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Prognosis of survival among older adults with COVID-19: A systematic review and meta-analysis

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***Abstract*---**Older adults hospitalized due to COVID-19 infection are at high risk of fatality. Additional fatalities such as obesity and comorbidity tend to rapidly develop into progressive clinical deterioration. Therefore, a complex survival prognosis is urgently needed to save more older adults. This study aims to systematically examine obesity and comorbidity as a prognosis of survival in older adults with COVID-19. A Systematic review was conducted using five databases; CINAHL; EMBASE; MEDLINE; PubMed, and Web of Science. Selected papers were published between 2019 and 2020 based on a computerized search. Three reviewers reviewed the quality of the included studies using the JBI (Joanna Briggs Institute) tool for cohort study. The data were compiled using the random-effect models while heterogeneity between studies was assessed using the Cochran Q and I^2 statistics. A total of 40,154 data were retrieved from 8 included studies, older adults ranging from 65 to 74-year-olds, with basal metabolism index (BMI) 30-35 kg/m^2, diabetes mellitus, hypertension, chronic kidney disease (CKD), and malignancy. Predictors of survival in older adults with COVID-19 include comorbidity (61.3%), obesity (7.1%), mortality (17.3%), female (6.0%), and male (8.3%). Obesity, diabetes, hypertension, CKD, and malignancy play significant roles in the prognosis of survival among older adults with COVID-19.

Keywords: Obesity, older adult, COVID-19, comorbidity, mortality.

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***Keywords*---**3-10 keywords separated by commas.

Introduction

The novel coronavirus is a recently discovered infectious disease. The first case of COVID-19 was reported to the World Health Organization (WHO) by Chinese authorities on December 31, 2019, as a report about a patient who suffered pneumonia in the city of Wuhan, Hubei province. After a rapid spread in China, new outbreaks occurred in northern Italy and in several European countries, followed by an accelerated spread to many countries in the world.

The current coronavirus disease-2019 (Richardson et al.) pandemic presents a huge challenge for health-care systems worldwide. The development of severe acute respiratory syndrome is seen more often in elderly patients with COVID-19 and with underlying chronic diseases or malignancies. Globally, the older age and obese population are more vulnerable to most of the non-communicable diseases. China and Italy reported older adults are at higher risk in being infected with COVID-19 and if they were infected, they have a higher risk of death (Petretto & Pili, 2020). The Italian National Institute of Health reported people 60 years old and over were about 96.5% of the total number of deaths due to COVID-19, while in China they were about 80.8% of the total number of death (Onder et al., 2020). Accordingly, various different risk factors are associated with COVID-19 severity, such as diabetes, hypertension, and most recently obesity were reported (Alberca et al., 2020). Concerning to obesity and its contribution to the severity, another study underlined that obesity has been considered to be a major risk factor for becoming seriously ill with COVID-19 (Ryan et al., 2020).

World Health Organization (2020) has been predicted the number of older adult age 60-year-old and up will increase to 1.4 billion by 2030 and 2.1 billion by 2050. This increase is occurring while COVID-19 as the global pandemic is spreading (WHO, 2020). This pandemic may take a significant precedented pace influencing the above prediction Considering to the WHO (2020), older adult aged 60-year-old and above was then defined as the targeted population of this study. Regarding obesity, World Health Organization (WHO) (2015) defined obesity as abnormal or excessive fat accumulation that presents a risk to health. It is characterized by a marked increase in the adipose tissue in the body and is defined by the Body Mass Index (BMI; the weight in kilograms divided by the square of the height in meters). Although it is not the most representative indicator of body composition, it is nevertheless the most widely used. According

to the World Health Organization (WHO), for adults, overweight is defined as BMI between 25–30 kg/m2 and obesity as BMI > 30 kg/m2.

Obesity is a chronic, multifactorial disease linked to multiple chronic conditions (Wilson, 2020). It is characterized by low-grade, systemic, chronic inflammation, and increased production and release of pro-inflammatory, atherogenic cytokines and oxidative stress (Alberca et al., 2020; Muscogiuri et al., 2020). Therefore, it is associated with several complications, including insulin resistance, dyslipidemia, hypertension, endothelial dysfunction, diabetes mellitus type 2, early onset atherosclerotic cardiovascular disease, hypogonadism, orthopedic problems, fatty liver disease, cholecystitis, social stigmatization, and increased incidence of malignancies (Malavazos et al., 2020; Wilson, 2020). Simonnet et al., (2020) reinforced a high prevalence of admissions (47.6%) in ICUs, pointing to obesity as an independent risk factor, and directly connected to worse outcomes by the coronavirus disease (Simonnet et al., 2020).

It is an urgent demand to protect older adults, respect, and support them in this complex global Pandemic COVID-19 situation. In view of the necessity to save as many lives as possible, the present review sought to analyze obesity and comorbidity as a prognosis of survival among older adults with COVID-19.

Methods

This systematic review-meta analysis study according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analysis) guideline (Moher et al., 2009). This study has registered in the International Prospective Register of Systematic Review (PROSPERO): CRD42020211035.

Search strategy

The following five academic databases; CINAHL, EMBASE, MEDLINE, PubMed, and Web of Science were accessed for published studies starting from 2019 to 2020 with help of a health science librarian. MeSH terms were used to find similar words that support the PICOS method by using the abstract/keyword for each database: “older adults” OR “older people” OR “elderly” OR “seniors” OR “aged people” AND “COVID 19” OR “coronavirus disease 2019” OR “sars-cov-2” OR “Cov-19 novel coronavirus 2019” OR “2019 n-cov” AND “Mortality” OR “death” OR “deceased”.

Eligibility criteria

To determine the inclusion criteria, the PICOS method (Population, Intervention/issue of interest, Comparison, Outcome, and Study design) was used (Liberati et al., 2009). Following were our eligibility criteria: (1) Include patients with COVID-19 over 65 years of age; (2) Computed clinical outcomes including survival; (3) Cohort studies d) Published in English language. The exclusion was made to only studies conducted within the last two years that were published in the English language. Studies that were not within the scope of the criteria of PICOS, did not give the full text, yield an insignificant result for this study, and the included participants were excluded. Each of the authors was involved in

determining the inclusion and exclusion criteria. The differences in the opinions were discussed and decided on a joint conclusion in this study.

Data extraction

Three authors (IS, IDS, and ISS) performed a comprehensive abstraction of key data points including's authors/year, design, country, a sample size of gender, comorbidities, obesity, and total death of participants infected with COVID-19.

Quality assessment

Initially, a study design assessment of selected studies through a methodological quality assessment scale to minimize the risk of bias was initiated (Ma et al., 2020). For each reviewed source, the Joana Briggs Institute (JBI) for cohort study to assess the level of evidence present; and the 12-items JBI Critical Appraisal Checklist for cohort studies updated and released in 2020 was applied, to assess the methodological quality with the grade systems were high, moderate, low, and very low (Buccheri & Sharifi, 2017; Morgan et al., 2016)

Statistical analysis

The heterogeneity of each variable in the study pooled estimate indicated by I^2 with random effects; the proportions of I^2 were 25% indicated low heterogeneity, 50% indicated moderate heterogeneity, and >75% indicated high heterogeneity (Huedo-Medina et al., 2006). Meta-analyses were conducted using Review Manager (RevMan) 5.3 software.Results

Study selection

The initial search retrieved 106 articles. Using EndNote software, 54 were removed because they were duplicates. Hence, a total of 52 publications in title and abstract was screening which further 36 were deemed ineligible as they did not meet the inclusion and exclusion criteria. a total of 18 full-text sources were screened against the inclusion/exclusion criteria. A total of 5 were removed because their participants were not older adults, 2 studies was removed because the study did not provide appropriate information as this review need, 2 studies were removed because they did not open access, 1 study removed because this study was report study, and 1 study removed because this study was not using English language. While we assessed the full articles, 1 study was found through screening references. Finally, 8 sources were included for quantitative synthesis. The selection of sources is presented in Figure 1 through a PRISMA flow diagram.

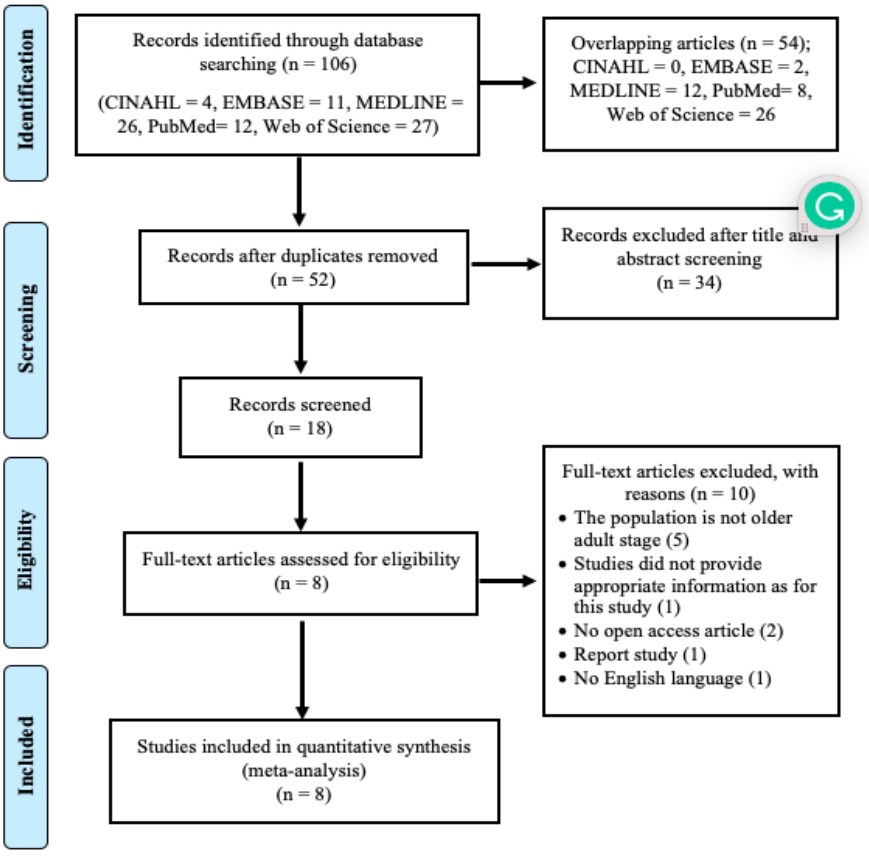

Figure 1: PRISMA Diagram – the process of study selection

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *Preferred Reporting Items for Systematic Reviews and Meta-Analyses:* The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097
For more information, visit **www.prisma-statement.org.**

Studies characteristics

The characteristics of the included reviews are presented in Table 1. The JBI (Joanna Briggs Institute) tool for the cohort study being used to analyze 8 articles in this study. Based on the methodological quality assessment of 8 articles assessed with 12 questions following the instructions of Tool JBI (Joanna Briggs Institute). Results from the methodological quality assessment were 11 points (Table 1).

Table 1 Demography characteristic of the study participants

Study	Joanna Briggs Institute (JBI) Score	Design Country	Characteristics		Basal Metabolism Index (BMI)		
					Normal weight (BMI < 25)	Obese (BMI: 30 to < 35)	Total
1 (Anderson et al., 2020)	11	Retrospective Study USA	Gender	Male	322	247	569
				Female	220	197	417
			Comorbidities	Chronic obstructive pulmonary disease	95	81	176
				Hypertension	305	251	556
				Chronic kidney disease	137	86	223
				Diabetes	226	214	440
				Cancer	100	52	152
				Pulmonary heart disease	43	31	74
			Mortality		90	55	145
2 (Busetto et al., 2020)	11	Retrospective Study Mexico	Gender	Male	17	21	38
				Female	15	17	32
			Comorbidities	Diabetes	9	11	20
				Hypertension	18	20	38
				Cardiovascular diseases	10	10	20
				Respiratory chronic diseases	2	9	11
				Renal chronic diseases	4	0	4
				Liver chronic diseases	1	1	2
				Inflammatory chronic diseases	3	0	3
				Cancer	6	4	10
				Dementia	14	3	17
			Mortality		10	2	12
3 (Nakeshbandi et	11	Retrospective Study USA	Gender	Male	84	95	179
				Female	55	120	175

al., 2020)			Age	≥65	96	105	201
			Comorbidities	Diabetes	72	112	184
				Hypertension	102	187	289
				Hyperlipidemia	38	81	119
				Coronary Artery Disease	30	27	57
				Chronic obstructive pulmonary disease	7	25	32
				Asthma	4	25	29
				Chronic kidney disease	21	32	53
				End stage renal disease.	18	23	41
				Acute kidney injury	31	33	64
				Acute cardiac injury	40	71	111
			Mortality		51	87	138
4 (Pettit et al., 2020)	11	Retrospective Study USA	Gender	Male	21	31	52
				Female	22	32	54
			Comorbidities	Hypertension	20	34	54
				Diabetes	7	26	33
				Pulmonary Disease	9	9	18
				Cardiovascular Disease	12	8	20
				Kidney Disease	7	3	10
				Cancer	11	4	15
				Human immunodeficiency virus	2	0	2
				Stroke	8	1	9
				Hyperlipidemia	3	1	4
				Venous thromboembolism	3	0	3
			Mortality		3	5	8
5 (Carrillo-Vega, Salinas-Escudero, García-Peña, Gutiérrez-Robledo, & Parra-Rodríguez, 2020)	11	Cohort study Mexico	Gender	Male	2286	264	2550
				Female	1537	219	1756
			Comorbidities	Hypertension	1372	271	1643
				Diabetes	1148	161	1309
				Cardiovascular Disease	197	56	253
				Chronic Kidney Disease	135	23	158
				Chronic obstructive pulmonary disease	156	75	231
				Asthma	101	12	113
				Pneumonia	1581	268	1849

			BMI	Obesity	864	74	938
			Mortality		573	135	708
6 (Halvatsiotis et al., 2020)	11	Retrospective Study Greece	Gender	Male	8		8
				Female	37		37
			Comorbidities	Chronic obstructive pulmonary disease	6		6
				Cancer	6		6
				Chronic Kidney disease	3		3
				Cardiovascular	16		16
				Diabetes	11		11
				Hypertension	27		27
				Asthma	1		1
			BMI	Obesity	8		8
			Mortality		11		11
7 (Palmieri et al., 2020)	11	Cohort study Italy	Comorbidities	Ischemic heart disease	814		814
				Atrial fibrillation	663		663
				Heart failure	459		459
				Stroke	294		294
				Hypertension	1883		1883
				Type 2 diabetes	808		808
				Dementia	468		468
				Chronic obstructive pulmonary disease	457		457
				Active cancer	424		424
				Chronic liver disease	96		96
				Chronic renal failure	576		576
				Dialysis	46		46
				Human immunodeficiency virus	2		2
				Autoimmune diseases	100		100
			BMI	Obesity	227		227
			Mortality		2664		2664
8 (Wortham et al., 2020)	11	Retrospective Study USA	Comorbidities	Cardiovascular disease	1565	1773	3338
				Diabetes mellitus	1107	1098	2205
				Chronic kidney disease	530	627	1157
				End-stage renal disease	100	70	170
				Chronic lung disease	504	574	1078

		Neurologic conditions	259	350	609
		Immunosuppression	441	445	886
		Chronic liver conditions	67	50	117
	BMI	Obesity	182	103	285
	Mortality		1884	1515	3399

A various method was applied in 14 studies, 5 was descriptive studies and the rest of 8 was cross-sectional studies. Reviewed sources were conducted in Greece (1 study), Italy (1 study), Mexico (2 studies), and United States of America (4 study). A total of 40154 data from 8 selected studies was analyzed in this review. We found the proportion of the predictor survival in older adults as following: comorbidities (61.3%), obesity (7.1%), mortality (17.3%), female (6%), and male (8.3%). The proportion of mortality predictors is presented in Figure 2.

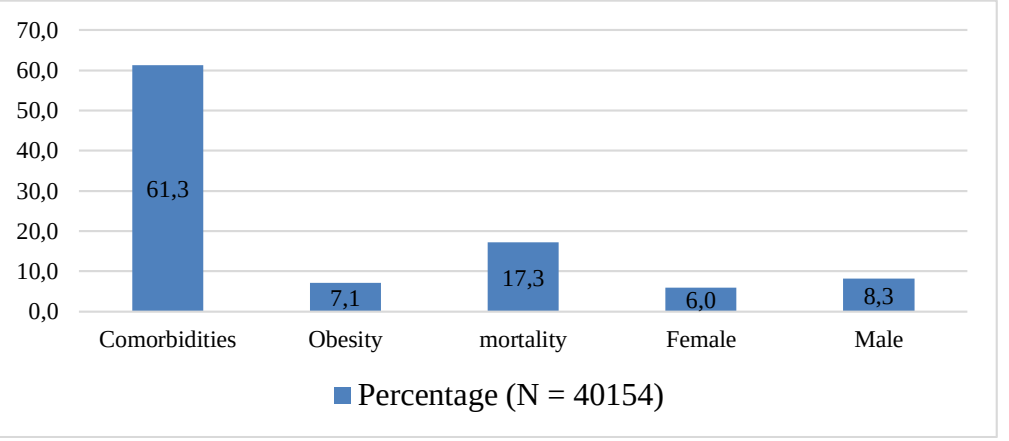

Figure 2 Predictors of survival in older adults with Covid-19

Subgroup and Data Synthesis

A total of 8 studies reported on predictors of survival in older adults with COVID-19 (Table 2). A subgroup of analysis and data synthesis was undertaken to answer the aim of this study: determining obesity and comorbidity as a prognosis of survival among older people with covid-19. Subgroups of older adults with normal weight and obesity, and the following major comorbidities: Diabetes, Hypertension, Chronic Kidney Disease (CKD), Cancer, Cardiovascular disease (CVD), and Chronic obstructive pulmonary disease (COPD) were identified, and those comorbidities were generated with a concerned to the fatality of elderly with COVID-19 (Kundi et al., 2019; Perrotta et al., 2020). Comprehensive results of the **m**eta-analysis of survival among older adults with COVID-19 (Table 2) and statistical tests of data synthesis were figured out of the 16 sub-groups: (1) normal body weight in male participants, (2) obesity in male participants, (3) normal body weight in female participants, (4) obesity in female participants, (5) normal body weight and Diabetes, (8) obesity and Diabetes, (9) normal body weight and Hypertension, (10) obesity and Hypertension, (11) normal body weight and CKD, (12) obesity and CKD, (13) Normal body weight and CVD, (14) obesity and CVD, (15) obesity and COPD, (16) obesity and CKD. Among those with normal weight (BMI < 25) and obesity (BMI: 30 to < 35) , female has a significant factor of mortality than a male.

Table 2 Meta-analysis of survival among older adults with COVID-19

Subgroups			OR	LOW CI	UP CI	Z-Score	P-value	I-Square	Tau^	Q	P-value
	Predictors										
Body weight in gender and mortality as the predictors of mortality among older adults with COVID-19	Normal weight (BMI < 25)	Male	0.88	0.46	1.67	0.39	0.69	68%	0.24	9.29	0.03
		Female	0.63	0.32	1.25	1.32	0.19	53%	0.23	6.34	0.10
	Obese (BMI: 30 to < 35)	Male	1.14	0.60	2.16	0.39	0.69	68%	0.24	9.29	0.03
		Female	1.43	1.04	1.96	2.20	0.03	8%	0.01	3.25	0.35
Body weight and comorbidity as the predictors of mortality among older adults with COVID-19	Normal weight (BMI < 25)	Diabetes	0.69	0.40	1.19	1.34	0.18	54%	0.14	6.52	0.09
	Obese (BMI: 30 to < 35)		1.45	0.84	2.49	1.34	0.18	54%	0.14	6.52	0.09
	Normal weight (BMI < 25)	Hypertension	0.78	0.55	1.11	1.39	0.16	22%	0.03	3.87	0.28
	Obese (BMI: 30 to < 35)		1.28	0.90	1.83	1.39	0.16	22%	0.03	3.87	0.28
	Normal weight (BMI < 25)	CKD	1.07	0.75	1.52	0.38	0.71	0%	0.00	2.03	0.57
	Obese (BMI: 30 to < 35)		0.94	0.66	1.33	0.38	0.71	0%	0.00	2.03	0.57
	Normal weight (BMI < 25)	Cancer	1.21	0.40	3.63	0.34	0.74	49%	0.50	3.95	0.14
	Obese (BMI: 30 to < 35)		0.83	0.28	2.48	0.34	0.74	49%	0.50	3.95	0.14
Obesity and comorbidity as the predictors of mortality among older adults with COVID-19	≥ Obese (BMI: 30 to < 35)	Diabetes	1.45	0.84	2.49	1.34	0.18	54%	0.14	6.52	0.09
		CVD	0.40	0.24	0.65	3.66	0.0003	79%	0.10	4.77	0.03
		COPD	0.30	0.11	0.82	2.34	0.02	95%	0.51	19.93	<.00001
		CKD	0.48	0.38	0.61	6.02	<.00001	0%	0.00	0.03	0.86

A comparison of two groups; normal weight (BMI < 25) and obese (BMI: 30 to < 35), obese older adults infected COVID 19 with Diabetes and Hypertension have a greater factor for mortality than normal weight (BMI < 25). The pooled estimated of obese older adults infected COVID-19 suffered diabetes was 1.33 (95%CI 1-1.76) with moderate inconsistency of effects (Q = 6.52; Tau^2 = 0.14; I^2 = 54%; p = 0.09) and the test for overall effect: Z = 1.98 (p = 0.05) and pooled estimated of obese older adults infected COVID-19 suffered hypertension was 1.28 (95%CI 0.98-1.67) with low inconsistency of effects (Q = 3.87; Tau^2 = 0.03; I^2 = 22%; p = 0.28) and the test for overall effect: Z = 1.8 (p = 0.07).

By repeating the analysis, the predictors for mortality in CKD and cancer were examined. Normal weight (BMI < 25) has a greater factor for mortality than obese older adults infected COVID-19 suffered CKD or cancer. The pooled estimated of older adults infected COVID-19 suffered CKD with normal weight (BMI < 25) was 1.07(95%CI 0.75-1.52) with no inconsistency of effects (Q = 2.03; Tau^2 = 0; I^2 = 0%; p = 0.57) and the test for overall effect: Z = 0.38 (p = 0.71) and pooled estimated of older adults infected COVID-19 suffered cancer with normal weight (BMI < 25) was 1.21 (95%CI 0.4-3.63) with moderate inconsistency of effects (Q = 0.5; Tau^2 = 3.95; I^2 = 49%; p = 0.74) and the test for overall effect: Z = 0.34 (p = 0.74).

Older adults infected COVID 19 with ≥65-74 years old, obese, and suffering disease(s) are significant factor for mortality. Further, in meta-analysis of four comorbidities: Diabetes, CVD, COPD, and CKD as predictors of mortality, Diabetes has become one of the most risk factor of mortality in older adults with COVID-19 with obesity. The pooled estimated of diabetes was 0.59 (95%CI 0.49-0.71) with no inconsistency of effects (Q = 0; Tau^2 = 0.12; I^2 = 0%; p = 0.73) and the test for overall effect: Z = 5.44 (p <.00001). After repeating the same analysis, CVD was found as the second significant factor for mortality in obese older adults infected COVID-19 . The pooled estimated was 0.4 (95%CI 0.24-0.65) with high inconsistency of effects (Q = 0.1; Tau^2 = 4.77; I^2 = 79%; p = 0.03) and the test for overall effect: Z = 3.66 (p = 0.0003).

Discussion

This current study is the first analysis investigating obesity and comorbidity as a prognosis of survival among older adults with COVID-19. Due to the global pandemic COVID-19, elder people were on the higher level of vulnerability. Comorbidity was recognized as determinant of a rapid-progressive clinical deterioration (Perrotta et al., 2020). Among patients infected by COVID-19, elder might represent the final event leading to death. As a result, elderly clearly represents a specific group of high-risk patients for developing COVID-19. This current study reports that obesity plays a role in the burden of comorbidities and increasing mortality risk in older adults with COVID-19.

Comorbidities that are associated with more severe outcomes from COVID-19 in the US, include Diabetes, Obesity, Hypertension, CVD, CKD, and COPD (Hirsch et al., 2020; Wortham, 2020). Previous study reported Diabetes, Obesity, and Hypertension are the top three conditions associated with fatal COVID-19 cases in China and Italy (Guan et al., 2020; Onder et al., 2020). Thus, most part of the

previous cohort study series reported COVID-19 concerns in older-adult patients was undertaken in China (Chen et al., 2020; Lian et al., 2020; Xu et al., 2020). Nevertheless, the current study was halved taken in the US and none from China. As a result, the findings fill the gap body of knowledge that was little known about elder people with obesity and suffered COVID-19.

In the Public data set of COVID-19 in China, the percentage of older age (age ≥65 years) was much higher in the deceased patients than in the patients who survived (83.8% in 37 deceased patients vs. 13.2% in 1,019 patients who survived) (Chen et al., 2020; Lian et al., 2020; Xu et al., 2020). This mirrors report in Italia, where more elderly (age ≥65 years old) were suffered from COVID-19 (Palmieri et al., 2020). These shreds of evidence are a matter of concern that older age is a determinant of morbidity and mortality. All participants in this study; older adults (age 65-year-old and above) infected with COVID-19, with BMI 30 to < 35 kg/m^2, presented with a number of pre-existing conditions. They suffered from three or more pre-existing diseases; diabetes mellitus, hypertension, CKD, and malignancy. As a result, they were more likely to have a severe COVID-19 or even die. The predictors of survival among older adults aged 65 to 74-year old infected with COVID-19 are as follow; female (6%), male (8.3%), obesity (7.1%), mortality (17.3%), and comorbidities (61.3%).

To date, there was emerging evidence related to COVID-19 reported that more males than females dying (Alamdari et al., 2020). This gender difference might be potentially due to sex-based immunological or sex related to gendered differences, such as a common pattern in society, males less to be active in household activities. Concerning sex as a determinant in the prognosis of COVID-19 and the clinical classification of morbidity, the prognosis of survival among those older obese-older adults, infected with COVID-19 and admitted to hospital, reported males were a slightly higher (2.3%) than in females. Sex is associated with patients infected with COVID-19 shows equal numbers of cases between males and females for the most part. It seems that sex differences play as a predictor of severity and mortality of the disease. Nevertheless, eight included studies reported on predictors of survival in older adults with COVID-19 with obesity, a female has a greater risk factor of mortality than a male.

In addition, among older adults with normal body weight and obesity, comorbid diseases as follows; Diabetes, Hypertension, CKD, Cancer, CVD, and COPD as predictor were found as a general finding of the mortality's risk factor. A comparison was made to determine the predictor of mortality among sub group of older adults with normal body weight, obesity with Diabetes, Hypertension, CKD, Cancer, CVD, and COPD. Among older adults with COVID-19, normal body weight, obesity, and CVD were found to be the predictor of mortality. The finding underlines that normal body weight among those with CVD and infected by COVID-19 did not decrease the risk of mortality.

Obesity and following comorbidity; Diabetes, CVD, COPD, and CKD were the predictors of mortality among older adults with COVID-19. As a result, obesity then placed to increase the fatality of older adults infected by COVID-19 with those four comorbidities. Concerning comorbidity, earlier reports on COVID-19 have placed patients infected with COVID-19 with one and more comorbidities for

poor health outcomes, high-risk of severity, and mortality (Alamdari et al., 2020; Harrison et al., 2020; Wortham, 2020). In this current study of older adults with obesity and infected with COVID-19 with the following comorbidities; Diabetes, CKD, CVD, and COPD have a greater factor for mortality than any other comorbidity. Nevertheless, those findings should be interpreted in light of potential limitations. No data reported for sub group of older adults with normal body weight with COPD, thus potentially limiting the generalizability of the results. This study was focused on Published-English articles; therefore, some relevant studies might be missing out.

Conclusion and recommendation

This study further highlights the need to provide special attention to older adults with obesity, comorbidity, and multi-morbidity. Hospitalized female, older adults aged 65 years old and above, obese with one or more pre-existing disease(s); diabetes and or CVD were a poor prognosis of survival. The existence of those predictors of survival placed this vulnerable cluster more likely to die with further complications as common fatalities found in patients with COVID-19. Given the multidimensional relationship of age, gender, multimorbidity, and its impact on biological reserves. This finding suggests that health care provider needs to combine appropriate management of pre-existing conditions with strategies to prevent and mitigate the effects of non-respiratory complications. This approach may reduce COVID-19 case fatality and save older adult's lives. Further studies should provide a comprehensive assessment of mechanisms underlying poor outcomes among older adults with COVID-19.

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