

Adult Mortality in the Metropolis of London 1100–1850

Supplement: Code structure, data source and processing

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17. November 2023

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Prerequisites

The calculations were made in R using R-Studio. The structure of the code is essentially based on the structure of the text. The raw code is in the file `order_of_code.R`. The file extended with Markdown is `order_of_code-doc.RMD` and the file `order_of_code-doc.html` is generated from it.

Note: The base path for rmd files is the folder in which they are located, not the r-project. Consequently, `order_of_code.R` and `order_of_code-doc.RMD` are both located in the root folder of the project.

Depending on the hardware, the subsequent code can run for several hours or even a few days.

Install “Just Another Gibbs Sampler” (JAGS) ([PLUMMER 2003](#)) if you want to run the Bayesian analyses anew. Version 4.3 - as used here - can be downloaded in pre-compiled form for a number of OS here: <https://sourceforge.net/projects/mcmc-jags/> . The manual can be found here: https://people.stat.sc.edu/hansont/stat740/jags_user_manual.pdf

The code makes extensive use of the function `source` to call external code. Thus, the main part of the code remains slim, well structured and readable.

Install required packages, set some options and link the sources for the helper functions.

Remark: Depending on your R version the package `osmplotr` may be installed from github using `devtools::install_github("ropensci/osmplotr")`.

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```

require(pacman) || install.packages("pacman")

## Loading required package: pacman
## [1] TRUE

pacman::p_load(coda, cowplot, demogR, dplyr, flexsurv, ggplot2, ggrepel, grid,
               gridExtra, HMDHFDplus, kableExtra, Metrics, mortAAR, osmdata,
               psych, readxl, reshape2, rjags, runjags, sf, tidyr, ggspatial)

options(scipen = 999)
options(dplyr.summarise.inform = FALSE)

source("./functions/bayes_cat_poisson.R")
source("./functions/gomp_MLE.R")
source("./functions/gomp_MLE_adapted.R")
source("./functions/gomp_MLE_interval.R")
source("./functions/gomp_anthr_age.R")
source("./functions/gomp_anthr_age_r.R")
source("./functions/gomp_known_age.R")
source("./functions/gomp_known_age_r.R")
source("./functions/helper_functions.R")
source("./functions/lt_MC.R")
source("./functions/lt_MC_Gomp.R")
RNGkind("L'Ecuyer-CMRG") # conservative random number generator to avoid periodicity

```

Important for saving time: Decide to run extensive code anew (app. 6 h +). In addition, you can set the folder for preprocessed files.

```

runCodeNew <- FALSE
#runCodeNew <- TRUE

# Ask for credentials of the Human Mortality Database if the code runs anew
if (runCodeNew){
  HMD_username <- readline(prompt = "Enter username: ")
  HMD_password <- readline(prompt="Enter password: ")
  credentials <- c(HMD_username, HMD_password)
}

# Specify filename prefix for saved files and create a folder if needed:
saveFileDir = "preprocessed_files"
if (saveFileDir %in% list.files(getwd())) {
  # Dir exists
}else{
  dir.create(file.path(".", saveFileDir), showWarnings = FALSE )
}

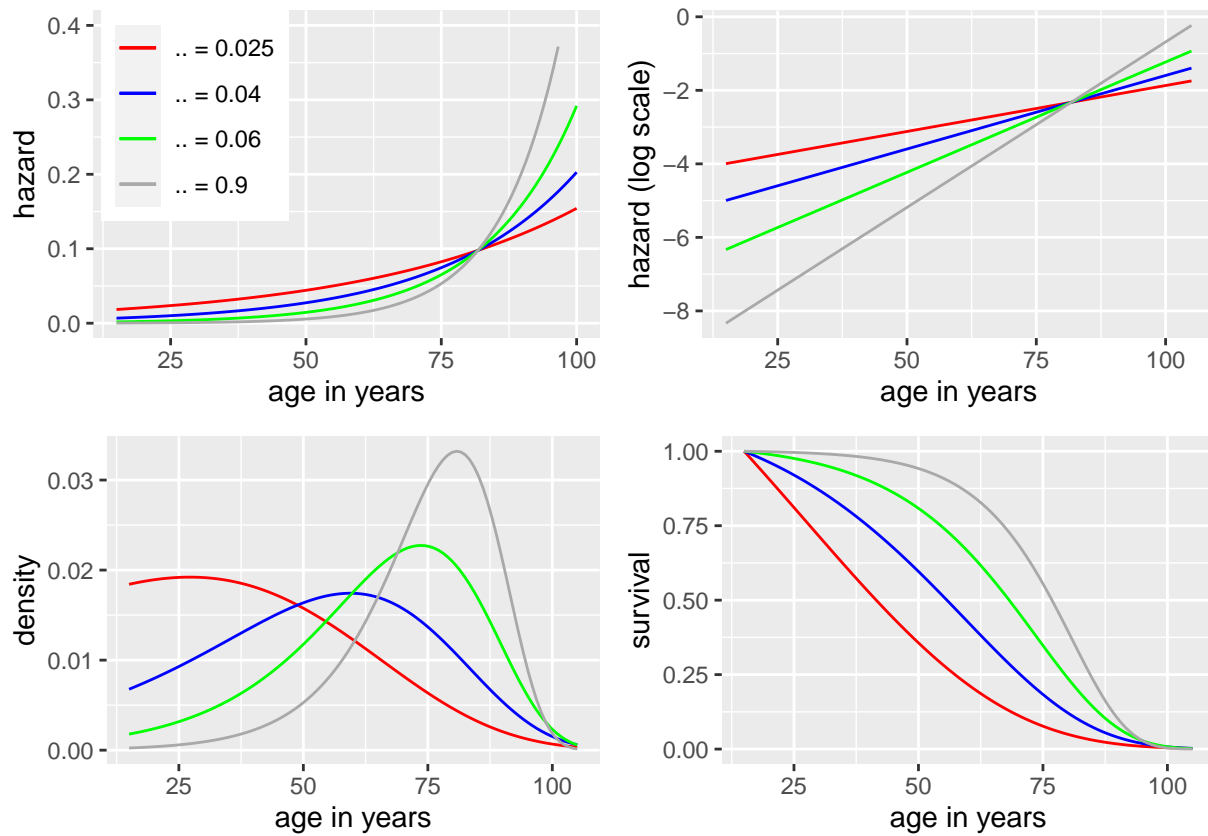
## NULL

```

Chapter 01 Introduction

Figure 1: Exemplary life table curves generated by Gompertz functions with different β parameters.

```
source("../chapter_01_introduction/gompertz_distribution.R")
```

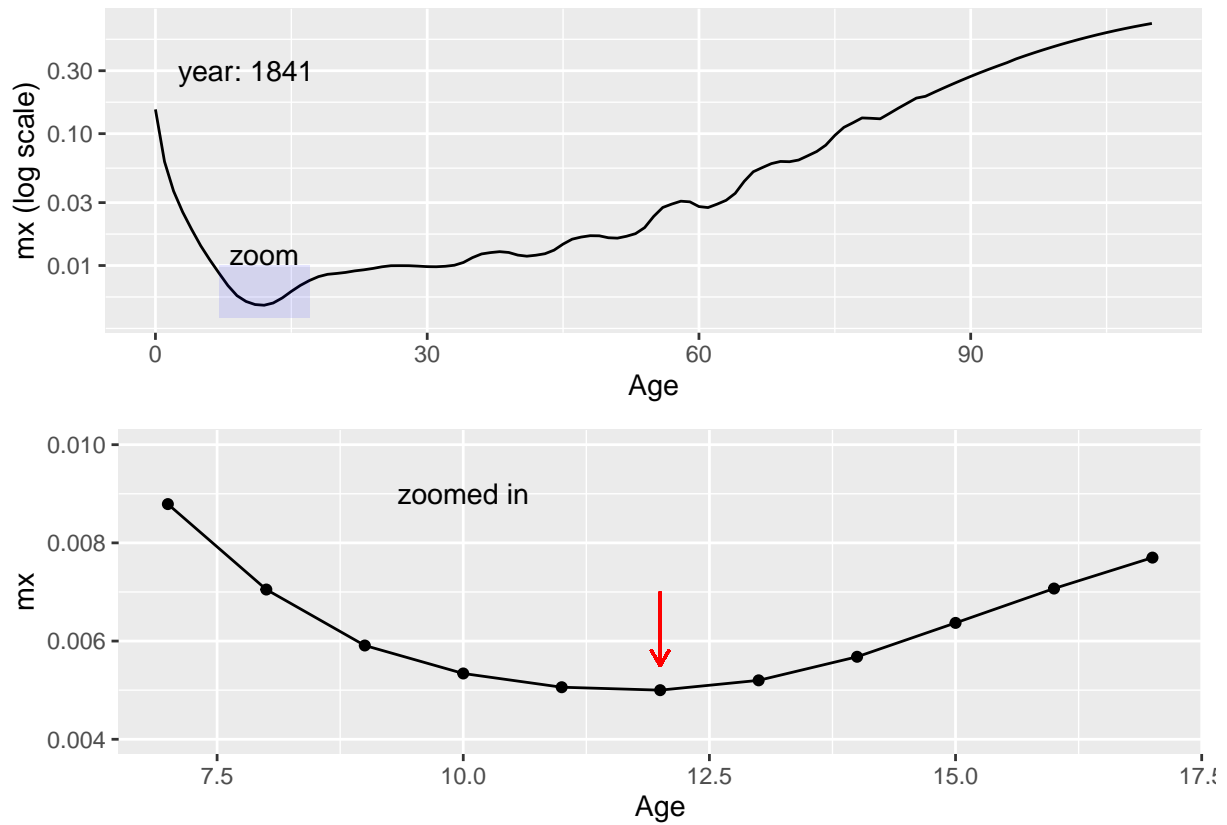


Chapter 02 Materials and methods

Figure 3: Hazard curve (mx) for HMD UK data of the year 1841.

```
source("../chapter_02_materials_and_methods/hazard_curve.R")
```

```
## Saving 6.5 x 4.5 in image
```



Chapter 03 Data

Figure 4: Major cemeteries in Greater London 1100–1850 used in the present study.

```
source("./chapter_03_data/London_places.R")
```

```
## Saving 6.5 x 4.5 in image
```

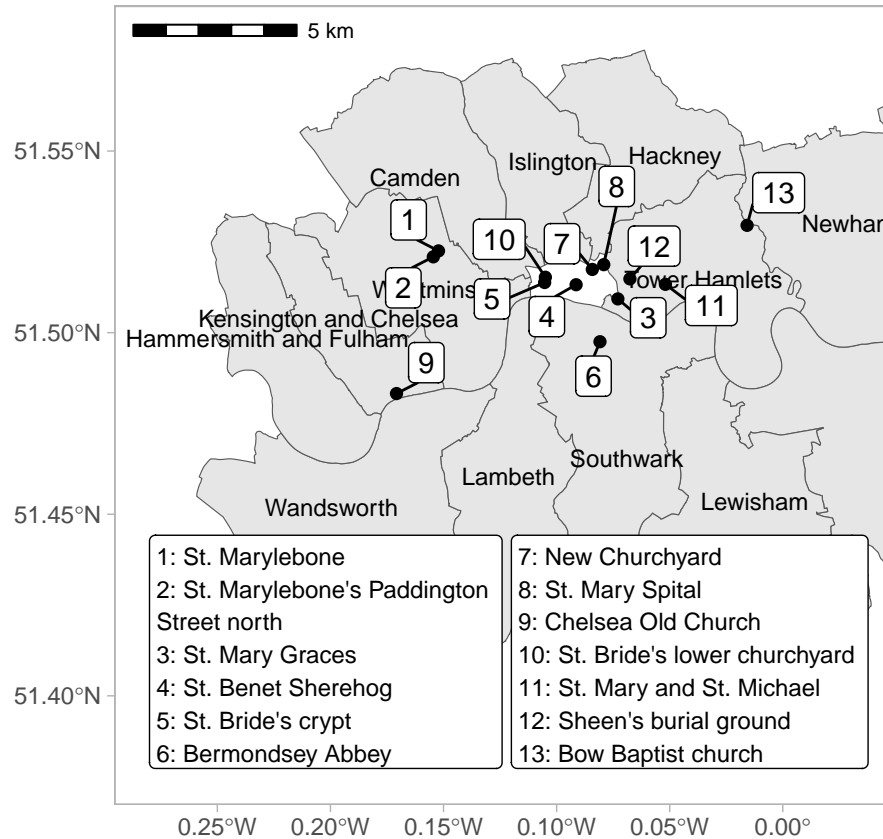


Table 1: Overview of included cemeteries with osteoarchaeological data.

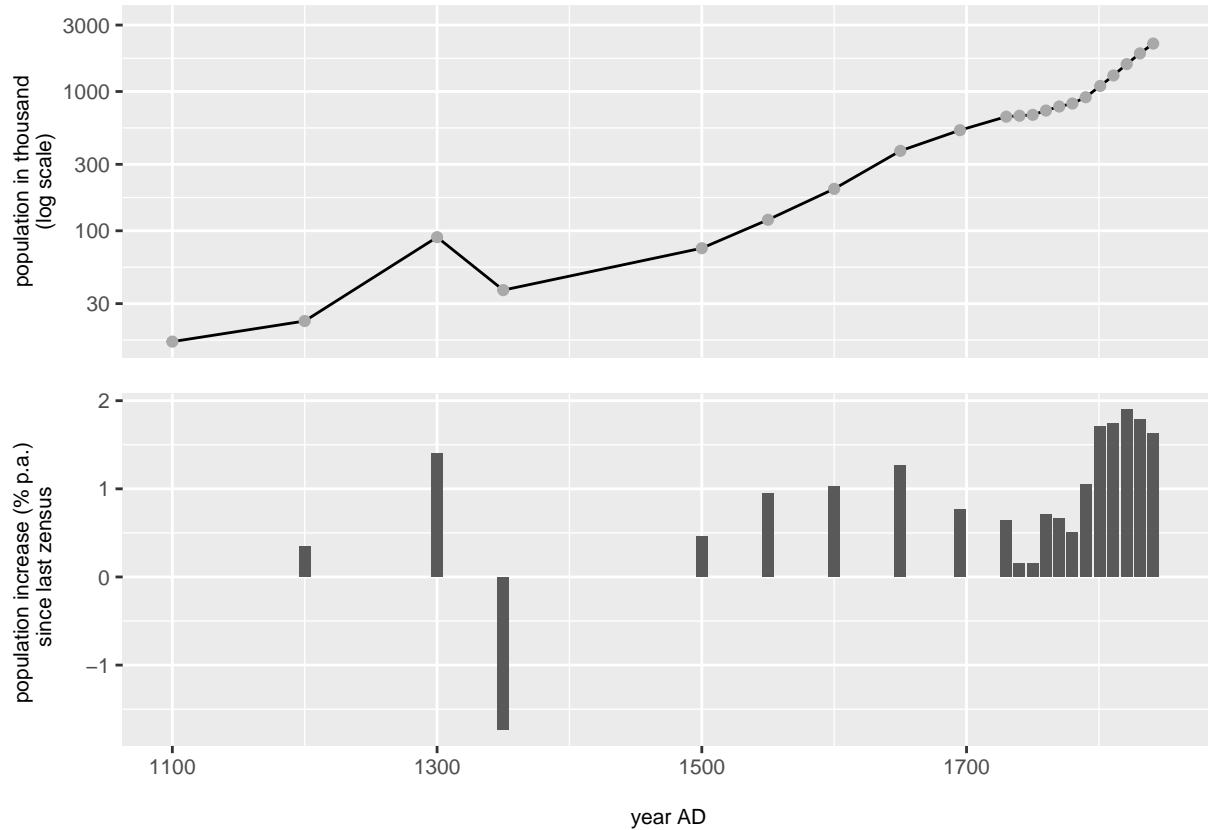
```
read.table("chapter_03_data/london_cemeteries.txt", header = T, sep = "\t") %>%
  knitr::kable(., caption = "Overview of included cemeteries with osteoarchaeological data.") %>%
  kableExtra::kable_styling(latex_options = "HOLD_position") %>% unclass() %>% cat()
```

Table 1: Overview of included cemeteries with osteoarchaeological data.

Map.nr.	name	period	excavation.date	social.character
6	Bermondsey Abbey	1089–1538	1984–1995	monks
8	St. Mary Spital	1120–1538	1991–2007	commoners
NA		period 14: 1120–1200		
NA		period 15: 1200–1250		
NA		period 16: 1250–1400		
NA		period 17: 1400–1539		
3	St. Mary Graces	1350–1540	1986–1988	commoners
7	New Churchyard	1569–1739	2011–2015	low status
4	St. Benet Sherehog	1670–1740	1994–1996	higher status
1	St. Marylebone	1767–1859	1992; 2003	high status
2	St. Marylebone Paddington Street north	1772–1853	2012–2013	high status
9	Chelsea Old church	1712–1842	2000	mixed
5	St. Brides crypt	1740–1853		high
10	St. Brides lower churchyard	1770–1849		low
11	St Mary and St Michaels burial ground	1843–1854	2004–2005	low, Irish immigrants
12	Sheens burial ground	1763–1853	2006–2007	low
13	Bow Baptist church	1816–1853	2006; 2008	villagers

Figure 5: Population development of London, compiled from FINLAY/SHEARER (1986), 39 table 1; LANDERS (1993), 41; 179 table 5.7; WEINREB et al. (2008), 655–657.

```
source("../chapter_03_data/London_population.R")
grid::grid.newpage()
grid::grid.draw(rbind(london_pop1, london_pop2))
```



Footnote 6: Re-calculation of population increase rates of London from RAZZELL/SPENCE (2007). Calculated in ./chapter_03_data/London_population.R

```
knitr::kable(razz_df, caption = "Re-calculation of population increase rates of London from Razzell/Spence 2007",
  kableExtra::kable_styling(latex_options = "HOLD_position"))
```

Table 2: Re-calculation of population increase rates of London from Razzell/Spence 2007.

date	population	rate.per.year
1520	55000	NA
1600	200000	0.016
1650	400000	0.014
1700	575000	0.007
1750	675000	0.003
1801	960000	0.007
1851	2685000	0.021

Chapter 04 Results

Preprocessing of data used in figure 6: Estimated modal ages.

Historical life tables

Written sources

Basic statistics and Bayes (extensive) calculations

The data is referenced and aggregated in “./chapter_04_results/historical_lifetables.R”. In this file, all records from individual preprocessing files located in “./lifetables_preprocessed/” are **sourced**. The corresponding data files are stored in “./data/”.

English_Peers.R, russell.txt, Source: LA POUTRÉ/JANSSEN (2021), table 2

```
source("./chapter_04_results/historical_lifetables.R")
kable(peers_ranges, caption = "English Peers") %>%
  kableExtra::kable_styling(latex_options = "HOLD_position")
```

Table 3: English Peers

parameter	modes	HDI.ranges
beta	0.0613	0.0559-0.0660
M	58.1758	56.4-59.8
e20	33.4148	NA
e25	29.4926	NA

Medieval_England.R, Christ_church_monks.txt, Source: HATCHER et al. (2006), 28 table 2

```
kable(monks_ranges, caption = "Christ Church monks") %>%
  kableExtra::kable_styling(latex_options = "HOLD_position")
```

Table 4: Christ Church monks

parameter	modes	HDI.ranges
beta	0.0461	0.0398-0.0523
M	52.7659	48.9-56.0
e20	31.0948	NA
e25	27.7530	NA

London_1728_1840.R, Mortality_bills_1728_1840.txt, Source: ROBERTS/COX (2003), 304 Table 6.5; > 100 years and < 1 year collapsed

```
kable(london_1728_1840_ranges,
      caption = "London Mortality bills 1728-1840.") %>%
  kableExtra::kable_styling(latex_options = "HOLD_position")
```

Table 5: London Mortality bills 1728-1840.

parameter	ranges
beta	0.0326-0.0418
M	43.3-54.8

```
kable(london_1728_1840_ranges_r,
      caption = "London Mortality bills 1728-1840, corrected for population growth.") %>%
  kableExtra::kable_styling(latex_options = "HOLD_position")
```


Table 6: London Mortality bills 1728-1840, corrected for population growth.

parameter	ranges
beta_r	0.034-0.0508
M_r	45.8-64.3
r	0.001-0.019

London_1841_raw_all.R, London_1841_raw.txt, Source: GRAHAM (1842), 19 table q.

```
kable(London_1841_ranges,
      caption = "Census data for London from 1841.") %>%
kableExtra::kable_styling(latex_options = "HOLD_position")
```

Table 7: Census data for London from 1841.

parameter	modes	HDI.ranges
beta	0.0547	0.0510-0.0585
M	60.4164	58.9-61.7

English_Mortality.R, wrigley_et_al_1997_england_1640-1809.txt, Source: WRIGLEY et al. (1997), 290 table 6.19

```
kable(eng_mort_ranges,
      caption = "English mortality data.") %>%
kableExtra::kable_styling(latex_options = "HOLD_position")
```

Table 8: English mortality data.

parameter	ranges
beta	0.0438-0.0608
M	52.2-67.4

HMD_UK_ranges.R

The data from the Human Mortality Database (<https://mortality.org/>) were retrieved with a personal account using the R package HMDHFDplus. Therefore, we only provide the processed data here.

```
kable(HMD_UK_ranges, caption = "Human Mortality Database UK.") %>%
kableExtra::kable_styling(latex_options = "HOLD_position")
```

Table 9: Human Mortality Database UK.

parameter	ranges
beta	0.05-0.0654
M	64.2-70.2

Extended statistics

```
kable(peers_result, caption = "English Peers.") %>%
kableExtra::kable_styling(latex_options = c("HOLD_position", "scale_down"))
```

Table 10: English Peers.

	PSRF Point est.	PSRF Upper C.I.	Mean	Median	Mode	ESS	MCSE	HDI _{mass}	HDI _{low}	HDI _{high}
a	1.000356	1.001061	0.0044095	0.0043879	0.0043263	11315.3	0.0000044	0.95	0.0035238	0.0053575
b	1.000307	1.000854	0.0609452	0.0609518	0.0612976	11121.9	0.0000244	0.95	0.0559415	0.0660412
M	1.000196	1.000696	58.1500750	58.1648975	58.1757927	20660.4	0.0059675	0.95	56.4492001	59.8036275

```
kable(monks_result, caption = "Christ Church monks.") %>%
  kableExtra::kable_styling(latex_options = c("HOLD_position", "scale_down"))
```

Table 11: Christ Church monks.

start	end	parameter	PSRF Point est.	PSRF Upper C.I.	Mean	Median	Mode	ESS	MCSE	HDI _{mass}	HDI _{low}	HDI _{high}
1395	1505	alpha	1.000569	1.001661	0.0102993	0.0102563	0.0100488	13991.9	0.0000096	0.95	0.0081076	0.0125497
1395	1505	beta	1.000498	1.001436	0.0459467	0.0459287	0.0461060	13623.6	0.0000273	0.95	0.0397953	0.0523389
1395	1505	M	1.000504	1.001504	52.5281106	52.6296486	52.7658924	15808.5	0.0143226	0.95	48.9344189	55.9631681

```
kable(london_1728_1840_result,
  caption = "London Mortality bills 1728-1840.") %>%
  kableExtra::kable_styling(latex_options = c("HOLD_position", "scale_down"))
```

Table 12: London Mortality bills 1728-1840.

year	parameter	PSRF Point est.	PSRF Upper C.I.	Mean	Median	Mode	ESS	MCSE	HDI _{mass}	HDI _{low}	HDI _{high}
X1728	alpha	1.000087	1.000306	0.0146842	0.0146345	0.0145833	17556.5	0.0000101	0.95	0.0121424	0.0173529
X1728	beta	1.000115	1.000412	0.0349280	0.0349276	0.0347502	17418.0	0.0000202	0.95	0.0296810	0.0401486
X1728	M	1.000083	1.000299	44.6441200	44.8860914	45.5314756	17327.3	0.0224261	0.95	38.6469401	50.0270569
X1730	alpha	1.000130	1.000390	0.0156561	0.0155984	0.0155550	17707.3	0.0000113	0.95	0.0127651	0.0186532
X1730	beta	1.000044	1.000181	0.0325647	0.0325599	0.0325660	17242.0	0.0000212	0.95	0.0271489	0.0380817
X1730	M	1.000124	1.000377	42.2325103	42.5795321	43.3073366	17007.1	0.0285150	0.95	34.7635858	49.1029390
X1740	alpha	1.000404	1.001423	0.0153988	0.0153491	0.0151995	17959.5	0.0000100	0.95	0.0128421	0.0180871
X1740	beta	1.000376	1.001376	0.0337368	0.0337428	0.0337806	17712.7	0.0000192	0.95	0.0286838	0.0387413
X1740	M	1.000496	1.001609	43.0631632	43.3280277	43.9606200	17454.0	0.0235235	0.95	36.6700553	48.6880952
X1750	alpha	1.000135	1.000198	0.0151763	0.0151270	0.0150364	18259.1	0.0000101	0.95	0.0125377	0.0178563
X1750	beta	1.000114	1.000178	0.0342964	0.0342869	0.0341703	18177.8	0.0000196	0.95	0.0290894	0.0394288
X1750	M	1.000179	1.000275	43.5924225	43.8460270	44.4983607	17767.1	0.0230817	0.95	37.4073951	49.2703888
X1760	alpha	1.000177	1.000629	0.0145817	0.0145330	0.0143877	17316.9	0.0000100	0.95	0.0120971	0.0172323
X1760	beta	1.000136	1.000506	0.0350143	0.0350086	0.0350484	17001.2	0.0000202	0.95	0.0298241	0.0401131
X1760	M	1.000187	1.000641	44.8612069	45.0945299	45.4484334	17136.0	0.0220610	0.95	39.0545641	50.2289914
X1770	alpha	1.000210	1.000234	0.0143004	0.0142472	0.0140950	17376.2	0.0000100	0.95	0.0117447	0.0168976
X1770	beta	1.000111	1.000112	0.0356448	0.0356520	0.0357779	17075.8	0.0000206	0.95	0.0303640	0.0408917
X1770	M	1.000272	1.000317	45.4735868	45.7082853	46.2765443	17338.6	0.0215703	0.95	39.8841834	50.8485089
X1780	alpha	1.000514	1.001561	0.0136096	0.0135643	0.0135416	17117.8	0.0000093	0.95	0.0112683	0.0160201
X1780	beta	1.000465	1.001440	0.0367597	0.0367653	0.0367765	16987.0	0.0000198	0.95	0.0317257	0.0418630
X1780	M	1.000566	1.001711	46.9184820	47.1022825	47.2254317	17138.4	0.0191612	0.95	41.9217381	51.6370888
X1790	alpha	1.001017	1.003544	0.0126577	0.0126131	0.0125275	16575.3	0.0000091	0.95	0.0104144	0.0149800
X1790	beta	1.000983	1.003179	0.0385025	0.0385094	0.0386019	16305.1	0.0000206	0.95	0.0333766	0.0437012
X1790	M	1.000966	1.003389	48.8104699	48.9690668	49.1799758	17098.7	0.0174550	0.95	44.3144300	53.1380827
X1800	alpha	1.000110	1.000420	0.0116860	0.0116468	0.0115927	16299.7	0.0000084	0.95	0.0096049	0.0137829
X1800	beta	1.000087	1.000347	0.0399538	0.0399387	0.0396845	16015.0	0.0000202	0.95	0.0349411	0.0449695
X1800	M	1.000108	1.000414	50.7157959	50.8389930	51.1834695	17252.3	0.0153333	0.95	46.6384629	54.4728117
X1810	alpha	1.000243	1.000527	0.0115193	0.0114800	0.0114383	15734.5	0.0000082	0.95	0.0095164	0.0135694
X1810	beta	1.000118	1.000358	0.0383935	0.0383896	0.0384657	15460.0	0.0000197	0.95	0.0335364	0.0431518
X1810	M	1.000326	1.000622	51.2962821	51.4292427	51.6215562	16508.4	0.0161901	0.95	47.0977231	55.2320786
X1820	alpha	1.000052	1.000181	0.0104841	0.0104445	0.0102781	15011.2	0.0000079	0.95	0.0086351	0.0124260
X1820	beta	1.000027	1.000124	0.0403826	0.0403829	0.0404617	14970.0	0.0000204	0.95	0.0354909	0.0452688
X1820	M	1.000055	1.000187	53.3587767	53.4706305	53.7399168	16366.7	0.0145839	0.95	49.6763807	56.9584942
X1830	alpha	1.000258	1.000430	0.0098584	0.0098256	0.0097258	14395.4	0.0000077	0.95	0.0080812	0.0116651
X1830	beta	1.000286	1.000581	0.0420293	0.0420238	0.0418237	14224.9	0.0000211	0.95	0.0371298	0.0469784
X1830	M	1.000236	1.000371	54.4809550	54.5648372	54.7531694	16267.7	0.0133487	0.95	51.0810043	57.7147665
X1840	alpha	1.000201	1.000590	0.0103011	0.0102629	0.0101990	14208.6	0.0000081	0.95	0.0084545	0.0122232
X1840	beta	1.000209	1.000633	0.0409196	0.0409247	0.0410181	14009.2	0.0000213	0.95	0.0359043	0.0457889
X1840	M	1.000202	1.000548	53.6779375	53.7846103	53.9681394	15624.6	0.0146214	0.95	50.0085204	57.1315996

```
kable(london_1728_1840_result_r,
  caption = "London Mortality bills 1728-1840, corrected for population growth.") %>%
  kableExtra::kable_styling(latex_options = c("HOLD_position", "scale_down"))
```

Table 13: London Mortality bills 1728-1840, corrected for population growth.

year	parameter	PSRF Point est.	PSRF Upper C.I.	Mean	Median	Mode	ESS	MCSE	HDImass	HDIlow	HDHigh
X1728	alpha	1.000216	1.000632	0.0117973	0.0117320	0.0118127	12703.3	0.0000126	0.95	0.0090855	0.0145984
X1728	beta	1.000264	1.000811	0.0383802	0.0383752	0.0385662	13742.4	0.0000251	0.95	0.0326747	0.0441749
X1728	M	1.000177	1.000534	50.6676878	50.8590788	51.5853562	13177.1	0.0252464	0.95	44.7887126	56.0258710
X1728	rate	1.000032	1.000061	0.0067646	0.0067607	0.0067957	25886.2	0.0000155	0.95	0.0018885	0.0116701
X1730	alpha	1.000059	1.000252	0.0144547	0.0143659	0.0142299	13146.7	0.0000151	0.95	0.0111507	0.0178779
X1730	beta	1.000039	1.000159	0.0340001	0.0340061	0.0339557	14387.4	0.0000246	0.95	0.0282645	0.0398947
X1730	M	1.000051	1.000222	44.9549040	45.3134221	45.8342311	13104.0	0.0348008	0.95	37.0599591	52.4002140
X1730	rate	1.000015	1.000087	0.0018961	0.0019028	0.0019156	29667.6	0.0000145	0.95	-0.0029809	0.0067911
X1740	alpha	1.000134	1.000373	0.0143016	0.0142310	0.0139908	12798.0	0.0000139	0.95	0.0113121	0.0174303
X1740	beta	1.000114	1.000346	0.0351313	0.0351306	0.0350897	13662.1	0.0000231	0.95	0.0298726	0.0404583
X1740	M	1.000145	1.000369	45.4444632	45.7017668	46.3552764	12730.5	0.0302372	0.95	38.7144365	51.8959603
X1740	rate	1.000018	1.000034	0.0016657	0.0016647	0.0013841	26006.3	0.0000154	0.95	-0.0032311	0.0064570
X1750	alpha	1.000049	1.000119	0.0124056	0.0123398	0.0121703	12999.5	0.0000128	0.95	0.0096605	0.0153459
X1750	beta	1.000114	1.000254	0.0374772	0.0374711	0.0375443	14176.6	0.0000242	0.95	0.0318783	0.0431958
X1750	M	1.000045	1.000095	49.4148732	49.6177878	50.0815627	13278.3	0.0263407	0.95	43.4814225	55.2646361
X1750	rate	1.000081	1.000287	0.0062345	0.0062421	0.0062999	26892.6	0.0000153	0.95	0.0013229	0.0111579
X1760	alpha	1.000133	1.000365	0.0116497	0.0115778	0.0113622	12538.9	0.0000123	0.95	0.0089760	0.0143165
X1760	beta	1.000123	1.000320	0.0385199	0.0385214	0.0387513	14046.2	0.0000242	0.95	0.0328950	0.0441009
X1760	M	1.000115	1.000314	50.9862854	51.1812512	51.5491083	12968.9	0.0247266	0.95	45.4054104	56.3142519
X1760	rate	1.000037	1.000142	0.0069574	0.0069683	0.0069632	25610.8	0.0000156	0.95	0.0020911	0.0118681
X1770	alpha	1.000262	1.000990	0.0119654	0.0118980	0.0118088	12468.2	0.0000127	0.95	0.0092575	0.0148053
X1770	beta	1.000151	1.000588	0.0385116	0.0384978	0.0384133	13499.5	0.0000251	0.95	0.0328164	0.0442370
X1770	M	1.000262	1.000981	50.2845848	50.4718699	50.8014826	12649.5	0.0255693	0.95	44.4684380	55.6510579
X1770	rate	1.000255	1.000978	0.0053766	0.0053775	0.0051547	26425.0	0.0000153	0.95	0.0004976	0.0102822
X1780	alpha	1.000510	1.001743	0.0099593	0.0099017	0.0097491	12281.7	0.0000108	0.95	0.0076519	0.0123387
X1780	beta	1.000584	1.001956	0.0415256	0.0415105	0.0415073	13729.8	0.0000246	0.95	0.0359297	0.0472338
X1780	M	1.000424	1.001436	54.3771628	54.5062255	54.6942083	13377.4	0.0204939	0.95	49.6650268	58.9237944
X1780	rate	1.000028	1.000137	0.0099015	0.0099020	0.0100127	24916.4	0.0000158	0.95	0.0050637	0.0148441
X1790	alpha	1.000162	1.000484	0.0075242	0.0074729	0.0073090	12760.2	0.0000085	0.95	0.0057152	0.0094630
X1790	beta	1.000225	1.000693	0.0463742	0.0463615	0.0461660	14273.5	0.0000252	0.95	0.0403834	0.0521632
X1790	M	1.000107	1.000307	59.2682552	59.3404861	59.6658408	16065.9	0.0150556	0.95	55.5022433	62.9845218
X1790	rate	1.000048	1.000143	0.0163814	0.0163799	0.0162194	25142.6	0.0000157	0.95	0.0114802	0.0212263
X1800	alpha	1.000144	1.000484	0.0066887	0.0066478	0.0066305	12151.0	0.0000078	0.95	0.0050562	0.0083976
X1800	beta	1.000078	1.000300	0.0483356	0.0483160	0.0483620	13263.3	0.0000257	0.95	0.0426266	0.0542268
X1800	M	1.000132	1.000476	60.9852657	61.0306400	60.9798946	15946.0	0.0138218	0.95	57.5412705	64.3730484
X1800	rate	1.000120	1.000381	0.0173361	0.0173323	0.0171962	22976.1	0.0000164	0.95	0.0123879	0.0221131
X1810	alpha	1.000955	1.003397	0.0061300	0.0060846	0.0059157	11868.0	0.0000074	0.95	0.0046001	0.0077324
X1810	beta	1.000895	1.003180	0.0477059	0.0476957	0.0476779	12759.7	0.0000258	0.95	0.0418983	0.0533158
X1810	M	1.000626	1.002298	63.0900868	63.1511612	63.3286616	15803.2	0.0140396	0.95	59.5468010	66.4600622
X1810	rate	1.000243	1.000880	0.0188104	0.0188125	0.0190338	21745.3	0.0000169	0.95	0.0139665	0.0237501
X1820	alpha	1.000249	1.000613	0.0055924	0.0055522	0.0054280	11381.2	0.0000069	0.95	0.0042113	0.0070737
X1820	beta	1.000239	1.000579	0.0497903	0.0497697	0.0497109	11993.8	0.0000266	0.95	0.0441232	0.0555551
X1820	M	1.000126	1.000412	63.9998648	64.0348523	64.0324397	15595.3	0.0129989	0.95	60.8212681	67.1779876
X1820	rate	1.000120	1.000469	0.0184395	0.0184350	0.0186655	21021.4	0.0000171	0.95	0.0135370	0.0232733
X1830	alpha	1.000420	1.001174	0.0055184	0.0054759	0.0054297	10602.3	0.0000072	0.95	0.0041318	0.0070030
X1830	beta	1.000315	1.000816	0.0508145	0.0508053	0.0507615	11519.5	0.0000275	0.95	0.0450319	0.0566171
X1830	M	1.000292	1.000965	63.7790204	63.8228311	63.7654406	15070.4	0.0128416	0.95	60.6337617	66.8190579
X1830	rate	1.000210	1.000768	0.0170345	0.0170393	0.0172684	20257.6	0.0000175	0.95	0.0122026	0.0219565
X1840	alpha	1.000903	1.002596	0.0054723	0.0054291	0.0053481	11006.4	0.0000070	0.95	0.0040897	0.0069422
X1840	beta	1.000552	1.001893	0.0504711	0.0504682	0.0503591	11741.2	0.0000273	0.95	0.0446290	0.0562058
X1840	M	1.000706	1.001888	64.1107439	64.1528480	64.2609238	15168.4	0.0130173	0.95	60.9779346	67.2784644
X1840	rate	1.000435	1.001221	0.0185215	0.0185225	0.0185345	20249.5	0.0000175	0.95	0.0136397	0.0234199

```
kable(London_1841_result,
      caption = "Census data for London from 1841.") %>%
      kableExtra::kable_styling(latex_options = c("HOLD_position", "scale_down"))
```

Table 14: Census data for London from 1841.

	PSRF Point est.	PSRF Upper C.I.	Mean	Median	Mode	ESS	MCSE	HDImass	HDIlow	HDHigh
a	1.000227	1.000481	0.0045780	0.0045654	0.0045126	15366.4	0.0000030	0.95	0.0038745	0.0053284
b	1.000173	1.000361	0.0547652	0.0547581	0.0546507	15261.7	0.0000155	0.95	0.0510256	0.0585294
M	1.000098	1.000288	60.3512664	60.3640713	60.4164328	26323.3	0.0044223	0.95	58.9378882	61.7484732

```
kable(eng_mort_result, caption = "English mortality data.") %>%
      kableExtra::kable_styling(latex_options = c("HOLD_position", "scale_down"))
```

Table 15: English mortality data.

year	parameter	PSRF Point est.	PSRF Upper C.I.	Mean	Median	Mode	ESS	MCSE	HDImass	HDIlow	HDHigh
X1640	alpha	1.000116	1.000213	0.0109640	0.0109440	0.0108724	20086.8	0.0000055	0.95	0.0094508	0.0125183
X1640	beta	1.000128	1.000269	0.0473794	0.0473646	0.0471615	19457.0	0.0000160	0.95	0.0430271	0.0517521
X1640	M	1.000098	1.000168	55.8790864	55.9257645	56.0762781	22766.9	0.0074788	0.95	53.6542245	58.0607633
X1650	alpha	1.000196	1.000699	0.0086495	0.0086305	0.0086386	17477.0	0.0000050	0.95	0.0073694	0.0099516
X1650	beta	1.000238	1.000818	0.0534298	0.0534191	0.0532174	17097.8	0.0000176	0.95	0.0488730	0.0579356
X1650	M	1.000122	1.000456	59.0892102	59.1180884	59.1222939	22875.6	0.0058105	0.95	57.3707403	60.8059797
X1660	alpha	1.000538	1.001899	0.0091323	0.0091133	0.0090836	17736.5	0.0000051	0.95	0.0078190	0.0104985
X1660	beta	1.000442	1.001588	0.0507107	0.0507012	0.0506517	17263.0	0.0000172	0.95	0.0463039	0.0551739
X1660	M	1.000484	1.001711	58.8100849	58.8427992	58.8427140	22595.3	0.0063824	0.95	56.9061034	60.6611103
X1670	alpha	1.000280	1.000678	0.0109726	0.0109471	0.0109033	20090.3	0.0000056	0.95	0.0094600	0.0125515
X1670	beta	1.000338	1.000812	0.0444972	0.0445019	0.0446316	19399.7	0.0000157	0.95	0.0402542	0.0488448
X1670	M	1.000211	1.000529	56.4443366	56.5061422	56.5992418	22544.4	0.0083487	0.95	53.9239107	58.8183187
X1680	alpha	1.000560	1.001531	0.0134499	0.0134251	0.0133309	22339.5	0.0000061	0.95	0.0116869	0.0152420
X1680	beta	1.000479	1.001399	0.0435646	0.0435605	0.0437501	21337.1	0.0000151	0.95	0.0392159	0.0478531
X1680	M	1.000597	1.001611	51.9412993	52.0117614	52.1884363	23152.8	0.0091727	0.95	49.1667363	54.6014009
X1690	alpha	1.000203	1.000424	0.0100036	0.0099815	0.0099278	19068.4	0.0000053	0.95	0.0085828	0.0114492
X1690	beta	1.000217	1.000487	0.0457255	0.0457144	0.0457837	18458.1	0.0000160	0.95	0.0414631	0.0499716
X1690	M	1.000156	1.000323	58.2265512	58.2748183	58.3311613	22552.3	0.0076819	0.95	55.9044003	60.4191960
X1700	alpha	1.000247	1.000813	0.0097904	0.0097696	0.0097670	19048.9	0.0000052	0.95	0.0083976	0.0112137
X1700	beta	1.000228	1.000792	0.0469162	0.0469091	0.0468449	18524.9	0.0000160	0.95	0.0426635	0.0512282
X1700	M	1.000210	1.000697	58.3940436	58.4388608	58.4010030	22362.5	0.0073779	0.95	56.2165699	60.5292073
X1710	alpha	1.000629	1.002202	0.0076344	0.0076175	0.0075883	16583.9	0.0000046	0.95	0.0064833	0.0088178
X1710	beta	1.000810	1.002798	0.0547320	0.0547184	0.0547561	16149.3	0.0000181	0.95	0.0502213	0.0592441
X1710	M	1.000354	1.001230	61.0059909	61.0278089	61.0396872	23904.2	0.0053119	0.95	59.3643989	62.5807876
X1720	alpha	1.001584	1.001584	0.0080028	0.0079824	0.0079301	17173.5	0.0000047	0.95	0.0068173	0.0092105
X1720	beta	1.000453	1.001645	0.0560063	0.0560001	0.0558861	16622.0	0.0000179	0.95	0.0514205	0.0604697
X1720	M	1.000297	1.001094	59.7548666	59.7785061	59.8227855	23615.5	0.0051845	0.95	58.1648789	61.2877274
X1730	alpha	1.000128	1.000485	0.0067962	0.0067781	0.0067500	15125.2	0.0000045	0.95	0.0057413	0.0078882
X1730	beta	1.000132	1.000481	0.0561362	0.0561233	0.0561525	14537.5	0.0000193	0.95	0.0516431	0.0607418
X1730	M	1.000086	1.000325	62.6345173	62.6558894	62.6742840	23395.6	0.0050475	0.95	61.1122439	64.1406077
X1740	alpha	1.000185	1.000678	0.0067863	0.0067674	0.0067507	15383.6	0.0000045	0.95	0.0057019	0.0078702
X1740	beta	1.000260	1.000953	0.0566936	0.0566911	0.0568096	15043.4	0.0000191	0.95	0.0520709	0.0612724
X1740	M	1.000063	1.000245	62.4655115	62.4849711	62.4345863	22893.7	0.0051037	0.95	60.9419302	63.9688404
X1750	alpha	1.000389	1.001407	0.0053793	0.0053645	0.0053635	13451.8	0.0000040	0.95	0.0044682	0.0062959
X1750	beta	1.000443	1.001627	0.0595510	0.0595305	0.0594825	12966.5	0.0000210	0.95	0.0548610	0.0642515
X1750	M	1.000167	1.000607	65.4071998	65.4213962	65.4642394	24607.7	0.0044311	0.95	64.0354191	66.7582250
X1760	alpha	1.000180	1.000387	0.0080565	0.0080378	0.0079359	17802.8	0.0000047	0.95	0.0068516	0.0092887
X1760	beta	1.000187	1.000346	0.0488550	0.0488417	0.0488743	16840.4	0.0000169	0.95	0.0445037	0.0531121
X1760	M	1.000119	1.000328	61.9016665	61.9336352	62.0050035	23618.5	0.0063598	0.95	59.9327761	63.7618010
X1770	alpha	1.000469	1.001234	0.0067654	0.0067476	0.0066997	14881.8	0.0000045	0.95	0.0057073	0.0078687
X1770	beta	1.000501	1.001341	0.0538935	0.0538804	0.0536262	14373.8	0.0000192	0.95	0.0494452	0.0584665
X1770	M	1.000270	1.000709	63.5277738	63.5489910	63.4921572	22585.6	0.0054864	0.95	61.9173469	65.1383522
X1780	alpha	1.000347	1.001235	0.0066384	0.0066225	0.0066110	15713.1	0.0000043	0.95	0.0055976	0.0076907
X1780	beta	1.000349	1.001303	0.0570824	0.0570677	0.0571475	15127.7	0.0000188	0.95	0.0526292	0.0616896
X1780	M	1.000195	1.000710	62.7166530	62.7352113	62.7235429	24154.0	0.0048243	0.95	61.2201635	64.1540268
X1790	alpha	1.000180	1.000376	0.0058127	0.0057951	0.0057825	13899.0	0.0000042	0.95	0.0048677	0.0068164
X1790	beta	1.000229	1.000478	0.0580897	0.0580826	0.0579337	13447.1	0.0000206	0.95	0.0533856	0.0627649
X1790	M	1.000055	1.000174	64.6577738	64.6756380	64.7246120	23430.8	0.0047208	0.95	63.2361972	66.0657933
X1800	alpha	1.000697	1.002167	0.0046142	0.0045977	0.0045567	12391.5	0.0000037	0.95	0.0038253	0.0054317
X1800	beta	1.000709	1.002222	0.0608363	0.0608357	0.0608310	11940.3	0.0000219	0.95	0.0561091	0.0654678
X1800	M	1.000239	1.000822	67.4325112	67.4451148	67.4486965	26907.8	0.0039816	0.95	66.1359322	68.6958522

```

kable(HMD_UK_result, caption = "Human Mortality Database UK.") %>%
  kableExtra::kable_styling(latex_options = c("HOLD_position", "scale_down"))

```

Table 16: Human Mortality Database UK.

year	parameter	PSRF Point est.	PSRF Upper C.I.	Mean	Median	Mode	ESS	MCSE	HDImass	HDIlow	HDHigh
X1841	alpha	1.000163	1.000417	0.0036316	0.0036148	0.0035704	13786.9	0.0000032	0.95	0.0029186	0.0043694
X1841	beta	1.000156	1.000468	0.0519888	0.0519880	0.0522191	13557.1	0.0000185	0.95	0.0476828	0.0561015
X1841	M	1.000083	1.000148	66.2542881	66.2748935	66.3111134	25227.7	0.0056085	0.95	64.4997322	67.9878895
X1845	alpha	1.000079	1.000297	0.0042938	0.0042780	0.0042669	14758.1	0.0000036	0.95	0.0034647	0.0051540
X1845	beta	1.000067	1.000247	0.0498996	0.0498859	0.0500069	14606.7	0.0000180	0.95	0.0455985	0.0541474
X1845	M	1.000065	1.000255	64.2120906	64.2353737	64.2258466	24443.1	0.0062539	0.95	62.2412879	66.0782225
X1850	alpha	1.000973	1.003549	0.0037558	0.0037391	0.0036783	13963.2	0.0000033	0.95	0.0030110	0.0045196
X1850	beta	1.000868	1.003159	0.0517607	0.0517548	0.0515669	13902.2	0.0000185	0.95	0.0475374	0.0561228
X1850	M	1.000670	1.002447	65.7445767	65.7656894	65.8470383	24788.4	0.0057544	0.95	63.9683713	67.5152044
X1855	alpha	1.000156	1.000325	0.0034310	0.0034165	0.0034148	13071.2	0.0000031	0.95	0.0027387	0.0041407
X1855	beta	1.000111	1.000252	0.0533405	0.0533264	0.0532089	12901.9	0.0000193	0.95	0.0489858	0.0575821
X1855	M	1.000055	1.000176	66.5070750	66.5214941	66.5377049	24496.9	0.0055156	0.95	64.7810996	68.1628553
X1860	alpha	1.000103	1.000169	0.0034785	0.0034615	0.0034062	13432.3	0.0000031	0.95	0.0027794	0.0041924
X1860	beta	1.000118	1.000200	0.0532621	0.0532640	0.0532106	13350.6	0.0000189	0.95	0.0490210	0.0575846
X1860	M	1.000016	1.000032	66.2956647	66.3134949	66.3500169	24949.1	0.0054798	0.95	64.5756127	67.9675086
X1865	alpha	1.000093	1.000333	0.0035991	0.0035837	0.0035330	13810.1	0.0000031	0.95	0.0028932	0.0043267
X1865	beta	1.000108	1.000353	0.0530530	0.0530491	0.0530859	13658.1	0.0000185	0.95	0.0488013	0.0572954
X1865	M	1.000045	1.000177	65.7780212	65.7953467	65.8802464	25507.4	0.0054316	0.95	64.0717897	67.4665740
X1870	alpha	1.000077	1.000191	0.0035027	0.0034908	0.0034765	13760.3	0.0000030	0.95	0.0028292	0.0042127
X1870	beta	1.000110	1.000242	0.0536849	0.0536587	0.0535650	13616.9	0.0000184	0.95	0.0495385	0.0579499
X1870	M	1.000013	1.000070	65.9071237	65.9205478	65.8577523	25746.8	0.0052524	0.95	64.2645935	67.5678728
X1875	alpha	1.000092	1.000343	0.0030605	0.0030478	0.0030211	12815.0	0.0000028	0.95	0.0024475	0.0036823
X1875	beta	1.000131	1.000471	0.0568401	0.0568279	0.0568980	12685.7	0.0000193	0.95	0.0526071	0.0611415
X1875	M	1.000031	1.000141	66.4668857	66.4785272	66.5086127	26537.0	0.0047162	0.95	64.9506366	67.9602202
X1880	alpha	1.000119	1.000291	0.0027376	0.0027242	0.0026867	12292.1	0.0000026	0.95	0.0021904	0.0033047
X1880	beta	1.000171	1.000388	0.0580794	0.0580802	0.0580583	12275.9	0.0000195	0.95	0.0538930	0.0623071
X1880	M	1.000016	1.000046	67.6639684	67.6752899	67.6594434	26763.5	0.0045057	0.95	66.2138218	69.0997903
X1885	alpha	1.000329	1.000699	0.0024297	0.0024169	0.0023954	11472.9	0.0000024	0.95	0.0019319	0.0029532
X1885	beta	1.000279	1.000617	0.0605593	0.0605577	0.0605172	11375.3	0.0000207	0.95	0.0561612	0.0648427
X1885	M	1.000124	1.000309	68.1749533	68.1842585	68.1928238	26834.9	0.0042250	0.95	66.8018933	69.5153058
X1890	alpha	1.000121	1.000451	0.0024118	0.0023997	0.0023802	11867.7	0.0000024	0.95	0.0019247	0.0029285
X1890	beta	1.000146	1.000531	0.0614665	0.0614588	0.0613662	11669.1	0.0000205	0.95	0.0571518	0.0657954
X1890	M	1.000045	1.000148	67.7519542	67.7613179	67.8037905	28081.6	0.0040695	0.95	66.4069818	69.0759956
X1895	alpha	1.000328	1.001210	0.0019825	0.0019735	0.0019634	10586.6	0.0000021	0.95	0.0015598	0.0024219
X1895	beta	1.000267	1.000994	0.0637922	0.0637712	0.0636859	10594.5	0.0000217	0.95	0.0594245	0.0681856
X1895	M	1.000224	1.000819	69.4924393	69.4994274	69.5249671	28489.7	0.0038280	0.95	68.2103261	70.7410684
X1900	alpha	1.000051	1.000194	0.0017882	0.0017794	0.0017686	10113.1	0.0000020	0.95	0.0013975	0.0021792
X1900	beta	1.000061	1.000247	0.0653147	0.0653019	0.0653664	10036.7	0.0000222	0.95	0.0609626	0.0696771
X1900	M	1.000007	1.000020	70.1656919	70.1713832	70.1615274	28126.0	0.0036879	0.95	68.9548389	71.3801825

London cemeteries

The data is mainly hard coded in the file `./chapter_04_results/Wellcome_DB.R`.

Only St. Bride's crypt is excluded but available from the Museum of London upon request. For general information: <https://www.museumoflondon.org.uk> go for: Collections > Archaeology at the Museum of London > Wellcome Osteological Research Database > St. Bride's Church Fleet Street. If `runCodeNew == TRUE` the file `./lifetables_processing/stbrides_crypt.R` will ask for the location of the retrieved dataset (Excel sheet) and process the data. In any other case pre-processed data will be loaded.

```
source("./lifetables_processing/stbrides_crypt.R")
source("./chapter_04_results/Wellcome_DB.R")

kable(wellcome_result, caption = "London cemeteries data.") %>%
  kableExtra::kable_styling(latex_options = c("HOLD_position", "scale_down"))
```

Table 17: London cemeteries data.

cemetery	start	end	parameter	PSRF Point est.	PSRF Upper C.I.	Mean	Median	Mode	ESS	MCSE	HDImass	HDlflow	HDlhigh
Bernondsey Abbey	1089	1538	alpha	1.000041	1.000053	0.0120002	0.0118785	0.0116312	27017.7	0.0000115	0.95	0.0084207	0.0157789
Bernondsey Abbey	1089	1538	beta	1.000092	1.000223	0.0409482	0.0409634	0.0408251	22834.7	0.0000317	0.95	0.0316152	0.0504127
Bernondsey Abbey	1089	1538	M	1.000035	1.000044	41.8141666	42.1314316	42.5895073	29598.0	0.0208466	0.95	34.6562818	48.5270207
St. Mary Graces	1350	1540	alpha	1.000036	1.000126	0.0198007	0.0197073	0.0193784	34402.8	0.0000121	0.95	0.0155288	0.0242842
St. Mary Graces	1350	1540	beta	1.000064	1.000246	0.0346132	0.0346317	0.0348101	28166.3	0.0000249	0.95	0.0264157	0.0427714
St. Mary Graces	1350	1540	M	1.000033	1.000137	27.5831668	28.2298103	29.4924985	30498.9	0.0285239	0.95	17.5838168	36.3160347
St. Mary Hospital, 1120-1200	1120	1200	alpha	1.000063	1.000248	0.0249305	0.0248335	0.0245704	50119.4	0.0000104	0.95	0.0204392	0.0295496
St. Mary Hospital, 1120-1200	1120	1200	beta	1.000092	1.000354	0.0363034	0.0363161	0.0362866	43635.8	0.0000180	0.95	0.0289140	0.0436573
St. Mary Hospital, 1120-1200	1120	1200	M	1.000087	1.000328	21.9080156	22.4413839	23.4629621	43383.4	0.0211197	0.95	13.684585	29.7011243
St. Mary Hospital, 1200-1250	1200	1250	alpha	1.000043	1.000155	0.0296609	0.0296700	0.0297095	52086.8	0.0000101	0.95	0.0255000	0.0345169
St. Mary Hospital, 1200-1250	1200	1250	beta	1.000025	1.000109	0.0356600	0.0356700	0.0357998	45476.7	0.0000161	0.95	0.0288443	0.0423032
St. Mary Hospital, 1200-1250	1200	1250	M	1.000055	1.000158	16.4320472	16.9298267	18.0758477	44418.2	0.0208129	0.95	7.6947843	24.2981680
St. Mary Hospital, 1250-1400	1250	1400	alpha	1.000091	1.000269	0.0183174	0.0182911	0.0182414	31202.6	0.0000060	0.95	0.0162463	0.0203748
St. Mary Hospital, 1250-1400	1250	1400	beta	1.000108	1.000371	0.0580880	0.0580939	0.0582603	28098.6	0.0000160	0.95	0.0527869	0.0633071
St. Mary Hospital, 1250-1400	1250	1400	M	1.000097	1.000266	31.8450682	31.8865114	31.9280610	32582.3	0.0049882	0.95	30.0500715	33.5580425
St. Mary Hospital, 1400-1539	1400	1539	alpha	1.000002	1.000017	0.0262290	0.0261623	0.0261803	45587.4	0.0000098	0.95	0.0221812	0.0303416
St. Mary Hospital, 1400-1539	1400	1539	beta	1.000008	1.000033	0.0374915	0.0375014	0.0376554	39121.9	0.0000175	0.95	0.0307322	0.0443098
St. Mary Hospital, 1400-1539	1400	1539	M	1.000003	1.000019	21.1841557	21.5861738	22.1624360	39436.4	0.0186094	0.95	13.7960573	27.8674612
New Churchyard	1569	1739	alpha	1.000206	1.000735	0.0257462	0.0256884	0.0256373	40806.4	0.0000097	0.95	0.0219617	0.0296139
New Churchyard	1569	1739	beta	1.000199	1.000707	0.0365457	0.0365565	0.0366304	34210.3	0.0000183	0.95	0.0299048	0.0431858
New Churchyard	1569	1739	M	1.000272	1.000889	21.2258099	21.6328825	22.3306337	34934.2	0.0199246	0.95	13.7631753	27.9240717
St. Benet Sherehog	1670	1740	alpha	1.000050	1.000192	0.0159695	0.0158344	0.0155270	33614.1	0.0000129	0.95	0.0114517	0.0206629
St. Benet Sherehog	1670	1740	beta	1.000023	1.000101	0.0353051	0.0353070	0.0351919	28485.1	0.0000279	0.95	0.0260577	0.0445070
St. Benet Sherehog	1670	1740	M	1.000095	1.000224	33.9387756	34.6336624	35.6591452	31613.7	0.0300240	0.95	23.2911398	43.3188976
Chelsea Old church	1712	1842	alpha	1.000174	1.000411	0.0085200	0.0084094	0.0082628	22595.9	0.0000100	0.95	0.0056726	0.0114954
Chelsea Old church	1712	1842	beta	1.000199	1.000584	0.0413802	0.0413954	0.0417518	17223.8	0.0000397	0.95	0.0311508	0.0515880
Chelsea Old church	1712	1842	M	1.000161	1.000289	50.1444365	50.3764766	51.0339838	33034.1	0.0178106	0.95	43.6080170	56.2225789
St. Marylebone	1742	1817	alpha	1.000149	1.000345	0.0126129	0.0125100	0.0123435	30508.0	0.0000100	0.95	0.0093134	0.0161206
St. Marylebone	1742	1817	beta	1.000215	1.000442	0.0420169	0.0420316	0.0423510	24759.8	0.0000289	0.95	0.0331890	0.0510176
St. Marylebone	1742	1817	M	1.000203	1.000496	40.4873958	40.7631246	41.0720604	32601.7	0.0170323	0.95	34.2841253	46.1526087
St. Marylebone Paddington Street north	1772	1853	alpha	1.000436	1.001381	0.0099103	0.0098295	0.0097195	26865.2	0.0000088	0.95	0.0071400	0.0127678
St. Marylebone Paddington Street north	1772	1853	beta	1.000344	1.001181	0.0488440	0.0488217	0.0487464	22754.0	0.0000306	0.95	0.0397557	0.0578682
St. Marylebone Paddington Street north	1772	1853	M	1.000369	1.001168	44.6592823	44.7761855	45.0643066	35660.2	0.0118925	0.95	40.2211140	49.0258609
St. Bride's lower churchyard	1770	1849	alpha	1.000259	1.000486	0.0062384	0.0061857	0.0061135	14003.7	0.0000074	0.95	0.0045631	0.0079738
St. Bride's lower churchyard	1770	1849	beta	1.000420	1.000694	0.0506585	0.0506701	0.0506832	10437.9	0.0000456	0.95	0.0414962	0.0597338
St. Bride's lower churchyard	1770	1849	M	1.000046	1.000066	53.4237068	53.4349280	53.5706223	46032.6	0.0076291	0.95	50.2007886	56.6385661
Sheen's burial ground	1763	1854	alpha	1.000042	1.000075	0.0131427	0.0129977	0.0127000	26693.3	0.0000135	0.95	0.0089556	0.0174737
Sheen's burial ground	1763	1854	beta	1.000055	1.000133	0.0345443	0.0345424	0.0345758	21003.0	0.0000346	0.95	0.0245852	0.0442423
Sheen's burial ground	1763	1854	M	1.000073	1.000118	39.4407311	40.1726728	41.0201866	26097.8	0.0343739	0.95	28.5142648	49.3905589
Bow Baptist Church	1816	1854	alpha	1.000030	1.000065	0.0178398	0.0177310	0.0176005	34249.7	0.0000121	0.95	0.0135668	0.0222875
Bow Baptist Church	1816	1854	beta	1.000101	1.000176	0.0342888	0.0343015	0.0344203	27531.6	0.0000267	0.95	0.0254971	0.0428912
Bow Baptist Church	1816	1854	M	1.000127	1.000215	30.4475147	31.1788204	32.1419453	30146.9	0.0303469	0.95	19.8828464	39.5245140
St. Mary and St. Michael	1843	1853	alpha	1.000033	1.000036	0.0186259	0.0185419	0.0184065	40361.5	0.0000101	0.95	0.0147251	0.0226015
St. Mary and St. Michael	1843	1853	beta	1.000022	1.000026	0.0402565	0.0402521	0.0402023	34625.2	0.0000217	0.95	0.0323302	0.0481678
St. Mary and St. Michael	1843	1853	M	1.000054	1.000056	30.8800161	31.2177577	32.2013493	37195.7	0.0173432	0.95	24.2287121	37.0137908
St. Bride's crypt (known age)	1740	1853	alpha	1.001301	1.004385	0.0048650	0.0048100	0.0046364	11054.4	0.0000077	0.95	0.0033513	0.0064885
St. Bride's crypt (known age)	1740	1853	beta	1.001527	1.004999	0.0492998	0.0492831	0.0490777	10841.1	0.0000350	0.95	0.0422819	0.0564716
St. Bride's crypt (known age)	1740	1853	M	1.000820	1.002819	59.1168993	59.1961001	59.4409448	16528.6	0.0139187	0.95	55.5069567	62.4858268
St. Bride's crypt (estimates)	1740	1853	alpha	1.000226	1.000828	0.0054592	0.0053893	0.0052386	9799.8	0.0000103	0.95	0.0035622	0.0075345
St. Bride's crypt (estimates)	1740	1853	beta	1.000156	1.000578	0.0421191	0.0420285	0.0422639	7187.2	0.0000633	0.95	0.0316832	0.0525833
St. Bride's crypt (estimates)	1740	1853	M	1.000167	1.000522	60.6660579	60.6789717	60.5443274	31247.5	0.0156171	0.95	55.1575927	66.0820439

```

kable(wellcome_result_r, caption = "London cemeteries data, corrected for population growth.") %>%
  kableExtra::kable_styling(latex_options = c("HOLD_position", "scale_down"))

```

Table 18: London cemeteries data, corrected for population growth.

cemetery	start	end	parameter	PSRF Point est.	PSRF Upper C.I.	Mean	Median	Mode	ESS	MCSE	HDImass	HDIlow	HDHigh
Bernondsey Abbey	1089	1538	alpha	1.0000838	1.0002832	0.0100400	0.0099166	0.0098446	26671.0	0.0000108	0.95	0.0067587	0.0135658
Bernondsey Abbey	1089	1538	beta	1.0000652	1.0002383	0.0433973	0.0434037	0.0433660	23814.9	0.0000314	0.95	0.0038812	0.0528532
Bernondsey Abbey	1089	1538	M	1.0000755	1.0002486	45.7191615	45.9209874	46.3252802	31878.5	0.0189265	0.95	38.9780944	52.1972837
Bernondsey Abbey	1089	1538	rate	1.0000464	1.0001265	0.0056675	0.0056664	0.0056281	103800.3	0.0000077	0.95	0.0007520	0.0104846
St. Mary Graces	1350	1540	alpha	1.0003274	1.0012227	0.0170500	0.0169374	0.0167563	32713.4	0.0000121	0.95	0.0128338	0.0213973
St. Mary Graces	1350	1540	beta	1.0003464	1.0010925	0.0371413	0.0371457	0.0369649	28970.8	0.0000250	0.95	0.0288199	0.0455081
St. Mary Graces	1350	1540	M	1.0000894	1.0012691	32.6147162	33.0717743	33.8230509	30846.2	0.0243233	0.95	23.9703547	40.3513000
St. Mary Graces	1350	1540	rate	1.0000894	1.0012691	0.0050173	0.0050061	0.0048331	101379.9	0.0000078	0.95	0.0001710	0.0099029
St. Mary Hospital, 1120-1200	1120	1200	alpha	1.0000744	1.0001585	0.0229069	0.0228072	0.0226962	44341.4	0.0000114	0.95	0.0182959	0.0276749
St. Mary Hospital, 1120-1200	1120	1200	beta	1.0000567	1.0000892	0.0379624	0.0379679	0.0379693	42156.5	0.0000186	0.95	0.0305304	0.0455041
St. Mary Hospital, 1120-1200	1120	1200	M	1.0000605	1.0001422	24.9618796	25.3956309	26.2337065	40136.4	0.0202360	0.95	16.8345961	32.3307248
St. Mary Hospital, 1120-1200	1120	1200	rate	1.0000999	1.0000514	0.0028186	0.0028210	0.0028928	117945.2	0.0000072	0.95	-0.0019895	0.0077526
St. Mary Hospital, 1200-1250	1200	1250	alpha	0.9999993	1.0000040	0.0231033	0.0230317	0.0229400	51319.5	0.0000094	0.95	0.0190531	0.0275413
St. Mary Hospital, 1200-1250	1200	1250	beta	1.0000217	1.0000637	0.0398151	0.0398203	0.0399163	50177.3	0.0000159	0.95	0.0328604	0.0467834
St. Mary Hospital, 1200-1250	1200	1250	M	1.0000356	1.0000620	25.4303509	25.7221369	26.4088252	46593.1	0.0150515	0.95	18.9334422	31.4155340
St. Mary Hospital, 1200-1250	1200	1250	rate	1.0000017	1.0000242	0.0127656	0.0127687	0.0127411	106452.0	0.0000076	0.95	0.0079367	0.0176308
St. Mary Hospital, 1250-1400	1250	1400	alpha	1.0001085	1.0003718	0.0162361	0.0162008	0.0161172	24263.4	0.0000075	0.95	0.0139430	0.0185303
St. Mary Hospital, 1250-1400	1250	1400	beta	1.0000542	1.0001499	0.0610252	0.0610180	0.0609588	24639.2	0.0000179	0.95	0.0556436	0.0666426
St. Mary Hospital, 1250-1400	1250	1400	M	1.0001158	1.0003940	33.6893300	33.7243315	33.8121968	26426.9	0.0061847	0.95	31.7114238	35.6535613
St. Mary Hospital, 1250-1400	1250	1400	rate	1.0000652	1.0002555	0.0048625	0.0048619	0.0048495	56023.5	0.0000104	0.95	0.0000656	0.0096067
St. Mary Hospital, 1400-1539	1400	1539	alpha	1.0000166	1.0000616	0.0232087	0.0231347	0.0230476	40999.7	0.0000106	0.95	0.0191172	0.0274781
St. Mary Hospital, 1400-1539	1400	1539	beta	0.9999983	0.9999994	0.0399330	0.0399334	0.0400079	39068.3	0.0000179	0.95	0.0329843	0.0468700
St. Mary Hospital, 1400-1539	1400	1539	M	1.0000033	1.0000227	25.3472628	25.6468575	25.9890888	37135.2	0.0169475	0.95	18.9767809	31.3741897
St. Mary Hospital, 1400-1539	1400	1539	rate	1.0000045	1.0000266	0.0047576	0.0047563	0.0047267	101354.3	0.0000078	0.95	-0.0001426	0.0095800
New Churchyard	1569	1739	alpha	1.0000623	1.0002419	0.0213942	0.0213813	0.0213813	37857.5	0.0000101	0.95	0.0177059	0.0253639
New Churchyard	1569	1739	beta	1.0000466	1.0001393	0.0399082	0.0399066	0.0396311	34593.4	0.0000188	0.95	0.0330861	0.0467680
New Churchyard	1569	1739	M	1.0000890	1.0002876	27.3195761	27.5994740	28.1540202	34654.1	0.0165077	0.95	21.1423459	32.9791097
New Churchyard	1569	1739	rate	1.0000561	1.0002218	0.0075734	0.0075739	0.0075115	87815.4	0.0000084	0.95	0.0027115	0.0124518
St. Benet Sherehog	1670	1740	alpha	1.0005010	1.0017417	0.0134970	0.0133484	0.0131236	32108.5	0.0000125	0.95	0.0092715	0.0179378
St. Benet Sherehog	1670	1740	beta	1.0002784	1.0009850	0.0378485	0.0378673	0.0381238	29662.3	0.0000278	0.95	0.0285729	0.0173985
St. Benet Sherehog	1670	1740	M	1.0006580	1.0019397	38.9536464	39.4335372	40.0114939	32229.6	0.0258883	0.95	29.6329494	47.4271450
St. Benet Sherehog	1670	1740	rate	1.0001948	1.0007213	0.0054418	0.0054411	0.0053026	113459.8	0.0000074	0.95	0.0005932	0.0103694
Chelsea Old church	1712	1842	alpha	1.0001811	1.0006712	0.0064632	0.0063545	0.0061118	22867.0	0.0000086	0.95	0.0046611	0.0090769
Chelsea Old church	1712	1842	beta	1.0004428	0.0454444	0.0454444	0.0454725	0.0459164	18280.3	0.0000395	0.95	0.0352119	0.0560876
Chelsea Old church	1712	1842	M	1.0001534	1.0005323	55.0853288	55.1552183	55.2739107	41669.3	0.0151367	0.95	48.8997340	61.0988923
Chelsea Old church	1712	1842	rate	1.0000501	1.0001803	0.0076252	0.0076270	0.0076555	87862.5	0.0000084	0.95	0.0027145	0.0124857
St. Marylebone	1742	1817	alpha	1.0002178	1.0007255	0.0101440	0.0100444	0.0098538	29194.7	0.0000093	0.95	0.0071645	0.0133415
St. Marylebone	1742	1817	beta	1.0000874	1.0002910	0.0451501	0.0451589	0.0449632	25950.2	0.0000287	0.95	0.0360568	0.0541524
St. Marylebone	1742	1817	M	1.0002147	1.0007379	45.0635516	45.2034367	45.4143652	36064.4	0.0149196	0.95	39.3573683	50.4715628
St. Marylebone	1742	1817	rate	1.0000526	1.0002126	0.0074543	0.0074524	0.0076205	104062.2	0.0000077	0.95	0.0025216	0.0122892
St. Marylebone Paddington Street north	1772	1853	alpha	1.0002542	1.0008084	0.0067637	0.0066864	0.0065593	29077.1	0.0000067	0.95	0.0046115	0.0090270
St. Marylebone Paddington Street north	1772	1853	beta	1.0002756	1.0009405	0.0540638	0.0540510	0.0536428	26137.3	0.0000292	0.95	0.0448796	0.0633775
St. Marylebone Paddington Street north	1772	1853	M	1.0001123	1.0003558	50.5839045	50.5997478	50.6283602	49144.3	0.0098183	0.95	46.3197116	54.8777040
St. Marylebone Paddington Street north	1772	1853	rate	1.0000530	1.0002108	0.0134486	0.0134466	0.0134276	101055.9	0.0000078	0.95	0.0084954	0.0182577
St. Bride's lower churchyard	1770	1849	alpha	1.0000541	1.0002105	0.0038968	0.0038498	0.0037027	15814.7	0.0000052	0.95	0.0026639	0.0052077
St. Bride's lower churchyard	1770	1849	beta	1.0000695	1.0002299	0.0575269	0.0575380	0.0577583	11764.5	0.0000441	0.95	0.0481929	0.0669497
St. Bride's lower churchyard	1770	1849	M	0.9999984	1.0000108	59.0021341	58.9401791	58.7233548	38951.3	0.0098755	0.95	55.2385781	62.9019341
St. Bride's lower churchyard	1770	1849	rate	1.0000531	1.0002107	0.0132263	0.0132286	0.0132474	53107.5	0.0000108	0.95	0.0083422	0.0181082
Sheen's burial ground	1763	1854	alpha	1.0000662	1.0001287	0.0084824	0.0083486	0.0082490	29144.7	0.0000098	0.95	0.0053643	0.0118347
Sheen's burial ground	1763	1854	beta	1.0000047	1.0000219	0.0407352	0.0407525	0.0409030	24694.0	0.0000327	0.95	0.0307178	0.0508684
Sheen's burial ground	1763	1854	M	1.0001086	1.0001918	50.5580937	50.7517380	51.2064976	37030.7	0.0206643	0.95	42.7047488	58.3109442
Sheen's burial ground	1763	1854	rate	0.9999988	0.9999988	0.0131541	0.0131562	0.0130473	97774.3	0.0000080	0.95	0.0082386	0.0179953
Bow Baptist Church	1816	1854	alpha	1.0000692	1.0001713	0.0110446	0.0109416	0.0106667	40268.7	0.0000084	0.95	0.0078860	0.0143967
Bow Baptist Church	1816	1854	beta	1.0002517	1.0008542	0.0408050	0.0408059	0.0403874	35377.1	0.0000242	0.95	0.0317338	0.0496223
Bow Baptist Church	1816	1854	M	1.0000353	1.0000572	43.9440782	44.1432122	44.7087330	45571.5	0.0156797	0.95	37.2262949	50.3267673
Bow Baptist Church	1816	1854	rate	0.9999931	0.9999937	0.0174495	0.0174502	0.0173566	103967.3	0.0000077	0.95	0.0125694	0.0223181
St. Mary and St. Michael	1843	1853	alpha	1.0000872	1.0002508	0.0122682	0.0121878	0.0120922	46330.1	0.0000074	0.95	0.0092311	0.0154130
St. Mary and St. Michael	1843	1853	beta	1.0001028	1.0002305	0.0459884	0.0459896	0.0456965	43129.1	0.0000201	0.95	0.0377459	0.0540983
St. Mary and St. Michael	1843	1853	M	1.0000848	1.0002707	40.6968622	40.8135754	41.0106266	52560.8	0.0108411	0.95	35.7575099	45.4830250
St. Mary and St. Michael	1843	1853	rate	1.0000133	1.0000654	0.0176438	0.0176430	0.0176538	111092.8	0.0000074	0.95	0.0128053	0.0225246
St. Bride's crypt (known age)	1740	1853	alpha	1.0004443	1.0013905	0.0032673	0.0032272	0.0031669	12848.3	0.0000049	0.95	0.0022166	0.0043711
St. Bride's crypt (known age)	1740	1853	beta	1.0004021	1.0012011	0.0548600	0.0548491	0.0546809	12567.4	0.0000327	0.95	0.0476639	0.0620221
St. Bride's crypt (known age)	1740	1853	M	1.0002073	1.0007301	63.6024120	63.6337709	63.7592027	32254.3	0.0081643	0.95	60.6589371	66.1269445
St. Bride's crypt (known age)	1740	1853	rate	0.9999985	1.0000287	0.0100126	0.0100126	0.0100097	119697.3	0.0000003	0.95	0.0098169	0.0102088
St. Bride's crypt (estimates)	1740	1853	alpha	1.0003969	1.0006972	0.0034987	0.0034246	0.0033551	9622.3	0.0000080	0.95	0.0020815	0.0050785
St. Bride's crypt (estimates)	1740	1853	beta	1.0008229	1.0016213	0.0486144	0.0486320	0.0486948	7469.0	0.0000656	0.95	0.0373576	0.0594958
St. Bride's crypt (estimates)	1740	1853	M	1.0000624	1.0002289	66.5428345	66.4297188	66.1209580	27068.3	0.0184177	0.95	60.6696338	72.5737015
St. Bride's crypt (estimates)	1740	1853	rate	1.0000319	1.0000996	0.0099656	0.0099642	0.0099909	35932.4	0.0000132	0.95	0.0050923	0.0148968

Modal ages from historical and osteological data

Figure 6: Modal ages from historical and osteological data

```
source("./chapter_04_results/english_welcome.R")
plot(modal_ages_plot)
```

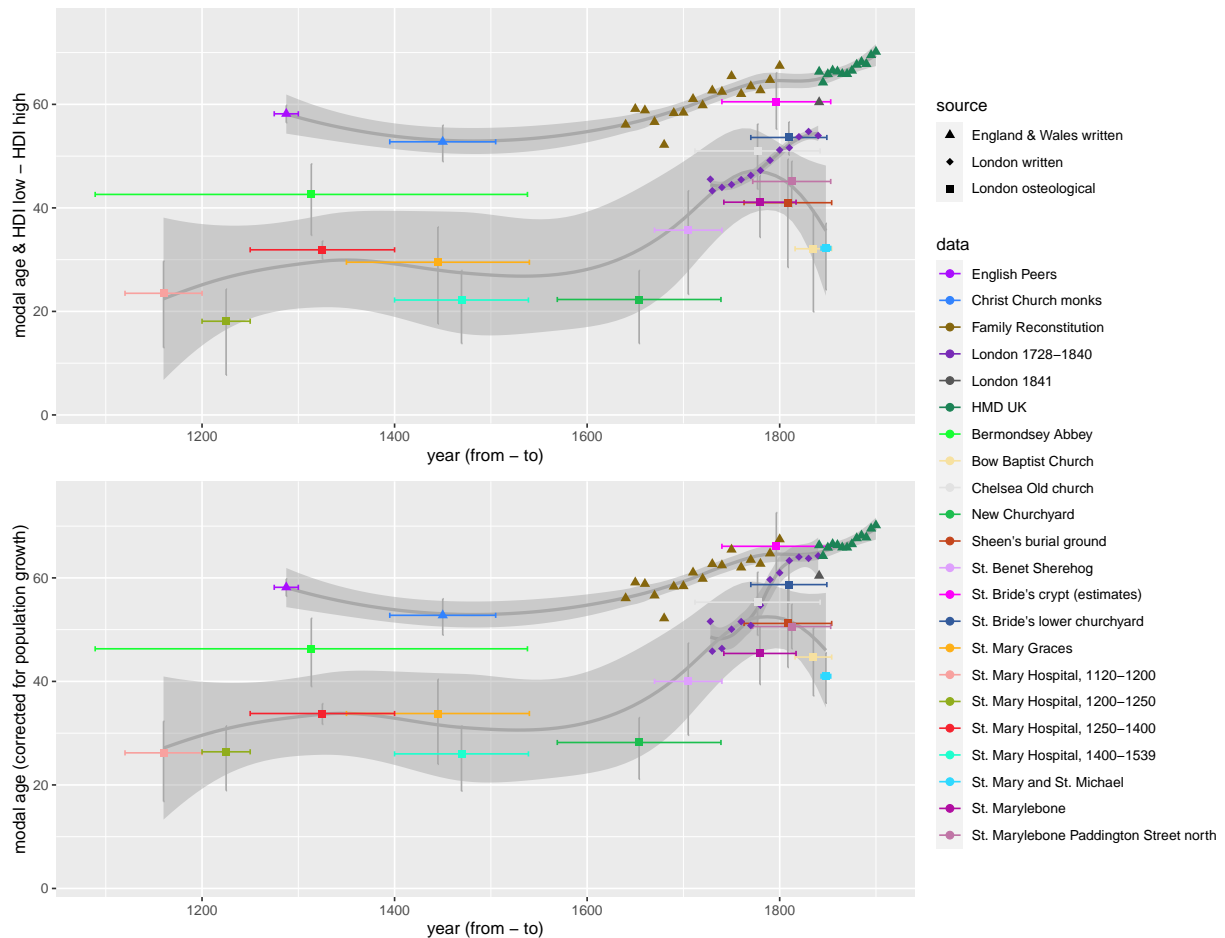



Table 2: Overview of modelled osteological data from London cemeteries

The data overview is build during pre-processing in `./chapter_04_results/Wellcome_DB.R` and saved to a textfile (sep = `\t`).

`wellcome_overview_all`

```
kable(wellcome_overview_all, caption = "London cemeteries overview.") %>%
  kableExtra::kable_styling(latex_options = c("HOLD_position", "scale_down"))
```

Table 19: London cemeteries overview.

cemetery	beta	beta_range	M	M_range	ex20	ex25	beta	beta_range	M	M_range	ex20	ex25
Bermondsey Abbey	0.0408	0.0316-0.0504	42.6	34.7-48.5	25.8	23.0	0.0434	0.0339-0.0529	46.3	39-52.2	27.2	24.2
Bow Baptist Church	0.0344	0.0255-0.0429	32.1	19.9-39.5	22.4	20.1	0.0404	0.0317-0.0496	44.7	37.2-50.3	27.3	24.4
Chelsea Old church	0.0418	0.0312-0.0516	51.0	43.6-56.2	30.5	27.4	0.0459	0.0352-0.0561	55.3	48.9-61.1	33.1	29.7
New Churchyard	0.0366	0.0299-0.0432	22.3	13.8-27.9	17.0	15.0	0.0396	0.0331-0.0468	28.2	21.1-33	18.3	16.1
Sheen's burial ground	0.0346	0.0246-0.0442	41.0	28.5-49.4	27.2	24.6	0.0409	0.0307-0.0509	51.2	42.7-58.3	31.0	27.8
St. Benet Sherehog	0.0352	0.0261-0.0445	35.7	23.3-43.3	23.9	21.4	0.0381	0.0286-0.0474	40.0	29.6-47.4	25.2	22.5
St. Bride's crypt (estimates)	0.0423	0.0317-0.0526	60.5	55.2-66.1	37.7	34.2	0.0487	0.0374-0.0595	66.1	60.7-72.6	41.1	37.2
St. Bride's crypt (known age)	0.0491	0.0423-0.0565	59.4	55.5-62.5	35.7	32.0	0.0547	0.0477-0.062	63.8	60.7-66.4	38.4	34.5
St. Bride's lower churchyard	0.0507	0.0415-0.0597	53.6	50.2-56.6	30.9	27.4	0.0578	0.0482-0.0669	58.7	55.2-62.9	34.6	30.8
St. Mary Graces	0.0348	0.0264-0.0428	29.5	17.6-36.3	21.0	18.7	0.0370	0.0288-0.0455	33.8	24-40.4	22.2	19.8
St. Mary Hospital, 1120-1200	0.0363	0.0289-0.0437	23.5	13-29.7	17.6	15.5	0.0380	0.0305-0.0455	26.2	16.8-32.3	18.1	15.9
St. Mary Hospital, 1200-1250	0.0358	0.0288-0.0423	18.1	7.7-24.3	15.6	13.7	0.0399	0.0329-0.0468	26.4	18.9-31.4	17.4	15.3
St. Mary Hospital, 1250-1400	0.0583	0.0528-0.0633	31.9	30.1-33.6	15.9	13.3	0.0610	0.0556-0.0666	33.8	31.7-35.7	16.5	13.8
St. Mary Hospital, 1400-1539	0.0377	0.0307-0.0443	22.2	13.8-27.9	16.5	14.5	0.0401	0.033-0.0469	26.0	18.8-31.4	17.3	15.2
St. Mary and St. Michael	0.0402	0.0323-0.0482	32.2	24.2-37	20.0	17.6	0.0457	0.0377-0.0541	41.0	35.8-45.5	23.5	20.7
St. Marylebone	0.0424	0.0332-0.051	41.1	34.3-46.2	24.4	21.7	0.0450	0.0361-0.0542	45.4	39.4-50.5	26.6	23.5
St. Marylebone Paddington Street north	0.0487	0.0398-0.0579	45.1	40.2-49	25.3	22.2	0.0536	0.0449-0.0634	50.6	46.3-54.9	28.7	25.2

Marylebone.R

Data are hard coded in the code. Sources: MILES et al. (2008), 97–103 table 32 (St Marylebone); HENDERSON et al. (2015), 81 (St Marylebone north of Paddington street)


```
source("../lifetables_processing/Marylebone.R")
kable(Marylebone_ranges, caption = "St Marylebone, corrected with population growth rate of 2.75 per
kableExtra::kable_styling(latex_options = "HOLD_position")
```

Table 20: St Marylebone, corrected with population growth rate of 2.75 per-cent.

parameter	modes	HDI.ranges
Marylebone beta	0.0530	0.0436-0.0619
Marylebone M	54.2072	49.6-59.3
Marylebone north beta	0.0595	0.0498-0.0683
Marylebone north M	55.5506	51.4-60.0

Figure 7: St. Bride's Crypt. Density of actual ages and Bayesian model of Gompertz distribution of actual ages and osteological estimates (without correction for population growth).

The plot is build in ./lifetables_processing/stbrides_crypt.R within the if-statement on `runCodeNew` (s. data limitations above).

```
plot(stbrides_crypt_plot)
```

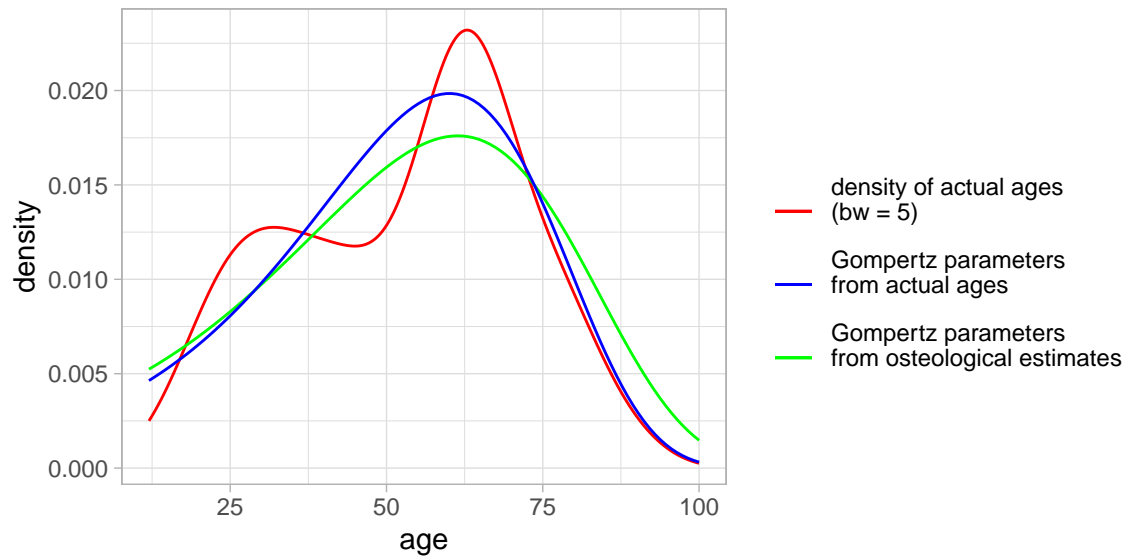
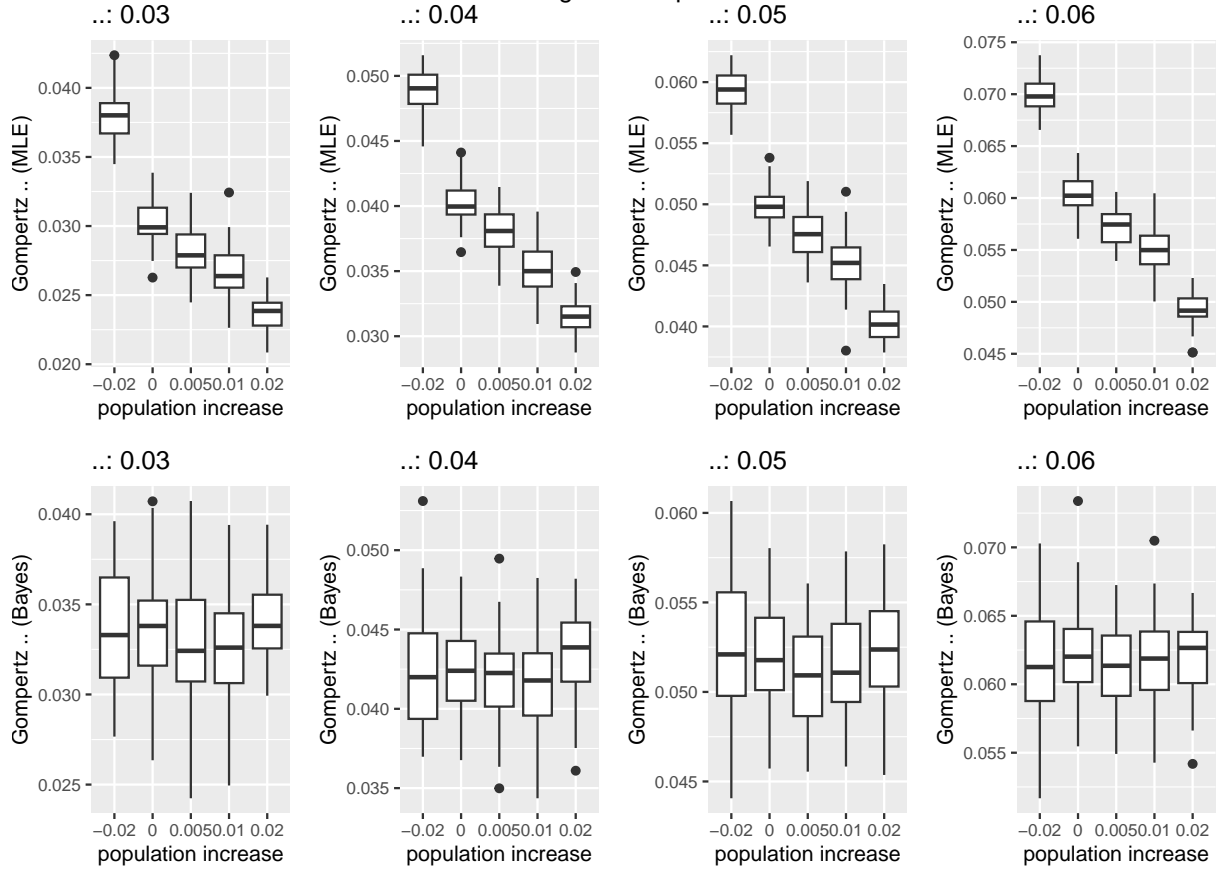


Figure 8: Simulation of population increase with known age-at-death and Maximum Likelihood Estimation (MLE) (top four) and osteological estimates, Bayesian model and including rate of increase (bottom four).

```
source("../chapter_04_results/simulations_pop_incr_run.R")
```

Original Gompertz



Supplements

The chapter ‘Supporting informations’ provides details about the London cemeteries included in the study.

The Coale & Demeny life tables

Calculation of the lowest β -value for any of the Coale & Demeny life tables (COALE/DEMENY (1983)) which is 0.0391 (the female table “West”, level 1).

```
source("./chapter_supplement/coale_demeny_life_tables_gompertz.R")
min(gompertz_df$Gompertz_shape)
```

```
## [1] 0.03913138
```

Simulations

Simulations for evaluation of algorithms for retrieving Gompertz parameters. The file “./chapter_supplement/simulations_run.R” provides various tests and plots from the evaluation process. The validity of the algorithms is tested via root mean square error (RMSE) of between expected and estimated values for Gompertz β .

Known age-at-death

Figure S1: Comparing expected and estimated Gompertz β -values by different algorithms with known age-at-death ($n = 1,000$).

```
source("./chapter_supplement/simulations_run.R")
gridExtra::grid.arrange(grobs = plot_list_shapes, ncol = 3)
```

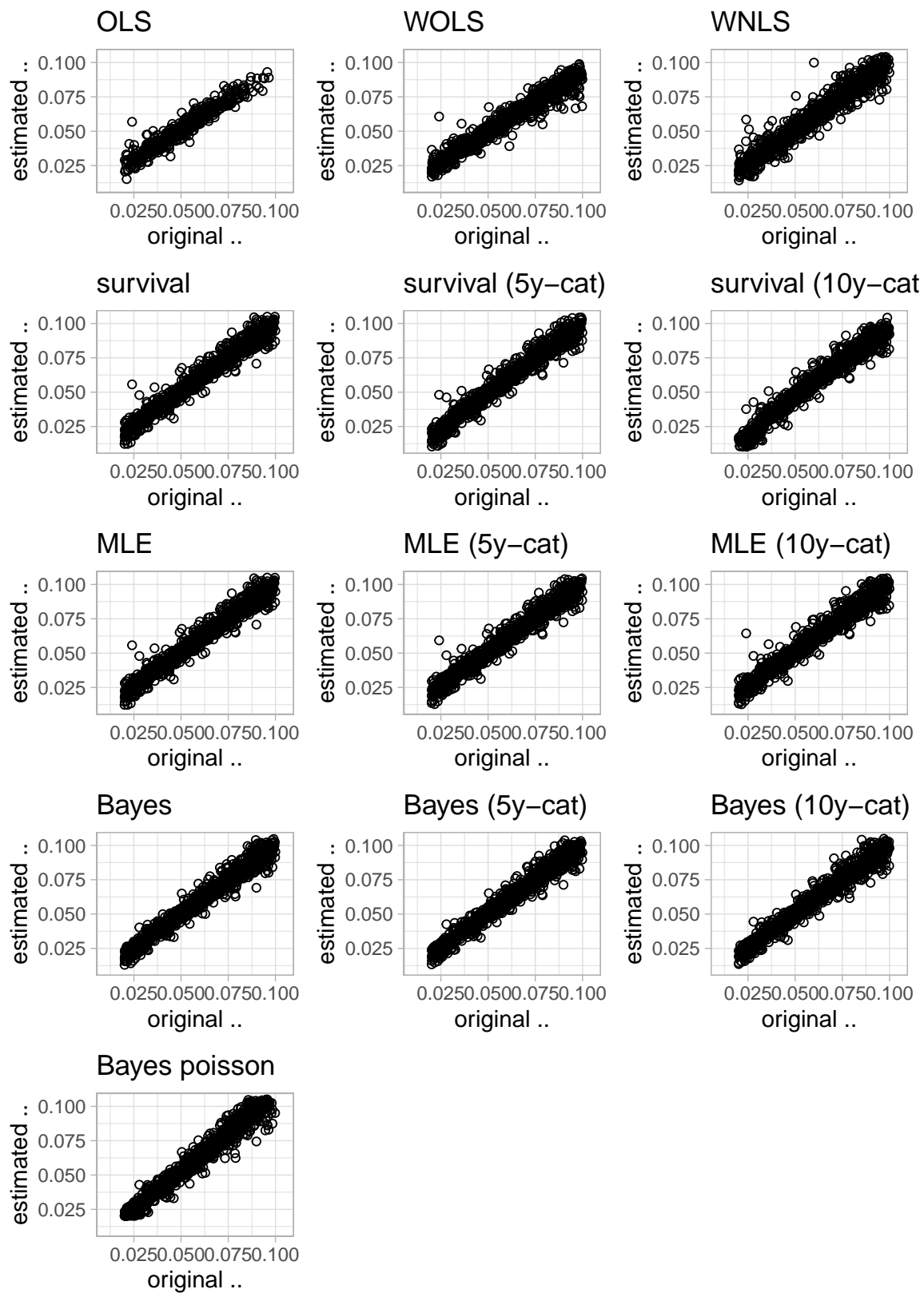


Figure S2: Difference between expected and estimated Gompertz β -values by different algorithms with known age-at-death ($n = 1,000$).

```
source("../chapter_supplement/simulations_run.R")
gridExtra::grid.arrange(grobs = plot_list_diff, ncol = 3)
```

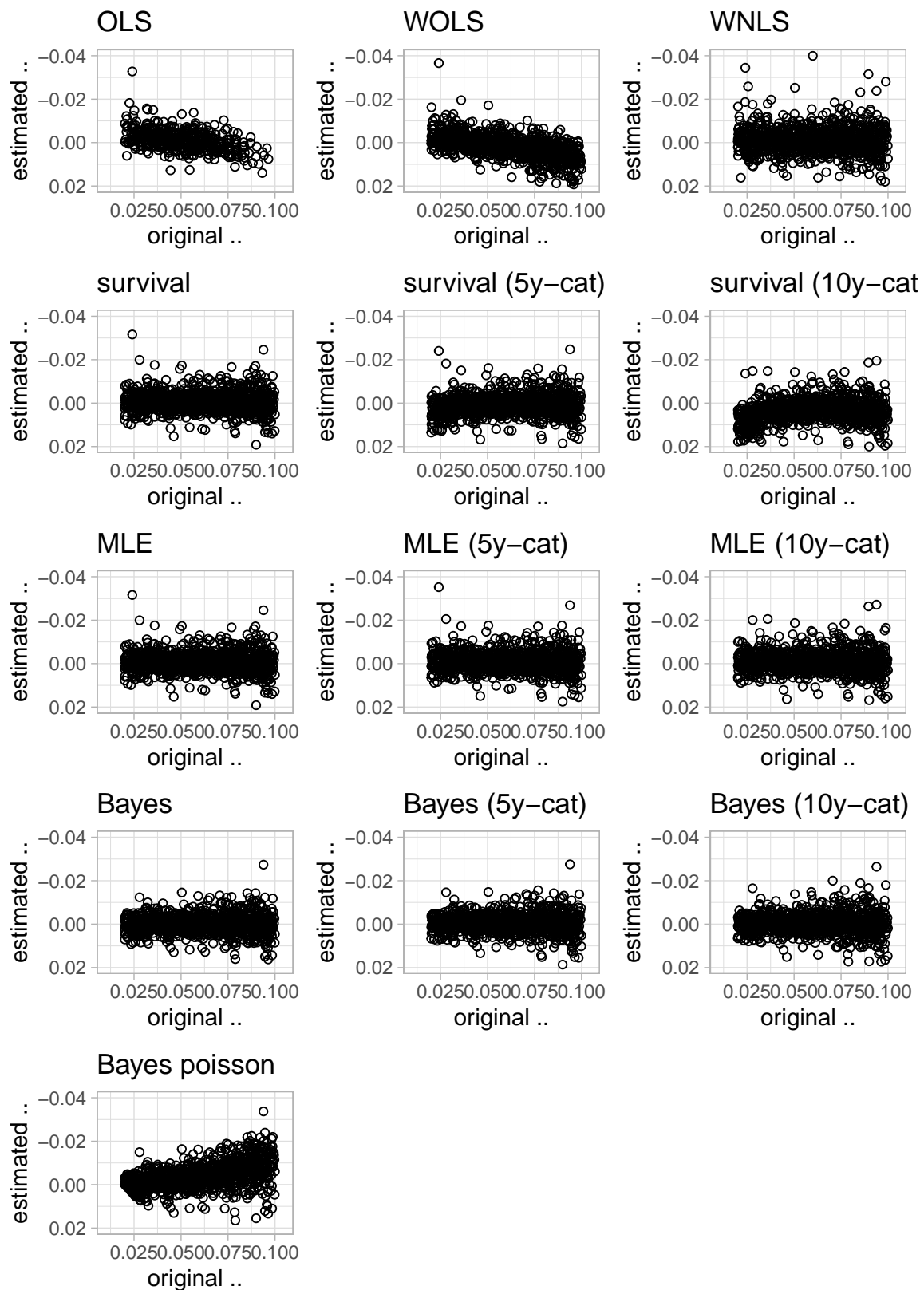


Table S1: Root mean square errors (RMSE) for different formulas for fitting known age-at-death, ordered ascendingly.

```
# table of RMSEs
kable(rmse_result[order(rmse_result$RMSE) ,], caption = "Evaluation of algorithms via RMSE.") %>%
  kableExtra::kable_styling(latex_options = "HOLD_position")
```

Table 21: Evaluation of algorithms via RMSE.

	method	RMSE	NAs
11	Bayes (5y-cat)	0.0045054	0
10	Bayes	0.0045342	0
7	MLE	0.0047464	0
4	survival	0.0047465	0
12	Bayes (10y-cat)	0.0048206	0
8	MLE (5y-cat)	0.0048251	0
5	survival (5y-cat)	0.0048980	0
1	OLS	0.0049008	545
9	MLE (10y-cat)	0.0051441	0
2	WOLS	0.0060401	0
3	WNLS	0.0061083	14
6	survival (10y-cat)	0.0067095	0
13	Bayes poisson	0.0073576	0

Figure S3: Comparing expected and estimated Gompertz β -values by different algorithms with estimated age-at-death ($n = 1,000$).

```
source("../chapter_supplement/simulations_run.R")
gridExtra::grid.arrange(grobs = plot_list_estim_shapes, ncol = 2)
```

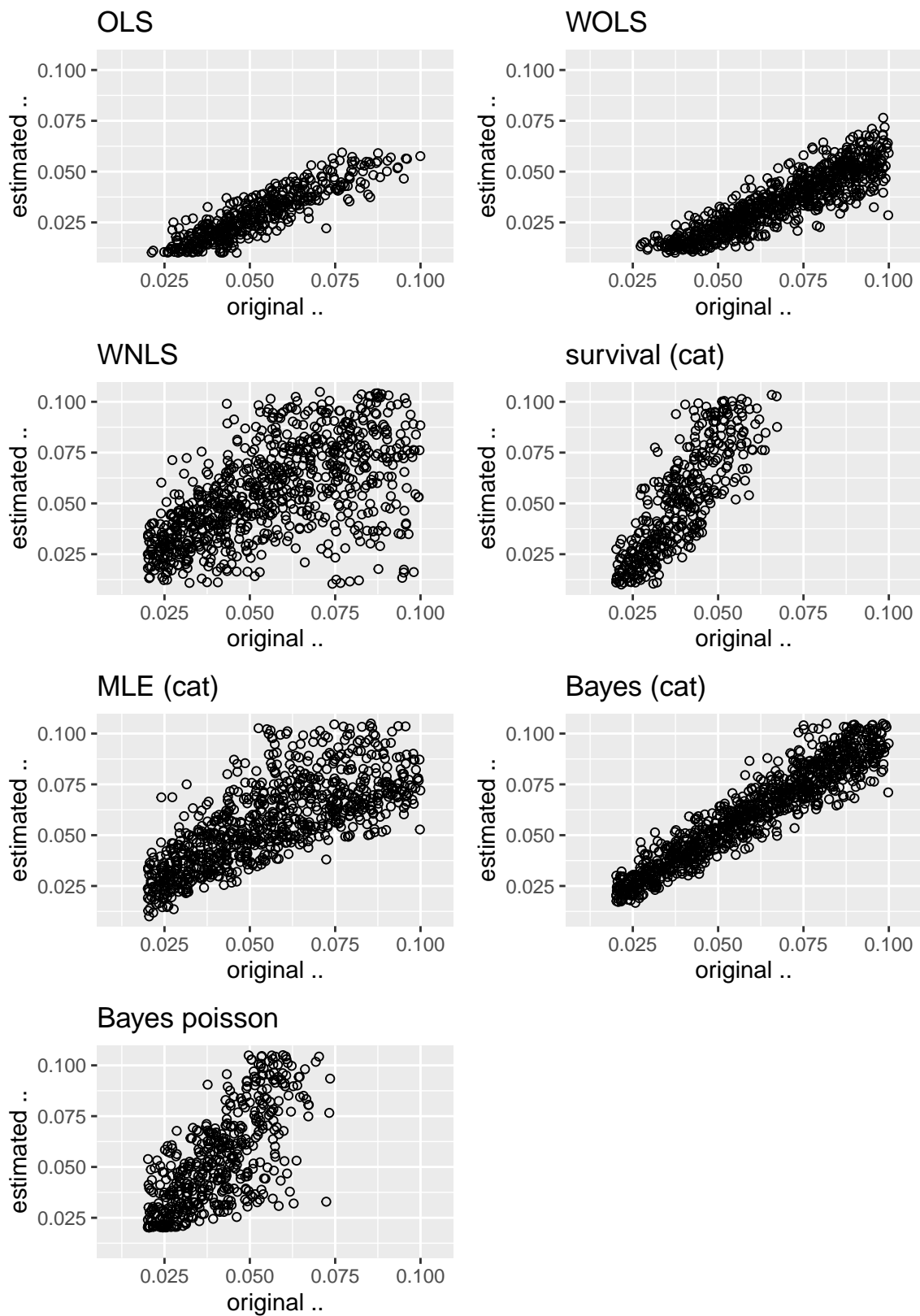


Table S2: Root mean square errors (RMSE) for different formulas for fitting estimated age-at-death, ordered ascendingly.

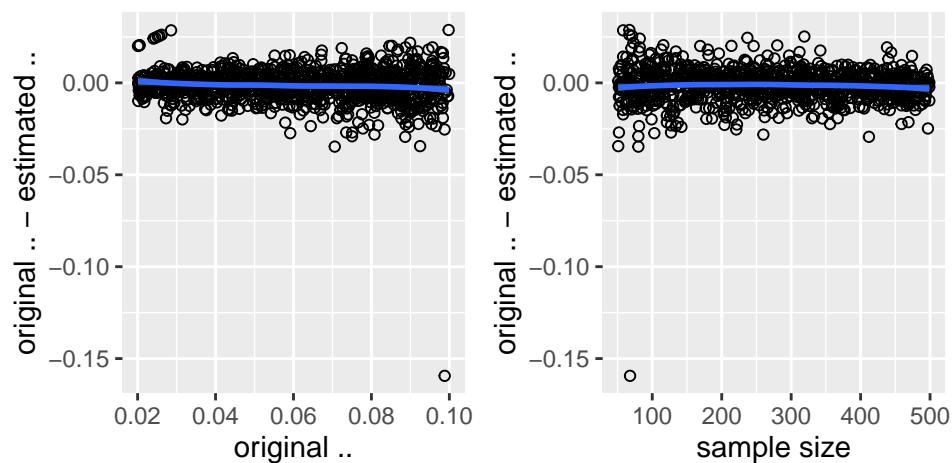
```
# table of RMSEs
kable(rmse_estim_result[order(rmse_estim_result$RMSE) ,], caption = "Evaluation of algorithms via RMSE")
kableExtra::kable_styling(latex_options = "HOLD_position")
```

Table 22: Evaluation of algorithms via RMSE for estimated age-at-death.

	method	RMSE	NAs
6	Bayes (cat)	0.0099026	0
8	MLE_wo_OL	0.0202114	71
1	OLS	0.0243214	442
3	WNLS	0.0293842	73
2	WOLS	0.0328083	2
5	MLE (cat)	0.0761568	0
7	Bayes poisson	0.1865772	0
4	survival (cat)	0.4731442	0

Figure S4: Detailed plot for the Bayesian model of expected Gompertz β -values (left) and sample size (right) vs. difference of expected/estimated Gompertz β -values.

```
#source("./chapter_supplement/simulations_run.R")
gridExtra::grid.arrange(grobs = plot_list_bayes_diff, ncol = 2)
```



Stability of means

Show that means are stable in Bayesian modelling, regardless of the number of MCMC-steps.

```
source("./chapter_supplement/bayes_complete.R") # can take a few minutes
kable(bayes_complete, caption = paste0("Bayesian model with simulated dataset and different number
kableExtra::kable_styling(latex_options = c("HOLD_position", "scale_down"))
```

Table 23: Bayesian model with simulated dataset and different number of steps. $n = 500$, Gompertz beta = 0.05.

mode	thinning	steps	parameter	PSRF Point est.	PSRF Upper C.I.	Mean	Median	Mode	ESS	MCSE	HDImass	HDIlow	HDHigh
known_age	1	10000	a	1.003210	1.006108	0.0028582	0.0028441	0.0027725	462.7	0.0000154	0.95	0.0022403	0.0035193
known_age	1	10000	b	1.001893	1.003920	0.0480363	0.0480265	0.0481745	488.6	0.0000947	0.95	0.0440097	0.0520917
known_age	1	10000	M	1.001259	1.003216	73.8375371	73.8501409	73.6934420	930.5	0.0357533	0.95	71.6915433	75.9608132
known_age	20	100000	a	1.000011	1.000109	0.0028495	0.0028327	0.0027934	71982.2	0.0000013	0.95	0.0022163	0.0035260
known_age	20	100000	b	1.000005	1.000090	0.0480993	0.0480962	0.0483082	71181.0	0.0000080	0.95	0.0438344	0.0521777
known_age	20	100000	M	1.000000	1.000078	73.8543153	73.8768307	73.9884330	84071.3	0.0037849	0.95	71.6339091	75.9294081
estimation	1	10000	a	1.007384	1.023678	0.0028312	0.0028026	0.0027942	167.5	0.0000382	0.95	0.0019049	0.0038193
estimation	1	10000	b	1.011691	1.038693	0.0510970	0.0508290	0.0503803	86.5	0.0005942	0.95	0.0404465	0.0624583
estimation	1	10000	M	1.005548	1.017117	71.9242579	71.9119671	72.0531786	392.2	0.1119194	0.95	67.6950056	76.3291669
estimation	20	100000	a	1.000247	1.000941	0.0027769	0.0027509	0.0027034	29177.9	0.0000026	0.95	0.0019290	0.0036726
estimation	20	100000	b	1.000354	1.001342	0.0516959	0.0514776	0.0502964	20843.0	0.0000356	0.95	0.0421542	0.0619696
estimation	20	100000	M	1.000091	1.000334	71.8362699	71.7754410	71.6155191	45976.8	0.0102799	0.95	67.6297829	76.2104655

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