

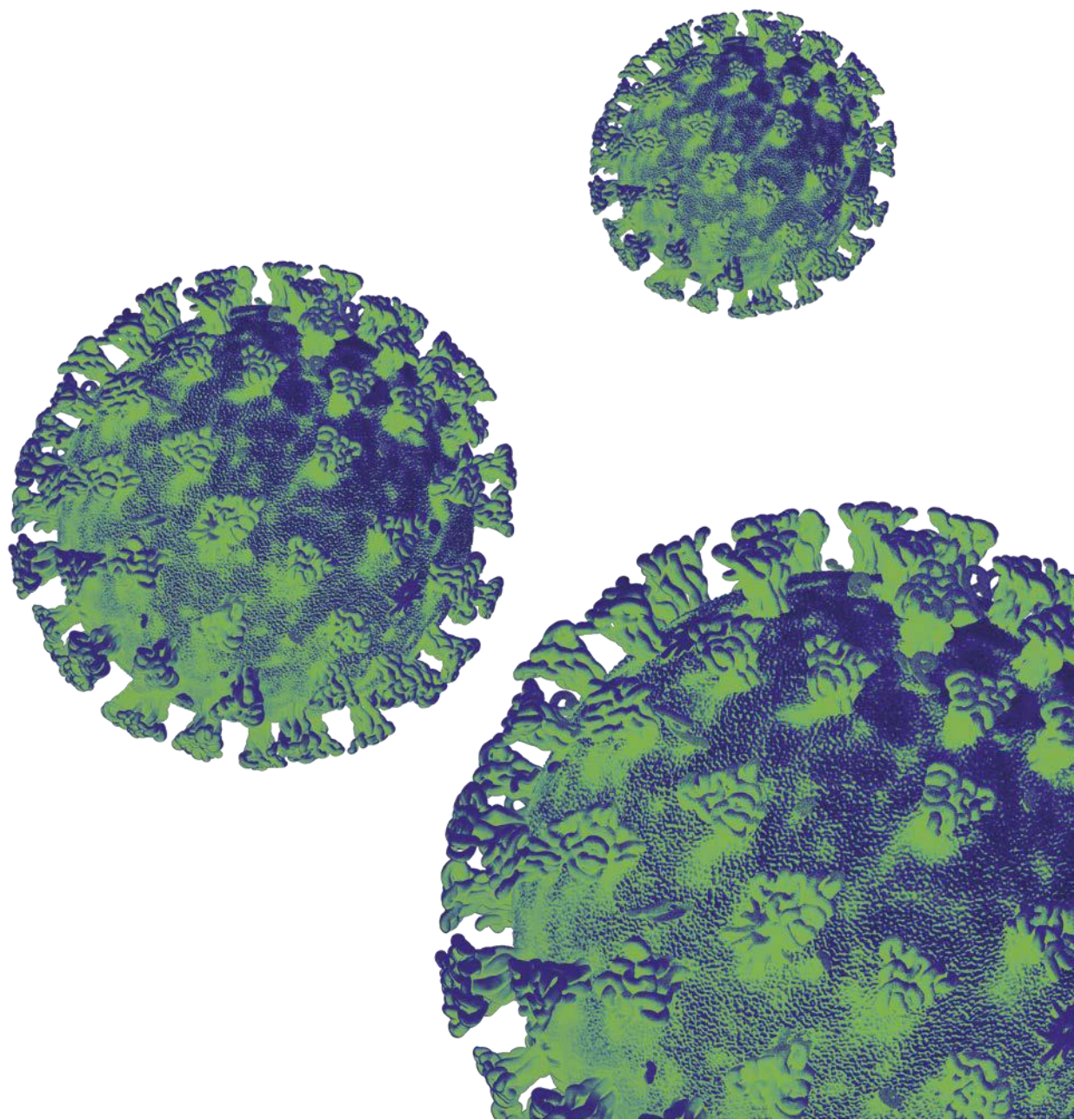


Llywodraeth Cymru
Welsh Government

Technical Advisory Group

What is the social value of a covid case and how has it changed?

20th August 2021



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Summary

This paper outlines the estimated direct social cost of one covid-19 case in December 2020, and in July 2021, to understand how this has changed over time. This is based on the ratio of cases to other outcomes – hospital admissions, ICU admissions, deaths and estimated long covid cases.

In December 2020, it is estimated that one covid-19 case had a social cost of around £13,000 whereas in July 2021, because of the vaccination programme and other interventions put in place to reduce cases and severe outcomes, the social cost of one covid-19 case is around £2,500. These estimates were robust to changes in assumptions around the costs and Quality Adjusted Life Year losses (an estimate of quality and quantity of life; QALY) associated with cases, admissions, and long covid. This has implications for the value for money for future policies to prevent covid-19 cases, while continuing to consider that preventing one infection prevents onward infections.

Introduction

Understanding the cost effectiveness of interventions to prevent covid-19 transmission is important. Previous analysis of mass testing has suggested it was very cost effective during a time of high prevalence and when vaccines were not yet available.¹ But it is likely that mass testing might not be cost effective now that there are fewer severe outcomes from covid-19 cases – the majority of the social value of preventing cases was from preventing deaths.

¹ [Cost-effectiveness of whole area testing of asymptomatic SARS-CoV-2 infections in Merthyr Tydfil, 2020: A Modelling and economic analysis | medRxiv](#)

To understand more about this, it is possible to estimate the Quality Adjusted Life Years (QALYs) and costs of every covid-19 case, on average, to help to balance the impact of interventions. Governments and health systems have fixed budgets with opportunity costs of spending more on covid-19 and less on other health conditions and social problems. If preventing covid-19 cases has a smaller return on investment than investing in other areas of health, then there is a case for moving investment elsewhere, for instance to other public health interventions for primordial prevention of cardiovascular disease, cancer and chronic obstructive pulmonary disease.²

Decisions need to be based on an integrated impact assessment where costs and benefits are quantified as best as possible. For instance if children lose around £1,600 in lifetime earnings for every week of face to face schooling they miss (based on losing £37,000 for 23.5 weeks of lost face to face schooling in England³), then this would need to be weighed against the social value of covid-19 cases prevented.

This short paper estimates the social cost of one covid-19 case in Wales at two different points in time: December 2020 which was in the middle of the second wave; and July 2021, which is in the middle of the third wave of covid-19 infections. This will enhance understanding of the changes in social cost of covid-19 over time and as the vaccination programme has progressed, offering further insight to decision-makers around the relative value of interventions to prevent Covid-19 cases.

Methods

Data on cases, admissions, ICU admissions and deaths was from Public Health Wales ICnet. We assumed hospital admissions occur 7 days after case onset, ICU 10 days after onset, and death 20 days after onset, on average. QALY losses and costs for cases, hospital, ICU and deaths as well as long covid, were multiplied by numbers of each outcome for December 2020 and July 2021. Our estimated QALYs and costs have been published previously.⁴ We discounted mortality related QALYs at 3.5% per annum to give a discounted loss of 6.78 QALYs per covid death. Actual data was used for confirmed cases, hospital and deaths, while long covid was estimated as described below.

² [Return on investment of public health interventions: a systematic review | Journal of Epidemiology & Community Health \(bmj.com\)](#)

³ [Education-Recovery_EPI.pdf](#)

⁴ [technical-advisory-cell-modelling-update-12-february-2021.pdf \(gov.wales\)](#)

Self-reported long covid prevalence varies by age.⁵ By estimating the percentage of the total population with self-reported long covid who previously had covid 12 weeks ago or more, we can estimate the proportion of covid cases that result in long covid by age group. To do this we combined the UK-level percentages of self-reported long covid from ONS Covid Infection Survey (CIS), with population data and confirmed covid cases by age for England. England data was used as the sample size was much larger than Wales, and England made the majority contribution to the UK sample for long covid in the CIS. This gave an estimated proportion of covid cases that became long covid (Table 1). This would not include people who were not yet 12 weeks post infection, or where they had long covid in the past but it had resolved itself – these may balance out to some extent. These were applied to cases in December and July by age group to get a weighted average of long covid cases – so assuming the proportion of cases leading to long covid is constant in each age group. Table 2 shows the estimated percentage and number of long covid cases in Wales in December 2020 and July 2021; this suggests that because the age structure of cases has changed, the percentage of cases that would result in long covid may have fallen from 16% in December 2020 to 12% in July 2021.

Table 1. Estimated proportion of confirmed Covid-19 cases that become long covid, based on ONS Covid-19 infection survey data combined with confirmed case data for England, up to 5th June 2021.

Age group	Estimated proportion of Covid-19 cases that become long covid
0-24	5%
25-34	11%
35-49	18%
50-69	26%
70+	16%

⁵ [Prevalence of ongoing symptoms following coronavirus \(COVID-19\) infection in the UK - Office for National Statistics \(ons.gov.uk\)](https://ons.gov.uk/people-and-population/health-and-life-expectancy/articles/prevalence-of-ongoing-symptoms-following-coronavirus-covid-19-infection-in-the-uk/2021-06-06)

We used Table 5 - Estimated percentage of people living in private households with self-reported long COVID who first had (or suspected they had) COVID-19 at least 12 weeks previously, UK: four-week period ending 6 June 2021

Table 2. Number of confirmed covid cases, and estimated long covid cases, December 2020 and July 2021. Actual cases data from PHW ICNet data- excludes age unknown.

Age group	0-24	25-34	35-49	50-69	70+	All ages
Number of cases Dec 2020	15,921	12,761	16,643	18,126	7,085	70,536
Estimated Long covid cases Dec 2020	852	1,398	2,915	4,683	1,167	11,015
Estimated % cases leading to long covid Dec 2020	5%	11%	18%	26%	16%	16%
Number of cases July 2021	10,662	4,496	4,192	3,047	880	23,277
Estimated Long covid cases Jul 2021	571	492	734	787	145	2,729
Estimated % of cases leading to long covid Jul 2021	5%	11%	18%	26%	16%	12%

Combining these estimates for the costs and QALY loss and number of cases, admissions, ICU and deaths gives an estimated number of outcomes per 100 covid cases, and an estimated social cost (financial cost plus QALYs lost valued at £60,000 per QALY) per covid case.

Results

The social cost of a Covid-19 case in December 2020 was around £13,000 whereas in July 2021 it was around £2,500. In December 2020, the QALYs lost from Covid-19 deaths made up the vast majority of social costs whereas in July 2021, morbidity-related QALYs and costs – in particular, long covid-related, made up around half of the social costs, with mortality making up the other half. So over time the social costs of Covid-19 are moving from mortality to morbidity. Interestingly ICU had not fallen as much as total admissions or deaths as a proportion of cases, which may be related to differences in clinical decision making in admitting people to ICU – for instance when there is more available capacity, changes in the age structure of hospital cases, or increased severity of non-vaccinated cases with the Delta variant.

Table 3. Number of long covid, admissions, ICU admissions and deaths per 100 covid cases in December 2020 and July 2021, with social cost per covid case.

December 2020							
100 Cases Produces:	Cases	Long covid cases	Admissions	ICU admissions	Deaths	Total	Social cost per covid case (£)
	100	15.6	6.8	0.4	2.7		
QALYs lost	0.009	2.340	0.076	0.015	18.195	21	
costs (£)	0	0	47987	9490	623	58,100	
total net monetary loss (£)	533	140,400	52,563	10,377	1,092,339	1,296,212	12,962
July 2021							
100 Cases Produces:	Cases	Long covid cases	Admissions	ICU admissions	Deaths	Total	
	100	11.7	2.2	0.3	0.3		
QALYs lost	0.009	1.755	0.025	0.010	1.956	3.755	
costs (£)	0	0	15,729	6,538	67	22,334	
total net monetary loss (£)	533	105,300	17,229	7,149	117,449	247,660	2,477

Figure 1 shows how the majority of social costs in December 2020 was through deaths, whereas in July 2021 it is split mainly between deaths and long covid. Figure 2 is a schematic showing how the outcomes of 100 covid cases has changed over time.

Figure 1. Social cost of 100 covid cases, disaggregated into cases, long covid, admissions, ICU and deaths.

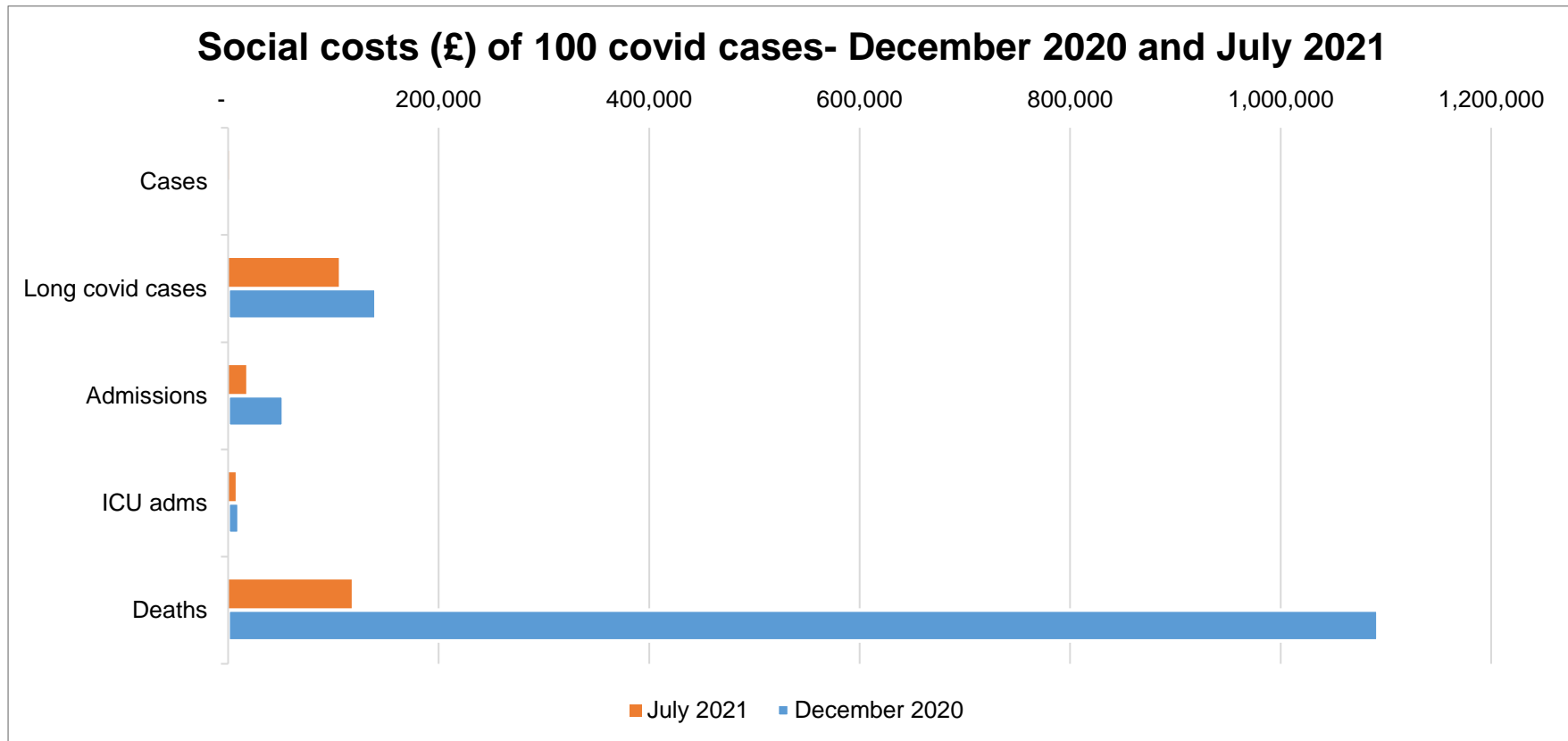
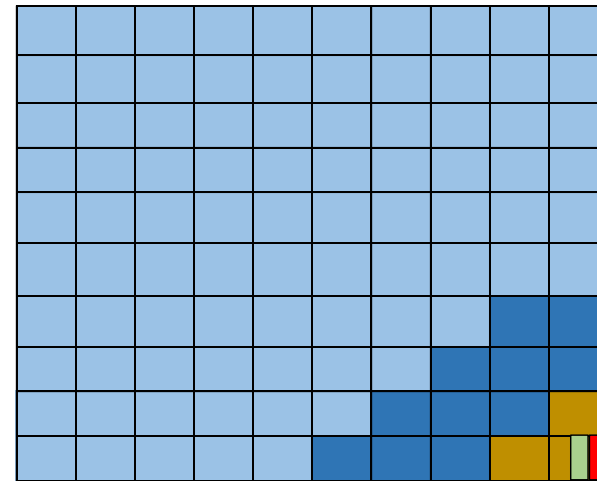
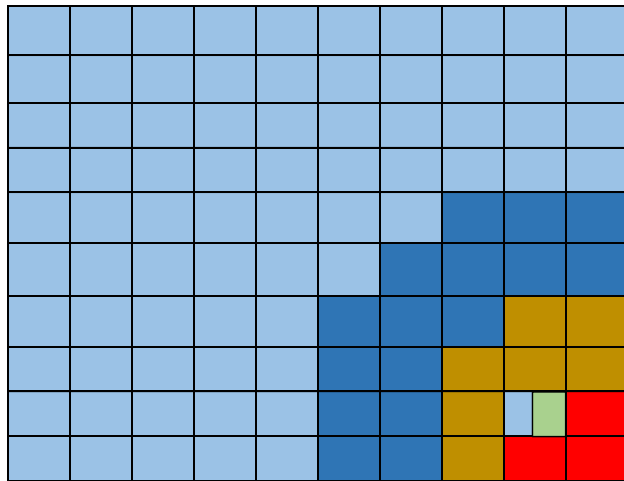


Figure 2. Outcomes per 100 covid cases in December 2020 and July 2021. Note this shows each outcome independently; in reality there will be overlap, so some individuals will be a hospital case, ICU case, and death. Numbers greater than 1 have been rounded.

Outcomes per 100 covid cases in December 2020

Outcomes per 100 covid cases in July 2021



Sensitivity analysis

We carried out two sensitivity analyses. Firstly, we substituted our cost and QALY estimates with those from a paper by Sandmann and colleagues (2021)⁶. In general the QALY losses in this paper were a lot higher than our basecase QALY losses, and the costs of hospital and ICU admissions were lower. This paper also included costs of community covid cases, assuming that 5% would require GP consultation and 10% would have a telephone NHS 111 consultation. We kept the mortality costs and QALYs from our original basecase scenario for this sensitivity analysis as the QALY estimates used similar life table methods to ours and the Sandmann paper did not include specific mortality costs.

In the second sensitivity analysis, we included additional £100 costs per covid case to represent potential productivity losses, and also had £4,000 costs per long covid case to represent an estimate of excess healthcare costs for long covid. These were simply to see the impact of including these costs – they were not based on any estimate from the literature but we felt like they were missing from the analysis.

The assumptions and results are shown in more detail in Appendix 1 and 2. Although the costs and QALYs associated with individual outcomes were very different, the overall social costs of one covid case were fairly similar to our base case scenario, at around £12,000 in December 2020 and £2,000 in July 2021 using the Sandmann parameters, and around £13,200 in December 2020 and £3,000 in July 2021 using original plus productivity and long covid costs (Table 4). So overall this suggests that the results of our analysis are fairly robust to changes in assumptions. This is partly because the mortality costs and QALYs did not change and these make up a large proportion of social costs.

⁶ Sandmann FG, Davies NG, Vassall A, Edmunds WJ, Jit M, Sun FY, Villabona-Arenas CJ, Nightingale ES, Showering A, Knight GM, Sherratt K. The potential health and economic value of SARS-CoV-2 vaccination alongside physical distancing in the UK: a transmission model-based future scenario analysis and economic evaluation. *The Lancet Infectious Diseases*. 2021 Mar 18.

Table 4. Summary results of sensitivity analysis.

Scenario	Time period	Social cost per covid case (£)
Original	Dec-20	12,962
	Jul-21	2,477
Sens 1: Sandmann paper assumptions	Dec-20	11,971
	Jul-21	1,994
Sens 2: original with productivity and long covid costs	Dec-20	13,156
	Jul-21	3,045

Discussion

Previous modelling work carried out across UK Government has estimated the costs and QALYs lost through the pandemic at a macro level;⁷ in this analysis we have not included indirect costs and QALYs lost (for instance through displaced healthcare, mental health problems related to social isolation, unemployment etc). Covid-19 has exacerbated health inequalities; we have not weighted costs or QALYs by socioeconomic position but this would be possible to do and the social costs would be higher if we did this. This paper does not disaggregate social costs of covid-19 by age – in reality the majority of social costs of Covid-19 are now in 50-69 year olds, particularly unvaccinated groups, with comorbidities, who are higher risk of hospitalisation, but also higher risk of long covid.

Most of the change in the social cost of Covid-19 cases is because of the vaccination programme, which started with health and social care workers as well as the oldest and most vulnerable groups and worked down the age bands into younger age groups. However the age structure of cases is often different at different times in the pandemic which will also drive hospitalisation and mortality; for instance it is likely that the first and second waves (in around March and September 2020) started with more cases in younger people before moving into older people and then producing outbreaks in hospitals and care homes. There are estimates of how many deaths have been prevented by vaccination, with PHE/Cambridge University estimating that around 85,000 deaths in

⁷ [DHSC/ONS/GAD/HO: Direct and indirect impacts of COVID-19 on excess deaths and morbidity - December 2020 update, 17 December 2020 - GOV.UK \(www.gov.uk\)](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/92424/dhsc-ons-gad-ho-direct-and-indirect-impacts-of-covid-19-on-excess-deaths-and-morbidity-december-2020-update-17-december-2020.pdf)

England have been prevented by the vaccination programme as of 6th August 2021.⁸ If we crudely assume Wales is 5.6% of England then this would be around 4,700 deaths prevented in Wales.

We have estimated the number of long covid cases per 100 cases based on self-reported data from the ONS survey – however there are issues with this around the self-reported nature of the data, possible issues around time lags, and possible changes over time in the risk of long covid. For instance it may be that if a proportion of Covid-19 cases now are in people who have been vaccinated, they may have a milder case than if they had not been vaccinated, and this may be less likely to lead to long covid. But there may also be differences in long covid risk between different variants – so during December, Alpha variant was becoming dominant, whereas during July, Delta was dominant.

Once nearly all adults have been vaccinated, we might find that perhaps counter-intuitively, an increasing proportion of cases are in the vaccinated population (known as the ‘base rate fallacy’),⁹ because a small rate of cases in a high number of vaccinated individuals produces a larger number than a large rate of cases in a small number of unvaccinated individuals. However it may be that the majority of cases are in children in future who should not have severe outcomes.

If we see waning immunity or new variants that are more transmissible or escape immune responses then the social costs of Covid-19 cases may increase again in future.

This paper outlines individual costs of Covid-19 cases, but there are other social costs that are non-linear. Evidence from the burgeoning field of economic epidemiology suggests that people change their behaviour based on their fear of infection.¹⁰ Evidence from the US suggests that states that were slow to implement restrictions to control the pandemic may have seen a similar reduction in economic activity because even with light touch state intervention, people’s behaviour changes in a pandemic due to fear of infection.¹¹ Therefore, even as social costs of Covid-19 cases are lower, there are externalities around having high rates of cases where economic activity may be affected. Economic activity has also been affected when high numbers of people have had to self-isolate.

⁸ [COVID-19 vaccine surveillance report - week 32 \(publishing.service.gov.uk\)](https://www.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/100000/covid-19-vaccine-surveillance-report-week-32.pdf)

⁹ [Comparison of Covid cases in a country where almost 90% of the population is vaccinated – GRID](#)

¹⁰ Bayham J, Kuminoff NV, Gunn Q, Fenichel EP. Measured voluntary avoidance behaviour during the 2009 A/H1N1 epidemic. *Proceedings of the Royal Society B: Biological Sciences*. 2015 Nov 7;282(1818):20150814.

¹¹ Goolsbee A, Syverson C. Fear, lockdown, and diversion: Comparing drivers of pandemic economic decline 2020. *Journal of Public Economics*. 2021 Jan 1;193:104311.

In the introduction, we mentioned about the estimated lost earnings from missing schooling - £1,600 per week. The effects of self-isolation and lockdown policies on schools are non-linear. An extra case within a school would clearly have led to missed schooling within the bubble due to self-isolation. However, cases in the community probably had relatively low effects on educational outcomes until they reached the threshold when school closures became necessary, at which point the education costs of extra cases becomes huge.

In this paper we have valued QALYs at £60,000 in line with UK Treasury Green Book advice,¹² however there has been debate about the health production cost in the English NHS being much lower than £60,000 – possibly as low as £5,000,¹³ evidence that has also been used to suggest that NICE’s threshold for paying for new health technologies is too high (often quoted as £20,000 - £30,000).

Covid-19 spread is non-linear and SARS-COV-2 has a low overdispersion parameter (k), meaning a small proportion of cases are responsible for a lot of onward transmission, while a high proportion of cases may only infect zero or one other person. So it may be regarded as less useful to say the value of an *average* covid case; but it is still relevant to decision making, and efforts should continue to focus on where overdispersion (‘superspreader’) events are likely to happen.¹⁴

Conclusion

Although there is some uncertainty around the social costs in this paper, and they may not include all relevant costs, it is likely that in December 2020, it was good value for money to spend £12,000 to prevent one covid case, whereas now it is unlikely to be good value for money to spend more than £4,000 to prevent one Covid-19 case, on average. This is because the direct social costs of one Covid-19 case are estimated to be lower than in December 2020 and therefore it may be favourable to allocate spending to other areas of improving health. However because Covid-19 is an infectious disease, one case leads to another, so any interventions need to ideally be modelled to see their effect on the whole epidemic curve.

¹² [The Green Book and accompanying guidance and documents - GOV.UK \(www.gov.uk\)](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/92422/gb202001.pdf)

¹³ Martin S, Lomas J, Claxton K, Longo F. How Effective is Marginal Healthcare Expenditure? New Evidence from England for 2003/04 to 2012/13. Applied Health Economics and Health Policy. 2021 Jul 21:1-9.

¹⁴ Endo A. Estimating the overdispersion in COVID-19 transmission using outbreak sizes outside China. Wellcome open research. 2020;5.

Thank you

Thank you to everyone who provided comments on this paper including Rebecca-Jane Law, Adam Jurd (Welsh Government) and Luke Sibieta (Education Policy Institute).

Appendix 1. QALY estimates and costs used.

Blue boxes are changed in sensitivity analysis.

QALY loss and unit costs

	original				
	Cases	long covid	admissions	ICU	deaths
QALY	0.0000889	0.15	0.0112603	0.034569863	6.78
costs			7,085	22198	232

Sensitivity analysis 1

based on Sandmann et al 2021

	Cases	long covid	admissions (non fatal)	ICU (non fatal)	deaths
QALY	0.008	0.034	0.0201	0.15	6.78
costs	3.336		1,770	1504	232

Notes

For cases used 5% *£39 GP visit plus 10% * £13.86 cost of 111 call used original for death QALYs and costs - no death costs included in study

Sensitivity analysis 2. including productivity cost of cases and long covid cost

including productivity loss per case £100 and long covid costs £4000

	Cases	long covid	admissions (non fatal)	ICU (non fatal)	deaths
QALY	0.0000889	0.15	0.0112603	0.034569863	6.78
costs	100	4000	7,085	22198	232

Appendix 2. Full Results of Sensitivity Analyses.

Sensitivity analysis using Sandmann (2021)

100 Cases Produces	Cases	Long covid cases	Admissions	ICU adms	Deaths	total	social cost per covid case (£)
December 2020	100	15.6	6.8	0.4	2.7		
QALYs lost	0.800	0.530	0.136	0.064	18.195	20	
costs	334	0	11991	643	623	13,591	
total loss	48,334	31,824	20,160	4,491	1,092,339	1,197,147	11,971
100 Cases Produces	Cases	Long covid cases	Admissions	ICU adms	Deaths		
July 2021	100	11.7	2.2	0.3	0.3		
QALYs lost	0.8	0.3978	0.0	0.0	2.0	3.2	
costs	334	0	3930	443	67	4774.1	
total loss	48,334	23,868	6,608	3,094	117,449	199,352	1,994

Sensitivity analysis using £100 productivity loss per case and £4000 excess costs per long covid case

100 Cases Produces	Cases	Long covid cases	Admissions	ICU adms	Deaths	total	social cost per covid case (£)
December 2020	100	15.6	6.8	0.4	2.7		
QALYs lost	0.009	2.340	0.076	0.015	18.195	21	
costs	10,000	9,360	540	328	4,221	24,450	
total loss	10,533	149,760	5,117	1,215	1,095,937	1,262,562	12,626
100 Cases Produces	Cases	Long covid cases	Admissions	ICU adms	Deaths		
July 2021	100	11.7	2.2	0.3	0.3		
QALYs lost	0.009	1.755	0.025	0.010	1.956	3.8	
costs	10,000	46,800	15,729	6,538	67	79,134	
total loss	10,533	152,100	17,229	7,149	117,449	304,460	3,045