Journal of Public Health
https://doi.org/10.1007/s10389-024-02203-4

ORIGINAL ARTICLE

Do sociodemographic factors play a role in the relation between COVID-19 infection and obesity? Findings from a cross-sectional study in eastern Oslo

Margarida Pereira[1,2]

Received: 30 August 2023 / Accepted: 28 January 2024

Abstract

Aim This study aims to assess the odds of having COVID-19 according to an individual's weight status and to identify the sociodemographic factors associated with having COVID-19 in a sample of individuals residing in the eastern districts of Oslo.

Subject and methods This is a cross-sectional study that uses primary survey data collected in six districts of Oslo in June 2021. Chi-square tests are used to test associations between sociodemographic variables and individuals with healthy weight vs overweight/obesity and those who reported having COVID-19 or not. Logistic regression models were computed to identify the sociodemographic factors associated with having COVID-19 (sex, age, educational level, income, employment status, district of residence and having been born in Norway) using body mass index and dichotomic and continuous variable.

Results The percentage of COVID-19 cases was higher in individuals with overweight/obesity (5.9%) than in individuals with healthy weight (5.0%). Being a woman, with overweight/obesity, from a younger age group, unemployed and not having been born in Norway, increases the odds of having COVID-19.

Conclusion More research on the relevance of sociodemographic factors in the association between weight status and COVID-19, together with biological aspects, is needed, to allow the identification and protection of groups at greater risk of infection.

Keywords COVID-19 · Obesity · Migrant · Women

Introduction

The prevalence of overweight/obesity has been increasing since the 1970s in individuals of all ages and from all regions of the world. In 2000, the World Health Organization acknowledged obesity as an epidemic (WHO 2000), and projections predict that the prevalence of overweight/obesity will continue to increase globally (Bjornelv et al. 2021). Currently, in Norway, the approximate proportion of the population with overweight alone is 50% and with obesity is over 23%, and these numbers are predicted to rise (Bjornelv et al. 2021). Increasing overweight/obesity is a major public health concern because excess weight is associated with several diseases, namely diabetes, heart diseases, hypertension (WHO 2000) as well as several types of cancers (Hill et al. 2021; Safiri et al. 2022). Furthermore, overweight/obesity decreases quality of life and life expectancy, and it represents a burden for health services budgets and for societies overall (Bjornelv et al. 2021; Tremmel et al. 2017; WHO 2000).

Only two months after COVID-19 was declared a pandemic, it was observed that having overweight/obesity increased the odds for severer disease from SARS-Cov-2 infection (Hill et al. 2021; Tamara and Tahapary 2020). These findings were not surprising, as obesity increases susceptibility to infections by weakening the immune system (Foo et al. 2021; Tamara and Tahapary 2020). In fact, obesity has been linked to severe outcomes of other infectious diseases before, such as seasonal influenza and influenza A (H1N1), for example (Foo et al. 2021; Hill et al. 2021).

Studies using ecological data show that obesity prevalence is an independent predictor for COVID-19 mortality and severity, but researchers argue that the mechanisms

✉ Margarida Pereira
mmiguel06@gmail.com

[1] Centre for Research On Pandemics & Society, Oslo Metropolitan University, Oslo, Norway

[2] Research Unit on Governance, Competitiveness, and Public Policies (GOVCOPP), University of Aveiro, Aveiro, Portugal

Published online: 12 February 2024

underlying such association are driven not only by biological processes, but also by social and environmental aspects (Foo et al. 2021). In other words, global variations of infection, mortality and severity of COVID-19 might be partially explained by overweight/obesity prevalence together with socioeconomic factors.

In general, the social dimension of infectious diseases tends to be neglected, particularly when designing response plans, even though there is vast evidence of the relevance of social inequality in past pandemics (Mamelund 2017). Mamelund and Dimka (2021) highlighted several reasons that might have led to the misconception that everyone is equally susceptible to infectious diseases, such as higher concerns with non-communicable diseases in the western world or the wrong perception that highly lethal infectious disease outbreaks occur mostly in low-income countries (Mamelund and Dimka 2021). Regardless of country, socially vulnerable individuals are more affected by infectious diseases, (Mamelund et al. 2021) and COVID-19 is no exemption, with individuals of low socioeconomic status, as well as those from more deprived areas, more prone to infection (Burstrom and Tao 2020; Kathe and Wani 2021; Li et al. 2021; Li et al. 2021). Sociodemographic factors, such as socioeconomic status, level of education or cultural aspects (WHO 2000), also determine overweight/obesity prevalence (Hill et al. 2021; Pereira et al. 2019). Globally, there is a higher prevalence of obesity among the most disadvantaged persons in high-income countries and the more advantaged individuals from low- or middle-income countries (Halpern et al. 2021).

In Norway, rates of COVID-19 were higher in immigrants, particularly those living in more deprived areas (Indseth et al. 2021; Kjollesdal et al. 2022), among whom a high prevalence of overweight/obesity is also observed (Ahmed et al. 2018). Similar trends were found in the USA, specifically in Native Americans and Mexican/Hispanic descents (Hill et al. 2021), as well as in non-White populations of São Paulo (Brazil) (Li et al. 2021). The combination of overweight/obesity and higher susceptibility to COVID-19 in minority communities fit the definition of a syndemic (Foo et al. 2021; Hill et al. 2021). Therefore, research on the interaction between weight status and COVID-19 should not only focus on the biological dimension but also explore the role that the demographic, social and economic factors play. The same is to say that studying the obesity and COVID-19 syndemic is enhanced when using a multidisciplinary perspective (Hill et al. 2021).

Contributions to reduce inequalities in health overall require an in-depth investigation of the social determinants of health and the overall living conditions of the poorest groups (Li et al. 2021). However, in the case of obesity and COVID-19 syndemic, little is known about the risk of infection by the new coronavirus according to specific sociodemographic factors in individuals with excess weight or obesity (Dalton et al. 2021; Foo et al. 2021). Therefore, this study hypothesizes that such factors are synergetically linked with the two health outcomes (Cabrera-Mendoza et al. 2021) and aims to assess the odds of having COVID-19 according to an individual's weight status and to identify the sociodemographic factors associated with having COVID-19, drawing on a survey sample of individuals that reside in the eastern districts of Oslo.

Methods

Study design, setting and data collection

This is a cross-sectional study that uses primary data collected in 6 of the 15 districts of Oslo municipality – Alna, Bjerke, Gamle Oslo, Grorud, Sondre Nordstand and Stovner. These districts are located in the eastern part of Oslo and were chosen due to being more socioeconomically deprived and with a higher migrant population (Steinmetz 2022). Oslo is located in the southern part of the country and has a total population of 698,660 individuals. Oslo's population density is over 1500 inhabitants per square kilometre according to the latest projections of September 2021, making it the most populated area of the country. Oslo was the epicentre of the COVID-19 pandemic in Norway (Mamelund and Dimka 2021) with a rate of over 22,400 reported cases per 100,000 inhabitants (as of 25 January 2022) (NIPH 2022).

The Centre for Research on Pandemics & Society (PANSOC) at Oslo Metropolitan University, in collaboration with the Pandemic Centre at the University of Bergen developed a questionnaire to be conducted as a web-based survey among residents of Oslo. The survey consisted of closed-choice Likert-type items, multiple answer questions and some open-ended questions in nine sections. A private company – Kantar – administered the survey on behalf of the researchers. Kantar has access to a population database with all phone numbers where they sampled 60,000 telephone numbers, 10,000 in each of the six parishes.

Text (SMS) messages, written in English, were sent to almost 60,000 potential participants. Recipients were directed to a web link where they were provided with further instructions and contact information, asked to consent to the survey, and allowed to select their preferred language – English, Arabic, Polish, Somali and Urdu – encourage responses from immigrants who may not have responded to a Norwegian-language survey. The SMS did not include any information on the survey content; therefore, the percent of complete and incomplete responses concern only those who accessed the survey. The final sample includes 5442 participants, for a response rate of around 9%, which might seem low but still allows for computing reliable statistical analysis with scientifically valuable and significant results (Steinmetz 2022).

Participants were eligible for a drawing for three gift cards valued at NOK 1000 (approximately 100 euros) each. The survey was approved by the Regional Committees for Medical and Health Research Ethics (REK Regional Ethics Committee, approval no 250310). Responses were collected between the 16th and the 24th of June 2021.

Study sample and data

This study uses a subsample of respondents (n = 4928) for which body mass index can be computed. Participants were asked to report their own height (in cm) and weight (in Kg). Of the 5442 participants in the total data set, 201 did not report height, 121 did not report weight and 175 reported neither. An additional 17 cases were excluded because the height reported was ≤ 100 cm or because the reported weight was ≤ 33 kg; these values are unlikely in adults. For the remaining subsample, BMI was computed, and participants were categorized according to WHO cut-off points into individuals with underweight (BMI < 18.5), healthy weight (BMI between 18.5 and 24.9) and overweight/obesity (BMI ≥ 25) (Ahmed et al. 2018). However, the group of individuals categorized as underweight were not considered in the subsequent statistical analysis, as these only represented 1.5% (n = 79) of the sample.

The other variables included in this study are sex (female, male or no answer), age (collected as numerical data and then recoded into four classes: 18–29 years, 30–44 years, 45–59 years and 60 or more years), highest completed education level (primary, higher general, higher vocational, vocational school/vocational education, university (less than 4 years) or university (4 years or more)), income (up to 399,999kr, 400,000—799,999kr or 800,000kr or more), employment status (full-time job, part-time job, self-employed, retired, unemployed, social security, student or stay-home), district of residence (Alna, Bjerke, Gamle Oslo, Grorud, Sondre Nordstand or Stovner), whether individuals had a confirmed case of COVID-19 any time before filling the questionnaire (yes or no) and whether they were born in Norway (yes or no). Those who were not born in Norway were considered migrants.

Statistical analysis

Chi-square tests were computed to compare the proportions of individuals with healthy weight and overweight/obesity, and individuals that had COVID-19 or not, by sex, age, schooling level, income, employment status, district of residence and whether they were born in Norway. The percentage of COVID-19 cases was computed for the total sample (number of COVID-19 cases/total sample*100), and separately for the group of individuals with healthy weight and the group of individuals with overweight/obesity, per district of residence.

Nine logistic regression models were computed using as dependent variable having COVID-19 and as independent variable weight status and other sociodemographic factors. In model 1, only weight status (having overweight/obesity) was included. In models 2 to 8, weight status and, respectively sex, age, schooling level, income, employment status, district of residence and born in Norway were included. Model 9 includes all variables. Additional logistic regression models using the Backwards Stepwise (conditional) method were computed to identify the sociodemographic factors associated with having COVID-19 using BMI as categorical and as continuous variables. Results are expressed as odds ratio (OR) and the respective 95% confidence interval (CI).

All statistical analysis were performed using SPSS (v. 27), and significance level was set at $p < 0.05$.

Results

Sociodemographic characteristics

The sample encompasses 4928 individuals that are distributed by districts as follows: Alna 881 (17.9%), Bjerke 711 (14.4%), Gamle Oslo 1537 (31.2%), Grorud 479 (9.7%), Sondre Nor. 794 (16.1%) and Stovner 526 (10.7%). There were 270 (5.5%) individuals who stated having had a confirmed case of COVID-19 and 2639 (53.6%) individuals were classified as having overweight/obesity.

Overall, a higher proportion of men (61.3%), individuals with higher vocational study as highest level of educational level (67.1%), and those unemployed (64.3%) had overweight/obesity. The proportion of individuals that had COVID-19 were under 30 years of age (9.4%), unemployed (11.7%) and not born in Norway (8.6%). (Table 1).

In the total sample, the proportion of individuals that had COVID-19 is higher among individuals with overweight/obesity (5.9%) than in individuals with healthy weight (5.0%), although the difference between these proportions is not statistically significant. The same result is observed in all districts except Stovner (Fig. 1).

In all logistic regression models, having overweight/obesity, when compared with having healthy weight, increases the odds of having COVID-19. However, this is only statistically significant when the regression models are adjusted for age (model 3—OR 1.385, IC 1.070–1.459), employment status (model 6—OR 1.335, IC 1.029–1.733) or for all variables (model 9—OR 1.422, IC 1.064–1.902) (Fig. 2).

When looking at which sociodemographic factors increase the odds of having COVID-19, we observe that age, employment status, district of residence, migrant status (having been born in Norway or not) and BMI are the most meaningful factors in this relation. In both models, the odds of having COVID-19 were higher in those who were

Table 1 Sociodemographic characteristics according to individuals' weight status and whether respondents had COVID-19

	Total	Having overweight/obesity (BMI 25 or more)	*p*	Total	Having COVID-19	*p*
	N (%)			*N* (%)		
Sex						
Female	2798 (58.0)	1381 (49.4)	< 0.000	2860 (58.3)	161 (5.6)	0.541
Male	2030 (42.0)	1244 (61.3)		2047 (41.7)	107 (5.2)	
Missing	100			21		
Age						
18–29 years	652 (13.4)	226 (34.7)	< 0.000	680 (13.8)	64 (9.4)	< 0.000
30–44 years	1538 (31.7)	770 (50.1)		1560 (31.7)	96 (6.2)	
45–59 years	1345 (27.7)	842 (62.6)		1357 (27.5)	78 (5.7)	
60 or more	1314 (27.1)	801 (61.0)		1331 (27.0)	32 (2.4)	
Missing	79			0		
Schooling level						
Primary	269 (5.6)	170 (63.2)	< 0.000	276 (5.6)	15 (5.4)	0.218
Higher general	686 (14.3)	388 (56.6)		701 (14.3)	47 (6.7)	
Higher vocational	438 (9.1)	294 (67.1)		447 (9.1)	32 (7.2)	
Vocational school/Vocational education	452 (9.4)	288 (63.7)		462 (9.4)	27 (5.8)	
University (less than 4 years)	1542 (32.0)	834 (54.1)		1561 (31.9)	82 (5.3)	
University (4 years or more)	1426 (29.6)	647 (45.4)		1445 (29.5)	66 (4.6)	
Missing	115			36		
Income						
up to 399,999kr	1149 (26.2)	595 (51.8)	0.059	1169 (26.3)	77 (6.6)	0.017
400,000—799 999kr	2667 (60.8)	1464 (54.9)		2702 (60.8)	144 (5.3)	
800,000kr or more	572 (13.0)	329 (57.5)		575 (12.9)	19 (3.3)	
Missing	540			482		
Employment status						
Full-time job	2828 (60.1)	1557 (55.1)	< 0.000	2862 (59.9)	160 (5.6)	< 0.000
Part-time job	330 (7.0)	159 (48.2)		333 (7.0)	29 (8.7)	
Self-employed	146 (3.1)	67 (45.9)		148 (3.1)	10 (6.8)	
Retired	795 (16.9)	461 (58.0)		809 (16.9)	17 (2.1)	
Unemployed	126 (2.7)	81 (64.3)		128 (2.7)	15 (11.7)	
Social security	250 (5.3)	160 (64.0)		254 (5.3)	7 (2.8)	
Student	203 (4.3)	57 (28.1)		217 (4.5)	16 (7.4)	
Stay-home	26 (0.6)	12 (46.2)		28 (0.6)	5 (17.9)	
Missing	224			149		
District						
Alna	872 (18.0)	522 (59.9)	< 0.000	881 (17.9)	48 (5.4)	0.003
Bjerke	700 (14.4)	346 (49.4)		711 (14.4)	37 (5.2)	
Gamle Oslo	1510 (31.1)	715 (47.4)		1537 (31.2)	86 (5.6)	
Grorud	471 (9.7)	291 (61.8)		479 (9.7)	24 (5.0)	
Sondre Nor	783 (16.1)	459 (58.6)		794 (16.1)	28 (3.5)	
Stovner	513 (10.6)	306 (59.6)		526 (10.7)	47 (8.9)	
Missing	79			0		
Born in Norway						
Yes	3730 (77.4)	2034 (54.5)	0.755	3791 (77.4)	172 (4.5)	< 0.000
No	1089 (22.6)	588 (54.0)		1107 (22.6)	95 (8.6)	
Missing	109			30		
Having COVID-19						
Yes	267 (5.5)	156 (58.4)	0.177			
No	4582 (94.5)	2483 (54.2)				
Missing	79					

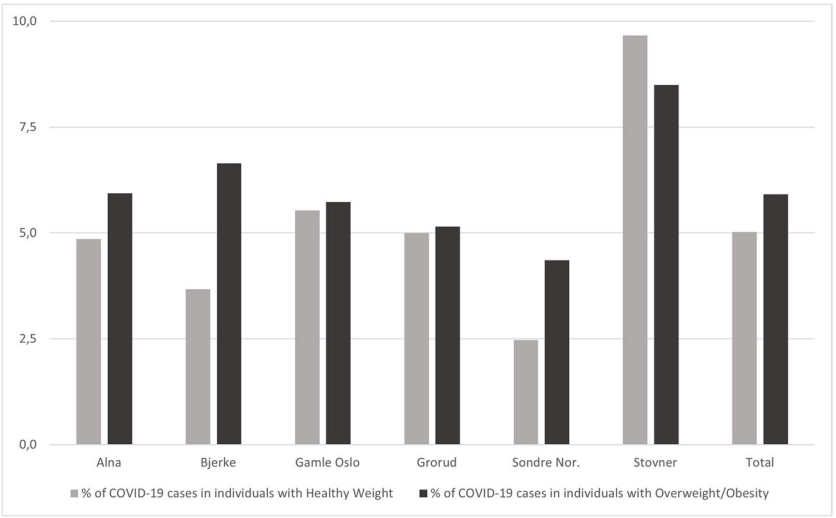

Fig. 1 Percentage of COVID-19 cases, in individuals with healthy weight and in individuals with overweight/obesity per district of residence and in the total sample

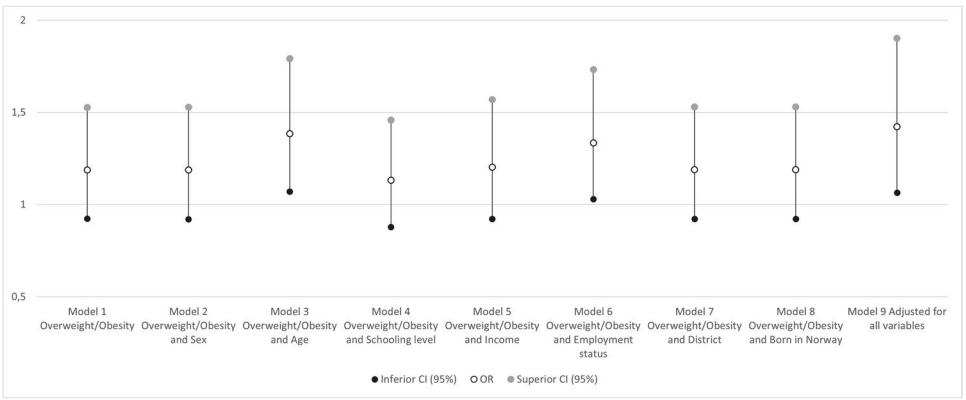

Fig. 2 Odds of having COVID-19 according to weight status (having overweight/obesity) alone or adjusted by sex, age, schooling level, income, employment status, district of residence, having been born in Norway and all variables

unemployed, not born in Norway and those with overweight/obesity (Table 2).

Discussion

As observed in other studies conducted in Norway, in this study's sample, the proportion of cases of COVID-19 was higher among individuals with overweight/obesity than in individuals with healthy weight (Orlewska et al. 2021). Moreover, the odds of having COVID-19 in individuals with overweight/obesity was positively and statistically significant in the regression models adjusted for age, employment status and all variables. This suggests that the link between obesity and COVID-19 might not only be attributable to a biological proneness for infection, but in fact, such relation is leveraged by sociodemographic features. The same is to say that there is a syndemic relationship between both health outcomes (Hill et al. 2021). In fact, the syndemic of obesity and COVID-19 was foreseen since the emergence of the COVID-19 pandemic (Halpern et al. 2021). Obesity had previously been associated with higher susceptibility to other infectious diseases (Foo et al. 2021; Hill et al. 2021); therefore, it was expected that individuals with overweight/obesity would be at greater risk for infection and severer cases of COVID-19 (Tamara and Tahapary 2020).

Consistent with other studies in Norway, in this study, the majority of the participants had overweight/obesity (53.6%), and the proportion was higher among men (61.3%) (Kholmatova et al. 2021; Ulset et al. 2007). That is, more than half of the adult population in Norway has a serious, though modifiable, risk factor for COVID-19 infection, severity and death. This is a worrying scenario because in a pandemic event it represents a higher pressure for specialized and prolonged health care (Tamara and Tahapary 2020).

In general, studies on weight status in Norway tend to place a higher value on the biological, physiological and

Table 2 Odds of having COVID-19 according to sociodemographic factors and BMI as dichotomic and continuous variable (final step of Backwards Stepwise (conditional) models)

	Having COVID-19	
	BMI (dichotomic)	BMI (continuous)
	OR (95% CI)	
Sex		
Female	x	x
Male	x	x
Age		
18–29 years	ref	ref
30–44 years	0.519 (0.353–0.766)	0.538 (0.366–0.792)
45–59 years	0.480 (0.318–0.726)	0.508 (0.337–0.767)
60 or more	0.319 (0.174–0.585)	0.339 (0.185–0.620)
Schooling level		
Primary	x	x
Higher general	x	x
Higher vocational	x	x
Vocational school/Vocational education	x	x
University (less than 4 years)	x	x
University (4 years or more)	x	x
Income		
up to 399,999kr	x	x
400,000—799 999kr	x	x
800,000kr or more	x	x
Employment status		
Full-time job	ref	ref
Part-time job	1.434 (0.917–2.241)	1.405 (0.900–2.195)
Self-employed	1.177 (0.560–2.475)	1.154 (0.549–2.424)
Retired	0.622 (0.297–1.302)	0.604 (0.289–1.264)
Unemployed	1.943 (1.024–3.685)	1.895 (1.002–3.583)
Social Security	0.445 (0.179–1.111)	0.433 (0.174–1.081)
Student	1.073 (0.564–2.040)	1.074 (0.566–2.040)
Stay-home	2.413 (0.524–11.106)	1.985 (0.440–8.958)
District		
Alna	ref	ref
Bjerke	0.761 (0.460–1.258)	0.778 (0.473–1.279)
Gamle Oslo	0.917 (0.617–1.363)	0.926 (0.624–1.376)
Grorud	0.966 (0.565–1.653)	0.946 (0.553–1.618)
Sondre Nor	0.626 (0.373–1.052)	0.621 (0.370–1.042)
Stovner	1.482 (0.918–2.390)	1.464 (0.908–2.361)
Born in Norway		
Yes	ref	ref
No	1.563 (1.154–2.118)	1.593 (1.179–2.153)
BMI		
Healthy Weight (18–24,9)	ref	ref
Overweight/Obese (above 25)	1.426 (1.071–1.897)	1.030 (1.004–1.056)

Ref, reference category; *OR*, Odds ratio, *95% CI*, 95% confidence interval; *BMI*, body mass index

genetic factors associated with overweight/obesity (Brandkvist et al. 2020). Nevertheless, there is some evidence highlighting that sociodemographic factors also determine weight status in Norway. For example, having lower educational levels or no university education has been associated with obesity in women and men (Kholmatova et al. 2021; Mousavi et al. 2021; Torkildsen et al. 2019), similarly to what was found in the present study where a higher proportion of individuals with overweight/obesity had higher vocational education as their highest completed level.

Other studies on obesity risk factors in Norway specifically among immigrant populations showed that Somali women have higher prevalence of overweight/obesity (Ahmed et al. 2018; Qureshi et al. 2020) that might be associated with the lack of health literacy found in this group of individuals (Qureshi et al. 2020). This is in line with one of the main findings of this study, i.e. that young, unemployed and immigrant women with overweight/obesity had a significantly increased odds of having COVID-19.

One might state that this study's findings are a pragmatic example of how the combination of biological and social factors determine who are most at risk in a pandemic situation. The vulnerability of the minority groups to infection is partially due to a pro-inflammatory state that might be explained by the exposure to higher levels of stress, that in turn, are associated with the perception of being outnumbered when experiencing a highly adverse event away from their country of origin and family (Wang 2021). Such findings add to the large volume of evidence on the ethno-racial disparities of the COVID-19 pandemic that contribute to the consolidation of the theories on the indissolubleness of biology and social aspects of health. Thus, the co-existence of COVID-19 infection and overweight/obesity in specific groups of the population in the eastern part of Oslo, might be explained by a cumulative result of biologic, genetic and sociodemographic reasons. In other words, the observed ethno-racial disparities on COVID-19 infection in individuals with overweight/obesity, essentially result from the effect of sociodemographic or socioeconomic factors on biological mechanisms of infection.

Other studies conducted using the same sample also highlight the way the sociodemographic context affects health status. One such study that assessed vaccine hesitancy, found that individuals not born in Norway reported higher hesitancy. This might reflect the little experience with vaccination in their country of origin and the lack of health literacy or knowledge on the health services functioning in Norway, as the author speculates (Steinmetz 2022). Further research is needed to better comprehend the mechanisms underlying the association between biological and social aspects in the syndemic of COVID-19 and obesity, but evidence suggests that individuals not born in the country tend to perceive less accessibility to health care services, as well as other barriers namely related with language, less understanding of public health measures and a lack of knowledge on how health issues are dealt with in the country of residence (Qureshi et al. 2020).

It is estimated that there are immigrants from over 200 different cultural/ethnic backgrounds in Norway and each one has its own conceptualization and perspectives on health, which is challenging when addressing specific diseases, namely obesity (Qureshi et al. 2020) and COVID-19 (Kjollesdal et al. 2022). The cultural aspects, traditions, beliefs, religion, together with overcrowded housing, poor living conditions and overall unhealthy lifestyles, are believed to be associated with poorer health status and higher social and clinical susceptibility to COVID-19 (Kjollesdal et al. 2022) as well as obesity (Qureshi et al. 2020).

This study's findings support the theory for the existence of a syndemic relation of COVID-19 and obesity. Therefore, if it is scientifically consensual that obesity is the product of a complex and dynamic exchange between social, demographic, environmental, economic, and political aspects and that the more successful interventions targeted at combating obesity act at multilevel, according to the socioecological model of health determinants (Pereira et al. 2019), there is reason to believe that similar approaches should be considered when addressing the obesity and COVID-19 syndemic (Hill et al. 2021). To test this hypothesis, more evidence is needed on this topic, which essentially results from transdisciplinary research on pandemics (Mamelund 2017), as well as research on obesity from a perspective that goes beyond the biomedical (Pereira et al. 2019).

Strengths and limitations

To our knowledge this is the first study aiming at exploring the role of sociodemographic factors in the association between obesity and COVID-19 using individual level data. Further, this study uses a relatively large dataset which strengths the study's findings. Height and weight were self-reported, so there might be a bias related to individuals' perception of their own body composition and self-image. The small number of confirmed COVID-19 cases might also affect the results' strength and significance. COVID-19 was inversely related with age in our sample (less frequent among older groups), which might be explained by the pandemic phase in which the sample was collected, corresponding to a period when most non-pharmaceutical interventions aimed at the protection of older groups of the population.

Conclusions

This study's findings corroborate the existence of a COVID-19 and obesity syndemic. The results shows that overweight/obesity alone is not significantly associated with having had COVID-19 but, having overweight/obesity together with being immigrant, young, women and unemployed, increases the odds of having had COVID-19. This cluster of lower socioeconomic conditions in immigrant women with overweight/obesity makes them a priority group for public health interventions targeted at controlling COVID-19 (or other infectious diseases).

More evidence of the relevance of sociodemographic factors in the association between weight status and COVID-19 is needed, especially resulting from transdisciplinary research, including the biological dimension, and from a multilevel perspective. This evidence is crucial to identify population groups at greater risk of infection in a more holistic way, which, in turn, would allow the planning and implementation of more tailored public health interventions.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10389-024-02203-4.

Acknowledgements The author thanks the contribution of SEM and JD in revising and providing significant suggestions to the final version of this manuscript.

Authorship contribution Margarida Pereira is the single author of the manuscript and is responsible for the study design, writing, data analysis and submission for publication.

Funding Open access funding provided by OsloMet - Oslo Metropolitan University. This work was supported by the Research Council of Norway, project "PANRISK: Socioeconomic risk groups, vaccination and pandemic influenza" with the grant agreement No. 302336.

Declarations

Ethical approval The survey was approved by the Regional Committees for Medical and Health Research Ethics (REK Regional Ethics Committee, approval no 250310).

Conflict of interest The author declares having no conflicts of interest.

References

Ahmed S, Meyer H, Kjollesdal M, Madar A (2018) Prevalence and predictors of overweight and obesity among Somalis in Norway and Somaliland: a comparative study. J Obes 2018:4539171. https://doi.org/10.1155/2018/4539171

Bjornelv GMW, Halsteinli V, Kulseng BE, Sonntag D, Odegaard RA (2021) Modeling obesity in Norway (the MOON Study): a decision-analytic approach-prevalence, costs, and years of life lost. Med Decis Making 41:21–36. https://doi.org/10.1177/0272989X20971589

Brandkvist M, Bjorngaard JH, Odegard RA, Brumpton B, Smith GD, Asvold BO et al (2020) Genetic associations with temporal shifts in obesity and severe obesity during the obesity epidemic in Norway: a longitudinal population-based cohort (the HUNT Study). PLoS Med 17:e1003452. https://doi.org/10.1371/journal.pmed.1003452

Burstrom B, Tao W (2020) Social determinants of health and inequalities in COVID-19. Eur J Public Health 30:617–618. https://doi.org/10.1093/eurpub/ckaa095

Cabrera-Mendoza B, Wendt FR, Pathak GA, De Angelis F, De Lillo A, Koller D et al (2021) The effect of obesity-related traits on COVID-19 severe respiratory symptoms is mediated by socioeconomic status: a multivariable Mendelian randomization study. medRxiv. https://doi.org/10.1101/2021.06.08.21258587

Dalton JE, Gunzler DD, Jain V, Perzynski AT, Dawson NV, Einstadter D et al (2021) Mechanisms of socioeconomic differences in COVID-19 screening and hospitalizations. PLoS ONE 16:e0255343. https://doi.org/10.1371/journal.pone.0255343

Foo O, Hiu S, Teare D, Syed AA, Razvi S (2021) A global country-level analysis of the relationship between obesity and COVID-19 cases and mortality. Diabetes Obes Metab 23:2697–2706. https://doi.org/10.1111/dom.14523

Halpern B, Louzada M, Aschner P, Gerchman F, Brajkovich I, Faria-Neto JR et al (2021) Obesity and COVID-19 in Latin America: a tragedy of two pandemics-Official document of the Latin American Federation of Obesity Societies. Obes Rev 22:e13165. https://doi.org/10.1111/obr.13165

Hill MA, Sowers JR, Mantzoros CS (2021) Commentary: COVID-19 and obesity pandemics converge into a syndemic requiring urgent and multidisciplinary action. Metabolism 114:154408. https://doi.org/10.1016/j.metabol.2020.154408

Indseth T, Grosland M, Arnesen T, Skyrud K, Klovstad H, Lamprini V et al (2021) COVID-19 among immigrants in Norway, notified infections, related hospitalizations and associated mortality: a register-based study. Scand J Public Health 49:48–56. https://doi.org/10.1177/1403494820984026

Kathe NJ, Wani RJ (2021) Determinants of COVID-19 case fatality rate in the United States: spatial analysis over one year of the pandemic. J Health Econ Outcomes Res 8:51–62. https://doi.org/10.36469/jheor.2021.22978

Kholmatova K, Kudryavtsev AV, Malyutina S, Hopstock LA, Cook S, Krettek A et al (2021) Obesity prevalence and associations with socio-economic and behavioral factors in population-based studies in Russia and Norway, 2015–2017. Eur Heart J 42. https://doi.org/10.1093/eurheartj/ehab724.2615.

Kjollesdal M, Skyrud K, Gele A, Arnesen T, Klovstad H, Diaz E et al (2022) The correlation between socioeconomic factors and COVID-19 among immigrants in Norway: a register-based study. Scand J Public Health 50:52–60. https://doi.org/10.1177/14034948211015860

Li D, Gaynor SM, Quick C, Chen JT, Stephenson BJK, Coull BA et al (2021) Identifying US County-level characteristics associated with high COVID-19 burden. BMC Public Health 21:1007. https://doi.org/10.1186/s12889-021-11060-9

Li SL, Pereira RHM, Prete CA Jr, Zarebski AE, Emanuel L, Alves PJH et al (2021) Higher risk of death from COVID-19 in low-income and non-White populations of Sao Paulo, Brazil. BMJ Glob Health 6. https://doi.org/10.1136/bmjgh-2021-004959

Mamelund SE (2017) Social inequality - a forgotten factor in pandemic influenza preparedness. Tidsskr nor Laegeforen 137:911–913. https://doi.org/10.4045/tidsskr.17.0273

Mamelund SE, Dimka J (2021) Social inequalities in infectious diseases. Scand J Public Health 49:675–680. https://doi.org/10.1177/1403494821997228

Mamelund SE, Shelley-Egan C, Rogeberg O (2021) The association between socioeconomic status and pandemic influenza: Systematic review and meta-analysis. PLoS ONE 16:e0244346. https://doi.org/10.1371/journal.pone.0244346

Mousavi SA, Hermundstad B, Saether PC, Nybruket MJ, Knutsen TR, Llohn AH (2021) Health behavior and lifestyle trends among platelet donors: results from a questionnaire-based survey in

Norway. Biomed Res Int 2021:8891885. https://doi.org/10.1155/2021/8891885
NIPH (2022) Daily report and statistics about coronavirus and COVID-19. https://www.fhi.no/en/id/corona/coronavirus/daily-reports/daily-reports-COVID19/. Accessed 26 Jun 2023
Orlewska K, Orlewski P, Klusek J (2021) Factors potentially influencing case fatality rate in different stages of COVID-19 outbreak in Europe. Arch Med Sci. https://doi.org/10.5114/aoms/136046
Pereira M, Padez CMP, Nogueira H (2019) Describing studies on childhood obesity determinants by Socio-Ecological Model level: a scoping review to identify gaps and provide guidance for future research. Int J Obes (lond) 43:1883–1890. https://doi.org/10.1038/s41366-019-0411-3
Qureshi SA, Straiton M, Gele AA (2020) Associations of socio-demographic factors with adiposity among immigrants in Norway: a secondary data analysis. BMC Public Health 20:772. https://doi.org/10.1186/s12889-020-08918-9
Safiri S, Karamzad N, Kaufman JS, Nejadghaderi SA, Bragazzi NL, Sullman MJM et al (2022) Global, regional, and national burden of cancers attributable to excess body weight in 204 countries and territories, 1990 to 2019. Obesity (silver Spring) 30:535–545. https://doi.org/10.1002/oby.23355
Steinmetz L (2022) Sociodemographic predictors of and main reasons for COVID-19 vaccine hesitancy in eastern Oslo: a cross-sectional study. BMC Public Health 22:1878. https://doi.org/10.1186/s12889-022-14261-y
Tamara A, Tahapary DL (2020) Obesity as a predictor for a poor prognosis of COVID-19: a systematic review. Diabetes Metab Syndr 14:655–659. https://doi.org/10.1016/j.dsx.2020.05.020
Torkildsen SE, Svendsen H, Raisanen S, Sole KB, Laine K (2019) Country of birth and county of residence and association with overweight and obesity-a population-based study of 219 555 pregnancies in Norway. J Public Health (oxf) 41:e290–e299. https://doi.org/10.1093/pubmed/fdz001
Tremmel M, Gerdtham UG, Nilsson PM, Saha S (2017) Economic burden of obesity: a systematic literature review. Int J Environ Res Public Health 14. https://doi.org/10.3390/ijerph14040435
Ulset E, Undheim R, Malterud K (2007) Er fedmeepidemien kommet til Norge? [Has the obesity epidemic reached Norway? Tidsskr Nor Laegeforen: tidsskrift for praktisk medicin, ny raekke 127:34–7. https://pubmed.ncbi.nlm.nih.gov/17205087/
Wang S (2021) Ethno-racial disparities in COVID-19 morbidity and mortality. Cahiers de l'Urmis.https://doi.org/10.4000/urmis.2409
WHO (2000) Obesity: preventing and managing the global epidemic. https://pubmed.ncbi.nlm.nih.gov/11234459/. Accessed 26 Jun 2023