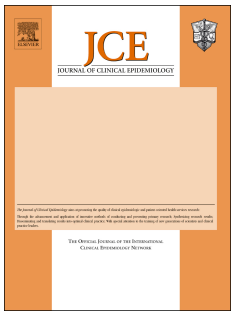

Exploring the effect of COVID-19 restrictions on the Social Functioning Scale in a clinical trial of Antipsychotic Reduction: using multiple imputation to target a hypothetical estimand

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Title Exploring the effect of COVID-19 restrictions on the Social Functioning Scale in a clinical trial of Antipsychotic Reduction: using multiple imputation to target a hypothetical estimand

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Abstract

Objective: Many trials are affected by unforeseen events after recruitment has commenced. The aim of this study is to explore a hypothetical strategy for dealing with an intercurrent event that occurred during trial follow-up; COVID-19 restrictions.

Study Design and Setting: Secondary analysis of a randomised controlled trial in schizophrenia, comparing antipsychotic reduction versus maintenance medication on the Social Functioning Scale (SFS) score at 12 months' follow-up. A hypothetical analysis strategy was used to estimate the treatment effect in a COVID-19 restriction-free world. Outcome data were set to missing and multiple imputation was used to replace values affected by COVID-19.

Results: The trial randomised 253 participants, 187 participants had an SFS score at 12 months, 75 of those were collected during COVID-19 restrictions. In the original complete case regression analysis, targeting a treatment policy estimand, the treatment effect was estimated to be 0.51 (95%CI -1.33, 2.35) points higher in the reduction group. After multiple imputation, targeting the hypothetical estimand, the mean SFS score was -3.01 (95%CI -7.22, 1.20) points lower in the reduction group, but varied with different assumptions about the timing of events and in sensitivity analyses to increase the size of difference between randomised groups.

Conclusion: We demonstrated how the intervention effect can change when estimating the intervention effect in a pandemic world (treatment policy estimand) versus a pandemic restriction-free world (hypothetical estimand) and that estimates are sensitive to imputation and input assumptions. Trialists should be aware of potential intercurrent events and plan the analysis to take them into account.

Keywords: missing data, COVID-19, estimands, social functioning, multiple imputation, randomised controlled trial

Abstract word count: 251
Manuscript word count: 3125 to the end of the conclusion

Running title: Multiple imputation and the hypothetical estimand

Plain Language Summary
Many medical research studies that enable us to find out how well things work had to change due to COVID-19 restrictions. This may have altered the results. We used data from a randomised controlled trial to examine whether there was evidence for this. The main outcome included questions on how often participants went to the cinema, swimming, to church or saw friends or relatives. Many of these activities were not possible during COVID-19 restrictions and became possible again over time. We used statistical methods to replace data that were collected during COVID-19 restrictions with the best possible estimate if COVID-19 had not happened. We found that the trial results were likely to have been different if the effect of COVID-19 restrictions were taken away. It is likely that most studies will be interested in results that do not include data collected during COVID-19.

What is new

Key findings
The intervention effect can change when estimating it in a pandemic world (treatment policy estimand) compared to a pandemic free world (hypothetical estimand).

Estimates are sensitive to imputation techniques and assumptions made; both should be considered in detail before analysis is carried out.

What this adds to what is known?
Intercurrent events may not be observed at the beginning of a trial. The estimand framework enables the research question to be reframed once new intercurrent events become clear.

Changes in intercurrent events are not unique to pandemics. They may occur due to other events that disrupt studies whilst in progress; for example, flooding or earthquakes. The methods used in this paper could be used in those situations too.

What is the implication, what should change now?
Trialists should be aware of potential intercurrent events and their potential implications as early as possible, adding sensitivity analyses to the statistical analysis plan to explore the effects of intercurrent events.

1 Introduction

During the COVID-19 pandemic, ongoing randomised controlled trials (RCT) were disrupted in many ways. For example, some had to stop recruiting, while others could continue follow-up, but were unable to do this in person moving to online or telephone contact and data collection. This overnight step change in the way trials were conducted had a profound impact on ongoing trials. For affected trials to provide useful and reliable estimates of the intervention effect, many statistical challenges needed to be overcome[1,2].

There was some guidance regarding mitigating the effects of COVID-19 to ongoing trials from regulatory bodies including the Medicines and Healthcare Products Regulatory Agency (MHRA), European Medicines Agency (EMA) and Food and Drug Administration (FDA)[3–5]. Their main message was to collect as much data as possible and develop an analysis plan for mitigating any problems before database lock. These were practical guidance but did not set out how such trials should be analysed.

The motivating example for this paper is Research into Antipsychotic Discontinuation and Reduction (RADAR)[6,7], an RCT of people with schizophrenia who were assigned to either reduction or maintenance of antipsychotics over two years' follow-up. This trial completed recruitment shortly before COVID-19 restrictions in England (16/03/2020), but follow-up continued remotely under COVID-19 restrictions, with some participants returning to in person appointments as restrictions eased.

The trial's primary outcome was the Social Functioning Scale (SFS), a 79 item, seven section measure (social engagement/ withdrawal, interpersonal communication, independence – performance, recreation, prosocial, independence – competence, occupation/ employment), which asks about the previous three months[8] (Table A1). This trial aimed to identify whether there was a difference in changes in social functioning between randomised groups measured at 6, 12 and 24 months, with primary endpoint at 24 months. However, many SFS items were not relevant during lockdown as many related to activities that were impossible to do[1]. For example, the independence–performance section asks about frequency of using the bus or trains in the previous three months, and the prosocial section enquires about activities such as going to the theatre, cinema, pub, playing sports, church activities – all of which were not permitted during restrictions, and only slowly reopened as restrictions eased (Appendix A).

The aim of this paper is to compare the trial's original planned treatment estimand and analysis approach which ignored COVID-19 to a hypothetical estimand which removed the impact of COVID-19 restrictions.

2 Methods

2.1 The RADAR trial

The trial design is described fully in the protocol paper and main results paper[6,7]. Briefly, RADAR was a two arm, 1:1 individually randomised controlled trial examining antipsychotic reduction versus antipsychotic maintenance. The trial included adults aged over 18 years with schizophrenia, schizoaffective disorder, delusional disorder or non-affective psychosis, who had at least one previous psychotic episode or a single episode lasting at least a year and were being prescribed antipsychotic medication.

2.2 Estimands

The planned primary analysis for RADAR as detailed in the statistical analysis plan was written after the pandemic began, with the estimand aligning with the primary analysis not stated. The original approach taken was to use all data for the main analysis without mitigation for the COVID-19 restrictions[9]. Although not stated explicitly in RADAR, this aligns with a treatment policy strategy for handling the intercurrent event of COVID-19 restrictions by ignoring the occurrence of COVID-19, i.e. addressed the treatment effect regardless of COVID-19

restrictions [11,12]. A sensitivity analysis which used a three-level categorical variable in a linear regression model was originally used to take account of the national level of restrictions (no COVID-19 restriction; partial restriction - non-essential shops being open; full restrictions - non-essential shops being closed) when the data were collected (Appendix B). A second sensitivity analysis where the model included an interaction between the COVID-19 restriction variable and randomised group was conducted. These mitigations did not alter the between randomised group differences[6].

However, alternative methods have been proposed to explore the effect of COVID-19 on an outcome using the estimand framework given in ICH-E9 (R1) as described by Cro et al[9,10]. The aim of this research is to explore these methods using data collected at 12 months from RADAR. The SFS data collected at 12 months was used as the outcome in this paper as a substantial portion was collected during COVID-19 restrictions. Cro et al explain how a hypothetical strategy can be employed to handle the intercurrent event of COVID-19 to understand the treatment effect in the absence of COVID-19 restrictions. A hypothetical strategy is one that assumes the intercurrent event has not happened[9]. We decided on the additional estimand we were aiming to achieve with this analysis, with respect to the study population, treatment condition of interest, the outcome to answer the research question, how to account for intercurrent events and the population level summary to give evidence of a difference between treatment groups (Figure 1). Specifically, we targeted the hypothetical estimand of the mean difference in SFS at 12 months for reduction compared to maintenance of antipsychotics for the population of eligible participants recruited to RADAR in a COVID-19 restriction free world.

2.3 Statistical methods

Details on how to calculate the SFS score and how missing items were handled are in Appendix C.

For all analyses, those who died before their 12-month follow-up was due were omitted from analysis. This aligned with the analysis of the trial[6] and the principal stratum intercurrent event strategy[11], which targets the intervention effect for only those who would not experience the intercurrent event of death, assuming death was independent of randomised treatment[12].

Initially summary statistics for the SFS at 12 months, including mean and standard deviation (SD), were calculated by level of restrictions. We performed linear regression analysis, with robust standard errors, including the randomisation variable and baseline SFS score in the model. This analysis is the same as the sensitivity analysis in Moncrieff et al[6] (shown in the supplementary material) using the treatment policy estimand. This was repeated including the COVID-19 restriction variable at 12 months.

To estimate the hypothetical estimand, SFS scores at 6 and 12 months collected during any COVID-19 restrictions were set to missing [13]. We then first fitted a similar model to the main model of interest without the data that were collected when there were any COVID-19 restrictions. This analysis assumed the missing outcomes of those individuals set missing due to COVID-19 restrictions were similar to those with the same value of covariates included in the analysis model who were observed during times without COVID-19 restrictions (i.e. missing at random), hence suitable for estimating the hypothetical estimand of interest. We tested which variables were related to the outcome and missingness; more details in Appendix D.

Next, we used multiple imputation by chained equations[14] as an alternative analytical method to estimate the hypothetical estimand in this study. This is suitable for handling the hypothetical intercurrent event because multiple imputation assumes those whose SFS score were set to missing were similar to those participants with the same covariates included in the

imputation model (missing at random). We included SFS at baseline, which would be part of the substantive models, factors associated with missingness of the outcome and factors associated with the outcome in the imputation model. Additionally, a small number of factors related to demographics and psychiatric history were included in the imputation model. We did not include the dichotomous variable related to COVID-19 timing as we did not want that to influence imputed values. We imputed the two randomised groups separately and appended them together before analysis. For imputation, we utilised linear regression for continuous variables, ordered logistic regression for educational attainment, and alcohol consumption and Poisson regression for number of mental health admissions at baseline. We could not include drug use (yes or no) or employed (yes or no) in the final imputation model despite them being predictors of missingness of the outcome because the imputation models would not converge with them included despite utilising bootstrap methods or augmenting the data as suggested by White et al[15]. We chose 100 multiple imputations for the main and sensitivity imputation models because this was above the number needed to satisfy the rule of thumb of the Monte Carlo error of an estimate being less than or equal to 10% of its standard error[14]. We did not include data from those who died before 12-month follow-up as it would be impossible for them to have 12-month follow-up data. Data missing for other reasons (all data at 12 months missing before, during or after COVID-19 restrictions, missing baseline data) were similarly imputed. The same linear regression model as the complete case models was used to analyse each imputed dataset, and Rubin's Rules[16] were used to obtain the overall treatment effect (95%CI) across imputed datasets. Sensitivity analyses explored the impact of varying restriction start dates for both estimands and for the hypothetical estimand, the impact of a better outcome than predicted under multiple imputation using a tipping point approach to vary delta until the significance was changed (Appendix E).

Results of the predictors of missingness and association with the outcome analyses for the main and sensitivity analyses can be seen in Tables A2-A3 and A5-A6 in the appendix. Descriptive statistics for complete case and after both multiple imputations are in Table A7 in the appendix.

All analyses were carried out using Stata version 17.

3 Results

At 12 months, 193/253 participants provided responses to some of the SFS items, 187 provided sufficient data to calculate an overall SFS score, 112 (60%) of these were when there were no COVID-19 restrictions, 40 (21%) when there were partial restrictions and 35 (19%) when there were full restrictions (75 (40%) with data collected at 12 months under any restrictions). The only difference in baseline characteristics between those who did (n=62) and did not have missing SFS data (n=187) at 12 months was educational attainment; a greater percentage of those who did not have missing data had tertiary education compared with those who had missing SFS at 12 months (42% versus 27% respectively) (Table A8 in the appendix). Four participants died before 12 months, three in the reduction group and one in the maintenance group, giving 249 participants who could have provided data at 12 months. Baseline characteristics by COVID-19 restrictions at 12 months are shown in Table 1 and mean (SD) SFS scores under the scenarios used in this paper are in Table 2.

Table 1: Baseline descriptive statistics by COVID-19 restrictions at 12 months

	No restrictions		Any Restrictions	
Characteristic	n/N	%	n/N	%
Male	69/112	62	53/75	71
Female	43/112	38	19/75	25
Transgender	0/112	0	3/75	4
Age mean (SD)	47	(11)	47	(12)
White	69/111	62	57/75	76
Black	26/111	23	12/75	16
Asian	9/111	8	4/75	5
Other	7/111	6	2/75	3
SFS score mean (SD)	109	(9)	107	(10)

Table 2: Descriptive statistics for SFS scores at 12 months under a number of scenarios related to COVID-19 by randomised group.

	Reduction group		Maintenance group	
Scenario	Mean	(SD)	Mean	(SD)
Using all available data (n=187)	106	(9)	107	(10)
No restrictions (n=112)	106	(9)	108	(11)
Any restrictions (n=75)	106	(8)	105	(10)
Hypothetical scenario with data imputed (100 imputations) (n=248) randomised groups imputed separately	105	*(14)	108	*(14)
Sensitivity (MI δ=0.5)	105	*(14)	109	*(14)
Sensitivity (MI δ=1.0)	105	*(14)	109	*(14)
Sensitivity (MI δ=1.5)	105	*(14)	110	*(14)
Sensitivity analyses				
No restrictions (n=154)	107	(10)	108	(11)
Any restrictions (n=33)	106	(8)	103	(8)
Hypothetical scenario with data imputed (100 imputations) (n=249) randomised groups imputed separately	106	*(10)	107	*(11)
Sensitivity (MI δ=0.5)	106	*(10)	108	*(11)
Sensitivity (MI δ=1.0)	106	*(10)	108	*(11)
Sensitivity (MI δ=1.5)	106	*(10)	109	*(11)

*SD the mean of the SD from each imputed dataset

Using data from participants who provided sufficient data to provide a score (complete case, treatment policy estimand) the adjusted treatment effect estimate was a non-significant higher score in the reduction group in comparison to the maintenance group (0.51; 95%CI -1.33, 2.35). This was attenuated slightly when including a categorical variable to indicate level of COVID-19 restrictions.

For the hypothetical estimand, when only including data when there were no restrictions, the result changed with a lower score in the reduction group although it remained not significant. After multiple imputation which included additional variables to predict the data affected by

COVID-19 for the hypothetical estimand, there was also a lower mean SFS score for those in the reduction group in comparison to maintenance group (Table 3).

Under sensitivity analysis conditions altering the COVID-19 restriction start and end dates, there were fewer 12-month SFS scores potentially affected by COVID-19 with 154 SFS completed without COVID-19 restrictions and 33 completed with restrictions. There was a greater percentage of male participants providing 12-month SFS data during restrictions (77%) than not during restrictions (63%) and the mean age was higher in the group providing 12 months SFS data during restrictions (Table A4). At 12 months those affected by COVID-19 restrictions in the reduction group had a mean SFS score of 106 (SD 8) and 103 (SD 8) in the maintenance group. There were a number of factors associated with 12-month SFS and missingness of the 12-month SFS (Tables A5-A6). Including predictors of missingness in modelling using the treatment policy estimand gave a lower SFS in the reduction than maintenance group. This was further lowered after multiple imputation using the hypothetical estimand.

Both sets of delta-based imputation models required an addition of 1.5 to the imputed SFS score in the maintenance group to reach the tipping point of the coefficient for the randomised group to be statistically significant (Table 3).

Table 3: Substantive model in terms of the reduction group under different data assumptions.

Model	Treatment Coefficient*	95% CI
Treatment policy estimand**		
Data and methods in the main paper (N=180)[6]	0.51	(-1.33, 2.35)
Including a categorical variable to indicate level of COVID-19 restrictions (3 categories) (N=180)	0.50	(-1.36, 2.37)
Including a categorical variable to indicate level of COVID-19 restrictions (2 categories) (N=180)	0.49	(-1.37, 2.35)
Sensitivity analysis similar to in the main paper including a categorical variable to indicate level of COVID-19 restrictions lagged (2 categories) (N=180)	0.34	(-1.53, 2.21)
Hypothetical estimand**		
Data collected when there were no COVID-19 restrictions (complete case) (N=101)	-0.81	(-3.45, 1.83)
Data collected when there were no COVID-19 restrictions including predictors of missingness (complete case) (N=100)	-0.82	(-3.42, 1.79)
After multiple imputation using hypothetical intercurrent events 100 imputations group imputed separately	-3.01	(-7.22, 1.20)
Sensitivity (MI δ=0.5) (N=248)	-3.43	(-7.64, 0.79)
Sensitivity (MI δ=1.0) (N=248)	-3.84	(-8.06, 0.37)
Sensitivity (MI δ=1.5) (N=248)	-4.26	(-8.48, -0.04)
Sensitivity analysis only including data not collected during lagged COVID-19 restrictions (complete case) (N=143)	-0.05	(-2.19, 2.09)
Sensitivity analysis only including data not collected during lagged COVID-19 restrictions including predictors of missingness (complete case) (N=140)	-0.50	(-2.67, 1.67)
After multiple imputation using hypothetical intercurrent events with changed dates of restriction (100 imputations) groups imputed separately (N=248)	-1.22	(-3.76, 1.33)
Sensitivity (MI δ=0.5) (N=248)	-1.67	(-4.22, 0.87)
Sensitivity (MI δ=1.0) (N=248)	-2.13	(-4.68, 0.41)
Sensitivity (MI δ=1.5) (N=248)	-2.59	(-5.13, -0.04)

All imputation analyses used 100 imputation and, imputation for each treatment group was conducted separately.
*In terms of the reduction group
**These strategies for dealing with intercurrent events are answering different research questions.

4 Discussion

This paper documents the potential problems of using the Social Function Scale during COVID-19 restrictions. The measure contained some items that were inaccessible during the pandemic, which could invalidate SFS as a measure. We found scores were lower during the pandemic which supports this. We suggest the measure is not an ideal outcome to use during a pandemic, but as the primary outcome of a trial cannot be changed, it would be important to undertake adjustments for this in the analysis such as the ones we demonstrate in this paper. Otherwise, the overall score would be too low and risks not showing a difference between

randomised groups at the outcome time point. The results of modelling the data using the treatment policy estimand, ignoring COVID-19 restrictions show that social functioning is higher in the reduction group.
In contrast the hypothetical estimand results that considered if COVID-19 restrictions did not happen were in favour of the maintenance group. This suggests COVID-19 had an impact on the treatment effect on the SFS score. However, for both estimands the estimated treatment effects were non-significant indicating this impact was not large enough to change the overall original conclusions of the study.[6]. The SFS has not been used by other published studies that have collected data during the COVID-19 restrictions of 2020 and 2021, so it is difficult to see whether the patterns shown in the data are unique to RADAR.

It may not be reasonable to assume the effect of the restrictions was immediate on participants. The results of the sensitivity analysis to examine the effect of a delayed impact of the restrictions showed a smaller difference between randomised groups. This is likely to be because the COVID-19 missing data were for a smaller group of participants who were truly affected by COVID-19. This possibly better represents those affected by COVID-19 than the crude delineation used in the main RADAR paper and the initial analyses in this paper. The delta based multiple imputation sensitivity analysis widened the gap in SFS score between the randomised groups, exacerbating the trend shown in the multiply imputed result before the delta method was carried out. This sensitivity analysis considered that those in the maintenance group who had missing SFS data (mostly due to COVID-19 restrictions) had even better social functioning than that shown by multiple imputation alone.

The treatment effect estimates for a pandemic restriction-free world was lower than the pre-specified clinically important difference in SFS score of four points used to power the trial.[17] However, the 95% confidence interval encompassed a decrease of more than four points in the primary reanalysis in this paper.

4.1 Strengths and limitations

We examined a number of scenarios, which could be considered the best and worst cases based on timing of when the SFS was completed in relation to COVID-19 restrictions and by considering the hypothetical intercurrent event. This gave a range of possible differences between randomised groups. It is likely the difference in a pandemic restriction-free world would have been greater than that shown in the trial paper[6] but may not be as large as our maximum difference with imputed SFS under the delta method, and therefore the estimate may not have reached the clinically important difference of 4, though this is likely to have been included in the 95%CI.

In our approach we imputed values for the total SFS score. It would have been preferable to impute values for each individual SFS item that had missing data, including those that were set to missing to take account of COVID-19 restrictions. However, this was not possible because this made the imputation models too complex, and it would not converge. Using simpler imputation models may mean we lost some accuracy in our estimates for the SFS in a pandemic free world.

Multiple imputation makes a strong assumption that the missing data are missing at random. Whilst this seems to be a reasonable assumption in this trial for participants whose SFS data were set to missing because of being collected during COVID-19 restrictions, this may not hold for those who did not provide data at other times during the trial. However, this is a common assumption used in many trials and will have been partially mitigated by including predictors of missingness. For participants who should have been followed up during COVID-19 restrictions, but were not, it is not clear whether this was because of COVID-19 – directly or indirectly or another reason unrelated to COVID-19 and therefore whether their data were likely to have been missing at random or another missing data mechanism.

We were most interested in an estimand in the absence of COVID-19 restrictions not COVID-19 in its entirety; for example, there was no intercurrent event related to a participant contracting COVID-19 infection and this is beyond the scope of this study. With the delta-based method of multiple imputation, the same adjustment was used for all data imputed in the maintenance arm, which may not have been appropriate for those in the maintenance groups whose SFS score was imputed.

We used a principal stratum strategy to handle death as an intercurrent event. This was the approach used in the main trial. While this may not be optimal, we employed this approach to align with the main paper. As there were only four deaths it is unlikely that another intercurrent event strategy would have changed the result.

Some trials in the pandemic replaced participants affected by COVID-19.[18]. This was not feasible for RADAR because funding was limited and many participants in RADAR were affected for at least one follow-up over the two-year follow-up. Mitigating through statistical methods was deemed to be a more feasible solution in these circumstances.

This unexpected intercurrent event, which could not have been fully mitigated against in RADAR because of the nature of the outcome, has to be reported correctly; to this end, the CONSERVE statement[19] was constructed in 2020 as an extension to CONSORT and STROBE to ensure that all important details related to a deviation from the protocol because of pandemics or other extenuating circumstances are fully explained.

5 Conclusion

This study demonstrates the potential impact of the pandemic on the results of the RADAR trial. We demonstrated how the intervention effect can change considerably when estimating the intervention effect in a pandemic world versus a pandemic restriction-free world (hypothetical estimand) and that estimates are sensitive to imputation and input assumptions. Trialists should be aware of potential intercurrent events and plan the analysis accordingly to take them into account.

6 Ethical approval

Written informed consent was obtained prior to participation in the trial, following a full explanation of the aims, methods, anticipated benefits and hazards of the trial. An assessment of each participant's capacity to provide consent was completed first. Following that, researchers asked for verbal consent at each follow-up assessment. All trial data were handled according to the UK Data Protection Act 1998 and UK General Data Protection Regulation (UK GDPR). The trial was approved by the Health Research Authority London - Brent Research Ethics Committee (reference 16/LO/1507) on 27/10/2016.

The trial was registered with the International Standard Randomised Controlled Trials register on 07/02/2017 (ISRCTN90298520), with ClinicalTrials.gov on 15/06/2018 (NCT03559426) and EudraCT number 2016-000709-36.

7 Data availability

The data will be downloaded and safely stored on a computing system maintained by University College London (UCL), London, UK. Deidentified participant data and a data dictionary will be made publicly available after publication through UCL's data repository (https://www.ucl.ac.uk/library/open-science-research-support/research-data-management/ucl-research-data-repository) according to NIHR policy.

8 Author contributions

JM was the Chief Investigator of RADAR. JM and SP conceived the idea of RADAR. LM and VRC conceived the idea of this paper. SC advised on the statistical analysis. LM undertook

the statistical analysis. LM wrote the first draft of the paper. All authors contributed to subsequent drafts of the paper.

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11 Conflict of interest
None declared

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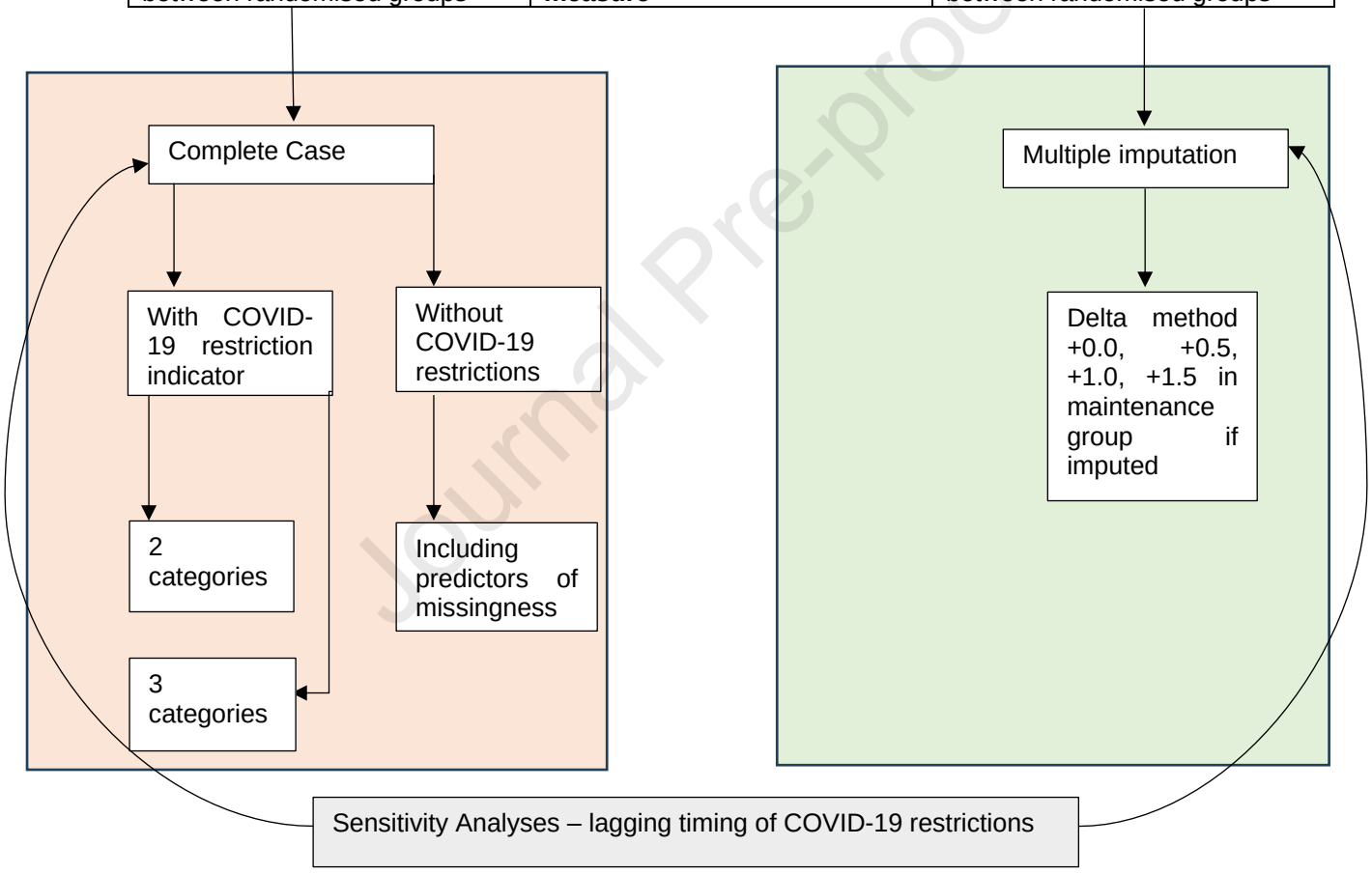
Figure 1: Flow diagram of estimands and analyses undertaken

Description in relation to RADAR original main analysis	**Estimand**	Description in relation to RADAR after COVID-19
People with schizophrenia or other psychosis who meet the RADAR eligibility criteria	**Population**	People with schizophrenia or other psychosis who meet the RADAR eligibility criteria
Discontinuation or maintenance of antipsychotics	**Treatment condition**	Discontinuation or maintenance of antipsychotics
Social Functioning Scale at 12 months	**Outcome**	Social Functioning Scale at 12 months
Covid pandemic - Treatment policy Death – Principal stratum	**Intercurrent event- strategy**	Covid pandemic – hypothetical policy (pandemic free world) Death – Principal stratum
Difference in SFS means between randomised groups	**Population Level summary measure**	Difference in SFS means between randomised groups



Highlights

It is important to think about the impact of unforeseen trial interruptions early

Analysis plans should be updated to take interruptions into account before analysis

A hypothetical estimand of pandemic free world is most appropriate for this situation

Multiple imputation was used to replace data collected interruptions

Results with the hypothetical estimand may differ to when interruptions are ignored

Declaration of interests

☐ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☒ The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Louise Marston reports financial support was provided by National Institute for Health and Care Research. Suzie Cro reports a relationship with National Institute for Health and Care Research that includes: funding grants. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.