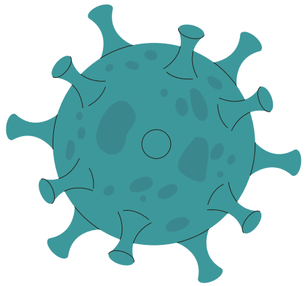
Global Pandemic

Analysing factors leading to excess deaths

WHY did we choose this topic?

The COVID-19 pandemic shook the whole world and led to 69,97,025 deaths globally.
In India, alone the pandemic led to 5,31,000 deaths.

76,27,91,152 cases- Globally



4,47,68,192 cases- India

OUR PROBLEM

With a recent increase in COVID cases, India again stands at the possibility of going through a catastrophic COVID way leading to large number of deaths. Through this project, we aim to analyse the data released by WHO to further find out which factors and their interactions are significant and are leading to excess deaths.

Our Purpose

Shift our focus on proper reporting of Covid deaths so as to inculcate the adherence of protective behaviours amongst individuals

Many studies suggest that knowledge supports adoption of protective behaviours like maintaining social distance, But expectations of strong illnesses actually thwart such behaviours

Such a mindset could prove to be fatal for others. Therefore, in light of reemergence of COVID in recent times, it would be useful to analyse the factors that cause excess deaths

Data Collection

We took secondary data for global excess deaths(modelled estimates) associated with COVID 19 released by World Health Organisation

income	year	sex	age	Nx	type	expected.mean	acm.mean	excess.mean
LIC	2020	Female	0 to 24	203977974	Predicted	852014	852014	0
LIC	2020	Female	25 to 39	65843490	Predicted	160914	149176	-11738
LIC	2020	Female	40 to 49	26801643	Predicted	139071	139805	734
LIC	2020	Female	50 to 59	18136805	Predicted	180251	195088	14837
LIC	2020	Female	60 to 69	11261450	Predicted	245556	279865	34309
LIC	2020	Female	70 to 79	5813135	Predicted	300020	329099	29079
LIC	2020	Female	80 plus	1743203	Predicted	223633	247736	24103
LIC	2020	Male	0 to 24	208309683	Predicted	1056490	1056490	0
LIC	2020	Male	25 to 39	65386472	Predicted	207103	183745	-23358
LIC	2020	Male	40 to 49	25950764	Predicted	181357	180039	-1318
LIC	2020	Male	50 to 59	16735763	Predicted	242116	262415	20299
LIC	2020	Male	60 to 69	9740786	Predicted	304748	348989	44241
LIC	2020	Male	70 to 79	4381209	Predicted	293639	334163	40524
LIC	2020	Male	80 plus	1066658	Predicted	158839	185768	26929
LIC	2021	Female	0 to 24	208445941	Predicted	831506	831506	0
LIC	2021	Female	25 to 39	68124322	Predicted	158571	164353	5782
LIC	2021	Female	40 to 49	27729035	Predicted	138856	154375	15519
LIC	2021	Female	50 to 59	18742260	Predicted	181266	213991	32725
LIC	2021	Female	60 to 69	11627425	Predicted	248387	304372	55985
LIC	2021	Female	70 to 79	5941427	Predicted	302937	353938	51001
LIC	2021	Female	80 plus	1861763	Predicted	236570	274313	37743
LIC	2021	Male	0 to 24	212910494	Predicted	1035222	1035222	0
LIC	2021	Male	25 to 39	67746944	Predicted	208527	210242	1715
LIC	2021	Male	40 to 49	26824358	Predicted	181941	201232	19291
LIC	2021	Male	50 to 59	17339446	Predicted	244533	289232	44699
LIC	2021	Male	60 to 69	10061079	Predicted	308775	379693	70918
LIC	2021	Male	70 to 79	4501886	Predicted	297339	364554	67215
LIC	2021	Male	80 plus	1149936	Predicted	169977	206777	36800
LMIC	2020	Female	0 to 24	762087503	Predicted	1933970	1918723	-15247
LMIC	2020	Female	25 to 39	378598490	Predicted	567762	522631	-45131
LMIC	2020	Female	40 to 49	191275477	Predicted	631098	630441	-657
LMIC	2020	Female	50 to 59	143324929	Predicted	1105181	1194529	89348
LMIC	2020	Female	60 to 69	94516981	Predicted	1700147	1932503	232356
LMIC	2020	Female	70 to 79	45403597	Predicted	1990046	2199839	209793
LMIC	2020	Female	80 plus	17412724	Predicted	2203123	2458215	255092
UMIC	2021	Female	0 to 24	405869877	Predicted	242953	245867	2914
UMIC	2021	Female	25 to 39	287091136	Predicted	205825	228216	22391
UMIC	2021	Female	40 to 49	179323237	Predicted	293950	344080	50130
UMIC	2021	Female	50 to 59	178643319	Predicted	634298	763685	129387
UMIC	2021	Female	60 to 69	129461666	Predicted	1230356	1531566	301210
UMIC	2021	Female	70 to 79	69203752	Predicted	1847601	2163420	315819
UMIC	2021	Female	80 plus	32979345	Predicted	3514529	3909934	395405
UMIC	2021	Male	0 to 24	443023132	Predicted	408804	412518	3714
UMIC	2021	Male	25 to 39	300001744	Predicted	534478	550347	15869
UMIC	2021	Male	40 to 49	180633935	Predicted	669371	753426	84055
UMIC	2021	Male	50 to 59	174836157	Predicted	1276625	1511722	235097
UMIC	2021	Male	60 to 69	119207503	Predicted	2167369	2649461	482092
UMIC	2021	Male	70 to 79	56570909	Predicted	2482711	2934705	451994
UMIC	2021	Male	80 plus	19905301	Predicted	2984083	3245630	261547
HIC	2020	Female	0 to 24	165662419	Predicted	56665	56521	-144
HIC	2020	Female	25 to 39	117182180	Predicted	70286	76871	6585
HIC	2020	Female	40 to 49	80201463	Predicted	114182	122148	7966
HIC	2020	Female	50 to 59	79915749	Predicted	275926	286175	10249
HIC	2020	Female	60 to 69	70738901	Predicted	530234	583868	53634
HIC	2020	Female	70 to 79	52826535	Predicted	955140	1059546	104406
HIC	2020	Female	80 plus	37916678	Predicted	3359355	3624360	265005
HIC	2020	Male	0 to 24	174474243	Predicted	101637	105545	3908
HIC	2020	Male	25 to 39	127118300	Predicted	159622	176145	16523
HIC	2020	Male	40 to 49	84245856	Predicted	203205	229682	26477
HIC	2020	Male	50 to 59	81082010	Predicted	490898	525670	34772
HIC	2020	Male	60 to 69	66537761	Predicted	907787	1014309	106522
HIC	2020	Male	70 to 79	44464325	Predicted	1327999	1510424	182425
HIC	2020	Male	80 plus	22955932	Predicted	2404438	2620759	216321
HIC	2021	Female	0 to 24	165298793	Predicted	55667	58397	2730
HIC	2021	Female	25 to 39	116774483	Predicted	70379	81188	10809
HIC	2021	Female	40 to 49	80054907	Predicted	113083	126763	13680
HIC	2021	Female	50 to 59	79979111	Predicted	273704	314431	40727
HIC	2021	Female	60 to 69	71542431	Predicted	530112	622475	92363
HIC	2021	Female	70 to 79	54109925	Predicted	964738	1106379	141641
HIC	2021	Female	80 plus	38677425	Predicted	3407203	3559460	152257

Data Collection

We further cleaned the data by grouping categories and considering 3 factors:

1. Income level of countries: We have taken 4 levels namely low-income countries (LIC), lower-middle income countries (LMIC), upper middle income countries (UMIC) and high income countries (HIC)
2. Age: We have taken 3 levels namely 0-40(0-24, 25-39), 40-60 (40-49,50-59) and 60+ (60-69,70-79, 80+)
3. Gender: We have taken 2 levels namely Male and Female

income	year	sex	age	total excess mean deaths
LIC	2020	Female	0-40	-11738
LIC	2020	Female	40-60	15571
LIC	2020	Female	60+	87491
LIC	2020	Male	0-40	-23358
LIC	2020	Male	40-60	18981
LIC	2020	Male	60+	111694
LIC	2021	Female	0-40	5782
LIC	2021	Female	40-60	48244
LIC	2021	Female	60+	144729
LIC	2021	Male	0-40	1715
LIC	2021	Male	40-60	63990
LIC	2021	Male	60+	174933
LMIC	2020	Female	0-40	-60378
LMIC	2020	Female	40-60	88691
LMIC	2020	Female	60+	697241
LMIC	2020	Male	0-40	-117767
LMIC	2020	Male	40-60	136052
LMIC	2020	Male	60+	1016994
LMIC	2021	Female	0-40	64095
LMIC	2021	Female	40-60	513813
LMIC	2021	Female	60+	2074145
LMIC	2021	Male	0-40	95130
LMIC	2021	Male	40-60	806848
LMIC	2021	Male	60+	2554221
UMIC	2020	Female	0-40	-10539
UMIC	2020	Female	40-60	84394
UMIC	2020	Female	60+	569268
UMIC	2020	Male	0-40	-55470
UMIC	2020	Male	40-60	136218

Step wise selection of terms

We carried out step wise selection of terms to include the most significant main and interaction effects in our analysis. We carried out the same using the following factor level values.

General Factorial Regression: excess.mean versus income, sex, age

Stepwise Selection of Terms

α to enter = 0.05, α to remove = 0.05

Factor Information

Factor	Levels	Values
income	4	LIC, LMIC, UMIC, HIC
sex	2	Female, Male
age	3	0-39, 40-59, 60+

Setting up hypothesis

We setup the following hypothesis to test the significance of the main effects and the interaction effects:

Null Hypothesis H0: There is no significant difference between any main or interaction effects that affect excess deaths due to COVID

Alternative Hypothesis H1: Atleast one of the main or interaction effects that affect excess deaths due to COVID is significant

ANOVA Table

Upon analysis of data, we got the following ANOVA table:

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	12	2.06E+13	1.72E+12	57.9	0
Linear	6	1.54E+13	2.57E+12	86.67	0
Income	3	4.90E+12	1.63E+12	55.03	0
Sex	1	1.75E+11	1.75E+11	5.9	0.033
Age	2	1.04E+13	5.18E+12	174.51	0
2-Way Interactions	6	5.19E+12	8.65E+11	29.13	0
income*age	6	5.19E+12	8.65E+11	29.13	0
Error	11	3.27E+11	29687048985		
Total	23	2.10E+13			

Rejecting H0 at 5% LOS and concluding that main and interaction effects are significantly different from zero

Coefficients

From the coefficients table of our dataset, we infer the following:

TERM	COEF	SE COEF	T-VALUE	P-VALUE	VARIANCE INFLATING FACTOR
CONSTANT	621258	35170	17.66	0.000	
INCOME					
LIC	-514919	60917	-8.45	0.000	1.50
LMIC	690256	60917	11.33	0.000	1.50
UMIC	85399	60917	1.40	0.189	1.50
SEX					
Female	-85427	35170	-2.43	0.033	1.00
AGE					
0-39	-620397	49739	-12.47	0.000	1.33
40-59	-288886	49739	-5.81	0.000	1.33
INCOME*AGE					
LIC 0-39	500259	86150	5.81	0.000	2.00
LIC 40-59	255940	86150	2.97	0.013	2.00
LMIC 0-39	-700577	86150	-8.13	0.000	2.00
LMIC 40-59	-249926	86150	-2.90	0.014	2.00
UMIC 0-39	-96820	86150	-1.12	0.285	2.00
UMIC 40-59	-58130	86150	-0.67	0.514	2.00

Setting up the model

We get the following model:

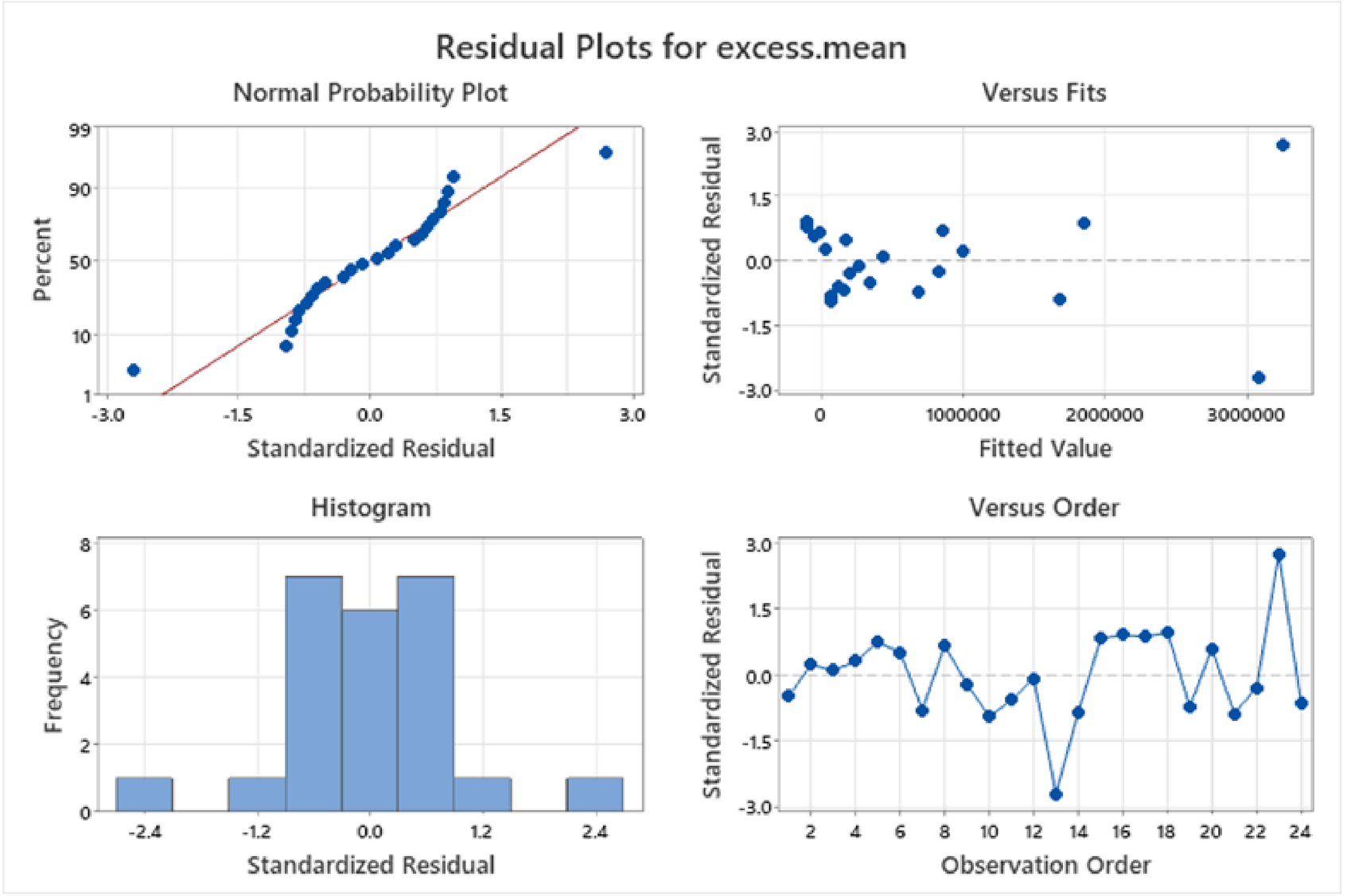
excess.mean = 621258 - 514919 income_LIC + 690256 income_LMIC + 85399 income_UMIC - 260735 income_HIC - 85427 sex_Female + 85427 sex_Male - 620397 age_0-39- 288886 age_40-59 + 909283 age_60+ + 500259 income*age_LIC 0-39 + 255940 income*age_LIC 40-59 - 756199 income*age_LIC 60+- 700577 income*age_LMIC 0-39 - 249926 income*age_LMIC 40-59 + 950503 income*age_LMIC 60+ - 96820 income*age_UMIC 0-39 - 58130 income*age_UMIC 40-59 + 154950 income*age_UMIC 60 + 297138 income*age_HIC 0-39 + 52116 income*age_HIC 40-59 - 349255 income*age_HIC 60+

MODEL SUMMARY

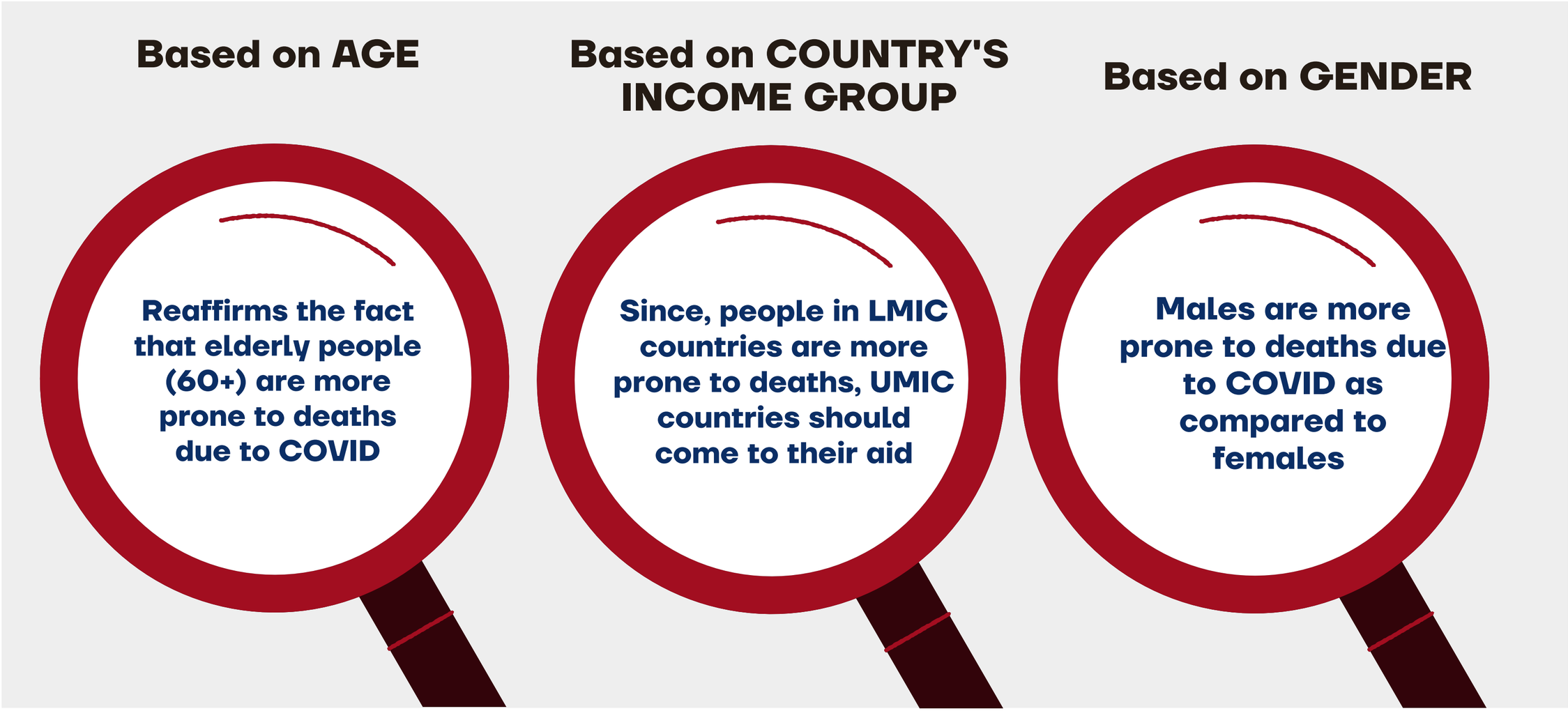
S	R-sq	R-sq(adj)	R-sq(pred)
172299	98.44%	96.74%	92.58%

We see the value of R-sq is 96.74% which means that the model explains 96% variation in the data.

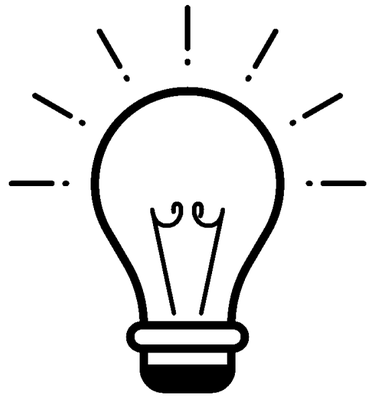
Model Diagnostic Checking



Conclusion


Based on AGE
Reaffirms the fact that elderly people (60+) are more prone to deaths due to COVID
Based on COUNTRY'S INCOME GROUP
Since, people in LMIC countries are more prone to deaths, UMIC countries should come to their aid
Based on GENDER
Males are more prone to deaths due to COVID as compared to females

How can we extend this study?

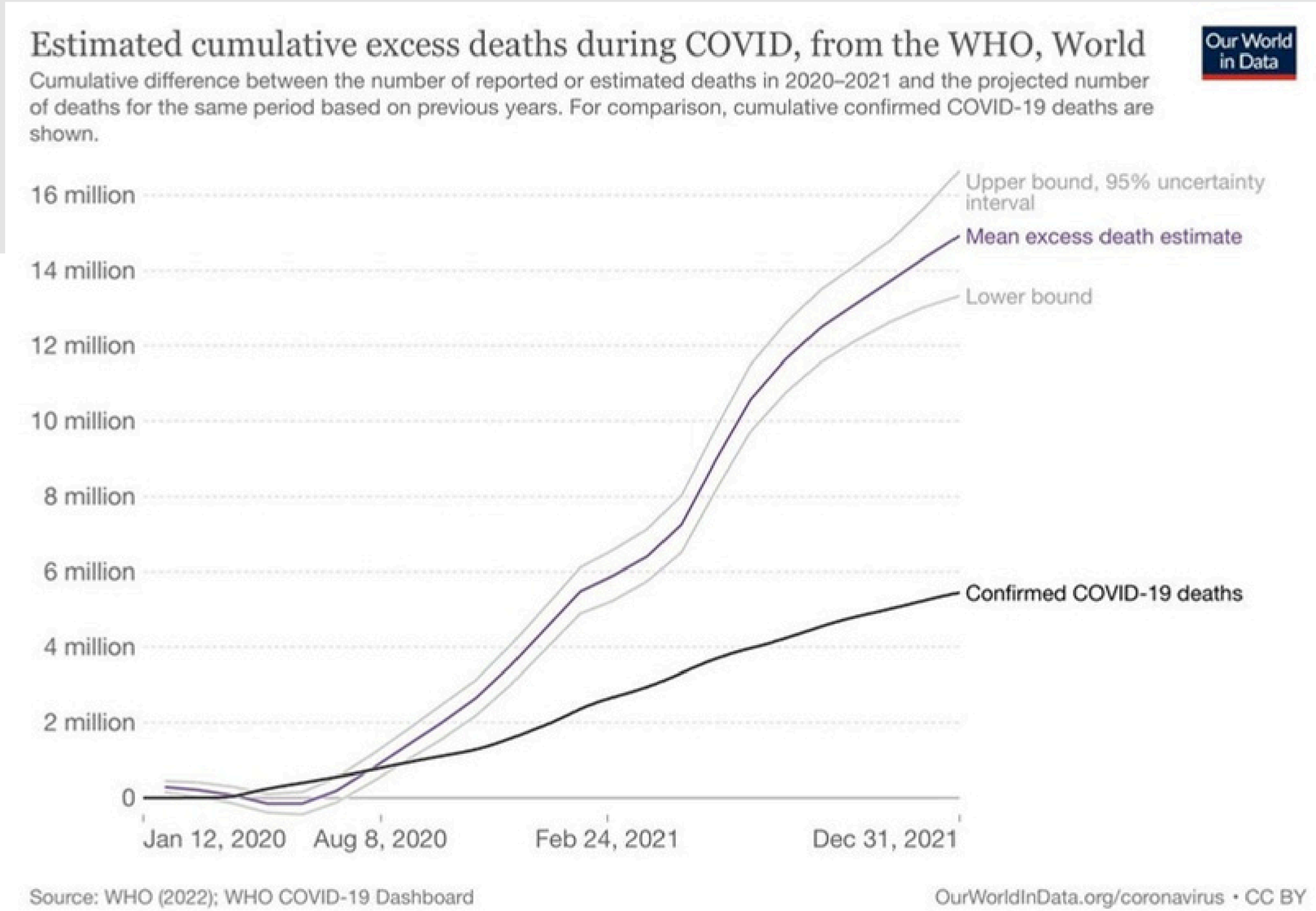


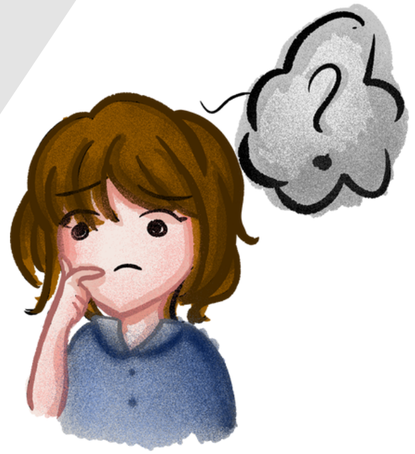
STUDY OF COMORBIDITIES

The data provided by countries do not always provide a complete picture of the health burden attributable to COVID-19. There have also been variations in the death certification rules countries have applied in the presence of comorbidities and COVID-19.

UNDERSTANDING GENDER DIFFERENCES

Future research is required to understand the causes of the gender difference in excess deaths due to COVID to incite a gender equity responsive approach to COVID-19 outbreak.





STRENGTHENING DEATH REGISTRATION SYSTEMS

The full impact of the pandemic has been much greater than what is indicated by reported deaths due to COVID-19 alone. Strengthening death registration systems around the world, long understood to be crucial to global public health strategy, is necessary for improved monitoring of this pandemic and future pandemics.