



Jointly Modelling Economics and Epidemiology to Support Public Policy Decisions for the COVID-19 Response: A Review of UK Studies

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Abstract

COVID-19 in the UK has had a profound impact on population health and other socially important outcomes, including on education and the economy. Although a range of evidence has guided policy, epidemiological models have been central. It is less clear whether models to support decision making have sought to integrate COVID-19 epidemiology with a consideration of broader health, wellbeing and economic implications. We report on a rapid review of studies seeking to integrate epidemiological and economic modelling to assess the impacts of alternative policies. Overall, our results suggest that few studies have explored broader impacts of different COVID-19 policies in the UK. Three studies looked only at health, capturing impacts on individuals with and without COVID-19, with various methods used to model the latter. Four models considered health and wider impacts on individuals' economic outcomes, such as wages. However, these models made no attempt to consider the dynamic impacts on economic outcomes of others and the wider economy. The most complex analyses sought to link epidemiological and dynamic economic models. Studies compared a wide range of policies, although most were defined in general terms with minimal consideration of their granular specifications. There was minimal exploration of uncertainty, with no consideration in half the studies. Selecting appropriate models to inform decisions requires careful thought of factors relevant to the decision options under consideration such as the outcomes of interest, sectors likely to be impacted and causal pathways. In summary, better linking epidemiological and economic modelling would help to inform COVID-19 policy.

1 Introduction

In the UK, the COVID-19 pandemic has had a profound impact on health with 4.1 million confirmed cases, over 430,000 patient admissions to hospital and over 120,000 deaths of individuals with a positive COVID test within 28 days until 23 February 2021 [1]. The impact on the economy of the virus and policies to control COVID-19 is also stark, with GDP in November 2020 approximately 9% below its

Key Points for Decision Makers

Policies to control COVID-19 such as lockdowns and vaccination strategies impact on population health in various ways, but also on a wider set of economic outcomes.

Few UK-focussed studies have attempted so far to balance health and economic outcomes of these policies, using a joint epidemiological and economic modelling framework.

Future studies to support decision making should provide appropriate linkage between epidemiological and economics models, have suitable granularity to evaluate nuanced policy options and characterise decision uncertainty if they are to explicitly and appropriately quantify the inevitable trade-offs between the different aspects of population health and wellbeing and livelihoods associated with COVID-19 control policies.

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pre-pandemic level [2]. There are likely also to have been major non-COVID-19 health effects (for example, those associated with mental health [3] and reductions in contacts with the health system [4]) as well as negative non-health consequences such as impacts on children's educational outcomes [5]. Similar patterns have emerged across the world with variation in the magnitude of impacts.

In the UK, there has been a range of policy decisions aiming to control the virus. These have included three versions of national lockdown, social distancing measures, test and trace of symptomatic cases, mandatory use of face coverings, regional tiered restrictions, travel restrictions and phased vaccination of the population. Considerable prominence has been given to the epidemiological evidence informing these decisions, most notably the use of epidemiological modelling. Modelling provides a technical framework, which, when parametrised and calibrated to available data, can simulate the epidemic under different scenarios and in the context of different policies. Although policy has doubtless been guided by a range of different evidence, it is less clear whether this has included models aiming to estimate a broad range of impacts from COVID-19 control policies based on the same core epidemiological evidence and assumptions. Given the inevitable trade-offs between alternative policy specifications in terms of their impacts on outcomes such as COVID-19-related health, health and wellbeing effects in individuals without COVID-19, other consequences of social value such as educational outcomes and wider economic metrics, there has been a potential role for broader-based modelling. Such integrated quantitative modelling might be labelled decision analytic in that it has the potential to be explicit regarding important considerations for decisions such as the key trade-offs between policies, the implications of alternative normative judgements about how to value alternative outcomes and the magnitude of evidential uncertainty.

This paper reports on a rapid review of published and grey literature up until November 2020. It aimed to identify studies seeking to integrate epidemiological, clinical and economic modelling to assess alternative COVID-19 control policies. The paper reports on the modelling approaches, types of impacts reported and policies evaluated. It seeks to draw insights into how such integrated models can best inform future policy decisions relating to COVID-19.

2 Methods

A rapid review was conducted to identify studies detailing modelling that aimed to integrate both economics and epidemiology with a view to informing UK policy decisions on COVID-19. In particular, these were studies that reported the outcomes for epidemiological, clinical and

economic metrics relating to alternative policies to control the epidemic in the UK in a modelling framework that was driven by a common epidemiological transmission model.

Systematic database and website searches were conducted in November 2020 to identify published and pre-printed titles (search strategies detailed in Online Resource 1, see Electronic Supplementary Material [ESM]). PubMed, Embase, arXiv, medRxiv, SSRN, Research Square, the economic websites of the National Bureau of Economics Research (NBER) and Centre for Economic Policy Research (CPER) real-time papers were searched. Supplementary online searching via Google was undertaken to identify grey literature reports (further details in Online Resource 1, see ESM).

The review included UK-focussed studies comparing at least two alternative policies and including an epidemiological model of severe acute respiratory syndrome coronavirus 2 (SARSCoV-2) transmission that linked to the estimation of outcomes beyond the direct health impacts of COVID-19 and/or wider economic impacts. The type of epidemiological models considered was not restricted to model types. Static Markov models, Bayesian hierarchical models as well as dynamic Susceptible-Exposed-Infectious-Recovered (SEIR) models or individual-based models, and both computer simulations and analytical solutions were included in the search and considered for inclusion. The inclusion criteria required that the studies quantified at least one of the following impacts of alternative policies:

- Costs falling on the health care sector (including direct costs related to COVID-19 [e.g. health care and consumables such as personal protective equipment] and unrelated health care costs);
- Non-COVID-19 health outcomes measured in terms of mortality, life-years or quality-adjusted life-years (QALYs), implying a trade-off between non-COVID-19-related and COVID-19-related health;
- Impacts on the UK public sector economy outside the NHS or on the private sector;
- Individual economic outcomes (e.g. wages, productivity, private consumption);
- Monetised value of avoided COVID-19 fatalities.

The search results were screened for inclusion independently by two researchers (AD and AM) at the title and abstract level. Full-text titles were retrieved for the studies identified at this first stage of screening, and assessed against the inclusion/exclusion criteria by the same researchers. Disagreement on inclusion of studies were resolved by a third researcher (SW).

A data extraction table developed for the purpose of this study was applied to each of the included studies (see Table 1 in Online Resource 2 [see ESM]). Data were

extracted on the following: decision problem, model structure (including the approach taken to link the epidemiological and economic components), outcomes, resource use and costs, constraints captured in the model, decision rules applied and the strengths and weaknesses in the approach taken to reflect economic impacts as identified by the study's authors. The extraction focused on obtaining information to characterise the approach taken to address the decision problem, rather than to assess the validity of study results and conclusions. A narrative approach to synthesis was taken given the heterogeneity between studies in their methods and metrics estimated.

3 Results

3.1 Studies Included

Results of the rapid review are summarised using a PRISMA flow chart [6] (Fig. 1). The searches identified 791 relevant titles. One additional publication [7] was sent to the authors via private correspondence (Dr Katharina Hauck, Imperial College. Personal communication by email, November 2020) and was also considered for screening. After deduplication and the first level of screening, 25 full-text manuscripts were assessed for inclusion. Thirteen of these titles did not match the inclusion/exclusion criteria. One further title [8] was excluded because, while the study relied on an underlying comparison of a policy of lockdown with no lockdown, it assessed the impact on GDP loss of knowledge on infection status conditional on symptoms rather than comparing alternative policies. More details on the excluded studies at full-text screening, including reasons for exclusion, are presented in Online Resource 2, Table 2 (see ESM). Data were extracted for the 11 studies included [7–9, 15–18].

3.2 Modelling Approaches

The approaches taken to link the epidemiological model component to health and wider impacts vary substantially across studies. These approaches can be grouped under three main categories, as illustrated in Table 1.

The health-only models captured the impacts of policies on the health of individuals with and without COVID-19 [13, 17, 18], but did not include non-health outcomes (e.g. earnings). These studies all used epidemiological models to estimate the number of deaths and hospitalisations due to COVID-19 under different policies to control the disease. In contrast, the health impacts on individuals without COVID-19, and the methods used to capture them, varied across studies. In principle, common links could have been applied between the modelled impacts of policies on COVID-19 cases and their health outcomes and the health impacts on others. For example, the impact of lockdown policies, which reduce average social contacts in a community, on COVID-19 cases, serious illness, hospitalisation and mortality could be generated by the 'engine' of the transmission model. The reduction in social contacts could also have driven the incidence of mental health problems, and the rates of hospitalisation against inpatient and outpatient capacity could have determined the cancellation of medical procedures and appointments for individuals without COVID-19 and their consequences for health outcomes. The studies that sought to estimate these 'indirect' impacts on the health of individuals without COVID-19 did not exploit any formal links in the model. In two studies [13, 18], these indirect impacts of COVID-19 and control policies on individuals without the disease are informed by assumptions and external data sources, with these impacts not directly linked to the epidemiological model. One study simply contrasts the magnitude of the impact on life expectancy of patients with COVID-19 of alternative COVID-19 control policies against the impact of suicide, drug poisoning and socioeconomic inequality-related deaths on life expectancy in the general population [17].

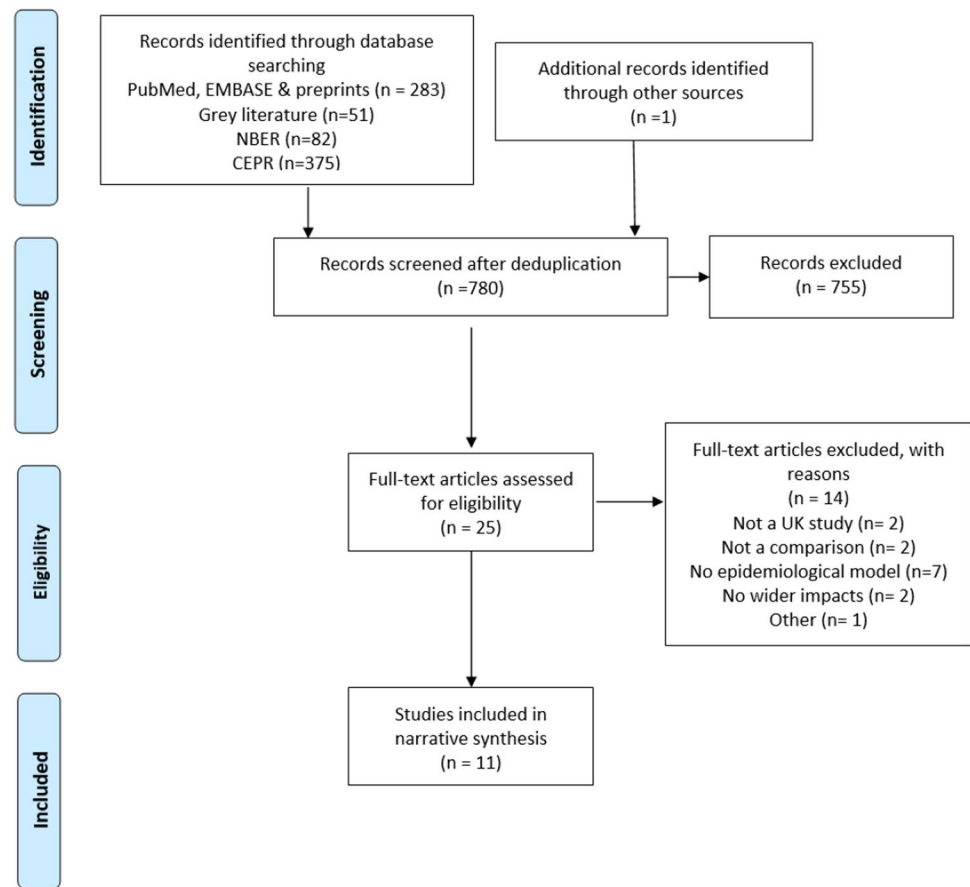
Health and individual outcome models aimed to capture the impact of policies on individuals in terms of their health and their economic outcomes, such as wages. However, these models did not attempt to implement the dynamic impacts of policies on economic outcomes associated with other individuals or the wider economy within the economic model component, even if the epidemiological component was dynamic (i.e. captured interactions between individuals to model disease transmission). Four studies [10, 11, 15, 16] used similar approaches to capture individual outcomes as those studies including health outcomes in individuals

Table 1 Modelling approach

Health only model	Health and individual outcomes	Health and general equilibrium/ dynamic model	Other
Dolan and Jenkins [13], McCartney et al. [17], DoHSC et al. [18]	Colbourn et al. [10], Cont et al. [11], Zala et al. [15], Sandmann et al. [16]	Haw et al. [7], Aum et al. [9], Keogh-Brown et al. [14]	Cuñat and Zymek [12]

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Fig. 1 PRISMA flow diagram.
 CPER Centre for Economic
 Policy Research, *NBER*
 National Bureau of Economics
 Research



without COVID-19. That is, whilst they utilised epidemiological models to capture the health outcomes for those with COVID-19, these studies applied external evidence, ‘delinked’ from epidemiological and clinical outcomes, to estimate the impact of policies on wider individual outcomes. Three of these studies capture the impact of social distancing measures [10, 11, 16]. Colbourn et al. [10] assume the number of contacts per day (type of contact not explicitly defined) in the epidemiological model to be a proxy for economic activity and relate this parameter to impact on GDP. In contrast, Sandmann et al. [16] assume a proportional relationship between daily incidence of COVID-19 and GDP loss. Cont et al. [11] estimated a social cost based on reduction in social contacts. One other study [15] based health outcomes on the outputs of an epidemiological model, while GDP impacts were sourced from the outcomes of a macroeconomic model for a hypothetical influenza pandemic with no direct link with the COVID-19 epidemiological model.

The most complex model structures, health and general equilibrium/dynamic models, directly linked an epidemiological model to a general equilibrium or other dynamic

economic model, which allowed them to capture impacts of the economic activity of an individual on other individuals and the wider economy. Aum and colleagues [9] developed a model linking infection transmission to a production economy model. The model captured the impact of labour supply choices (working from home or not) on individual earnings, utility (based on consumption, health and a ‘fear’ factor) and GDP. Two studies [7, 14] captured the impacts of COVID-19-related reductions in labour supply on outputs of a multi-sectoral macroeconomic model. Haw et al. [7] modelled the optimisation of policies to control COVID-19 based on GDP maximisation subject to a number of constraints including health care system capacity, relationship between supply and demand between sectors, level of demand and levels of economic activity reduction across sectors.

Cuñat and Zymek [12] took an alternative approach to modelling the impacts of the disease on welfare which fell outside of the classification of model types. They applied a model of individual location choice to capture the impact of geographical restrictions and loss of life on welfare, based on country-specific estimates of the value of life (which was GDP based in the UK case).

3.3 Policies Compared

The studies compared a wide range of alternative policies to control COVID-19, as summarised in Fig. 2.

Mitigation usually referred to a package of measures aiming to slow the spread of disease, so as to manage the burden on the health care system and to protect the most vulnerable [19]. These measures included household isolation (when one member is identified as infected), shielding of vulnerable individuals, school closures and social distancing of the population. Suppression policies include similar measures but aimed to reduce and maintain the number of infected cases in the population at a low level [19]. Both types of policy were considered in the epidemiological modelling by Ferguson et al. [19], which informed UK government policy when the first lockdown was declared in March 2020. Five of the included studies [13–18] compared mitigation and/or suppression policies to a ‘do nothing’ or unmitigated pandemic policy. Mitigation and suppression policies were compared against each other and/or to a ‘do nothing’ policy where no measures are set in place to control disease spread (also referred to as ‘unmitigated pandemic’).

Lockdown policies consisted of a set of social distancing and confinement measures, with the exact details varying across studies. Lockdown was used as a general term (or referred to the set of measures defined by the UK government in March 2020). Some studies compared lockdown policies with different time profiles for start and release [9, 10]. Other studies compared lockdown policies with particular geographical patterns (centralised vs decentralised lockdown rollout) [20] or pre-planned versus adaptive lockdown [11].

Social distancing policies were considered in two studies [11, 16]. These policies were loosely defined as those that reduce contacts between individuals. It is worth noting that there was considerable overlap in the individual measures that comprised lockdown, social distancing and mitigation

policies, with some of these terms used interchangeably within the same study.

While most studies compared a small number of generally defined policies including multiple disease control measures (such as mitigation, suppression and lockdown), others compared a wider set of policies that are defined more granularly. Colbourn et al. [10] compared a number of different policies combining different levels of population-scale test and trace (whole population vs symptomatic cases, and over different timelines) with lockdown release (at particular timepoints or triggered by number of infections) and the use of face coverings. These policies also included the package of measures imposed by the UK government in March 2020 and a ‘do nothing’ policy. Sandmann et al. [16] compared vaccination, with varying levels of assumed effectiveness, with and without social distancing.

Test and trace policies were only evaluated in two studies [9, 10]. One study considered the easing of lockdown restrictions for individuals with hypothetical ‘virus visas’, demonstrating they have antibodies to the virus, while maintain the intensity of lockdown for the remaining individuals [9]. A ‘virus visas’ policy implicitly requires antibody testing to be widely available. Only one study considered travel restrictions; Cuñat and Zymek [12] assessed regional quarantines (imposing barriers to travel within countries) [9]. Only two studies [9, 11] explicitly compared the impact of closures of different sectors of the economy (and at different levels of activity), including school closures.

3.4 Outcomes, Resource Use and Costs

The outcomes, resource use and costs considered in the studies are presented in Fig. 3. All but one of the studies quantified the health outcomes of patients infected with COVID-19. These outcomes included number of deaths [7, 10, 12, 14, 16, 18], infections [7, 10, 14, 16], hospitalisations [10, 14, 16] and ICU cases [7, 10, 14, 16]. Three studies

Study	Do nothing	Mitigation	Suppression	Whole population T&T	Symptomatic T&T	Lockdown	Face coverings	Sector closures	Quarantine	Vaccine	Social distancing	Virus visas	Number of comparisons
Aum et al., [9]													5
Colbourn et al., [10]													31
Cont et al. [11]													9
Cuñat & Zymek [12]													5
DoHSC et al. [18]													6
Dolan & Jenkins [13]													2
Haw et al., [7]													5
Keogh-Brown et al. [14]													3
McCartney et al. [17]													2
Sandmann et al. [16]													18
Zala et al. [15]													3

Fig. 2 Policies compared in the included studies. *DoHSC* Department of Health and Social Care, *T&T* test and trace

Study	Outcomes			Cost and resource use					
	Health COVID patients	Health non COVID patients	Non health	Health care sector COVID related	Health care sector non COVID related	Other public sector	Private sector	Across all sectors	Individuals
Aum et al., [9]									
Colbourn et al., [10]									
Cont et al. [11]									
Cuñat & Zymek [12]									
DoHSC et al. [18]									
Dolan & Jenkins [13]									
Haw et al., [7]									
Keogh-Brown et al. [14]									
McCartney et al. [17]									
Sandmann et al. [16]									
Zala et al. [15]									

Fig. 3 Outcomes, costs and resource use included in the studies. DoHSC Department of Health and Social Care

quantified the health outcomes of COVID-19 patients in terms of QALY losses [15, 16, 18] and one used ‘welfare loss’ [12].

The health outcomes of non-COVID-19 patients were included in five studies [13, 15–18], including impacts on mortality [13, 17, 18, 20] and health-related quality of life (HRQoL) [15, 16, 18]. Mortality outcomes were expressed in terms of numbers of deaths and years of life lost or accrued; while HRQoL was expressed as QALY losses.

Wider non-health outcomes captured included GDP losses [7, 9, 10, 15], gross value added (GVA; a sector-specific measure of production outputs) losses [7], value of a day of life [12] (based on either average daily consumption or statistical value of life) and earnings [9], which were expressed in absolute monetary terms (pound sterling or purchasing-power-adjusted US dollars) or as a proportion (e.g. percentage of GDP or earnings loss). GDP and GVA losses were also considered as costs falling on the economy more generally, which could fall on the public sector, private sector or across all sectors, depending on the level of aggregation at which the studies reported them.

Only four studies [10, 14–16] reported costs falling on the NHS budget. The studies all included costs associated with hospitalisations (ICU and non-ICU) and death/end of life. In addition, Sandmann et al. [16] considered vaccine-related costs (acquisition, administration and adverse events management), enhanced personal protective equipment, visits to general practitioners and remote helpline calls. Colbourn et al. [10] included the costs of tests and contact tracing. The costs reported in these studies were expressed in pound sterling, with the exception of Keogh-Brown et al. [14] where costs were expressed in terms of real GDP, government or private consumption (in pound sterling or as a percentage).

Costs falling on the individual included the social cost of physical distancing (a theoretic cost expressed without units) [11], value of a day of life (in pound sterling or purchasing-power-adjusted US dollars) [12] and reductions in private consumption (in pound sterling) [14].

4 Discussion

One of the many challenges of analysis to support policy decisions relating to COVID-19 is the inevitable range of possible costs and consequences across individuals and sectors of the economy. However, this review identified only 11 UK-focussed modelling studies that assessed the impact of COVID-19 control policies on non-COVID-19-related health outcomes and/or wider economic outcomes. To address the fact that this apparently small number may reflect the delayed timeline of publication of studies, we also searched grey literature, including preprints, to identify relevant studies. Despite the small number of studies identified, there was considerable variation between studies in the modelling approaches taken, the policies compared, the health and economic impacts captured and the values used to inform decisions.

Any assessment of the appropriateness of the modelling approaches taken needs to consider the specific decision problem(s) being informed, including the nature of the policy options, the outcomes relevant to the decision makers and how these are valued. The majority of modelling approaches identified considered quite broad policy options and, consequently, lacked granularity to compare more nuanced policies with multiple potential specifications. This approach may be suitable to inform higher level policy decisions, such as comparing the impact of early versus extended national lockdown. However, the

lack of granularity restricts not only the types of policies that can be informed, but also the range of outcomes of interest that can be captured. The decision to increase the level of detail in the model structure should depend on whether additional granularity in particular model features allows modelling causal links not captured otherwise and whether modelling these is likely to have a sizeable differential impact across policies [21]. Although an increase in granularity may be desirable, this may be constrained by data availability.

Since March 2020, the governments of the UK have rolled out a number of COVID-19 control policies; these include three different forms of national lockdown (with different sector closures in each), social distancing measures, test and trace of symptomatic cases, mandatory use of face coverings, regional-level restrictions conditional on local infection levels (i.e. the tier allocation system), travel restrictions and phased vaccination of the population. Models like the one proposed by Haw et al. [7] seem particularly suited to evaluate different forms of lockdown and schedule partial sector closures subject to explicit health and economic constraints such as level of transmission, health care system capacity, level of school closures, etc. Different modalities of test and trace policies have been modelled by Colbourn et al. [10], who demonstrated the potential impact on health outcomes and GDP of these types of policies in combination with different lockdown start and stopping rules, and the use of face coverings.

However, policies such as the tier allocation system (in terms of their specification and/or compared with whole-nation arrangements) have not been formally modelled in the identified studies. Models that consider regional heterogeneity in transmission rates [11] may be better suited to model these policies, but would require extensions to capture the impacts on health and wider outcomes of travel restrictions between regions and different levels of uptake of these restrictions by the public. Another challenge in modelling to inform policies such as the tier allocation system relates to the heterogeneity of measures that are considered within tiers and uncertainty regarding their relative impact on transmission rates and economic outcomes. None of the identified studies appears to have the granularity to capture the differential impact of different tier allocation system specifications (e.g. the use of the initial three-tier system vs the most recent five tiers in England). Travel restrictions between countries have also been overlooked by the UK studies; extensions to existing models to characterise the impact of international travel restrictions would be an important feature as new variants of the virus emerge with different infectiousness and potential to impact mortality and morbidity. There has been a concern about the impact of the pandemic and policy responses on health inequalities [22]. None of the models considered the impact of policies on this measure of

outcome and potential trade-offs with other outcomes. Existing methods could have been used to quantify potentially unequal policy impacts across socioeconomic groups (or groups defined according to other dimensions of equality). These methods require that the identification of the relevant groups and that differences in these groups are reflected in the model parameters (e.g. different vaccine uptake rates by ethnicity) and are propagated to final model outputs to quantify the differential impact of the policies across the groups. This also allows quantifying the impact of the policies on overall (health) inequality [23].

A common limitation of the identified studies relates to the consideration of uncertainty in the health and economic effects of policies. Almost half of the studies did not assess uncertainty [9, 10, 12, 17, 18], and the others did so in a limited manner, which mostly consists of testing a few structural assumptions and/or the robustness of the results when varying key parameters [7, 13–16]. Only one study claimed to have incorporated parameter uncertainty, although it is unclear how this was conducted [11]. It is unclear whether data limitations or model features were the main barriers in considering uncertainty in existing studies. Quantifying uncertainty is crucial when projecting outcomes from both epidemiological and economic modelling and for informing decision uncertainty. Consideration of uncertainty should be routinely incorporated in the models, or, where this is not feasible, its potential implications should be discussed.

Ensuring the appropriateness of models to inform decision making requires careful consideration of the modelling approach, both within the epidemiological and economic elements of the model, the available evidence and the methodology to quantify uncertainty. It should also focus on the main factors relevant to decision options, such as the outcomes of interest, sectors likely to be impacted and causal pathways. The selection of modelling approach is also interconnected with the set of policy options under comparison and the suitable level of granularity required to evaluate them. The characteristics of the COVID-19 pandemic and the associated policy options require a type of modelling that is not widely used to inform resource allocation decisions in health. The widely used models in health technology assessment generally focus on a narrow set of direct health effects without explicit consideration of disease transmission and use a health system perspective on costs. There are good examples of models using transmission modelling and economic evaluation [24, 25], although technical challenges exist in terms of reflecting the full range of uncertainties. The use of economic evaluation to inform policy decisions when costs and consequences fall across different types of individuals and sectors is also not a well-developed area [26]. Although modelling policy options relating to COVID-19 is characterised by often extreme uncertainty in estimated effects, there are also challenging normative issues about

how to value different types of impact to inform policy trade-offs. So far, policies to control COVID-19 spread in the UK have appeared to focus on preventing immediate irreversible harms (COVID-19-related deaths). While the potential harms of these policy responses to, for example, the economy and educational outcomes, may be ameliorated to some extent in the future, it is unclear how and whether potentially irreversible versus reversible harms have been explicitly considered by policy makers in the inevitable trade-off they had to make. Models that seek to bring together the epidemiological, clinical and economic implications of policies cannot solve these normative issues but can make them more transparent. There remains a question, however, as to how explicit policy makers want to be in exposing those trade-offs when justifying policy choices.

The findings of our study need to be considered in the context of the limitations imposed by its scope and design. This study aimed to characterise the available modelling studies that have aimed to integrate epidemiological and economics evidence that could be used to inform UK-level COVID-19 control policies. The narrow focus on UK modelling studies may have excluded relevant evidence from other countries that might have some applicability to UK policy. However, the restricted scope allowed for a rapid review and examination of evidence with direct relevance to UK decision makers. It also highlighted the knowledge gaps and limitations, which may be addressed by further modelling. The use of a rapid systematic review design during the public health crisis, as opposed to a full systematic review beyond the pandemic, also limits the body of evidence examined in terms of its comprehensiveness. There is, nevertheless, value in using a rapid review to characterise the current state of evidence to support contemporaneous decision making and to guide future research. Finally, narrowing the scope of the study to published papers, preprints and grey literature on modelling studies may not capture other types of evidence relevant to policy makers (e.g. interviews with policy makers and analysts to provide insight into the determinants of the real-time policy choices during the COVID-19 pandemic [27]).

5 Conclusion

A small number of UK-focussed studies have attempted to balance the health and economic outcomes of these policies, using a joint epidemiological and economic modelling framework. When selecting modelling approaches, future studies to inform decisions should carefully consider a number of factors relevant to decision options, such as the outcomes of interest, sectors likely to be impacted and causal pathways. This is strongly interconnected with the set of

policy options under comparison and the suitable level of granularity required to evaluate them. In summary, a better linkage between impact, from epidemiological models, and economic costs of different policies is necessary for the appropriate assessment of COVID-19 policies.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s40273-021-01045-2>.

Declarations

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Ethical approval This study did not require any ethical approval.

Authors contributions All authors contributed to the study conception and design. Ruth Wong developed and conducted the literature searches. Ana Duarte, Andrew Metry and Simon Walker screened and identified titles for inclusion, and performed the data extraction. Ana Duarte drafted the manuscript with substantial input from all authors. Mark Sculpher had oversight of the project. All authors read and approved the final manuscript.

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