Adult Mortality in the Metropolis of London 1100–1850

Supplement: Code structure, data source and processing

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Contents

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.pdf` is generated from it.

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.

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.

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

Remark: The current version of osmplotr has to be installed from github using `devtools::install_github ("ropensci/osmplotr")`.

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

```
## Loading required package: pacman
```

```
## [1] TRUE
```

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```
pacman::p_load(dplyr, fitdistrplus, flexsurv, ggplot2, gridExtra, kableExtra,
               mortAAR, nlme, osmplotr, reshape2, rgdal, HMDHFDplus, Metrics,
               svMisc, tibble, tidyr, cowplot, MortalityLaws, rio,
               coda, rjags, runjags, demogR, sf, rnaturalearth, readxl,
               ggrepel)
```

```
## Installing package into '/Volumes/SanDisk/Nils/Library/R/arm64/4.3/library'
## (as 'lib' is unspecified)
```

```
## Warning: package 'osmplotr' is not available for this version of R
##
## A version of this package for your version of R might be available elsewhere,
## see the ideas at
## https://cran.r-project.org/doc/manuals/r-patched/R-admin.html#Installing-packages
```

```
## Warning: 'BiocManager' not available.  Could not check Bioconductor.
##
## Please use `install.packages('BiocManager')` and then retry.
```

```
## Warning in p_install(package, character.only = TRUE, ...):
```

```
## Warning in library(package, lib.loc = lib.loc, character.only = TRUE,
## logical.return = TRUE, : there is no package called 'osmplotr'
```

```
## Warning in pacman::p_load(dplyr, fitdistrplus, flexsurv, ggplot2, gridExtra, : Failed to install/
## osmplotr
```

```
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_bayes_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

saveFileDir = "preprocessed_files"
if (saveFileDir %in% list.files(getwd()))
 {}else{
    dir.create(file.path(".", saveFileDir), showWarnings = FALSE )
 }
```

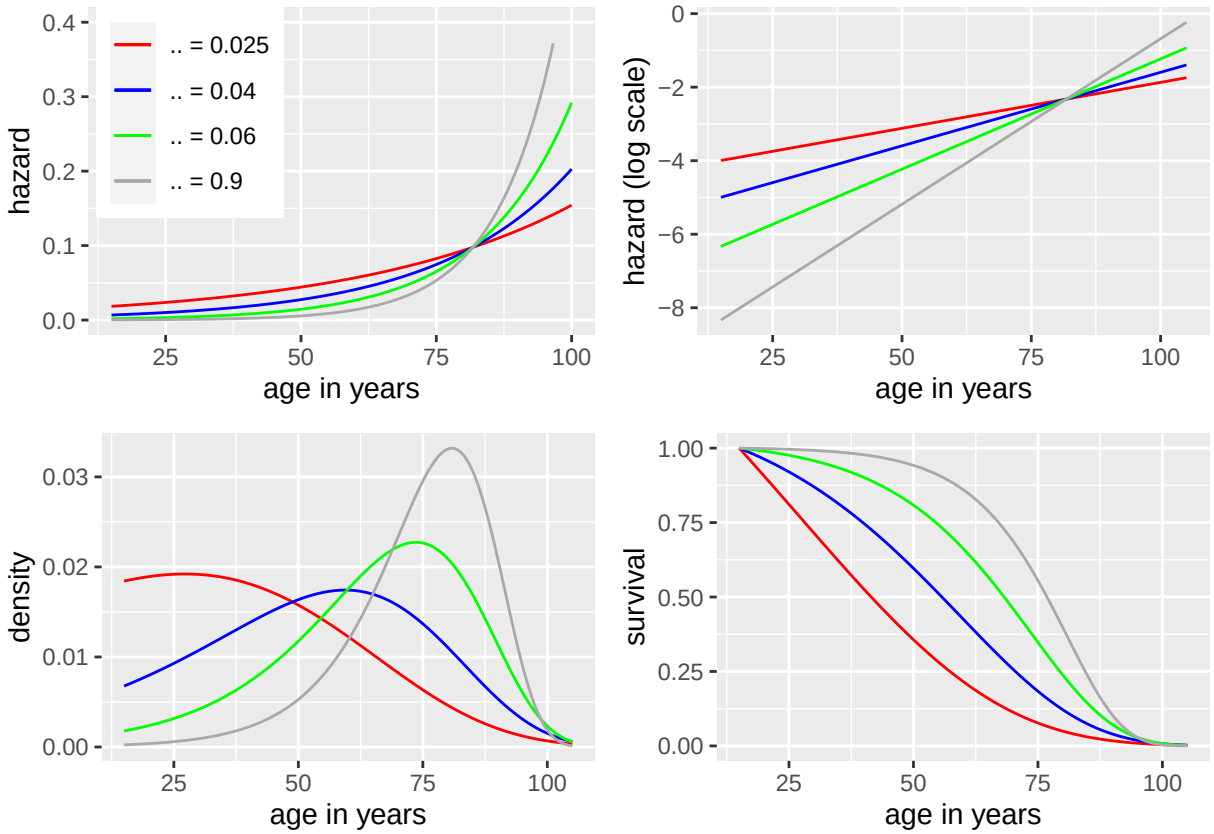
```
## NULL
```

1 Chapter 01 Introduction

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

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

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

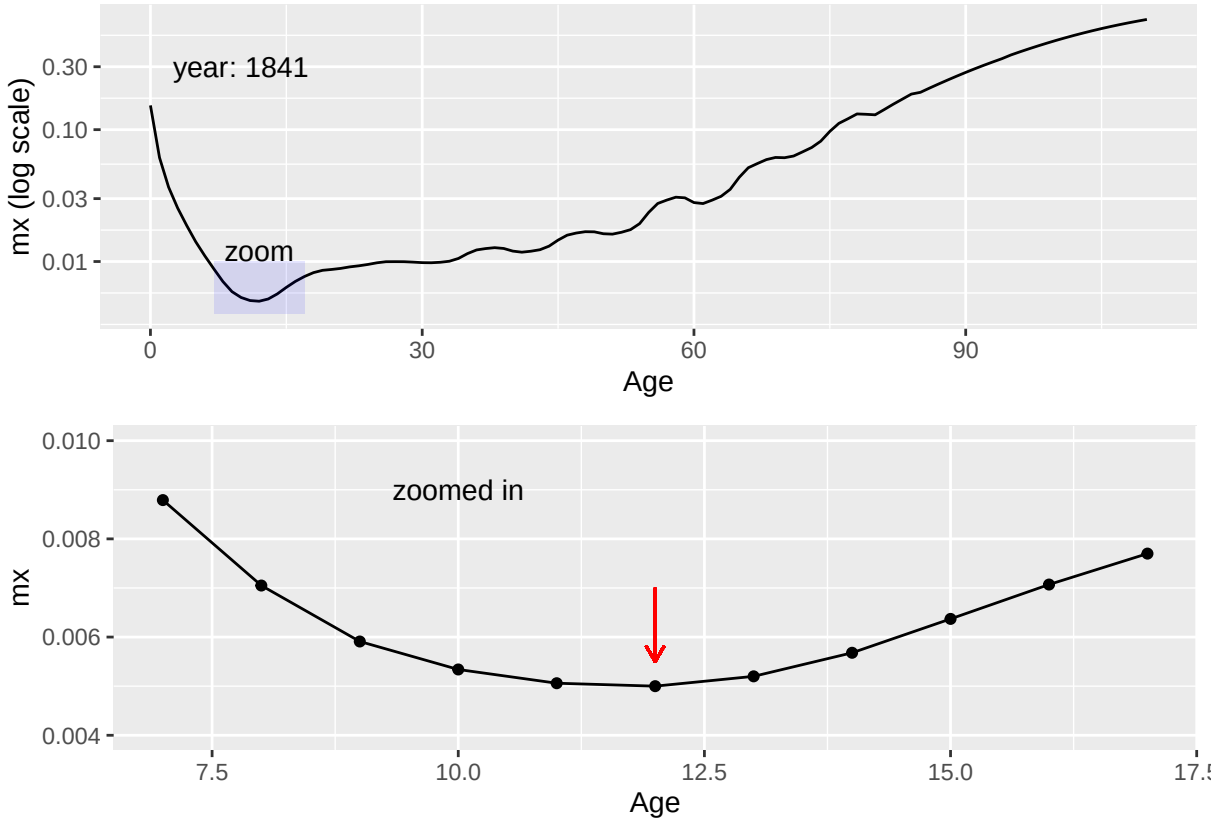


2 Chapter 02 Materials and methods

Figure 3: Hazard curve 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
```



3 Chapter 03 Data

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

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

```
## Data (c) OpenStreetMap contributors, ODbL 1.0. https://www.openstreetmap.org/copyright
## Saving 6.5 x 4.5 in image
```

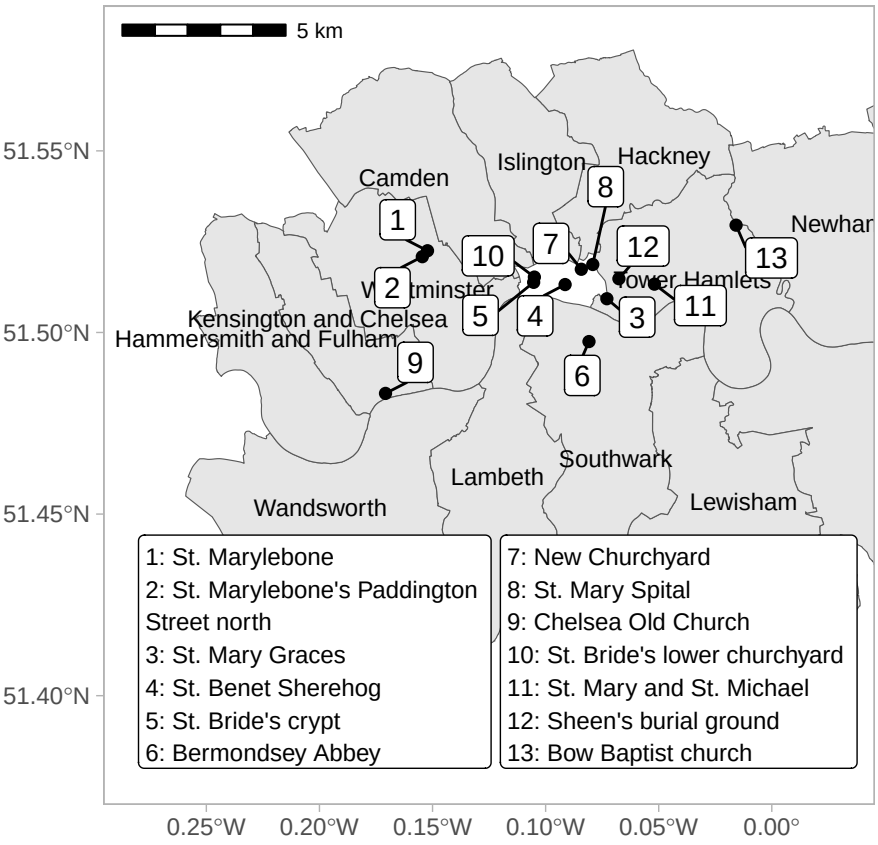
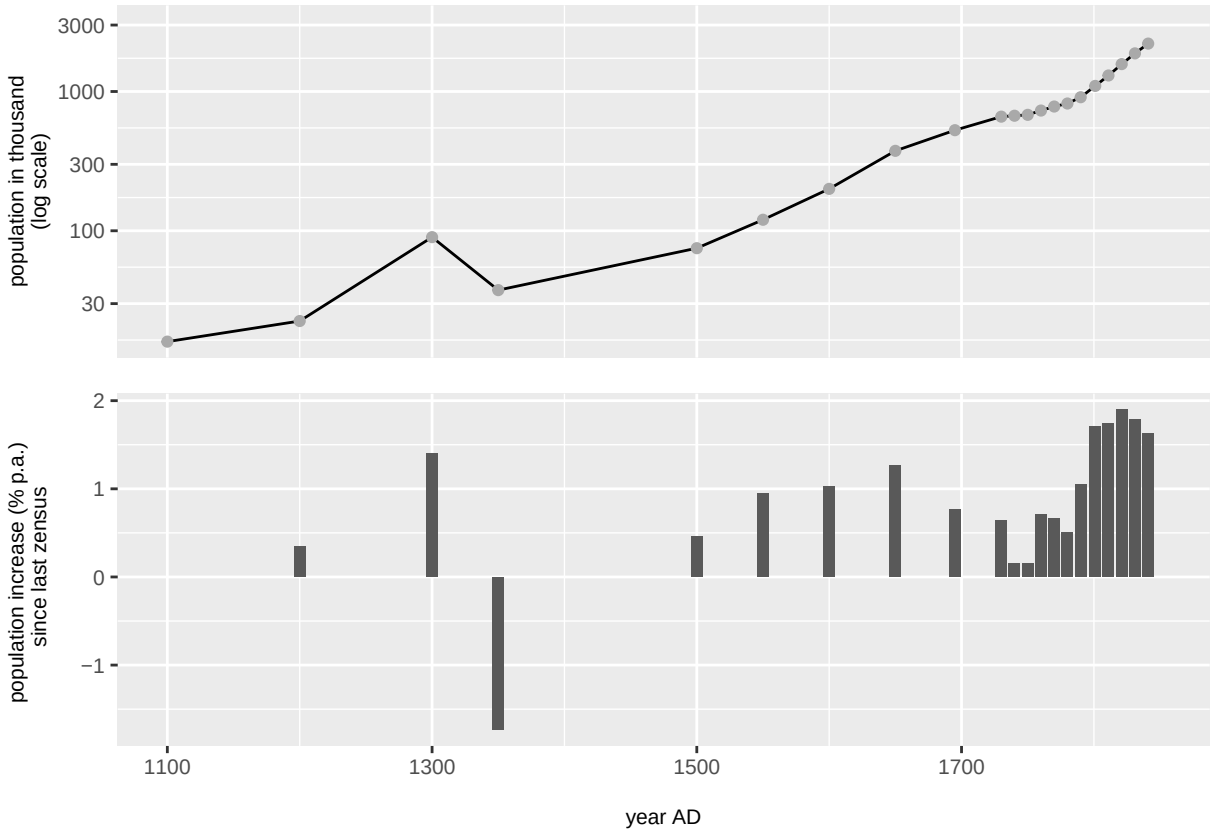


Figure 5: Population development of London, compiled from Finlay/Shearer (1986), 39 table 1; Landers (1993), 41; 179 table 5.7; Weinreb et al. (2008), 655–657.

```
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/
  kableExtra::kable_styling(latex_options = "HOLD_position")
```

Table 1: 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

4 Chapter 04 Results

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

4.1 Historical life tables

4.1.1 Written sources

Basic statistics

The data is referenced and aggregated in "./chapter_04_results/historical_lifetables.R". In this file, all records from individual preprocessing files located in "./liftables_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 2: 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 3: 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 4: 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 5: London Mortality bills 1728-1840, corrected for population growth.

parameter	ranges
beta_r	0.034-0.0507
M_r	46-64.3
r	0.002-0.019

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 6: 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 7: 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 8: 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 9: English Peers.

	PSRF Point est.	PSRF Upper C.I.	Mean	Median	Mode	ESS	MCSE	HDImass	HDIlow	HDIhigh
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 10: Christ Church monks.

start	end	parameter	PSRF Point est.	PSRF Upper C.I.	Mean	Median	Mode	ESS	MCSE	HDImass	HDIlow	HDIhigh
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 11: London Mortality bills 1728-1840.

year	parameter	PSRF Point est.	PSRF Upper C.I.	Mean	Median	Mode	ESS	MCSE	HDImass	HDIlow	HDIhigh
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 12: 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	HDIhigh
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	1.000179	1.000607	0.0143632	0.0142738	0.0140413	13423.4	0.0000148	0.95	0.0111303	0.0178349
X1730	beta	1.000209	1.000645	0.0340807	0.0340719	0.0339992	14402.5	0.0000247	0.95	0.0282252	0.0398462
X1730	M	1.000167	1.000545	45.1548428	45.5041559	46.1942144	13398.1	0.0340936	0.95	37.2310898	52.4481763
X1730	rate	1.000100	1.000359	0.0021254	0.0021267	0.0023925	28508.1	0.0000148	0.95	-0.0027647	0.0070247
X1740	alpha	1.000250	1.000351	0.0143131	0.0142474	0.0141781	12578.6	0.0000142	0.95	0.0112583	0.0174506
X1740	beta	1.000181	1.000319	0.0351166	0.0351062	0.0349517	13779.1	0.0000232	0.95	0.0297582	0.0404467
X1740	M	1.000278	1.000415	45.4168492	45.6666273	45.9931494	12599.0	0.0307477	0.95	38.5335175	51.8684034
X1740	rate	1.000068	1.000120	0.0016517	0.0016515	0.0015142	25567.8	0.0000156	0.95	-0.0031950	0.0065573
X1750	alpha	1.000044	1.000069	0.0122439	0.0121749	0.0120834	13261.9	0.0000125	0.95	0.0094963	0.0150957
X1750	beta	1.000071	1.000205	0.0376537	0.0376479	0.0373656	14801.1	0.0000236	0.95	0.0320020	0.0432862
X1750	M	1.000031	1.000056	49.7546558	49.9590937	50.2151068	13705.5	0.0254226	0.95	43.7054776	55.2902303
X1750	rate	1.000077	1.000111	0.0067105	0.0067114	0.0065398	27317.4	0.0000151	0.95	0.0018180	0.0115565
X1760	alpha	1.000225	1.000700	0.0116585	0.0115897	0.0114879	12463.7	0.0000123	0.95	0.0090429	0.0144036
X1760	beta	1.000110	1.000420	0.0385112	0.0385024	0.0386022	13804.0	0.0000244	0.95	0.0328832	0.0441388
X1760	M	1.000236	1.000723	50.9671802	51.1574788	51.4559256	12906.8	0.0247727	0.95	45.4374663	56.3675483
X1760	rate	1.000227	1.000754	0.0069377	0.0069444	0.0071785	25388.2	0.0000156	0.95	0.0020562	0.0118077
X1770	alpha	1.000913	1.002565	0.0119572	0.0118855	0.0116788	12401.3	0.0000128	0.95	0.0092493	0.0148011
X1770	beta	1.000842	1.002526	0.0385160	0.0385119	0.0385913	13729.2	0.0000249	0.95	0.0328861	0.0442661
X1770	M	1.000933	1.002591	50.3026157	50.5009459	50.9360513	12779.1	0.0255623	0.95	44.5382288	55.7354351
X1770	rate	1.000327	1.001024	0.0054059	0.0053991	0.0053967	26694.8	0.0000153	0.95	0.0005155	0.0103390
X1780	alpha	1.000024	1.000080	0.0098947	0.0098375	0.0097623	12144.8	0.0000109	0.95	0.0076036	0.0122621
X1780	beta	1.000089	1.000332	0.0416234	0.0416156	0.0412466	13529.3	0.0000249	0.95	0.0357590	0.0470951
X1780	M	1.000009	1.000034	54.5099445	54.6330090	54.9472107	13234.3	0.0205386	0.95	49.7839622	58.9932689
X1780	rate	1.000029	1.000052	0.0101105	0.0101157	0.0102186	23262.7	0.0000163	0.95	0.0051865	0.0149529
X1790	alpha	1.000780	1.002619	0.0074628	0.0074099	0.0072730	12511.4	0.0000086	0.95	0.0056365	0.0093699
X1790	beta	1.000634	1.002266	0.0465156	0.0465133	0.0464524	13814.5	0.0000257	0.95	0.0405791	0.0524046
X1790	M	1.000594	1.002037	59.3920496	59.4676688	59.6465203	15210.4	0.0154250	0.95	55.6352570	63.0795140
X1790	rate	1.000364	1.001370	0.0165769	0.0165808	0.0166141	24083.9	0.0000160	0.95	0.0116026	0.0213767
X1800	alpha	1.000673	1.001733	0.0067061	0.0066571	0.0065314	12303.3	0.0000078	0.95	0.0050738	0.0084373
X1800	beta	1.000450	1.001205	0.0482926	0.0482882	0.0482750	13472.8	0.0000254	0.95	0.0425605	0.0540970
X1800	M	1.000481	1.001391	60.9494935	61.0079704	61.2925933	16004.8	0.0138784	0.95	57.4654475	64.3420718
X1800	rate	1.000147	1.000554	0.0172842	0.0172863	0.0173351	24114.8	0.0000161	0.95	0.0123533	0.0221326
X1810	alpha	1.000778	1.002825	0.0061205	0.0060764	0.0060231	11885.0	0.0000073	0.95	0.0046308	0.0077169
X1810	beta	1.000722	1.002651	0.0477278	0.0477231	0.0477969	12935.3	0.0000252	0.95	0.0421088	0.0533294
X1810	M	1.000533	1.001967	63.1111594	63.1645788	63.3883652	15759.0	0.0139295	0.95	59.6818113	66.5370162
X1810	rate	1.000355	1.001232	0.0188379	0.0188404	0.0189439	21465.1	0.0000169	0.95	0.0139210	0.0236200
X1820	alpha	1.000095	1.000132	0.0055976	0.0055572	0.0054458	11229.6	0.0000070	0.95	0.0041772	0.0070725
X1820	beta	1.000042	1.000144	0.0497736	0.0497549	0.0494675	11848.9	0.0000269	0.95	0.0440723	0.0555463
X1820	M	1.000089	1.000100	63.9900524	64.0294417	64.0859524	15792.1	0.0130000	0.95	60.7385660	67.1324448
X1820	rate	1.000054	1.000169	0.0184286	0.0184243	0.0183352	20638.3	0.0000173	0.95	0.0136164	0.0233407
X1830	alpha	1.000685	1.002323	0.0055328	0.0054915	0.0053316	10784.7	0.0000071	0.95	0.0041241	0.0069785
X1830	beta	1.000541	1.001972	0.0507604	0.0507524	0.0506613	11479.7	0.0000273	0.95	0.0450068	0.0564989
X1830	M	1.000452	1.001586	63.7527679	63.7940673	63.8373687	14596.3	0.0130407	0.95	60.6000558	66.7627670
X1830	rate	1.000340	1.001284	0.0170084	0.0170011	0.0170444	20042.5	0.0000176	0.95	0.0121792	0.0219144
X1840	alpha	1.000307	1.001096	0.0054664	0.0054244	0.0053739	11068.3	0.0000069	0.95	0.0040888	0.0069308
X1840	beta	1.000429	1.001483	0.0504923	0.0504880	0.0504433	12336.9	0.0000266	0.95	0.0445658	0.0561736
X1840	M	1.000118	1.000460	64.1209693	64.1581002	64.3153799	15983.6	0.0125993	0.95	61.0149913	67.2673873
X1840	rate	1.000057	1.000244	0.0185439	0.0185336	0.0183673	20908.7	0.0000172	0.95	0.0136249	0.0233586

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

Table 13: Census data for London from 1841.

	PSRF Point est.	PSRF Upper C.I.	Mean	Median	Mode	ESS	MCSE	HDImass	HDIlow	HDIhigh
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 14: English mortality data.

year	parameter	PSRF Point est.	PSRF Upper C.I.	Mean	Median	Mode	ESS	MCSE	HDImass	HDIlow	HDIhigh
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	1.000438	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 15: Human Mortality Database UK.

year	parameter	PSRF Point est.	PSRF Upper C.I.	Mean	Median	Mode	ESS	MCSE	HDImass	HDIlow	HDIhigh
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

4.2 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 16: London cemeteries data.

cemetery	start	end	parameter	PSRF Point est.	PSRF Upper C.I.	Mean	Median	Mode	ESS	MCSE	HDImass	HDIlow	HDIhigh
Bermondsey Abbey	1089	1538	alpha	1.000095	1.000352	0.0119872	0.0118695	0.0117349	26882.4	0.0000115	0.95	0.0084108	0.0157410
Bermondsey Abbey	1089	1538	beta	1.000115	1.000319	0.0410531	0.0410516	0.0413654	23098.5	0.0000312	0.95	0.0318561	0.0503895
Bermondsey Abbey	1089	1538	M	1.000071	1.000266	41.8366810	42.1437778	42.5664355	29309.6	0.0207896	0.95	34.6719658	48.4310632
St. Mary Graces	1350	1540	alpha	1.000196	1.000732	0.0197808	0.0196850	0.0195223	35662.0	0.0000118	0.95	0.0154857	0.0241619
St. Mary Graces	1350	1540	beta	1.000244	1.000894	0.0346722	0.0346636	0.0349129	29450.8	0.0000239	0.95	0.0266567	0.0427213
St. Mary Graces	1350	1540	M	1.000288	1.000951	27.6620555	28.2853721	29.0829030	31343.0	0.0275212	0.95	17.7908628	36.1544161
St. Mary Hospital, 1120-1200	1120	1200	alpha	1.000021	1.000058	0.0249328	0.0248411	0.0247596	47240.6	0.0000108	0.95	0.0203838	0.0295337
St. Mary Hospital, 1120-1200	1120	1200	beta	1.000010	1.000041	0.0363031	0.0363142	0.0366087	42155.0	0.0000184	0.95	0.0288655	0.0437148
St. Mary Hospital, 1120-1200	1120	1200	M	1.000014	1.000048	21.9000883	22.4278307	23.6171674	41316.5	0.0217592	0.95	12.9358328	29.6933479
St. Mary Hospital, 1200-1250	1200	1250	alpha	1.000142	1.000479	0.0299501	0.0298832	0.0296347	50227.8	0.0000103	0.95	0.0254561	0.0345077
St. Mary Hospital, 1200-1250	1200	1250	beta	1.000145	1.000390	0.0356927	0.0356959	0.0355017	44544.0	0.0000163	0.95	0.0288836	0.0423855
St. Mary Hospital, 1200-1250	1200	1250	M	1.000138	1.000388	16.4726206	16.9685941	17.8228768	43773.7	0.0209091	0.95	7.6941741	24.3391668
St. Mary Hospital, 1250-1400	1250	1400	alpha	1.000058	1.000230	0.0183232	0.0182986	0.0182568	30711.1	0.0000060	0.95	0.0162397	0.0203837
St. Mary Hospital, 1250-1400	1250	1400	beta	1.000039	1.000160	0.0580756	0.0580643	0.0577145	27569.9	0.0000162	0.95	0.0529190	0.0634424
St. Mary Hospital, 1250-1400	1250	1400	M	1.000056	1.000226	31.8403051	31.8802975	31.9815271	32452.4	0.0050096	0.95	30.0460798	33.5688087
St. Mary Hospital, 1400-1539	1400	1539	alpha	1.000184	1.000413	0.0262455	0.0261845	0.0258468	45106.6	0.0000098	0.95	0.0222297	0.0303974
St. Mary Hospital, 1400-1539	1400	1539	beta	1.000202	1.000384	0.0374668	0.0374646	0.0373648	37992.2	0.0000178	0.95	0.0307176	0.0443176
St. Mary Hospital, 1400-1539	1400	1539	M	1.000255	1.000509	21.1562579	21.5422484	22.2118499	38394.6	0.0188420	0.95	13.7317283	27.8355824
New Churchyard	1569	1739	alpha	1.000100	1.000375	0.0257447	0.0256826	0.0256229	40693.9	0.0000097	0.95	0.0219664	0.0296497
New Churchyard	1569	1739	beta	1.000143	1.000447	0.0365472	0.0365523	0.0364771	33659.4	0.0000185	0.95	0.0298776	0.0431955
New Churchyard	1569	1739	M	1.000167	1.000489	21.2258180	21.6422371	22.4873708	34065.6	0.0202506	0.95	13.6829257	27.9012158
St. Benet Sherehog	1670	1740	alpha	1.000103	1.000388	0.0159324	0.0158024	0.0157241	35332.7	0.0000126	0.95	0.0114989	0.0206750
St. Benet Sherehog	1670	1740	beta	1.000166	1.000541	0.0354819	0.0354675	0.0352938	29914.9	0.0000268	0.95	0.0265131	0.0446216
St. Benet Sherehog	1670	1740	M	1.000123	1.000414	34.0694974	34.7174821	36.0672253	33191.8	0.0286473	0.95	23.6417236	43.3454393
Chelsea Old church	1712	1842	alpha	1.000092	1.000284	0.0083989	0.0083033	0.0082201	24055.1	0.0000095	0.95	0.0056545	0.0113658
Chelsea Old church	1712	1842	beta	1.000107	1.000363	0.0422444	0.0421520	0.0421527	20068.2	0.0000343	0.95	0.0327982	0.0517568
Chelsea Old church	1712	1842	M	1.000066	1.000214	50.2412943	50.4255236	50.6944550	32126.8	0.0173728	0.95	43.9580757	56.1242381
St. Marylebone	1742	1817	alpha	1.000026	1.000095	0.0125953	0.0125006	0.0123046	29334.6	0.0000102	0.95	0.0092608	0.0160318
St. Marylebone	1742	1817	beta	1.000017	1.000034	0.0420937	0.0420895	0.0423370	23957.1	0.0000291	0.95	0.0331445	0.0508272
St. Marylebone	1742	1817	M	1.000036	1.000085	40.5179648	40.7766676	41.3760128	31991.5	0.0170220	0.95	34.3796076	46.1332104
St. Marylebone Paddington Street north	1772	1853	alpha	1.000045	1.000166	0.0099037	0.0098127	0.0096774	27403.8	0.0000087	0.95	0.0071709	0.0127837
St. Marylebone Paddington Street north	1772	1853	beta	1.000055	1.000206	0.0488613	0.0488575	0.0485839	23270.2	0.0000301	0.95	0.0398523	0.0578266
St. Marylebone Paddington Street north	1772	1853	M	1.000039	1.000116	44.6690555	44.7919466	45.0496301	37001.7	0.0116510	0.95	40.1953904	48.9817326
St. Bride's lower churchyard	1770	1849	alpha	1.000035	1.000073	0.0061790	0.0061316	0.0059751	14779.1	0.0000071	0.95	0.0045330	0.0078754
St. Bride's lower churchyard	1770	1849	beta	1.000155	1.000339	0.0510752	0.0510280	0.0511331	11203.6	0.0000422	0.95	0.0423814	0.0598976
St. Bride's lower churchyard	1770	1849	M	1.000130	1.000460	53.4368072	53.4511152	53.4536777	46992.7	0.0074618	0.95	50.2090353	56.5697935
Sheen's burial ground	1763	1854	alpha	1.000091	1.000320	0.0129642	0.0128270	0.0124596	28565.8	0.0000128	0.95	0.0089230	0.0173233
Sheen's burial ground	1763	1854	beta	1.000171	1.000495	0.0353994	0.0353305	0.0350479	24673.6	0.0000300	0.95	0.0262620	0.0446735
Sheen's burial ground	1763	1854	M	1.000120	1.000420	39.9956498	40.5717091	41.5741951	29050.5	0.0299067	0.95	29.5817256	49.0658033
Bow Baptist Church	1816	1854	alpha	1.000037	1.000121	0.0177742	0.0176655	0.0171967	37363.4	0.0000114	0.95	0.0135868	0.0221462
Bow Baptist Church	1816	1854	beta	1.000013	1.000063	0.0344658	0.0344556	0.0344680	30272.0	0.0000249	0.95	0.0259810	0.0429301
Bow Baptist Church	1816	1854	M	1.000031	1.000063	30.6580796	31.3283020	32.6360138	33171.9	0.0277771	0.95	20.3999444	39.3695617
St. Mary and St. Michael	1843	1853	alpha	1.000523	1.001826	0.0186478	0.0185639	0.0182508	41699.1	0.0000099	0.95	0.0148267	0.0227130
St. Mary and St. Michael	1843	1853	beta	1.000441	1.001467	0.0402140	0.0402172	0.0404972	35162.0	0.0000216	0.95	0.0322916	0.0481568
St. Mary and St. Michael	1843	1853	M	1.000616	1.001944	30.8426109	31.1889790	31.6656994	38394.2	0.0171194	0.95	24.1587401	36.9724139
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	1.000250	1.000942	0.0050511	0.0049857	0.0049500	13935.6	0.0000077	0.95	0.0033266	0.0068431
St. Bride's crypt (estimates)	1740	1853	beta	1.000251	1.000919	0.0461973	0.0460966	0.0460772	11655.0	0.0000408	0.95	0.0375863	0.0548062
St. Bride's crypt (estimates)	1740	1853	M	1.000110	1.000431	60.0918241	60.1324772	60.2370171	29765.3	0.0137390	0.95	55.4315320	64.7329115

```
kable(wellcome_result_r, caption = "London cemeteries data, corrected for population growth.") %>%
  kableExtra::kable_styling(latex_options = c("HOLD_position","scale_down"))
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Table 17: 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	HDIhigh
Bermondsey Abbey	1089	1538	alpha	1.0001999	1.0007416	0.0105288	0.0104025	0.0101065	26895.4	0.0000111	0.95	0.0071225	0.0141935
Bermondsey Abbey	1089	1538	beta	1.0003786	1.0010986	0.0429176	0.0429090	0.0434181	24113.7	0.0000308	0.95	0.0335341	0.0522185
Bermondsey Abbey	1089	1538	M	1.0001327	1.0004472	44.7061829	44.9293082	45.3226906	30386.5	0.0198385	0.95	37.7940665	51.2834230
Bermondsey Abbey	1089	1538	rate	1.0000303	1.0000756	0.0039098	0.0039108	0.0039733	106914.0	0.0000076	0.95	-0.0009505	0.0088325
St. Mary Graces	1350	1540	alpha	1.0001410	1.0003568	0.0169749	0.0168588	0.0167558	33748.3	0.0000119	0.95	0.0128271	0.0213266
St. Mary Graces	1350	1540	beta	1.0000433	1.0001007	0.0372463	0.0372464	0.0370084	30177.8	0.0000242	0.95	0.0289760	0.0454249
St. Mary Graces	1350	1540	M	1.0001281	1.0002492	32.7675640	33.2209124	33.9417464	31746.8	0.0236912	0.95	24.2993787	40.4275089
St. Mary Graces	1350	1540	rate	1.0001305	1.0004837	0.0051616	0.0051627	0.0052870	100496.1	0.0000078	0.95	0.0003122	0.0100454
St. Mary Hospital, 1120-1200	1120	1200	alpha	1.0000331	1.0001286	0.0228885	0.0227897	0.0226513	43799.9	0.0000115	0.95	0.0183155	0.0276638
St. Mary Hospital, 1120-1200	1120	1200	beta	1.0000350	1.0001314	0.0379869	0.0379887	0.0379277	41935.6	0.0000186	0.95	0.0304787	0.0454167
St. Mary Hospital, 1120-1200	1120	1200	M	1.0000459	1.0001549	24.9940336	25.4195077	26.1632091	39863.2	0.0202351	0.95	16.8860536	32.3216380
St. Mary Hospital, 1120-1200	1120	1200	rate	1.0000328	1.0000475	0.0028308	0.0028305	0.0028200	115634.2	0.0000073	0.95	-0.0021173	0.0076306
St. Mary Hospital, 1200-1250	1200	1250	alpha	1.0000810	1.0003099	0.0230203	0.0229469	0.0229048	50830.0	0.0000094	0.95	0.0189207	0.0272159
St. Mary Hospital, 1200-1250	1200	1250	beta	1.0001545	1.0005234	0.0398856	0.0398998	0.0399483	51029.8	0.0000157	0.95	0.0328956	0.0468336
St. Mary Hospital, 1200-1250	1200	1250	M	1.0000928	1.0003558	25.5429589	25.8389492	26.4616904	46661.4	0.0149967	0.95	19.0144549	31.4789393
St. Mary Hospital, 1200-1250	1200	1250	rate	1.0000406	1.0000908	0.0129320	0.0129281	0.0127274	107875.9	0.0000076	0.95	0.0080676	0.0177871
St. Mary Hospital, 1250-1400	1250	1400	alpha	1.0000497	1.0001170	0.0184492	0.0184122	0.0182888	23215.0	0.0000084	0.95	0.0159587	0.0209832
St. Mary Hospital, 1250-1400	1250	1400	beta	1.0000407	1.0001310	0.0588094	0.0588085	0.0589706	23589.8	0.0000177	0.95	0.0534970	0.0641442
St. Mary Hospital, 1250-1400	1250	1400	M	1.0000497	1.0001156	31.6963826	31.7396954	31.8464384	24117.1	0.0070508	0.95	29.5007009	33.7824781
St. Mary Hospital, 1250-1400	1250	1400	rate	0.9999962	0.9999989	-0.0026207	-0.0026209	-0.0027932	56055.6	0.0000104	0.95	-0.0073601	0.0022509
St. Mary Hospital, 1400-1539	1400	1539	alpha	1.0000223	1.0000549	0.0231055	0.0230308	0.0230113	41925.6	0.0000104	0.95	0.0190097	0.0273502
St. Mary Hospital, 1400-1539	1400	1539	beta	1.0000087	1.0000259	0.0399576	0.0399616	0.0400633	39732.1	0.0000178	0.95	0.0330820	0.0469712
St. Mary Hospital, 1400-1539	1400	1539	M	1.0000141	1.0000391	25.4683995	25.7644549	26.3462367	38317.9	0.0165837	0.95	18.9737587	31.4815633
St. Mary Hospital, 1400-1539	1400	1539	rate	1.0000340	1.0000951	0.0050553	0.0050563	0.0051778	103432.2	0.0000077	0.95	0.0001496	0.0098918
New Churchyard	1569	1739	alpha	1.0001279	1.0002871	0.0211766	0.0211136	0.0212054	37764.5	0.0000100	0.95	0.0174176	0.0249711
New Churchyard	1569	1739	beta	1.0000753	1.0001933	0.0400944	0.0400933	0.0400801	35294.2	0.0000185	0.95	0.0332312	0.0468600
New Churchyard	1569	1739	M	1.0001440	1.0003447	27.7108539	27.9722139	28.4872019	35217.0	0.0160479	0.95	21.6010226	33.2292167
New Churchyard	1569	1739	rate	1.0000620	1.0001365	0.0082621	0.0082646	0.0083576	87104.3	0.0000084	0.95	0.0033814	0.0131413
St. Benet Sherehog	1670	1740	alpha	1.0001805	1.0006101	0.0132861	0.0131411	0.0129458	34008.4	0.0000119	0.95	0.0091934	0.0176933
St. Benet Sherehog	1670	1740	beta	1.0001190	1.0003512	0.0381719	0.0381737	0.0382241	31530.9	0.0000266	0.95	0.0289791	0.0474535
St. Benet Sherehog	1670	1740	M	1.0002037	1.0006791	39.3972135	39.8401136	40.1526185	34591.5	0.0241655	0.95	30.3535344	47.6481468
St. Benet Sherehog	1670	1740	rate	1.0000344	1.0000931	0.0059873	0.0059983	0.0060528	119114.7	0.0000072	0.95	0.0011010	0.0108270
Chelsea Old church	1712	1842	alpha	1.0002873	1.0010299	0.0058789	0.0057818	0.0055736	24844.5	0.0000075	0.95	0.0036917	0.0082560
Chelsea Old church	1712	1842	beta	1.0002128	1.0007988	0.0472765	0.0472197	0.0472248	21617.0	0.0000341	0.95	0.0374445	0.0571072
Chelsea Old church	1712	1842	M	1.0001776	1.0006011	56.3070206	56.3582529	56.7461356	44134.7	0.0138780	0.95	50.5873981	62.0866861
Chelsea Old church	1712	1842	rate	1.0000451	1.0001660	0.0100601	0.0100643	0.0101297	89138.8	0.0000084	0.95	0.0051571	0.0149469
St. Marylebone	1742	1817	alpha	1.0000748	1.0001372	0.0095679	0.0094649	0.0091973	30628.4	0.0000087	0.95	0.0067098	0.0125807
St. Marylebone	1742	1817	beta	1.0000415	1.0001241	0.0459357	0.0459208	0.0457528	27451.1	0.0000277	0.95	0.0370076	0.0549197
St. Marylebone	1742	1817	M	1.0000736	1.0001274	46.1751078	46.2984132	46.3570171	40003.8	0.0136968	0.95	40.7083583	51.4616051
St. Marylebone	1742	1817	rate	1.0000683	1.0002323	0.0095688	0.0095712	0.0093581	99214.5	0.0000079	0.95	0.0047434	0.0145099
St. Marylebone Paddington Street north	1772	1853	alpha	1.0000358	1.0000900	0.0065801	0.0065013	0.0064360	29127.9	0.0000066	0.95	0.0044463	0.0087891
St. Marylebone Paddington Street north	1772	1853	beta	1.0001415	1.0004460	0.0544281	0.0544209	0.0547945	26218.3	0.0000292	0.95	0.0452271	0.0637787
St. Marylebone Paddington Street north	1772	1853	M	0.9999975	1.0000085	50.9632692	50.9739902	50.9618065	49233.1	0.0098106	0.95	46.6741737	55.2372052
St. Marylebone Paddington Street north	1772	1853	rate	1.0000364	1.0001074	0.0144206	0.0144255	0.0141691	101071.9	0.0000078	0.95	0.0094983	0.0192607
St. Bride's lower churchyard	1770	1849	alpha	1.0011697	1.0042730	0.0037341	0.0036868	0.0036269	16620.6	0.0000049	0.95	0.0025631	0.0049982
St. Bride's lower churchyard	1770	1849	beta	1.0015090	1.0051365	0.0582705	0.0582224	0.0580684	12836.2	0.0000410	0.95	0.0491681	0.0672636
St. Bride's lower churchyard	1770	1849	M	1.0003029	1.0011116	59.3567949	59.3049875	59.1753323	40772.1	0.0095119	0.95	55.5901301	63.1117920
St. Bride's lower churchyard	1770	1849	rate	1.0003038	1.0011395	0.0143225	0.0143172	0.0141355	52696.3	0.0000108	0.95	0.0094154	0.0191705
Sheen's burial ground	1763	1854	alpha	1.0001549	1.0002068	0.0081112	0.0079857	0.0076079	28990.1	0.0000095	0.95	0.0051656	0.0113978
Sheen's burial ground	1763	1854	beta	1.0000827	1.0001417	0.0418442	0.0418050	0.0417337	27930.4	0.0000294	0.95	0.0322170	0.0514367
Sheen's burial ground	1763	1854	M	1.0001259	1.0001599	51.3035346	51.4719153	51.7458183	37127.6	0.0196709	0.95	43.8156221	58.7122226
Sheen's burial ground	1763	1854	rate	1.0000471	1.0000606	0.0143440	0.0143429	0.0142681	101954.9	0.0000078	0.95	0.0093921	0.0191445
Bow Baptist Church	1816	1854	alpha	1.0000751	1.0002591	0.0110080	0.0109048	0.0107115	41439.7	0.0000082	0.95	0.0078878	0.0143335
Bow Baptist Church	1816	1854	beta	1.0000831	1.0003245	0.0409501	0.0409441	0.0407475	36617.2	0.0000234	0.95	0.0322211	0.0497674
Bow Baptist Church	1816	1854	M	1.0000690	1.0002060	44.0086393	44.2046299	44.6069317	46933.1	0.0152560	0.95	37.4300374	50.3741413
Bow Baptist Church	1816	1854	rate	1.0000216	1.0000239	0.0174851	0.0174851	0.0173758	106259.5	0.0000076	0.95	0.0125967	0.0223740
St. Mary and St. Michael	1843	1853	alpha	1.0001563	1.0005720	0.0122807	0.0121938	0.0120196	46093.7	0.0000074	0.95	0.0092409	0.0154457
St. Mary and St. Michael	1843	1853	beta	1.0002253	1.0007624	0.0459562	0.0459699	0.0456100	42613.3	0.0000202	0.95	0.0378149	0.0541866
St. Mary and St. Michael	1843	1853	M	1.0001425	1.0005089	40.6794124	40.8054593	41.3726101	51800.7	0.0109648	0.95	35.7481079	45.5245164
St. Mary and St. Michael	1843	1853	rate	1.0000407	1.0001181	0.0176425	0.0176439	0.0178219	111336.5	0.0000075	0.95	0.0128415	0.0226355
St. Bride's crypt (known age)	1740	1853	alpha	11.3187848	26.7160198	0.0062628	0.0058303	0.0034420	1.5	0.0018915	0.95	0.0031442	0.0102527
St. Bride's crypt (known age)	1740	1853	beta	11.7161168	22.9647008	0.0510415	0.0510591	0.0509381	1.4	0.0034864	0.95	0.0443241	0.0572525
St. Bride's crypt (known age)	1740	1853	M	11.7488400	23.5976438	53.9513110	54.4984270	54.3621152	1.4	4.7419679	0.95	44.8901900	62.3280593
St. Bride's crypt (known age)	1740	1853	rate	1.0001302	1.0004858	-0.9898864	-0.9898864	-0.9898825	68206.5	0.0000004	0.95	-0.9900793	-0.9896890
St. Bride's crypt (estimates)	1740	1853	alpha	1.0010883	1.0036469	0.8089951	0.8096464	0.8091857	3141.3	0.0003460	0.95	0.7708209	0.8467743
St. Bride's crypt (estimates)	1740	1853	beta	1.0011031	1.0035351	0.0049692	0.0049308	0.0048867	3152.0	0.0000121	0.95	0.0036820	0.0063247
St. Bride's crypt (estimates)	1740	1853	M	1.0008190	1.0029237	-1038.5780551	-1022.5151667	-1000.6858905	3228.3	3.1452459	0.95	-1405.8300586	-716.0579775
St. Bride's crypt (estimates)	1740	1853	rate	1.0000235	1.0000707	-0.9873975	-0.9873961	-0.9874078	123992.2	0.0000071	0.95	-0.9922468	-0.9824618

4.3 Modal ages from historical and osteological data

Figure 6: Modal ages from historical and osteological data

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

```
## `geom_smooth()` using method = 'loess' and formula = 'y ~ x'
## `geom_smooth()` using method = 'loess' and formula = 'y ~ x'
## `geom_smooth()` using method = 'loess' and formula = 'y ~ x'
```

```
plot(modal_ages_plot)
```

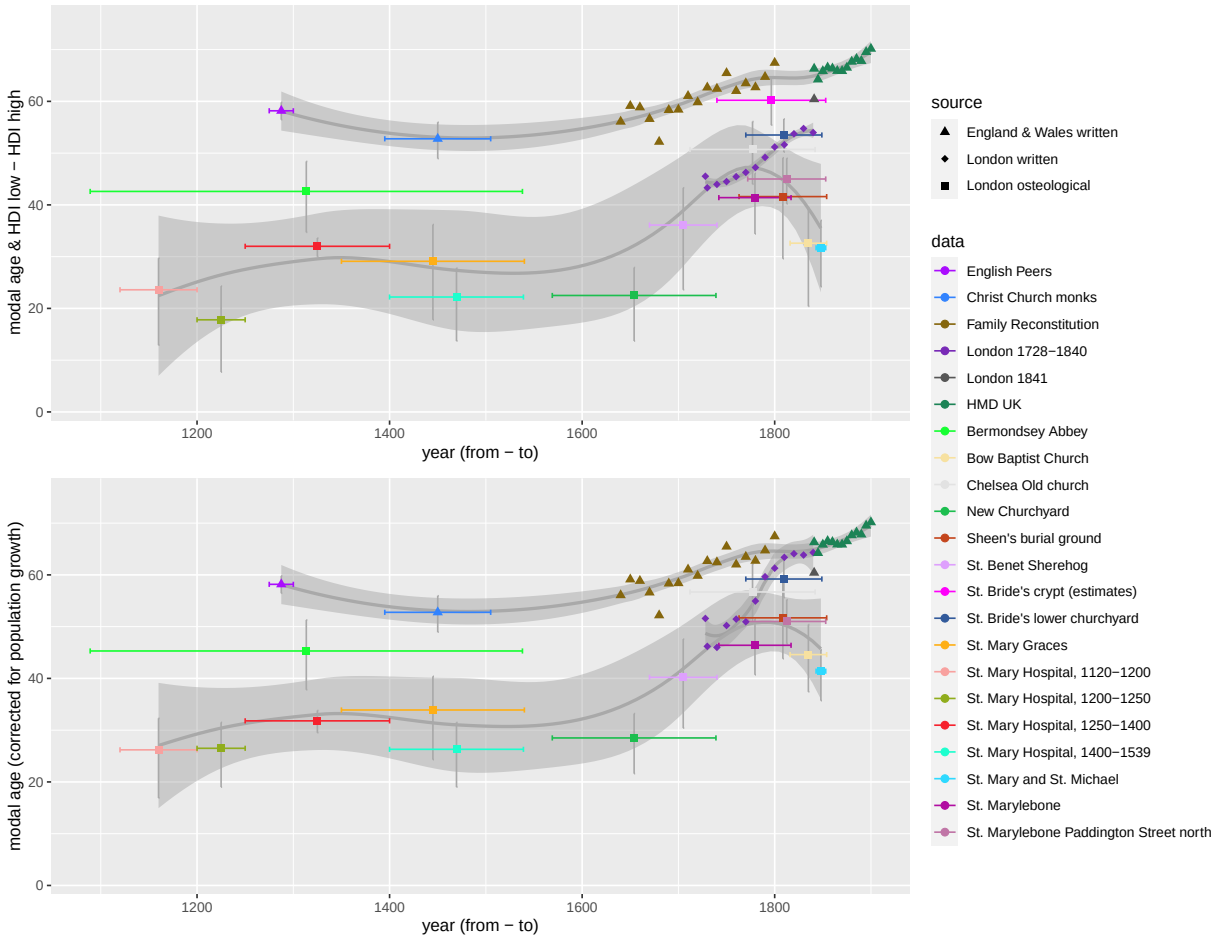


Table 2: Overview of modelled osteological data from London cemeteries

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 18: London cemeteries overview.

cemetery	beta	beta_range	M	M_range	ex20	ex25	beta	beta_range	M	M_range	ex20	ex25
Bermondsey Abbey	0.0414	0.0319-0.0504	42.6	34.7-48.4	25.5	22.7	0.0434	0.0335-0.0522	45.3	37.8-51.3	26.8	23.8
Bow Baptist Church	0.0345	0.026-0.0429	32.6	20.4-39.4	22.7	20.4	0.0407	0.0322-0.0498	44.6	37.4-50.4	27.1	24.2
Chelsea Old church	0.0422	0.0328-0.0518	50.7	44-56.1	30.4	27.3	0.0472	0.0374-0.0571	56.7	50.6-62.1	33.9	30.4
New Churchyard	0.0365	0.0299-0.0432	22.5	13.7-27.9	17.0	15.0	0.0401	0.0332-0.0469	28.5	21.6-33.2	18.3	16.1
Sheen's burial ground	0.0350	0.0263-0.0447	41.6	29.6-49.1	27.3	24.6	0.0417	0.0322-0.0514	51.7	43.8-58.7	31.8	28.6
St. Benet Sherehog	0.0353	0.0265-0.0446	36.1	23.6-43.3	23.7	21.2	0.0382	0.029-0.0475	40.2	30.4-47.6	25.3	22.7
St. Bride's crypt (estimates)	0.0461	0.0376-0.0548	60.2	55.4-64.7	36.4	32.8	0.0049	0.0037-0.0063	-1000.7	-1405.8–716.1	1.2	1.2
St. Bride's crypt (known age)	0.0491	0.0423-0.0565	59.4	55.5-62.5	35.7	32.0	0.0509	0.0443-0.0573	54.4	44.9-62.3	39.3	35.4
St. Bride's lower churchyard	0.0511	0.0424-0.0599	53.5	50.2-56.6	31.0	27.5	0.0581	0.0492-0.0673	59.2	55.6-63.1	34.8	30.9
St. Mary Graces	0.0349	0.0267-0.0427	29.1	17.8-36.2	20.8	18.6	0.0370	0.029-0.0454	33.9	24.3-40.4	22.2	19.8
St. Mary Hospital, 1120-1200	0.0366	0.0289-0.0437	23.6	12.9-29.7	17.4	15.4	0.0379	0.0305-0.0454	26.2	16.9-32.3	18.1	16.0
St. Mary Hospital, 1200-1250	0.0355	0.0289-0.0424	17.8	7.7-24.3	15.7	13.8	0.0399	0.0329-0.0468	26.5	19-31.5	17.5	15.3
St. Mary Hospital, 1250-1400	0.0577	0.0529-0.0634	32.0	30-33.6	16.0	13.4	0.0590	0.0535-0.0641	31.8	29.5-33.8	15.7	13.1
St. Mary Hospital, 1400-1539	0.0374	0.0307-0.0443	22.2	13.7-27.8	16.7	14.7	0.0401	0.0331-0.047	26.3	19-31.5	17.4	15.2
St. Mary and St. Michael	0.0405	0.0323-0.0482	31.7	24.2-37	20.0	17.6	0.0456	0.0378-0.0542	41.4	35.7-45.5	23.6	20.8
St. Marylebone	0.0423	0.0331-0.0508	41.4	34.4-46.1	24.5	21.7	0.0458	0.037-0.0549	46.4	40.7-51.5	27.2	24.1
St. Marylebone Paddington Street north	0.0486	0.0399-0.0578	45.0	40.2-49	25.4	22.4	0.0548	0.0452-0.0638	51.0	46.7-55.2	28.5	25.0

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

parameter	modes	HDI.ranges
Marylebone beta	0.0526	0.0435-0.0618
Marylebone M	54.2470	49.5-59.3
Marylebone north beta	0.0588	0.0496-0.0682
Marylebone north M	55.6570	51.3-59.9

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)
```

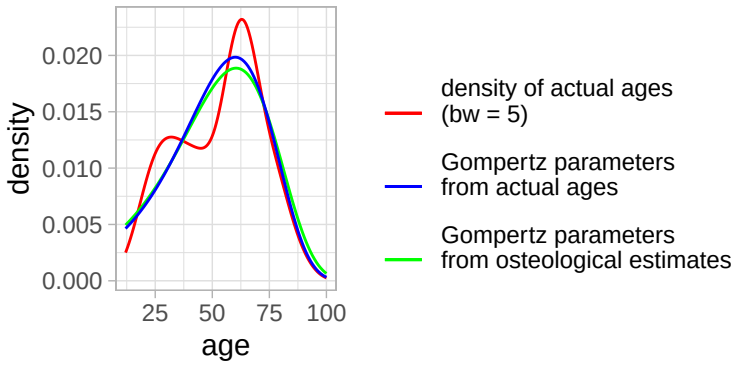
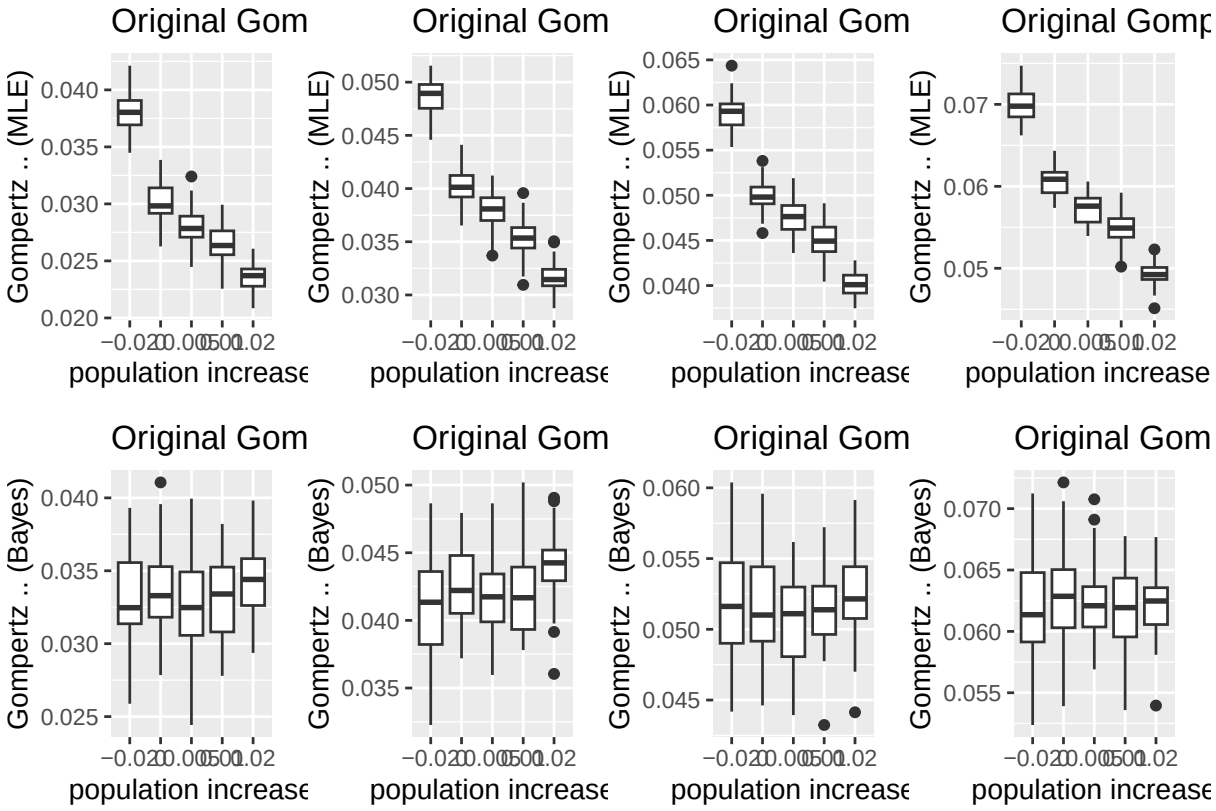


Figure 8: Simulation of population increase with known age-at-death and Maximum Likelihood Estimation (MLE) (top four) and osteological estimates, Bayesian model and including rate of increase (bottom four).

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


Original Gom
Original Gom
Original Gom
Original Gomp
Gompertz .. (MLE)
population increase
Original Gom
Original Gom
Original Gom
Original Gom
Gompertz .. (Bayes)
population increase

5 Supplements

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

5.1 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
```

5.2 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.

5.2.1 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")
```

```
## Scale for y is already present.
## Adding another scale for y, which will replace the existing scale.
```

```
gridExtra::grid.arrange(grobs = plot_list_shapes, ncol = 3)
```

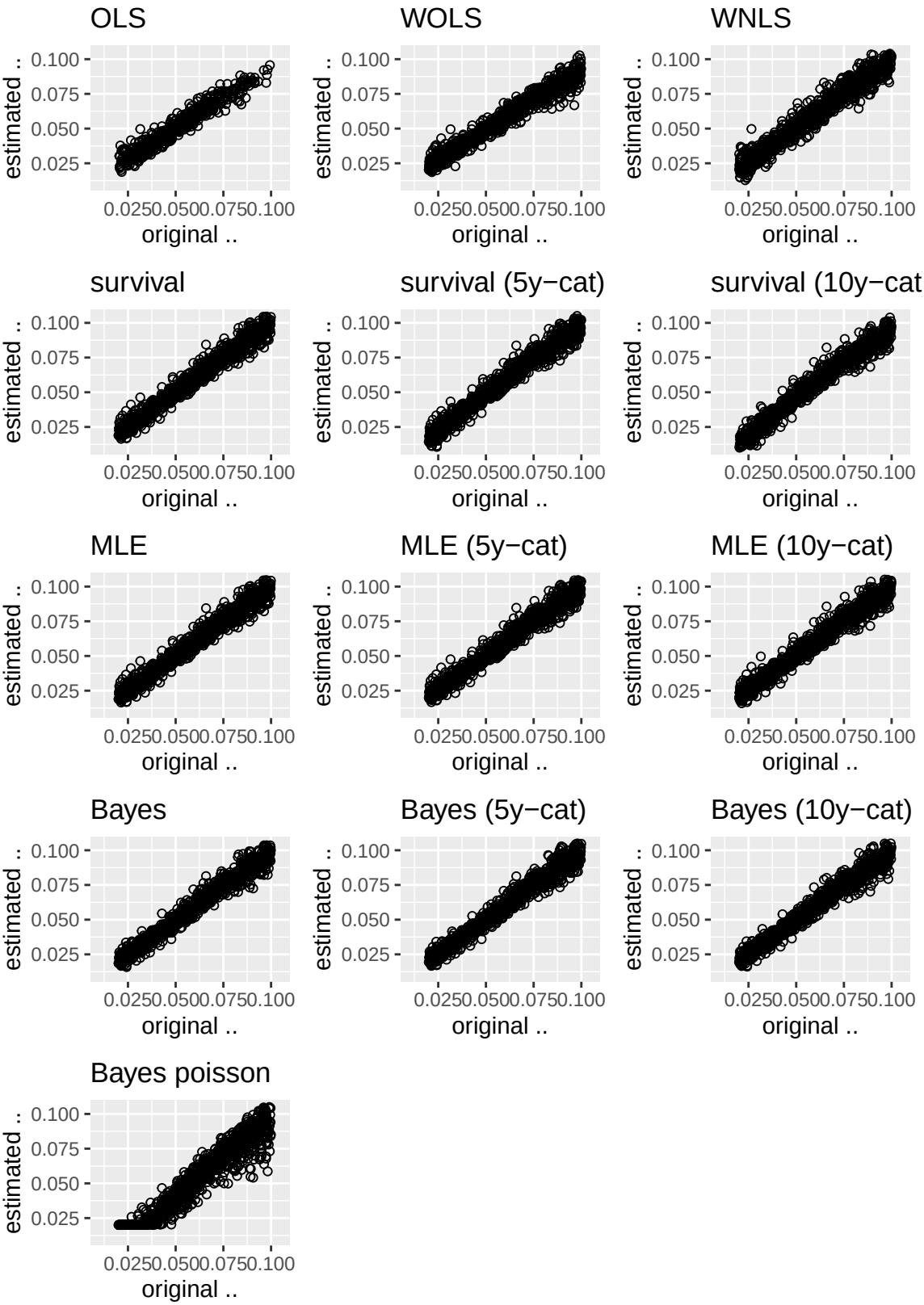

OLS
WOLS
WNLS
survival
survival (5y−cat)
survival (10y−cat
MLE
MLE (5y−cat)
MLE (10y−cat)
Bayes
Bayes (5y−cat)
Bayes (10y−cat)
Bayes poisson
estimated ..
original ..
0.025
0.050
0.075
0.100
0.0250.0500.0750.100

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")
```

```
## Scale for y is already present.
## Adding another scale for y, which will replace the existing scale.
```

```
gridExtra::grid.arrange(grobs = plot_list_diff, ncol = 3)
```

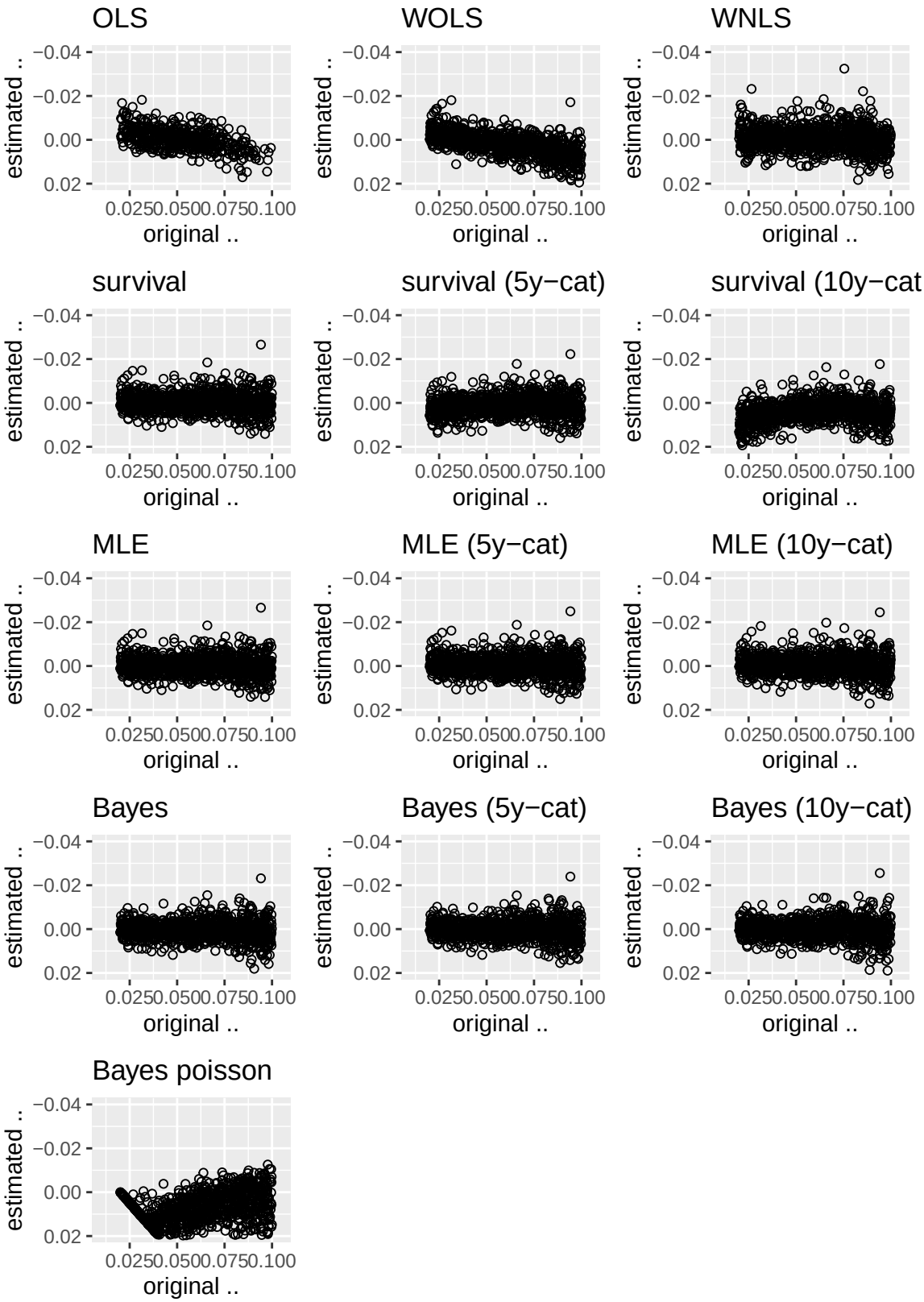

OLS
WOLS
WNLS
survival
survival (5y−cat)
survival (10y−cat
MLE
MLE (5y−cat)
MLE (10y−cat)
Bayes
Bayes (5y−cat)
Bayes (10y−cat)
Bayes poisson
estimated ..
original ..
−0.04
−0.02
0.00
0.02
0.025
0.050
0.075
0.100

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 20: Evaluation of algorithms via RMSE.

	method	RMSE	NAs
11	Bayes (5y-cat)	0.0041953	0
10	Bayes	0.0042255	0
4	survival	0.0042981	0
7	MLE	0.0043000	0
12	Bayes (10y-cat)	0.0043487	0
8	MLE (5y-cat)	0.0043686	0
9	MLE (10y-cat)	0.0045265	0
5	survival (5y-cat)	0.0046064	0
1	OLS	0.0049051	519
3	WNLS	0.0053132	16
2	WOLS	0.0057136	0
6	survival (10y-cat)	0.0065228	0
13	Bayes poisson	0.0106965	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")
```

```
## Scale for y is already present.
## Adding another scale for y, which will replace the existing scale.
```

```
gridExtra::grid.arrange(grobs = plot_list_estim_shapes, ncol = 2)
```

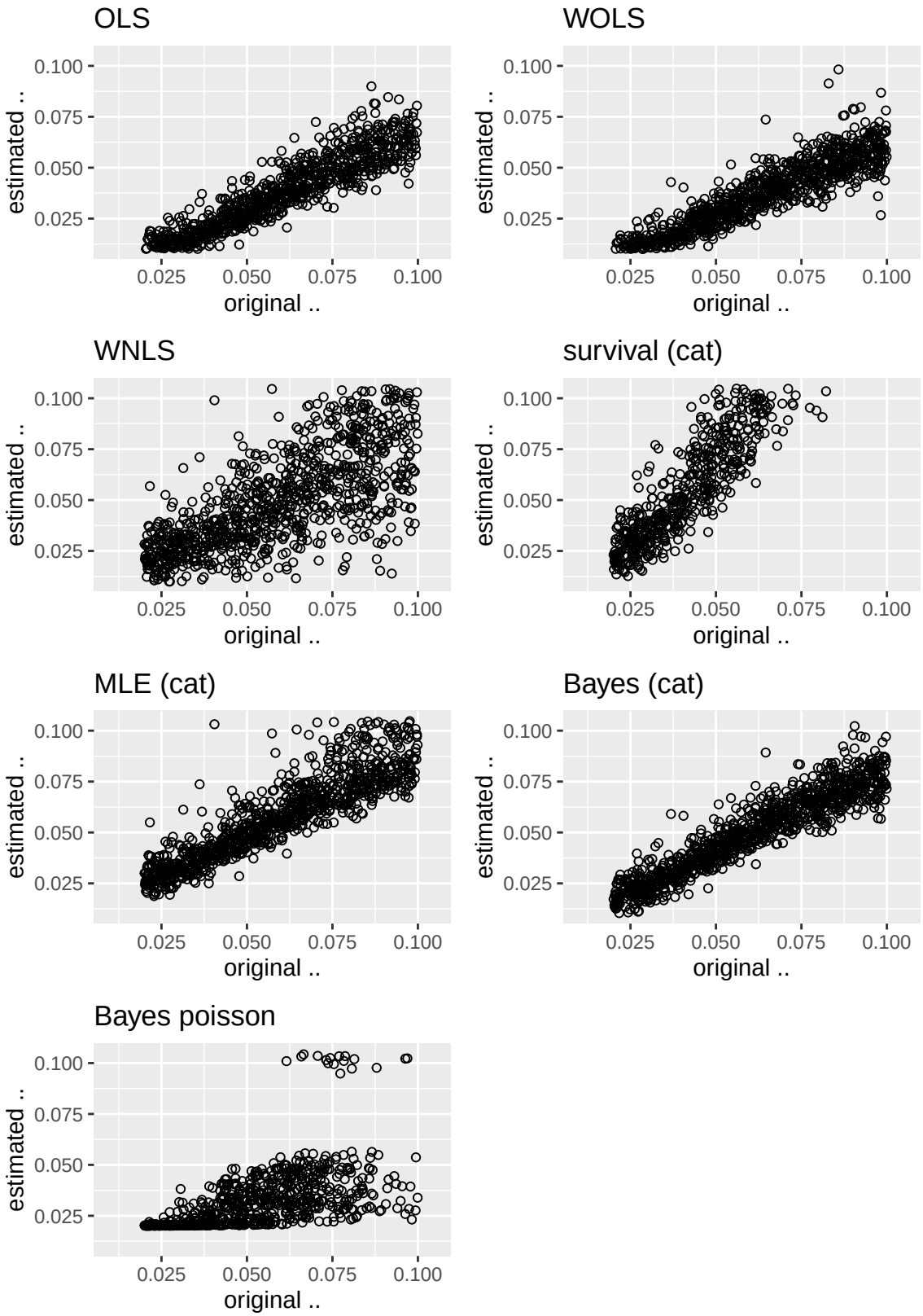

OLS
WOLS
WNLS
survival (cat)
MLE (cat)
Bayes (cat)
Bayes poisson
estimated ..
original ..
0.025
0.050
0.075
0.100

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

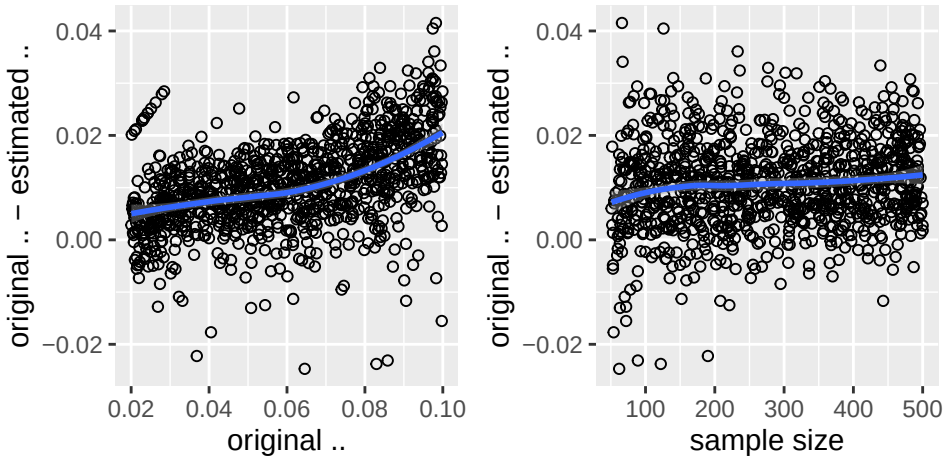
```
# table of RMSEs
kable(rmse_estim_result[order(rmse_estim_result$RMSE) ,], caption = "Evaluation of algorithms via RM
  kableExtra::kable_styling(latex_options = "HOLD_position")
```

Table 21: Evaluation of algorithms via RMSE for estimated age-at-death.

	method	RMSE	NAs
8	MLE_wo_OL	0.0128521	18
6	Bayes (cat)	0.0137203	0
1	OLS	0.0237398	95
3	WNLS	0.0260833	9
2	WOLS	0.0276202	0
5	MLE (cat)	0.0302704	0
7	Bayes poisson	0.0599111	0
4	survival (cat)	0.1454623	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)
```



5.2.2 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
                                n, ", Gompertz beta = ", round(beta, 4), ".", sep = "")) %>%
  kableExtra::kable_styling(latex_options = c("HOLD_position","scale_down"))
```

Table 22: 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	HDIhigh
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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