# Interwoven challenges of covid-19, poor diet, and cardiometabolic health

**Carmen Piernas** and **Jordi Merino** argue that suboptimal diet and poor metabolic health aggravated the covid-19 pandemic and require greater attention to increase population resilience and reduce health inequalities

The covid-19 pandemic emerged at a time when many countries were already grappling with unprecedented levels of obesity and cardiometabolic disease.[1] Underlying poor metabolic health, unhealthy diets, and increased health inequalities compounded the pandemic's economic, public health, and social burdens.

The initial policy responses reasonably aimed at containing the spread of the virus through restricting movement (lockdowns). However, in the context of suboptimal diets and poor metabolic health, these measures unintentionally imposed additional challenges on people's lifestyles, with observed trends towards overeating, unhealthy snacking, and increased alcohol consumption across many countries.[2] In addition, the pandemic restrictions amplified food insecurity, which further compromised dietary quality, especially among people already living in difficult conditions.[3]

Even though effective vaccines and treatment advances have significantly reduced covid-19 severity and death rates, a compromised health system during the pandemic has delayed adequate medical care, increasing morbidity and mortality among those with underlying, preventable, and treatable medical conditions.[4] We argue that suboptimal nutrition, obesity, and cardiometabolic diseases aggravated the burden of covid-19 and propose preventive strategies that can help mitigate future pandemics.

## People with obesity and diabetes were disproportionately affected

Early in the pandemic, numerous observational studies reported a high prevalence of obesity and related morbidities among patients admitted to hospital with covid-19.[5] Subsequent evidence has confirmed that obesity and impaired metabolic health are strong independent predictors of covid-19 severity (box 1). A systematic review of studies across the world reported with high certainty that a body mass index (BMI) ≥40 is an independent prognostic risk factor for covid-19 severity and mortality.[6] Body fat distribution, specifically a higher proportion of adipose tissue around the visceral area, has also been associated with worst covid-19 outcomes, though the number of studies is limited.[9]

Impaired metabolic health, particularly diabetes, has been linked with a worse prognosis after SARS-CoV-2 infection (box 1). Evidence shows that people with type 1 or type 2 diabetes have increased risk of severe covid-19.[13-15] Particularly, the acute effects of raised blood glucose levels have been shown to affect disease severity after SARS-CoV-2 infection.[16] These findings are in contrast to studies using Mendelian randomisation—a statistical method that uses genetic variants associated with an exposure (ie, diabetes) to examine causal associations with an outcome (ie, covid-19). These studies have not found that type 2 diabetes and glycaemic traits are causally related to severe covid-19 outcomes, suggesting that the increased risk of severe covid-19 attributed to type 2 diabetes may be largely mediated by adiposity.[10-12] These contrasting findings warrant further investigation as, given the molecular heterogeneity of type 2 diabetes, covid-19 severity might be associated with specific phenotypes related to insulin resistance and systemic inflammation.

The rates of severe illness and death from covid-19 have been drastically reduced since the introduction of vaccines. Early reports hypothesised that covid-19 vaccines might be less effective in people with obesity because of poorer innate and adaptive immune responses, as seen with vaccines for other respiratory viruses.[17] However, a community based study using primary care medical records from 9 million adults in the UK comparing vaccinated and unvaccinated people showed a high level of protection against severe covid-19 regardless of weight.[18] A J shaped association was reported among fully vaccinated individuals, with increased risk of severe covid-19 outcomes found at both extremes of the BMI spectrum. Consistent results were subsequently observed after the administration of boosters.[19] Similarly, poor glycaemic control in people with type 2 diabetes has been associated with a worse immunological response after vaccination and increased risk of SARS-CoV-2 infection.[20-22] Although debate continues about the need for boosters against new SARS-CoV-2 variants across the population, experts agree that the most vulnerable people will benefit from them, and this includes those with poor metabolic health and risk factors such as obesity.[23]

Prolonged symptoms after SARS-CoV-2 infection—long covid—are an increasing public health concern. Long covid is a debilitating illness comprising over 200 symptoms affecting multiple organ systems.[24] Population based studies of large cohorts from England, including a cohort of 17 million adults, have reported

### KEY MESSAGES

- Poor metabolic health together with unhealthy diets and health inequalities have compounded the covid-19 pandemic's economic, social, and public health burdens
- Studies have consistently reported that obesity and diabetes are independent predictors of covid-19 severity
- Evidence from dietary studies suggests that adopting a healthy dietary pattern lowers covid-19 risk and severity, especially in disadvantaged communities
- Health policy needs to recognise obesity and metabolic health as important risk factors for infectious disease severity and prioritise higher risk groups for healthcare and nutritional support
- Reorienting health systems towards health promotion, including targeted efforts to reduce existing inequalities, will increase resilience

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**Box 1: Evidence from systematic reviews and primary studies investigating associations between obesity, diabetes, and covid-19 severity***

**Body mass index and body composition**

- A Cochrane review and meta-analysis of 149 observational studies including >12 million participants reported with high certainty (based on GRADE system) that severe obesity (BMI>40) is an independent prognostic risk factor for covid-19 mortality. In people with a milder grade of obesity, there is lower certainty evidence for covid-19 death but higher certainty for the risk of intensive care admission or mechanical ventilation[6]

- Other evidence comes from two large community based studies using primary care medical records in the UK. One study in 17 million adults reported increased risk of covid-19 death for BMI 35-39.9 (hazard ratio 1.40; 95% CI 1.30 to 1.52) and ≥40 (1.92; 1.72 to 2.13) compared with a BMI<30.[7] Another study of 6.9 million adults reported a J shaped association for the risk of covid-19 hospital admission, need for intensive care, and death across the whole range of BMI values, with the lowest risk at BMI of 23 and significant linear increases above this point. This study found significant heterogeneity in the reported risks, with younger people and those of black ethnicity showing increased risks of severe covid-19 associated with BMI[8]

- A systematic review of 62 studies investigated the role of body composition on covid-19 severity,[9] reporting that visceral adipose tissue was associated with intensive care admission (6 out of 7 studies) and that intramuscular adipose tissue was associated with covid-19 severity (2 out of 2 studies) and mortality (4 out of 5 studies).

- Mendelian randomisation studies using data from large biorepositories and genetically proxied BMI have consistently reported a causal role of BMI in covid-19 severity, independently, or through its effect on obesity related cardiometabolic disease. However, there is weaker evidence supporting an independent effect of central fat distribution, over and above the observed effects of overall adiposity[10-12]

**Diabetes**

- Systematic reviews have consistently reported increased risk of severe covid-19 among people with type 1 and 2 diabetes (odds ratios for in-hospital covid-19 related death 2.86 (95% CI 2.58 to 3.18) for type 1 diabetes and 1.80 (1.75 to 1.86) for type 2 diabetes), with a clear association between glucose control and covid-19 severity and mortality.[13 14] There is also evidence of increased risks in people with diabetes for haemoglobin $A_{1c}$ levels below and above 58 mmol/mol (7.5%) as well as in people with diabetes and other pre-existing comorbidities[15]

- Mendelian randomisation studies have generally not supported causal associations between genetically proxied type 2 diabetes traits (referring to a genetic predisposition to develop type 2 diabetes, not a clinical diagnosis) and severe covid-19 outcomes, independently of the BMI effect[10-12]

*Studies have been selected based on their methodological rigour as well as the impact and implications of their results.

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an increased risk of clinically coded long covid in people with obesity compared with those without obesity.[25 26] In absolute terms, the increased risk of developing long covid was marginal among people with obesity who had received at least two doses of the vaccine, and overall null effects were reported for diabetes and cardiovascular risk factors before and after vaccination.[26]

**Suboptimal diets underlie disease**

Our understanding of the relation between nutrition and immunity has evolved since the 18th century, when observations first linked nutritional deficiencies to increased mortality rates from infectious diseases. We now have extensive knowledge about the crucial role that nutrition plays in supporting immune system function,[27] and global health organisations and medical societies endorse healthy dietary patterns to help tackle the complex public health challenges arising from the intersection of communicable and non-communicable diseases.

The evidence around dietary patterns, consumption of specific foods, and supplement use in relation to covid-19 outcomes has increased, though most comes from observational studies that recruited health conscious participants from higher income countries (table 1). A study of 3000 healthcare workers from six countries showed that people following plant based or pescatarian dietary patterns had lower odds of moderate-to-severe covid-19, independent of other potential confounders such as comorbidities and demographic or lifestyle factors, including BMI.[28] Data from the covid-19 Symptom Study, a smartphone based survey of nearly 600 000 people in the UK and US before vaccines were available, showed that a dietary pattern consisting of healthy plant based foods was associated with a lower risk of infection and a lower risk of hospital admission related to covid-19.[30] Another study showed that adherence to a Mediterranean diet is related to a lower risk of covid-19,[29] while consumption of ultra-processed foods or sugar sweetened beverages has been linked with increased covid-19 infection and mortality, respectively.[31 32] These studies underscore the potential benefits of adopting a healthy diet, independently of other risk factors, in lowering covid-19 risk and severity, over and above the known beneficial effects on non-communicable diseases.

Despite evidence of benefit for dietary patterns, there is no evidence that using dietary supplements reduces the risk of covid-19 infection and complications.[34-36] The strongest evidence comes from randomised clinical trials of vitamin D supplementation, one of which found no effect on the incidence of covid-19.[37] One reason for this difference could be that a healthy diet improves immunity and protects against infectious disease outcomes through the effect of multiple nutritional components that interact with many cellular mechanisms and metabolic processes.

**Importance of nutritional status in lower socioeconomic groups**

Overstretched health systems and socio-economic inequalities have increased vulnerability in certain communities and contributed to disparities in mortality during the covid-19 pandemic. Before covid-19, people living in areas of higher deprivation were already disproportionally affected by obesity and cardiometabolic disease.[38] During covid-19, these communities were particularly affected by food insecurity, experiencing more problems in maintaining healthy food habits and meeting nutrient recommendations,[3] including families with children relying on school meal programmes. The Covid-19 Eating and Activity Over Time Study surveyed people experiencing food insecurity in the

**Table 1 | Overview of selected studies investigating links between diet and covid-19 risk and severity[*]**

| Study characteristics | Summary of findings |
| --- | --- |
| **Dietary patterns** | |
| Case-control study including 3000 healthcare workers from six countries[28] | Plant based diets or pescatarian diets were associated with lower odds of moderate-to-severe covid-19 (ORs 0.28, 95% CI 0.10 to 0.82 and 0.41, 0.16 to 0.99, respectively, compared with those that didn't follow those diets) |
| Prospective study including 5194 health professionals from Spain[29] | High adherence to Mediterranean diet was associated with lower odds of covid-19 (OR 0.36, 0.16 to 0.84) compared with low adherence |
| Prospective study including 592 571 participants from the UK and US[30] | Diet characterised by healthy plant based foods was associated with lower risk (HR 0.91, 95% CI 0.88 to 0.94) and severity (0.59, 0.47 to 0.74) of covid-19 compared with lower dietary quality |
| **Food groups** | |
| Prospective study in 41 012 UK Biobank participants[31] | Higher consumption of ultra-processed foods was associated with higher odds (OR 1.22, 95%CI 1.12 to 1.34) of covid-19 infection compared with lower consumption |
| Ecological study including data from 158 countries[32] | Covid-19 mortality was higher for higher sugar sweetened beverages intakes and lower for higher fruits, beans, and legumes intake |
| Prospective study in 37 988 UK Biobank participants[33] | Higher v lower consumption of coffee (OR 0.90, 0.83 to 0.96) and vegetables (0.88, 0.80 to 0.98) was associated with lower odds of covid-19 infection; but higher odds for those consuming processed meat 1.14, 1.01 to 1.29) |
| **Supplements** | |
| Randomised trial of 34 601 adults from Norway[34] | Supplementation with cod liver oil did not reduce the incidence of SARS-CoV-2 infection (RR 1.00, 99.9% CI 0.82 to 1.22) or serious covid-19 (1.20, 0.87 to 1.65) |
| Systematic review and meta-analysis of nutrient supplementation[35] | Vitamins C, D, and zinc supplementation were not associated with reduced covid-19 mortality (RR 1.00, 95% CI 0.62 to 1.62; 0.75, 0.49 to 1.17; and 0.79, 0.60 to 1.03, respectively) |
| Prospective study including 372 720 UK participants[36] | Modest association between use of probiotics, omega-3 fatty acid, multivitamin, or vitamin D supplements and lower risk of testing positive for SARS-CoV-2 (14%, 95% CI 8% to 19%; 12%, 8% to 16%; 13%, 10% to 16%; and 9%, 6% to 12%, respectively). Associations were significant only in women after sex stratification |

*Studies have been selected based on their methodological rigour as well as the impact and implications of their results.

US, who reported increases in irregular eating patterns and hunger as well as lower consumption of fruits and vegetables and higher intakes of fast food or takeaways during the lockdown.[39] Evidence indicates that an adequate nutritional status is particularly important for people living in disadvantaged communities in the context of covid-19. For instance, results from the Covid-19 Symptom Study suggest that nearly one third of covid-19 cases in people living in areas of high economic deprivation could have been prevented if poor diet quality or socioeconomic deprivation were absent.[30] These observed patterns during covid-19 may have implications for people's nutritional status and susceptibility to infections,[40] reinforcing the need for effective public policies tackling food insecurity.

### Can we be ready for the future?

The evidence supporting the intricate connections between diet, cardiometabolic health, and covid-19 emerged as a focal point in public health research during the pandemic. People with underlying cardiometabolic diseases, often influenced by poor dietary habits and complex social determinants of health, are widely recognised as having a higher risk of severe covid-19 outcomes. While the world navigates the current "post-pandemic phase," it is imperative to shift our attention to dietary adequacy and metabolic health.

We need to empower people to adopt healthier dietary patterns and promote nutrition in order to strengthen immune function and resilience against infections (fig 1). In the context of a pandemic such as covid-19, public health policies must ensure equitable access to healthy foods, particularly in vulnerable communities. Specifically, policies that help improve food security and reduce food deserts, as well as strategies to make healthier options more accessible and affordable while making unhealthier options less ubiquitous, convenient, and cheap can be transformative. Adequate nutrition is even more essential for deprived communities and in low and middle income countries where food insecurity is common.[41] Nutrient deficiencies and sarcopenia are prevalent in older people and have been documented in patients admitted to hospital with covid-19.[42] Deficiencies in key nutrients may expose these groups to greater morbidity and mortality after infection.[43] Effective coordination between public health agencies, healthcare providers, food authorities, and community organisations is crucial to ensure a comprehensive and responsive public health approach to mitigate the consequences of a pandemic.

Recognition of the relevance of diet related diseases such as obesity and type 2 diabetes as risk factors for infectious disease severity can guide targeted public health efforts to protect the most vulnerable people. For instance, as scientific data on covid-19 risk factors became rapidly available, some countries prioritised vaccinating people with diabetes and severe obesity.[44] However, the success of these targeted vaccination programmes can vary as people may underestimate the seriousness of their disease or may not consider themselves at risk of infection. Hence, communication strategies must ensure that programmes reach those at risk, especially in disadvantaged communities where obesity and cardiometabolic diseases are still underdiagnosed and undertreated. In addition, given the high prevalence
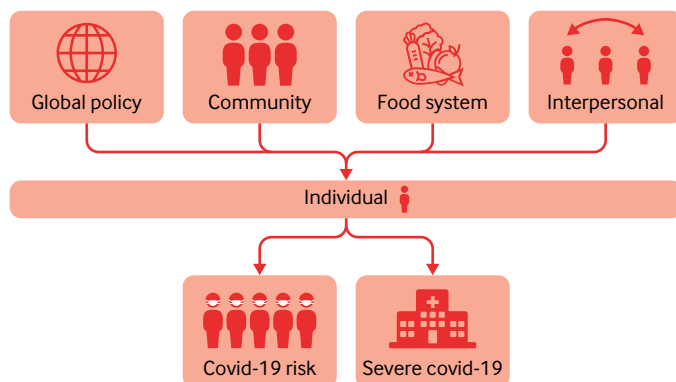


Fig 1 | Factors influencing diet and consequently risk of cardiometabolic disease and covid-19

of obesity and cardiometabolic disease globally, efforts must continue to support people to achieve and maintain a healthy weight. Evidence suggests that even modest weight loss can rapidly improve insulin resistance and cardiometabolic risk factors, which can help reduce infectious disease severity. A comparative risk assessment study suggested that a 10% reduction in the prevalence of obesity and type 2 diabetes would have prevented around 11% of covid-19 hospital admissions among US adults from March 2020 to November 2020.[45]

The covid-19 crisis has been a stark reminder of the vulnerabilities in our healthcare systems. The prioritisation of emergency clinics and the transformation of routine hospital rooms into intensive care units negatively affected cardiometabolic risk management,[46] which may have contributed to longer term health consequences that we are just starting to observe.[47] Populations with the highest burden of covid-19, including people affected by chronic disease or multimorbidity and those with a poor nutritional status, should therefore be prioritised for healthcare and specialised nutritional support (eg, older adults at risk of malnutrition) to reduce disease severity.

Overall, the covid-19 pandemic has amplified existing inequalities and undermined the already fragile progress towards achieving the United Nations sustainable development goals by 2030, particularly those concerning good health and wellbeing for all. Amid this challenge, lies a real opportunity to raise the profile of optimal nutrition within the intricate social determinants of health. By recognising the importance of nutrition as a critical component, health systems can be reoriented towards a proactive approach that emphasises health promotion rather than focusing solely on treatment. Emphasising nutrition as a core pillar of public health efforts will be instrumental not only to combating the immediate effects of covid-19 and other prevalent chronic diseases but also to paving the way for reducing health inequalities while building healthier and more resilient populations.

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