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Costs of the COVID-19 pandemic associated with obesity in Europe: A health-care cost model

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Summary

Excess weight is associated with severe outcomes of coronavirus disease 2019 (COVID-19). We aimed to estimate the total secondary care costs by body mass index (BMI, kg/m^2) category when hospitalized due to COVID-19 in Europe during the first wave of the pandemic from January to June 2020. Building a health-care cost model, this study aimed to estimate the total costs of COVID-19. Information on risk of hospitalization, admission to intensive care unit (ICU) and risk of ventilation were based on published data. Average cost per patient and in total were calculated based on risks of admission to ICU, risk of invasive mechanical ventilation and length of hospital stay when hospitalized and published costs associated with hospitalization. The total direct costs of secondary care during the first wave of COVID-19 in Europe were estimated at EUR 13.9 billon, whereof 76% accounted for treating people with overweight and obesity. The average cost per hospital admission increased with BMI, from EUR 15831 for BMI <25 kg/m^2 to EUR 30982 for BMI ≥40 kg/m^2. This study reveals that excess weight contributes disproportionally to the costs of COVID-19. This might reflect that overweight and obesity caused the COVID-19 pandemic to result in more severe outcomes for citizens and higher secondary care costs throughout Europe.

KEYWORDS
COVID-19, health economics, obesity, pandemic, SARS-CoV-2

1 | INTRODUCTION

The burden of coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS CoV-2), increased continuously during the first 6 months of 2020, referred to as the first wave of the COVID-19 pandemic. As of June 30, 2020, more than 2.4 million people in Europe had been tested and reported positive with the virus, and COVID-19 led to more than 190 000 deaths in this region, with presumably many more unconfirmed cases.[1,2]

Throughout Europe, the prevalence of obesity (defined as having a body mass index, or BMI, at or above 30 kg/m^2) in the adult population has risen during the past decade.[3] According to the World Obesity Federation, 58% of people over the age of 15 in Europe were overweight (corresponding to a BMI at or greater than 25 kg/m^2 for adults) and 21% had obesity in 2018.[4] These numbers are expected to increase further unless significant interventions are taken.[5]

Recent studies from Europe, the United States and China have identified obesity as an independent risk factor for the most severe outcomes of COVID-19, including death.[6-14] A nationwide Danish

study[6] of 11 122 individuals with a positive polymerase chain reaction test for SARS-CoV-2 found hospitalization rates of 20% among all patients and 29% among patients with overweight or obesity. A US study by Petrilli et al[10] that looked at 5279 people with COVID-19 found that an individual's risk of hospitalization increased with higher BMI. Furthermore, a French study by Simonnet et al[7] of 124 COVID-19 patients admitted to the intensive care unit (ICU) indicated that the risk of invasive mechanical ventilation (IMV) increased with higher BMI, and that the age- and sex-adjusted odds ratio (OR) for IMV in hospitalized patients with BMI >35 kg/m^2 was 7.36 (1.63-33.14) compared with hospitalized patients with BMI <25 kg/m^2.

Although the underlying mechanisms of the increased risk of severe outcomes of COVID-19 among people with overweight and obesity are poorly understood, potential mechanisms have been hypothesised. Among these, it has been proposed that insulin resistance, and not fat mass, is the link between obesity and severe COVID-19 outcomes. Another explanation is that low circulating levels of adiponectin predispose to aggressive pulmonary inflammation.[15] However, no hypotheses have yet been confirmed.

Because people with obesity experience more severe outcomes due to COVID-19, the purpose of this study was to investigate the total treatment cost per patient with overweight or obesity when hospitalized due to COVID-19 in European countries.

2 | MATERIALS AND METHODS

This study applied a healthcare cost model to estimate the total direct costs to secondary care of COVID-19 in the first 6 months of 2020 in Europe, defined as the EU 27, the European Free Trade Association (Iceland, Norway, Switzerland and Lichtenstein) and the United Kingdom. Total direct costs of secondary care in Europe were defined as publicly funded hospital service usage within the healthcare system, including hospital admissions, admissions to ICU and support by IMV during ICU stays (henceforth known as ICU + IMV). Primary care costs, that is, visits to a general practitioner or an associated healthcare professional with associated treatments, and indirect costs, for example, lost productivity during illness, were not included in the analysis.

The healthcare cost model applied in this study is based on a parallel methodology as a healthcare cost model estimating the direct costs of secondary care according to diabetes categories. The manuscript for this article is currently in press.[16]

2.1 | Data sources

As the number of people testing positive for COVID-19 throughout Europe depended heavily on the testing strategy applied in each country, we used modelled country-specific data on number of hospitalizations from January 1, 2020 to June 30, 2020 as a starting point for the healthcare cost model.[17]

To obtain knowledge on the severe disease course of COVID-19 among people with overweight and obesity to be used in the healthcare cost model, a rapid literature review was performed. We searched PubMed up until July 1, 2020 using the key terms "COVID-19" *or* "coronavirus infection" *or* "SARS-CoV-2" *and* "obesity" and identified relevant studies published from January 1, 2020 to June 30, 2020 estimating risks of severe outcomes associated with COVID-19 among people with overweight and obesity. Specifically, studies estimating risk of general hospitalization, risk of admission to ICU, risk of admission to ICU + IMV regarding COVID-19 and length of hospital stay among people with overweight and obesity were of interest.

The literature was screened using predefined inclusion criteria. Initially, the literature search identified 334 articles published in the specified date range. European or US publications estimating severe outcomes of COVID-19 written in English were included (Figure 1). In total, 19 of the 334 publications were selected for potential full-text review. Articles that did not estimate outcomes of interest or were not peer-reviewed were excluded, leaving 15 publications included in the review.

2.2 | Input to the healthcare cost model

Estimates of risk of general hospitalization for COVID-19 among five BMI categories (<25, 25-29.9, 30-34.9, 35-39.9 and ≥ 40 kg/m^2) were based on Danish, UK and US publications.[6,10,18] Because only the US study by Petrilli et al[10] and the UK study by Hamer et al[18] reported results by BMI category, these were chosen for use in the model. However, the Danish data were found to be consistent with the US and UK data.

Estimates of risk of ICU admission or critical illness among people with obesity were based on Danish data from Reilev et al[6] and US data from Petrilli et al,[10] while estimates of risk of admission to ICU + IMV among hospitalized COVID-19 patients with obesity were based on French data from Simonnet et al.[7] Estimates of the number of bed days in hospital, ICU and ICU + IMV were based on data from Italy reported by Moriconi et al[19] and data from Spain provided by Abajo et al.[20] Moriconi et al estimated that obesity significantly prolonged the hospital stay of patients with COVID-19. Specifically, people with obesity who were admitted to the hospital had an average hospital stay of 21 days, while people with BMI <30 kg/m^2 required 13 days' hospital stay.[19]

An overview of the inputs to the economic model is presented in Table 1. Where estimates were presented as OR in the literature, we recalculated these as risk ratios (RR) by RR = OR/([1-prevalence in reference group] + [prevalence in reference group*OR]), in order to estimate the prevalence of the three outcomes within BMI categories.[21] To minimize confounding risk, we preferred estimates already adjusted for sex and age, when available. If adjusted estimates were not identified, unadjusted estimates were used.

2.3 | Unit costs

Estimates of costs of general hospitalization, admission to ICU and admission to ICU + IMV were based on publicly available costs from Denmark, France, Spain and the United Kingdom.[22-28] We assumed that unit costs are evenly distributed within the examined population.

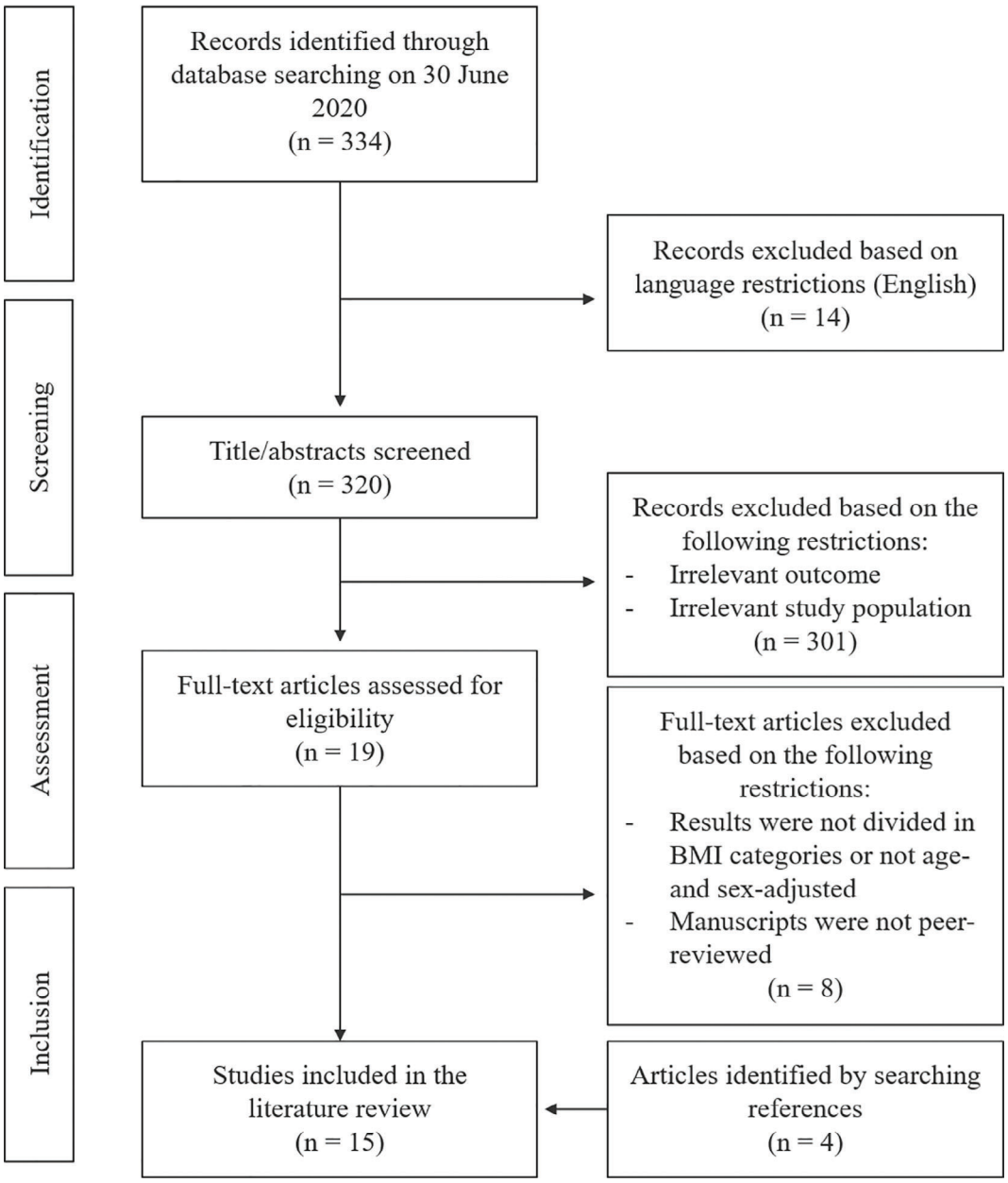

FIGURE 1 Flow chart for the rapid literature search

All results are presented in euros (EUR) (2020 price level). Cost estimates were converted to EUR using exchange rates (as of June 18, 2020) of 1.11 for GBP and 0.13 for DKK. Subsequently, costs for the remaining 28 European countries were estimated using a relative cost index derived from Eurostat (the statistical office of the European Union).[29]

2.4 | Economic model

The elements and methodology of the economic model are presented in Figure 2.

The left-hand side of the model (a–i) presents inputs obtained from the literature that are used to compute the estimates and results that are presented on the right-hand side (Figure 2). We applied the following information per BMI category to our model: number of COVID-19 patients admitted to the hospital per country (a); risk of general hospitalization with COVID-19 (b); distribution of the total population per country (c); admission rates to the ICU and ICU + IMV (h); and average number of hospital bed days in general hospital, ICU and ICU + IMV (i). Additional inputs were the country-specific costs for Denmark, France, Spain and the United Kingdom (d, e) and the relative price level for each country (f). The average 2020 costs (g) were estimated as the weighted average cost for Denmark, France, Spain and the United Kingdom. Each country's share of total admitted patients was used as weight, to get as close as possible to the real cost.

TABLE 1 Characteristics of the population hospitalized due to COVID-19 according to BMI category

	BMI <25	BMI 25–29.9	BMI 30-34.9	BMI 35-39.9	BMI ≥40	Total
BMI distribution among the European population	42%	37%	14%	5%	2%	100%
Risk of hospitalization (RR), 95%CI[a]	1.00	1.41 (1.16–1.70)	2.28 (1.88–2.77)	2.28 (1.88–2.77)	2.28 (1.88–2.77)	
BMI distribution among hospitalized COVID-19 patients[b]	29%	36%	24%	8%	3%	100%
Total number of people hospitalized in Europe (N), 1 January-30 June 2020[c]	211 407	259 764	174 278	54 673	20 424	720 547

Note: Numbers have been rounded. BMI distribution in the European population was based on data from the World Obesity Federation.[4] RRs were calculated based on data from Petrilli et al,[10] Reilev et al[6] and Hamer et al.[18]
Abbreviations: BMI, body mass index; RR, risk ratio.
[a](b) in Figure 2.
[b](c) in Figure 2.
[c](j) in Figure 2.

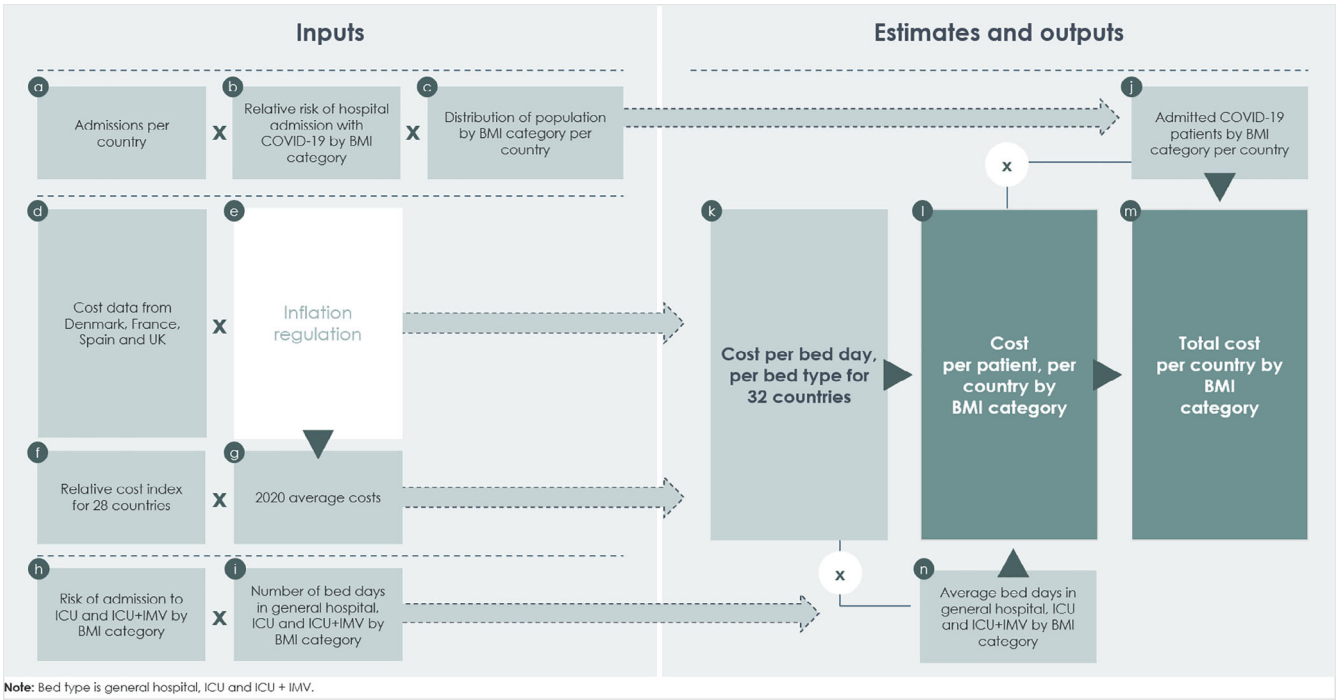

FIGURE 2 Economic model outline

The right-hand side of the model (specifically l and m) represents the central output of the economic model. The cost inputs (d-g) were used to estimate the cost per bed day per bed type for all 32 countries (l). The inputs for Denmark, France, Spain and the UK were used directly, while the costs for the remaining countries were estimated as the average cost multiplied by their cost index calculated on the basis of data from Eurostat[29] (g).

The risk of admission (h) and the number of bed days (i) were used to estimate the average length of stay for general hospital, ICU and ICU + IMV across five BMI categories (n). The possible costs and consequences of reaching hospital capacity limits are not considered in the model. The cost per patient, per country by BMI category (l) was estimated by multiplying the cost per day (k) and the average length of stay (n). The estimated number of admitted COVID-19 patients across countries and BMI categories (j) was estimated by multiplying per-country admissions (a), relative risk of admission per BMI category (b) and distribution of population by BMI category (c). All risk ratios for hospitalization, admission to ICU and ICU + IMV are presented as relative risks compared with BMI <25 kg/m^2. The distribution of admitted COVID-19 patients was therefore standardized; this ensured that the estimated patients reflected the total number of admissions.

The total cost per BMI category (m) was estimated for each country by multiplying the cost per patient, per country per BMI category (l) and the estimated number of patients in each country and BMI category (j). Adding the country-specific costs across BMI groups gives the total estimated secondary care costs of COVID-19 in Europe.

3 | RESULTS

3.1 | Admissions and type of treatment

In Europe, more than 720 547 people were admitted to hospital for COVID-19 between 1 January 2020 and 30 June 2020.[17] Table 1 summarizes the BMI distribution of the European population, the increased risk of hospitalizations according to BMI category, and the resulting BMI distribution among patients hospitalized and number of people admitted to hospital in Europe in the BMI categories. Information on risk of hospitalization regarding COVID-19 were obtained from Hamer et al[18] estimating sex- and age-adjusted RRs of 1.41 (1.16-1.70) among people with BMI 25-29.9 kg/m^2 and 2.28 (1.88-2.77) among people with BMI ≥30 kg/m^2 compared with people with BMI <25 kg/m^2. The results from Petrilli et al[10] supported those findings. Based on the overrepresentation of people with overweight and obesity admitted to hospital due to COVID-19 and the BMI distribution in the total population,[4,18] our model suggests that 71% of all patients admitted to the hospital with COVID-19 had overweight (BMI at or above 25 kg/m^2) and 35% had obesity (BMI at or above 30 kg/m^2).

In addition to having a higher probability of being admitted to a general hospital with COVID-19, those with obesity also have a higher probability of being admitted to ICU and ICU + IMV compared with people with BMI <25 kg/m^2. Table 2 indicates the percentage of people admitted to a general hospital for COVID-19 who were also treated in ICU and ICU + IMV in each of the five BMI categories. Data on admission to ICU were obtained from Petrilli et al[10] estimating that people with BMI of 30 to 39.9 kg/m^2 and people with BMI ≥40 kg/m^2 had increased age- and sex-adjusted ORs of 1.11 (0.85-1.5) and 1.71 (1.10-2.7) compared with people with BMI <25 kg/m^2, respectively. Data on risk of IMV while in ICU were obtained from Simonnet et al[7] estimating increased age- and sex-adjusted ORs of 1.69 (0.52-5.48), 3.45 (0.83-14.31) and 7.36 (1.63-33.14) among people with BMI 25-30 kg/m^2, 30-35 kg/m^2 and at or above 35 kg/m^2 compared with BMI <25 kg/m^2, respectively. Thus, among people admitted to ICU and who had a BMI ≥35 kg/m^2, 86% were treated with IMV.

3.2 | Cost per bed type

The average costs of a hospital bed day (ie, 24 hours) for a general hospital admission, an ICU admission and an ICU + IMV admission are EUR 883, EUR 1925 and EUR 3183, respectively. All country-specific costs are presented in Supplementary Table 1.

3.3 | Cost per average hospital admission according to BMI category

Because the risk of admission to ICU and ICU + IMV increases alongside BMI, and because ICU admission and ICU admission including ventilator support are more expensive than a general hospital admission, the estimated average cost per hospital admission due to COVID-19 also increases alongside BMI (Table 3). The cost of an average admission varied among the four reference countries and was most expensive in Denmark. All country-specific costs are presented in Supplementary Table 2.

Hence, the average hospital costs of treating a person with BMI ≥40 kg/m^2 are twice as high than the hospital costs of treating a person with BMI <25 kg/m^2 due to increased risk of severe outcomes of COVID-19 (30 982/15831 = 1.96).

3.4 | Total direct costs of secondary care

We estimated the total direct costs of secondary care of COVID-19 in Europe to be EUR 13.9 billion (Table 4). The total direct costs of secondary care of COVID-19 associated with overweight or obesity (BMI ≥25 kg/m^2) were estimated at EUR 10.5 billion. Thus, costs related to treating people with COVID-19 and overweight or obesity account for 76% of the total costs.

The costs of severe COVID-19 outcomes among people with obesity (BMI ≥30 kg/m^2) were estimated at EUR 6.1 billion. Thus,

TABLE 2 Percentage of all patients admitted to general hospital for COVID-19 requiring treatment in ICU or ICU + IMV, by BMI category

	BMI <25	BMI 25–29.9	BMI 30-34.9	BMI 35–39.9	BMI ≥40
Admission to ICU among hospitalizations[a]	13.9%	13.9%	15.4%	15.4%	23.7%
Treatment in ICU including IMV among hospitalizations[a]	6.6%	8.4%	11.6%	13.2%	20.3%

Note: Estimates from the literature were converted to shares within each BMI category. The risk of admission to ICU among hospitalisations for BMI ≥30 was calculated based on adjusted RRs for BMI 30-39.9 and BMI ≥40 from Petrilli et al.[10] and the risk of ICU for BMI <25 from Reilev et al.[6] No increased risk of ICU for BMI 20-29.9 was found. Risks of treatment in ICU, including IMV, were calculated based on the crude IMV rates for the BMI categories from Simonnet et al.[7] Sources: Petrilli et al.,[10] Simonnet et al.[7] and Reilev et al.[6]

Abbreviations: ICU, intensive care unit; BMI, body mass index; IMV, invasive mechanical ventilation; RRs, risk ratio.

[a](h) in Figure 2. The rate of admission to ICU was obtained from Reilev et al.[6] for BMI <25.

TABLE 3 Modelled cost (EUR) per average hospital admission by BMI category per patient, per country

	BMI <25	BMI 25-29.9	BMI 30-34.9	BMI 35-39.9	BMI ≥40
Denmark	17 806	19 604	26 740	28 344	37 669
France	13 301	14 228	19 968	20 795	25 606
Spain	15 831	17 104	23 918	25 054	31 434
United Kingdom	17 162	18 441	25 765	26 906	33 538
Average (weighted)	15 831	17 021	23 809	24 871	30 982

Note: The differences in costs among BMI categories were calculated based on increased risk of admission to ICU and ICU + IMV among people with obesity. (l) in Figure 2.
Abbreviations: ICU, intensive care unit; BMI, body mass index; IMV, invasive mechanical ventilation.

TABLE 4 Total direct costs of secondary care of COVID-19 in Europe, by BMI category and type of admission (million EUR)

							Overweight		Obesity	
	BMI <25	BMI 25–29.9	BMI 30–34.9	BMI 35–39.9	BMI ≥40	Total	Total BMI ≥25	% BMI ≥25	Total BMI ≥30	% BMI ≥30
Total direct costs of secondary care[a]	**3379**	**4397**	**4117**	**1366**	**650**	**13 908**	10 529	76%	6133	44%
Total costs of general hospitalization	1905	2300	2309	733	280	7527	5621	75%	3322	44%
Total costs of ICU admissions	577	699	519	165	97	2057	1481	72%	782	38%
Total costs of ICU + IMV admissions	897	1399	1289	467	273	4325	3427	79%	2029	47%

Note: Numbers have been rounded.
Abbreviations: ICU, intensive care unit; BMI, body mass index; IMV, invasive mechanical ventilation.
[a](m) in Figure 2.

costs related to obesity accounted for 44% of the total direct costs of secondary care.

In comparison, the estimated prevalence of overweight including obesity in Europe is 58%, and the prevalence of obesity in Europe is estimated at 21%. The country-specific total direct costs of secondary care are presented in Supplementary Table 3.

3.5 | Alternative scenarios

If there was no additional risk of hospitalization, ICU and ICU + IMV for people with overweight and obesity, the estimated total direct costs of secondary care related to COVID-19 in Europe would have been EUR 11.4 billion, that is, EUR 2.5 billion lower than the main scenario. This is equal to a 18% reduction of total costs of COVID-19 in Europe.

4 | DISCUSSION

In this study, we found that overweight and obesity is associated with excess costs in relation to COVID-19 in Europe. Of the total costs of COVID-19 in Europe, 44% were related to treating people with obesity even though they constitute only 21% of the general population in Europe. The cost drivers for the excess costs for people with obesity are (a) a higher probability of being hospitalized due to COVID-19, (b) a higher risk of severe outcomes and (c) a prolonged stay when hospitalized.

To our knowledge, this is the first study to estimate the total direct costs of secondary care of COVID-19 associated with overweight and obesity in Europe. The lack of knowledge on costs of COVID-19 is in line with previous studies, which found that there is generally little evidence on the cost of infectious diseases.[30,31] Because COVID-19 is a novel disease, the knowledge regarding the disease is limited and the long-term effects are unknown. The results presented here were based on the best available evidence and knowledge for selected European countries. The inputs and the application of these estimates to other European countries should be interpreted with caution. While it is a limitation that the study used data from a limited number of countries with different healthcare systems instead of observational data from all countries, this was chosen due to lack of data availability and reliability in many countries. We used data from countries with available cost of inpatient care for public hospitals representing healthcare models for Europe.

Previous studies have shown that people with obesity have an increased risk of admissions to general hospital or ICU, have an increased need for ventilator support, and have increased mortality due to influenza.[32] However, to our knowledge, it has not been

established that people with obesity have a significantly increased risk of contracting influenza, even considering social and economic determinants that could influence both the risk of infection and having obesity. Studies of COVID-19 and obesity have indicated the same correlation: people with obesity are at higher risk of becoming critically ill compared with people with BMI <25 kg/m^2, but to our knowledge, no studies have indicated that people with obesity have either a higher or lower risk of developing COVID-19. The magnitude of any such increased or decreased risk is hence unknown and not considered in this study. Thus, since this factor was not taken into account, the cost driver of the study was increased risk of severe outcomes of COVID-19, that is, risk of hospitalization, risk of admission to ICU and risk of ventilator support while in ICU.

In a UK study by Holman et al,[33] an increased risk of mortality due to COVID-19 was found among people with BMI <20 kg/m^2. However, to our knowledge, the risk of severe outcomes, for example, hospitalization and admission to ICU, due to COVID-19 among people with underweight (BMI <18.5 kg/m^2) has not been investigated. However, it can be hypothesised that people with BMI below 18.5 kg/m^2, like people with overweight and obesity, have an increased risk of severe outcomes due to COVID-19. In this study, people with underweight were included in the reference group (ie, BMI <25 kg/m^2), without a distinction between people with underweight and those with normal weight. If being underweight is associated with increased risk of severe outcomes of COVID-19, the relative risk between people with normal weight and those in overweight or obesity groups will have been underestimated.

We included direct costs of secondary care of COVID-19 in this study. However, the total costs of COVID-19 in Europe in the first 6 months of 2020 will be even higher, given that we included neither primary-sector costs and indirect costs (ie, loss of productivity during illness) nor outpatient costs during the recovery phase. In addition, because no information was available regarding the treatment costs of COVID-19 specifically, the fact that the costs of treating a person with overweight or (especially) obesity might be higher per bed day compared with the costs of treating a person with BMI <25 kg/m^2 (due to the need for larger equipment and possibly even additional staff) was not considered. Furthermore, the costs used in the healthcare cost model were based on admissions to general hospital or ICU in existing units. However, hospitals are creating special COVID-19 units or transforming other beds to ICU beds with requirements that could be associated with a higher cost level; examples include private isolation rooms; multiple-occupancy rooms with at least two meters (social distancing) between beds, as well as physical barriers for separation; negative pressure rooms; and rooms with more staff present or on hold.[34] All of these factors could increase the costs of hospital admission due to COVID-19.

On the other hand, a recent study from France suggested that people with obesity in general, independent of COVID-19, visit emergency departments more often than do people with BMI <25 kg/m^2,[35] potentially due to the risk of comorbidities associated with obesity. This could be part of the explanation for the higher hospitalization rate among COVID-19 patients with obesity and consequently the higher costs associated with obesity in COVID-19 patients. The World Health Organization has estimated that hospitalisations of people with obesity are in general associated with higher costs compared with hospitalisations of people with BMI <25 kg/m^2.[36]

Because the focus of this study was on direct costs of secondary care, the risk of a fatal outcome associated with COVID-19 was not included in the economic model. However, a number of studies have estimated the mortality risk of COVID-19 associated with obesity, and most studies found a higher risk of dying among COVID-19 patients with obesity as compared with those with BMI <25 kg/m^2.[6,11,37,38] Naturally, increased mortality among people with both obesity and COVID-19 influences the total costs of COVID-19.

The COVID-19 pandemic was far from over in the first half of 2020,, and several epidemiologists suggested a second wave of infections.[39] A second wave was seen during the autumn of 2020, with infections and deaths increasing throughout Europe once again.[1] With this in mind, knowledge about risk factors and economic consequences of COVID-19 becomes even more important. Our study reveals that overweight and obesity contribute disproportionally to the costs of COVID-19. Both the economic costs and the number of people dying from COVID-19 would be lower if overweight and obesity rates were lower across all European countries. Overweight and obesity[40] appears to have caused the COVID-19 pandemic to hit both citizens and secondary care systems in Europe to a high extent.

CONFLICTS OF INTEREST

Sebastien Czernichow declares honoraria from Novo Nordisk, Lilly France, Janssen-Cilag, Fresenius Kabi and Servier in the last 36 months. He owns a share of MyGoodLife. No funding was received for work associated with this manuscript. Stephen C. Bain declares honoraria, teaching and research sponsorship/grants from AstraZeneca, Boehringer Ingelheim, Eli Lilly & Co, GlaxoSmithKline, Merck Sharp & Dohme, Novo Nordisk, Roche, Sanofi-Aventis; funding for development of educational programs from Cardiff University & Medscape. He owns a share of Glycosmedia and has provided expert advice to the All-Wales Medicines Strategy Group and National Institute for Health and Care Excellence (NICE) UK. No funding was received for work associated with this manuscript. Matthew Capehorn declares research funding in the past from Novo Nordisk, Novartis, Janssen, Boehringer, Eli Lilly & Co, Glaxo Smith Kline, Abbott, Syneos, Weightwatchers, Cambridge Weight plan and Lighterlife as well as honoraria or travel/accommodation expenses to attend Advisory Boards or Conferences or speaker meetings from Novo Nordisk, the BI/Lilly Alliance, and Lighterlife. No funding was received for work associated with this manuscript. Mette Bøgelund, Maria Elmegaard Madsen, Cecilie Yssing and Annabell Cajus McMillan are employees at Incentive Denmark ApS, which is a paid vendor of Novo Nordisk A/S. Ulrik Haagen Panton and Ana-Paula Cancino are employees at Novo Nordisk A/S.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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