Am J Clin Nutr.; 111(5):1036-1047. https://doi.org/10.1093/ajcn/nqaa056.
48. Pereira-Santos M.; Costa P.R.; Assis A.M.; Santos C.A.; Santos D.B. (2015). "Obesity and vitamin D deficiency: a systematic review andmeta-analysis". Obesity Reviews. 16 (4): 341–9.
49. Petrakis D.; Margină D.; Tsarouhas K.; Tekos F.; Stan M.; Nikitovic D.;Kouretas D.; Spandidos D.A.; Tsatsakis A. (2020). Obesity—a risk factor for increased

COVID-19 prevalence, severity and lethality(Review). Mol Med Rep. 22:9–19.
50. Petrilli C.M.; Jones S.A.; Yang J.; Rajagopalan H.; O'Donnell L.; Chernyak Y.; Tobin K.A.; Cerfolio R.J.; Francois F.; Horwitz L.I. (2020). Factors associated with hospitalization and critical illness among 4,103 patients with COVID-19 disease in New York.https://doi.org/10.1101/2020.04.08.20057794.
51. Popkin B.M.; Du S.; Green W.D.; Beck M.A.; Algaith T.; Herbst C.H.; Alsukait R.F.; Alluhidan M.; Alazemi N.; Shekar M. (2020). Individuals with obesity and COVID-19: A global perspective on the epidemiology and biological relationships. COVID-19/PUBLIC HEALTH. Obesity Reviews. P. 1-17.
52. Rello J.; Rodríguez A.; Ibañez P.; Socias L.; Cebrian J.; Marques A.; Guerrero J.; Ruiz-Santana S.; Marquez E.; Del Nogal-Saez F.; Alvarez-Lerma F.; Martínez S.; Ferrer M.; Avellanas M.; Granada R.; Maraví-Poma E.; Albert P.; Sierra R.; Vidaur L.; Ortiz P.; del Portillo I.P.; Galván B.; León-Gil C. (2009). Intensive care adult patients with severe respiratory failure caused by influenza A (H1N1)v in Spain. Crit Care.; 13(5):R148.
53. Rezabakhsh A., Ala A. and Khodaei S. H. (2020). Novel coronavirus (COVID-19): a new emerging pandemic threat. Journal of Research in Clinical Medicine, 8, 5-5.
54. Rothan H.A. and Byrareddy S.N. (2020). The epidemiology and pathogenesis of coronavirus disease (COVID-19) outbreak. Journal of autoimmunity, 102433.
55. Rychter A.M.; Zawada A.; Ratajczak A.E.; Dobrowolska A.; Krela- Kaźmierczak I. (2020). Should patients with obesity be more afraid of COVID-19.
56. Sabetta J.R.; De Petrillo P.; Cipriani R.J.; Joanne Smardin J.; Burns L.A.; Landry M.L. (2010). Serum 25-hydroxyvitamin D and the incidence of acute viral respiratory tract infections in healthy adults. PLoS One; 5:e11088.
57. Sattar N. and Valabhji J., (2021). Obesity as a Risk Factor for Sever COVID-19: Summary of the Best Evidence and Implications for Health Care. Current Obesity Reports. 10:282–289
58. Savastano S.; Barrea L.; Savanelli M.C.; Nappi F.; Di Somma C.; Orio F. & Colao A. (2017). Low vitamin D status and obesity: role of nutritionist. Rev Endocr Metab Disord. 2017;18(2):215-225. https://doi.org/10.1007/s11154-017-9410-7.
59. Seth S.; Batra J.; Srinivasan S. (2020). COVID-19: Targeting Proteases in Viral Invasion and Host Immune Response. Frontiers in Molecular Biosciences, Vol. (7): 215, P. 1-9. www.frontiersin.org.
60. Sheikhi K. and Shirzadfar H. (2020). A Review on Novel Coronavirus (Covid-19): Symptoms, Transmission and Diagnosis Tests. Research in Infectious Diseases and Tropical Medicine. Review Article; 2(1), 1-8.

61. Su S.; Wong G.; Shi W.; Liu J.; Lai A.C.K.; Zhou J.; Liu W.; Yuhai Bi Y.; Gao G.F. (2016). Epidemiology, genetic recombination, and pathogenesis of coronaviruses. Trends in microbiology, 24, 490-502.
62. Tsatsanis C.; Margioris A.N.; Kontoyiannis D.P. (2010). Association between H1N1 infection severity and obesity-adiponectin as a potential etiologic factor. J Infect Dis. 202:459–60.
63. Tyrrell D. and Bynoe M. (1965). Cultivation of a novel type of common- cold virus in organ cultures. British medical journal, 1, 1467.
64. Undurraga E.A.; Chowell G. and Mizumoto K. (2021). COVID-19 case fatality risk by age and gender in a high testing setting in Latin America: Chile, March–August 2020. Infect Dis Poverty; 10:11.
65. Van Kerkhove M.D.; Vandemaele K.A.H.; Shinde V.; Jaramillo- Gutierrez G.;Koukounari A.; Donnelly C.A.; Carlino L.O.; Owen R.; Paterson B.; Pelletier L.; Vachon J.; Gonzalez C.; Hongjie Y.; Zijian F.; Chuang S.K.; Au A.; Buda S.; Krause G.; Haas W.; Bonmarin I.; Taniguichi K.; Nakajima K.; Shobayashi T.; Takayama Y.; Sunagawa T.; Heraud J.M.; Orelle A.; Palacios E.; van der Sande M.A.B.; Wielders L.; Hunt D.; Cutter J.; Lee V.J.; Thomas J.; Santa-Olalla P.; Sierra-Moros M.J.; Hanshaoworakul W.; Ungchusak K.; Pebody R.; Jain S.; Mounts A.W. (2011). Risk factors for severe outcomes following 2009 influenza a (H1N1) infection: a global pooled analysis. PLOS Med.; 8(7):e1001053.
66. Verdecchia P.; Cavallini C.; Spanevello A.; Angeli F. (2020). "The pivotal link between ACE2 deficiency and SARS-CoV-2infection". European Journal of Internal Medicine. 76: 14–20.
67. Verity R.; Okell L.C.; Dorigatti I.; Winskill P.; Whittaker C.; Imai N.; Cuomo-Dannenburg G.; Thompson H.; Walker P.G.T.; Fu H.; Dighe A.; Griffin J.T; Baguelin M.; Bhatia S.; Boonyasiri A.; Cori A.; Cucunub Z.; John R.F.; Gaythorpe K.; Green W.; Hamlet A.; Hinsley W.; Laydon D.; Nedjati-Gilani G.; Riley S.; van Elsland S.; Volz E.; Wang H.; Wang Y., Xi X.; Donnelly C.A.; Ghani A.C.; Ferguson N.M. (2020). Estimates of the severityof coronavirus disease 2019: a model-based analysis. PublishedOnline , Lancet Infect Dis ; 20: 669–77.
68. Wang CC, Prather KA, Sznitman J, Jimenez JL, Lakdawala SS, TufekciZ, Marr LC (2021). "Airborne transmission of respiratory viruses". Science. 373 (6558). Bibcode: 2021 Sci...373 W. doi:10.1126/science.abd9149. PMID 34446582.
69. WHO (2015). "Obesity and overweight Fact sheet N°311".
70. Zaki A.M.; van Boheemen S.; Bestebroer T.M.; Osterhaus A.D.; Fouchier R.A. (2012). Isolation of a novel coronavirus from a man with pneumonia in Saudi Arabia. N Engl. J Med. 367:1814–20.

71. Zhu N.; Zhang D.; Wang W.; Li X.; Yang B.; Song J.; Zhao X.; Huang B.; Shi W.; Lu R.; Niu P.; Zhan F.; Ma X.; Wang D.; Xu W.; WuG.; Gao G.F.; Wenjie Tan W. (2020). A novel coronavirus from patients with pneumonia in China, 2019. New England journal of medicine.