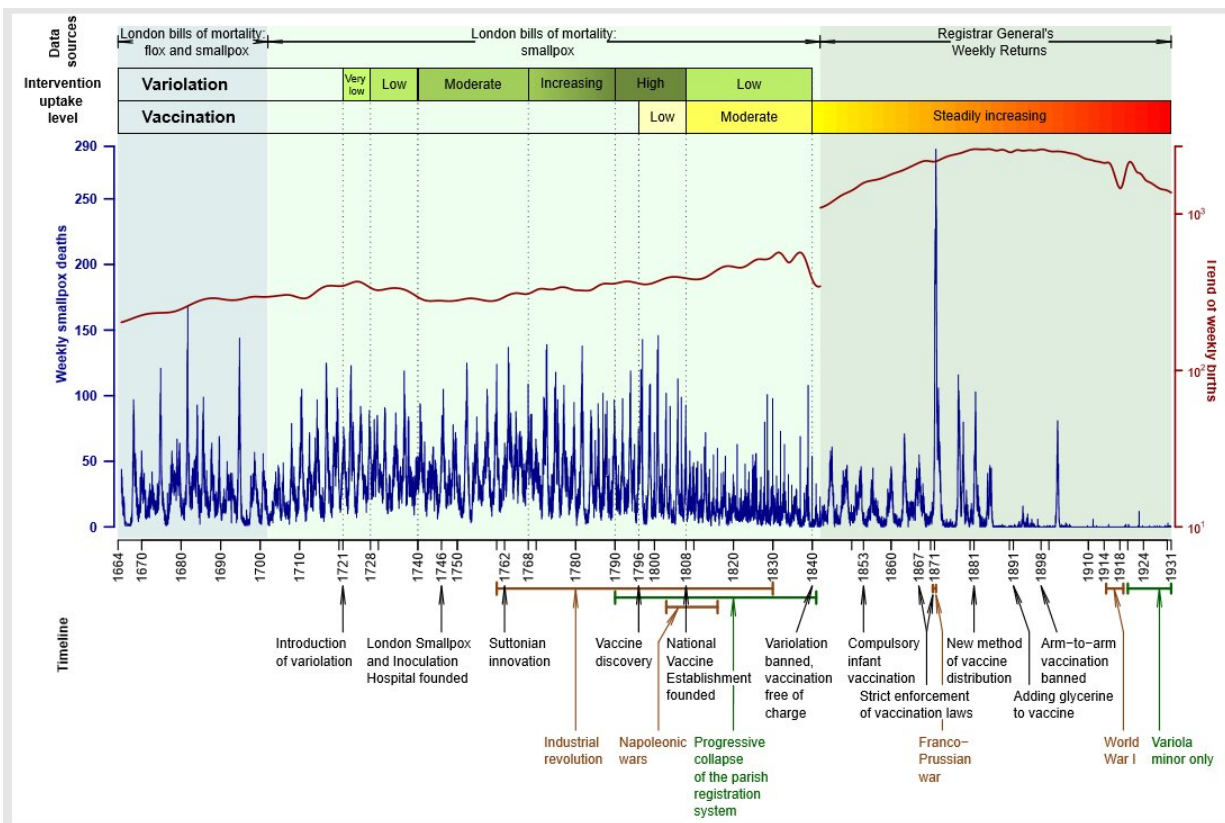


Researchers track and analyze smallpox epidemics over three centuries

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Smallpox deaths (blue) in London, England, 1664--1930, and the long-term trend of weekly births (red). Credit: Olga Krylova and David J.D. Earn

Researchers from McMaster University have studied and analyzed thousands of weekly records documenting the deaths of smallpox victims

in London, England over the span of nearly 300 years.

The analysis provides new and rare insights into the ecology of infectious disease, establishing that the time between epidemics, the size of the outbreaks, and even the season when the epidemics occurred, changed over the centuries.

Smallpox was one of the most devastating viral diseases ever to strike humankind, killing about three out of every 10 people who were infected. Those who survived were frequently left disabled, blind or disfigured. Until the 19th century, [smallpox](#) was thought to have accounted for more deaths than any other single infectious disease, even plague and cholera.

The World Health Organization recently celebrated the 40th anniversary of the eradication of smallpox, the most successful such campaign ever attempted. Smallpox is one of only two [infectious diseases](#) that have been wiped out by human efforts.

"The current COVID-19 pandemic has caused a surge of interest in the study of infectious disease transmission and how [public health interventions](#) could change the course of the pandemic," says author David Earn, a professor in the Department of Mathematics & Statistics at McMaster who specializes in modelling of infectious disease transmission.

"Our goal was to describe and make publicly available the weekly time series of smallpox mortality in London and to identify [historical events](#) that might have influenced smallpox dynamics over the centuries," he says.

For the analysis, outlined in the journal *PLOS Biology*, Earn and colleague Olga Krylova, studied and digitized more than 13,000 weekly

smallpox mortality records published in the London Bills of Mortality and the Registrar General's Weekly Returns from 1664 to 1930.

The Diseases and Casualties this Week

Impothume — 11
Infans — 16
Killed by a fall from the Bellfry at Alhalows the Great — 1
Kingfevil — 2
Lethargy — 1
Palſie — 1
Plague — 7165
Rickets — 17
Riſing of the Lights — 11
Scouring — 5
Scurvy — 2
Spleen — 2
Spotted Feaver — 101
Stilborn — 17
Stone — 2
Stopping of the ſtomach — 9
Strangury — 1
Suddenly — 1
Surfeit — 49
Teeth — 121
Thruſh — 5
Timpany — 1
Tiſſick — 11
Vomiting — 3
Winde — 3
Wormes — 15

Buried
Aged — 43
Ague — 2
Apoplexie — 1
Bleeding — 2
Burnt in his Bed by a Candle at Sr. Giles Cripple-gate — 1
Canker — 1
Childbed — 42
Chriſomes — 18
Conſumption — 134
Convulſion — 64
Cough — 2
Dropſie — 33
Feaver — 309
Flox and Small-pox — 5
Frighted — 3
Govt — 1
Grief — 3
Gripping in the Guts — 5
Jaundies — 5

Christened
Males — 95
Females — 81
In all — 176

Buried
Males — 4095
Females — 4202
In all — 8297

Increased in the Burials this Week — 607
Parishes clear of the Plague — 4 Parishes Infected — 126

The Aſiſe of Bread ſet forth by Order of the Lord Mayor and Courts of Aldermen. A penny Wheaten Loaf to contain Nine Ounces and a half, and three half-penny White Loaves the like weight.

London 40	From the 19 of September to the 26,	1665
Bur.	Plage.	Bar. Plage.
S ^t Alban Woodſtreet 10 5	S ^t George Boſephlane 2 1	S ^t Martin Ludgate 27 20
S ^t Alhalows Barkin 32 41	S ^t Gregory by S ^t Pauls 31 26	S ^t Martin Orgate 8 3
Alhalows Breadſtreet 3 3	S ^t Helen 4 1	S ^t Martin Outwich 3 5
Alhalows Great 24 59	S ^t James Dukes place 14 21	S ^t Martin Vintria 38 56
Alhalows Honylane 1 1	S ^t James Garlickchiche 14 10	S ^t Matthew Fridayſtreet 1 1
Alhalows Leſle 25 24	S ^t John Baptiſt 10 7	S ^t Maundlin Milkeſtreet 2 1
Alhalows Lambardſtreet 11 16	S ^t John Evangeliſt 7 7	S ^t Maudlin Oldfiſhſtreet 10 8
Alhalows Staining 16 11	S ^t John Zachary 2 2	S ^t Michael Baſillaw 18 16
Alhalows the Wall 41 35	S ^t Katharine Coleman 36 35	S ^t Michael Cornhill 7 5
S ^t Albargy 11 3	S ^t Katharine Creechurch 30 20	S ^t Michael Crookedlane 15 13
S ^t Andrew Hubbard 26 23	S ^t Lawrence Jewry 7 5	S ^t Michael Queneſhill 12 10
S ^t Andrew Underhiſt 26 37	S ^t Lawrence Poſteney 17 14	S ^t Michael Quern 4 3
S ^t Andrew Widdowſ 30 37	S ^t Leonard Fildchurc 3 2	S ^t Michael Royall 14 12
S ^t Ann Aldergate 20 16	S ^t Leonard Foſterlane 30 27	S ^t Michael Woodſtreet 9 5
S ^t Ann Blackeryes 39 31	S ^t Magnus Parliſh 3 1	S ^t Mildred Breadſtreet 1 1
S ^t Andolins Parliſh 8 7	S ^t Margaret Lothbury 6 3	S ^t Mildred Paultry 4 4
S ^t Auſtin Parliſh 5 3	S ^t Margaret Meſes 3 3	S ^t Nicholas Acree 7 5
S ^t Bartholomew Exchange 6 6	S ^t Margaret Newfiſhſtreet 7 7	S ^t Nicholas Coleby 14 14
S ^t Bennet Fynce 2 2	S ^t Margaret Pattons 5 4	S ^t Nicholas Olaves 7 4
S ^t Bennet Gracechurch 7 2	S ^t Mary Abchurch 6 4	S ^t Olive Hartſtreet 20 19
S ^t Bennet Paulwharfe 30 19	S ^t Mary Aldermanbury 19 15	S ^t Olive Jewry 4 1
S ^t Bennet Shoreditch 1 1	S ^t Mary Aldermarſy 13 12	S ^t Olive Silverſtreet 9 7
S ^t Bonholſe Billinggate 3 2	S ^t Mary le Bow 3 1	S ^t Pancras Soperlane 4 2
S ^t Chriffs Church 49 43	S ^t Mary Bothaw 1 1	S ^t Peter Cheap 6 5
S ^t Chriſtophers 5 6	S ^t Mary Colechurch 3 2	S ^t Peter Cornhill 10 10
S ^t Clement Fildchurc 1 1	S ^t Mary Hill 3 4	S ^t Peter Paulwharfe 15 11
S ^t Dionis Backchurch 5 2	S ^t Mary Mountchaw 3 3	S ^t Peter Poor 8 6
S ^t Dunſton Eaſt 21 17	S ^t Mary Sommerſet 30 26	S ^t Seven Colemanſtreet 56 51
S ^t Edmund Lumbardſtr. 5 3	S ^t Mary Spayning 8 6	S ^t Seven Walbrook 3 2
S ^t Etheborough 11 7	S ^t Mary Woolchurch 6 6	S ^t Swithan 7 6
S ^t Faith 13 10	S ^t Mary Woolchurch 11 6	S ^t Thomas Aſpſic 10 5
S ^t Filders 10 9	S ^t Martin Iremongerlane 2 2	Trinity Parliſh 7 9
S ^t Gabriel Fenchurch 7 6		

Christened in the 97 Parishes within the Walls — 38 Buried — 1268 Plague — 1025

S ^t Andrew Halborn — 203 184	S ^t Bonolph Aldgate — 469 433	S ^t Vinton Southwark — 356 341
S ^t Bartholomew Great — 10 16	S ^t Bonolph Biſhoppgate — 186 145	S ^t Sepulchres Parliſh — 193 138
S ^t Bartholomew Leſle — 11 11	S ^t Dunſton Weſt — 72 58	S ^t Thomas Southwark — 39 26
S ^t Bridge — 11 791	S ^t George Southwark — 153 137	Trinity Minories — 21 18
S ^t Bridewell Precinct — 26 24	S ^t Giles Cripple-gate — 277 255	At the Peſthouſe — 7 7
S ^t Bonolph Aldergate — 67 64	S ^t Olive Southwark — 173 344	

Christened in the 16 Parishes without the Walls — 41 Buried, and at the Peſthouſe — 2688 Plague — 2252

S ^t Giles in the fields — 119 107	Hamberth Parliſh — 46 40	S ^t Mary Hington — 44 41
Hackney Parliſh — 8 6	S ^t Leonard Shorechurch — 146 133	S ^t Mary Whitechappel — 346 320
S ^t James Clerkenwel — 76 64	S ^t Magdalen Bermondſey — 201 174	Rodwith Parliſh — 20 18
S ^t Kath. near the Tower — 78 62	S ^t Mary Newington — 94 94	Stepney Parliſh — 616 579

Christened in the 12 out Parishes in Middleſex and Surry — 44 Buried — 1794 Plague — 1643

S ^t Clement Danes — 152 128	S ^t Martin in the fields — 219 171	S ^t Margaret Weſtmiſter — 300 283
S ^t Paul Covent Garden — 19 18	S ^t Mary Savoy — 20 13	Atreeſt at the Peſthouſe — 11

Christened in the 5 Parishes in the City and Liberties of Weſtmiſter — 23 Buried — 710 Plague — 613

Burials by cause for the week ending 26 September 1665, during the GreatPlague of London. Five deaths from "Flox and Small-pox" are listed. Credit: Public Domain Review, publicdomainreview.org/collection/londons-dreadful-visitation-bills-of-mortality

The data span an era starting before any public health practices were in place, then the introduction of variolation (a procedure that involved deliberately infecting a healthy individual with smallpox virus taken from a pustule or dried scab of a person suffering from the [disease](#)),

then the discovery of a vaccine, and finally the decline of smallpox mortality until the final smallpox death was recorded in London.

Some scientists have suggested recently that "variola" with COVID-19 might be occurring as a beneficial side-effect of the use of masks.

"During the time period covered by the data, smallpox changed from a terrifying and unavoidable danger to an easily preventable infection. Introduction of better control measures, especially vaccination, naturally led to decreased smallpox mortality and eventually eradication," says Earn.

During the 267 years under analysis, London underwent major demographic and [social changes](#), and there were a variety of historical events that may have had substantial impacts on smallpox dynamics.

"It is clear that the introduction of smallpox control measures—variola and later vaccination—made eradication possible. Our analysis also suggests that greater use of control measures and changes in public health policies were correlated with changes in the frequency of the epidemics", says co-author Olga Krylova, a former Ph.D. student in the Department of Mathematics & Statistics at McMaster.

Other events that could potentially have impacted smallpox epidemics include wars and the Industrial Revolution, which was accompanied by urbanization and demographic transitions.

"Further research using mathematical models is needed to quantify the impacts of interventions and historical events on the smallpox outbreaks", says Krylova.

More information: Krylova O, Earn DJD (2020) Patterns of smallpox mortality in London, England, over three centuries. *PLoS Biol* 18(12): e3000506. doi.org/10.1371/journal.pbio.3000506

Provided by McMaster University

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