mortAAR: the analysis of archaeological mortality data in R

Christoph Rinne, Nils Müller-Scheeßel, Martin Hinz

DFG
LANDESMUSEEN GOTTORF ZBSA
JMA
C A U Christian-Albrechts-Universität zu Kiel

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  - representativeness of data can be questioned
  - assumption of stationary populations is questionable
- consequence: life tables have somewhat gone out of fashion

mortAAR: the analysis of archaeological mortality data in R

Age (x)	Distribution of deaths: No. (D_x)	Distribution of deaths: Per cent (d_x)	Survivors (l_x)	Probability of death (q_x)	Total no. of years lived between ages x and $x+5$ (L_x)	Total after lifetime (T_x)	Life expectancy (e_x^0)
0–4	—	—	100·00	—	500·000	3,987·510	39·88
5–9	1·000	2·86	100·00	0·0286	492·850	3,487·510	34·88
10–14	1·000	2·86	97·14	0·0294	478·550	2,994·660	30·83
15–19	1·500	4·29	94·28	0·0455	460·675	2,516·110	26·69
20–24	4·023	11·49	89·99	0·1277	421·225	2,055·435	22·84
25–29	5·169	14·77	78·50	0·1882	355·575	1,634·210	20·82
30–34	4·357	12·45	63·73	0·1954	287·525	1,278·635	20·06
35–39	2·675	7·64	51·28	0·1490	237·300	991·110	19·33
40–44	1·439	4·11	43·64	0·0942	207·925	753·810	17·27
45–49	3·632	10·38	39·53	0·2626	171·700	545·885	13·81
50–54	3·205	9·16	29·15	0·3142	122·850	374·185	12·84
55–59	1·272	3·63	19·99	0·1816	90·875	251·335	12·57
60–64	0·948	2·71	16·36	0·1656	75·025	160·460	9·81
65–69	2·034	5·80	13·65	0·4249	53·750	85·435	6·26
70–74	1·948	5·57	7·85	0·7096	25·325	31·685	4·04
75–79	0·722	2·06	2·28	0·9035	6·250	6·360	2·79
80–84	0·076	0·22	0·22	1·0000	0·110	0·110	0·50
Total	35·000	100·00	—	—	3,987·510	—	—

A typical life table
(after Acsádi/Nemeskéri 1970, 166 tab. 46)

Advantages of life tables:

- comparability
- easily computable
- different angles on the same data (e.g., dx vs. qx)

mortAAR – essential functions

- prep.life.table: preparation of raw data (proportional partitioning of age ranges into single years)
- life.table: generating the life table
- plot: plotting diagnostic graphs

prep.life.table – options

Usage

```
prep.life.table(x, dec = NA, agebeg, ageend, group = NA,
  method = "Standard", agerange = "included")
```

- dec: useful for already pooled data
- group: categorisation of individuals (e.g., sex)
- method: configuration of age cohorts (standard: 0, 1, 5, 10, 15 etc.)
- agerange: depending on the age format, overlapping age categories can be avoided

life.table – options

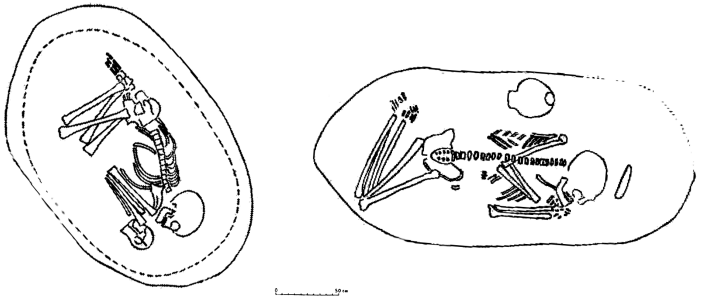
Usage

```
life.table(neclist, agecor = TRUE, agecorfac = c())
```

- neclist: output of prep.life.table
- agecor: children < 5 do not tend to die in the middle of their age class, so the number of lived years should be downweighted
- agecorfac: the default value for the correction factor is a/3

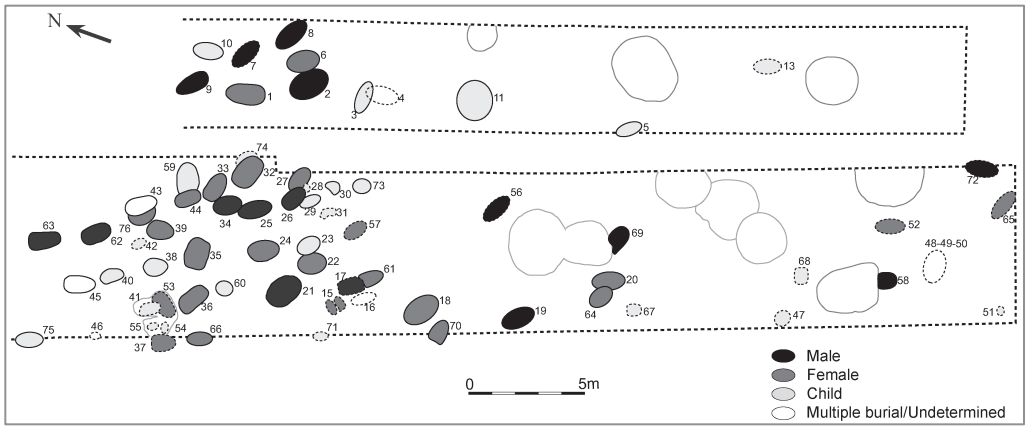
Putting mortAAR into action – An Early Neolithic cemetery

Female, 45+



Male, 45+

Examples of burials from the cemetery of Nitra (after Pavuk 1972, 9 fig. 4).



Plan of the LBK cemetery of Nitra (after Whittle et al. 2013, 138 fig. 4.20).

```
> nitra<-read.table(file.choose(),header=TRUE,row.nam
> nitra
     sex age_start age_end
1      f        20      25
2      m        36      45
3      u        13      17
4_1    u        13      17
4_2    f        26      35
4_3    m        36      45
5      u        13      17
6      f        45      69
7      m        18      45
8      m        45      69
9      m        26      45
14     f        18      45
15_1   f        20      69
15_2   u         1       1
16     u        18      45
17     m        45      69
18     f        26      45
19     m        36      45
20     f        26      30
21     m        36      69
22     f        45      69
23     u        11      12
24     f        26      35
25     m        45      69
26     m        30      45
27     f        40      69
28     u         0       0
29     u        10      12
30     u         6       7
31     u         1       2
32     f        18      25
33     f        26      35
34     m        26      45
35     f        36      69
36     f        45      69
37     f        26      35
38     u         6       7
```

Individuals from the cemetery of Nitra (data after Whittle et al. 2013, 139ff. tab. 4.15).

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```
prep.life.table(nitra,group="sex",agebeg="age_start"
,ageend="age_end",agerange="included")
$f
        x a       Dx
1    0--0 1 0.000000
2    1--4 4 0.000000
3    5--9 5 0.000000
4  10--14 5 0.000000
5  15--19 5 1.071429
6  20--24 5 3.611905
7  25--29 5 4.545238
8  30--34 5 3.978571
9  35--39 5 2.696218
10 40--44 5 2.758964
11 45--49 5 1.982773
12 50--54 5 1.588725
13 55--59 5 1.588725
14 60--64 5 1.588725
15 65--69 5 1.588725
```

Output of prep.life.table
(data after Whittle et al. 2013, 139ff. tab. 4.15).

```
$m
        x a       Dx
1    0--0 1 0.0000000
2    1--4 4 0.0000000
3    5--9 5 0.0000000
4  10--14 5 0.0000000
5  15--19 5 0.5714286
6  20--24 5 1.5285714
7  25--29 5 1.7285714
8  30--34 5 2.0910714
9  35--39 5 3.0087185
10 40--44 5 3.2381303
11 45--49 5 1.6452731
12 50--54 5 1.0470588
13 55--59 5 1.0470588
14 60--64 5 1.0470588
15 65--69 5 1.0470588

$u
        x a       Dx
1    0--0 1 3.0000000
2    1--4 4 7.5000000
3    5--9 5 7.5000000
4  10--14 5 4.9684211
5  15--19 5 3.2642761
6  20--24 5 0.3624446
7  25--29 5 0.5624446
8  30--34 5 0.6124446
9  35--39 5 0.6124446
10 40--44 5 0.6124446
11 45--49 5 0.2695874
```

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```
> life.table(nitra_nec)
```

mortAAR life table forsex: f (n = 27 individuals)

Life expectancy at birth (e0): 38.821

	x	a	Ax	Dx	dx	lx	qx	Lx	Tx	ex	rel_popx
1	0--0	1	0.333	0.000	0.000	100.000	0.000	100.000	3882.057	38.821	2.576
2	1--4	4	1.333	0.000	0.000	100.000	0.000	400.000	3782.057	37.821	10.304
3	5--9	5	2.500	0.000	0.000	100.000	0.000	500.000	3382.057	33.821	12.880
4	10--14	5	2.500	0.000	0.000	100.000	0.000	500.000	2882.057	28.821	12.880
5	15--19	5	2.500	1.071	3.968	100.000	3.968	490.079	2382.057	23.821	12.624
6	20--24	5	2.500	3.612	13.377	96.032	13.930	446.715	1891.978	19.702	11.507
7	25--29	5	2.500	4.545	16.834	82.654	20.367	371.186	1445.263	17.486	9.562
8	30--34	5	2.500	3.979	14.735	65.820	22.387	292.262	1074.077	16.318	7.529
9	35--39	5	2.500	2.696	9.986	51.085	19.548	230.458	781.815	15.304	5.936
10	40--44	5	2.500	2.759	10.218	41.099	24.863	179.947	551.356	13.415	4.635
11	45--49	5	2.500	1.983	7.344	30.880	23.781	136.042	371.409	12.027	3.504
12	50--54	5	2.500	1.589	5.884	23.537	25.000	102.973	235.367	10.000	2.653
13	55--59	5	2.500	1.589	5.884	17.653	33.333	73.552	132.394	7.500	1.895
14	60--64	5	2.500	1.589	5.884	11.768	50.000	44.131	58.842	5.000	1.137
15	65--69	5	2.500	1.589	5.884	5.884	100.000	14.710	14.710	2.500	0.379

mortAAR life table forsex: m (n = 18 individuals)

Life expectancy at birth (e0): 41.099

	x	a	Ax	Dx	dx	lx	qx	Lx	Tx	ex	rel_popx
1	0--0	1	0.333	0.000	0.000	100.000	0.000	100.000	4109.891	41.099	2.433
2	1--4	4	1.333	0.000	0.000	100.000	0.000	400.000	4009.891	40.099	9.733
3	5--9	5	2.500	0.000	0.000	100.000	0.000	500.000	3609.891	36.099	12.166
4	10--14	5	2.500	0.000	0.000	100.000	0.000	500.000	3109.891	31.099	12.166
5	15--19	5	2.500	0.571	3.175	100.000	3.175	492.063	2609.891	26.099	11.973
6	20--24	5	2.500	1.529	8.492	96.825	8.770	462.897	2117.828	21.873	11.263
7	25--29	5	2.500	1.729	9.603	88.333	10.872	417.659	1654.931	18.735	10.162
8	30--34	5	2.500	2.091	11.617	78.730	14.756	364.608	1237.272	15.715	8.871
9	35--39	5	2.500	3.009	16.715	67.113	24.906	293.778	872.664	13.003	7.148
10	40--44	5	2.500	3.238	17.990	50.398	35.695	207.016	578.887	11.486	5.037
11	45--49	5	2.500	1.645	9.140	32.408	28.204	139.191	371.871	11.475	3.387
12	50--54	5	2.500	1.047	5.817	23.268	25.000	101.797	232.680	10.000	2.477
13	55--59	5	2.500	1.047	5.817	17.451	33.333	72.712	130.882	7.500	1.769
14	60--64	5	2.500	1.047	5.817	11.634	50.000	43.627	58.170	5.000	1.062
15	65--69	5	2.500	1.047	5.817	5.817	100.000	14.542	14.542	2.500	0.354

mortAAR life table forsex: u (n = 30 individuals)

Life expectancy at birth (e0): 11.448

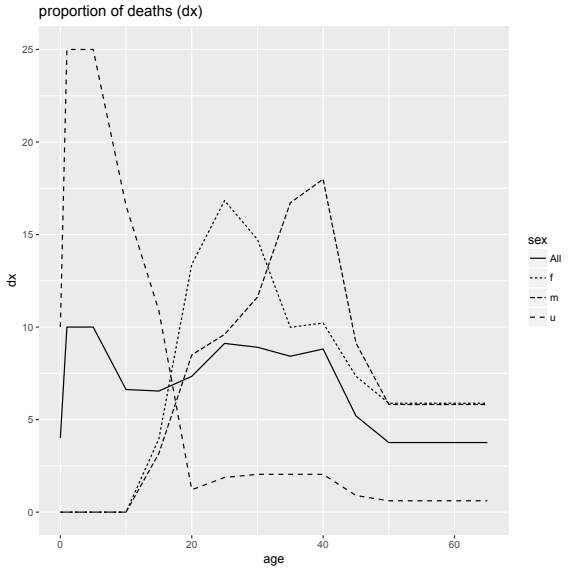
	x	a	Ax	Dx	dx	lx	qx	Lx	Tx	ex	rel_popx
1	0--0	1	0.333	3.000	10.000	100.000	10.000	93.333	1144.791	11.448	8.153
2	1--4	4	1.333	7.500	25.000	90.000	27.778	293.333	1051.458	11.683	25.623
3	5--9	5	2.500	7.500	25.000	65.000	38.462	262.500	758.124	11.663	22.930
4	10--14	5	2.500	4.968	16.561	40.000	41.404	158.596	495.624	12.391	13.854
5	15--19	5	2.500	3.264	10.881	23.439	46.423	89.991	337.028	14.379	7.861
6	20--24	5	2.500	0.362	1.208	12.558	9.621	59.768	247.037	19.672	5.221
7	25--29	5	2.500	0.562	1.875	11.350	16.519	52.061	187.269	16.500	4.548
8	30--34	5	2.500	0.612	2.041	9.475	21.547	42.270	135.209	14.270	3.692
9	35--39	5	2.500	0.612	2.041	7.433	27.464	32.062	92.939	12.503	2.801
10	40--44	5	2.500	0.612	2.041	5.392	37.863	21.855	60.876	11.291	1.909
11	45--49	5	2.500	0.270	0.899	3.350	26.822	14.505	39.021	11.647	1.267
12	50--54	5	2.500	0.184	0.613	2.452	25.000	10.726	24.516	10.000	0.937
13	55--59	5	2.500	0.184	0.613	1.839	33.333	7.661	13.790	7.500	0.669
14	60--64	5	2.500	0.184	0.613	1.226	50.000	4.597	6.129	5.000	0.402
15	65--69	5	2.500	0.184	0.613	0.613	100.000	1.532	1.532	2.500	0.134

mortAAR life table forsex: All (n = 75 individuals)

Life expectancy at birth (e0): 28.418

	x	a	Ax	Dx	dx	lx	qx	Lx	Tx	ex	rel_popx
1	0--0	1	0.333	3.000	4.000	100.000	4.000	97.333	2841.831	28.418	3.425
2	1--4	4	1.333	7.500	10.000	96.000	10.417	357.333	2744.498	28.589	12.574
3	5--9	5	2.500	7.500	10.000	86.000	11.628	405.000	2387.164	27.758	14.251
4	10--14	5	2.500	4.968	6.625	76.000	8.717	363.439	1982.164	26.081	12.789
5	15--19	5	2.500	4.907	6.543	69.375	9.431	330.520	1618.726	23.333	11.631
6	20--24	5	2.500	5.503	7.337	62.833	11.677	295.820	1288.206	20.502	10.409
7	25--29	5	2.500	6.836	9.115	55.495	16.425	254.689	992.386	17.882	8.962
8	30--34	5	2.500	6.682	8.909	46.380	19.210	209.628	737.696	15.905	7.377
9	35--39	5	2.500	6.317	8.423	37.471	22.479	166.297	528.068	14.093	5.852
10	40--44	5	2.500	6.610	8.813	29.048	30.339	123.207	361.772	12.454	4.335
11	45--49	5	2.500	3.898	5.197	20.235	25.682	88.183	238.565	11.790	3.103
12	50--54	5	2.500	2.820	3.760	15.038	25.000	65.792	150.382	10.000	2.315
13	55--59	5	2.500	2.820	3.760	11.279	33.333	46.994	84.590	7.500	1.654
14	60--64	5	2.500	2.820	3.760	7.519	50.000	28.197	37.595	5.000	0.992
15	65--69	5	2.500	2.820	3.760	3.760	100.000	9.399	9.399	2.500	0.331

Putting mortAAR into action – An Early Neolithic cemetery



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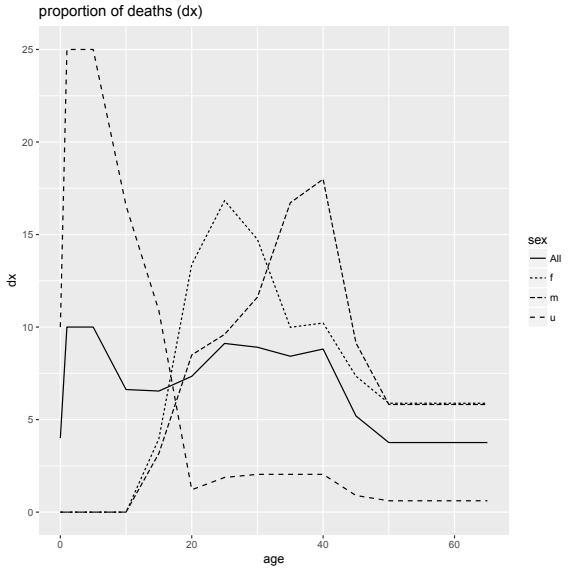

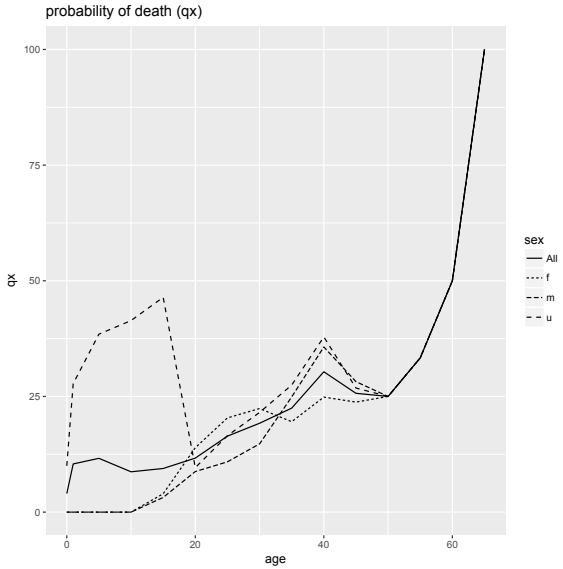

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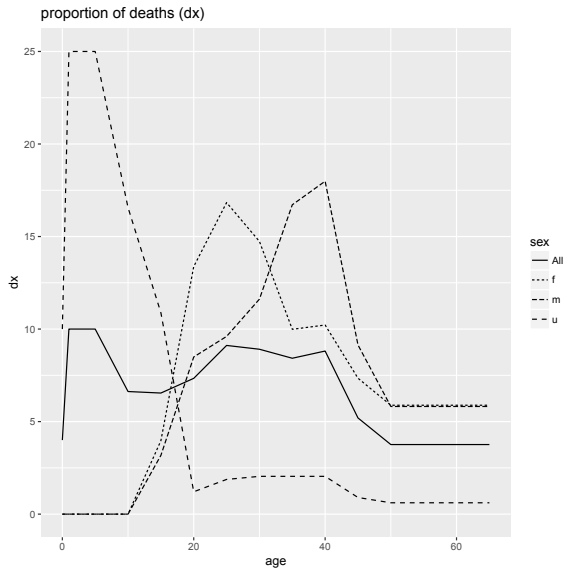

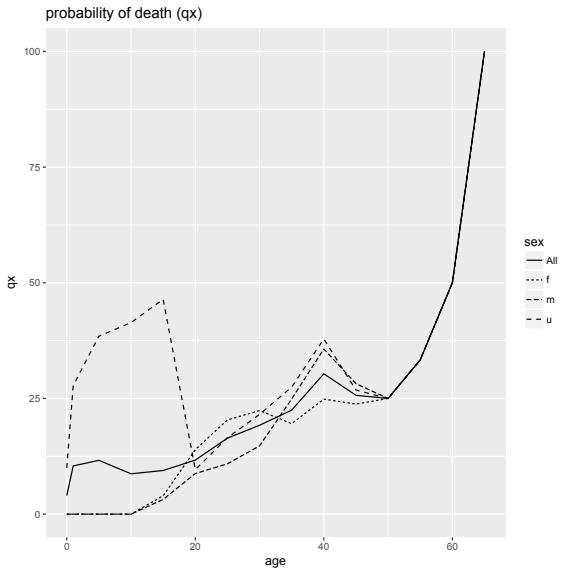

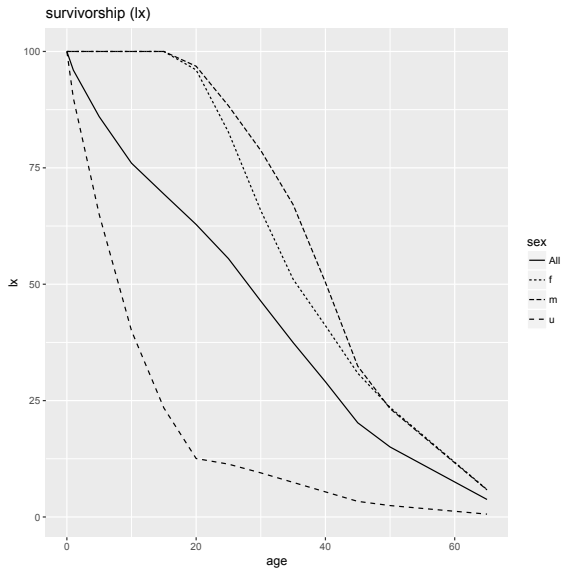

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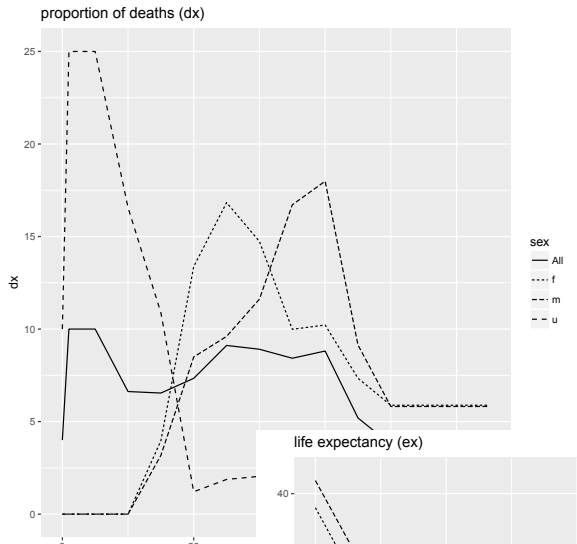

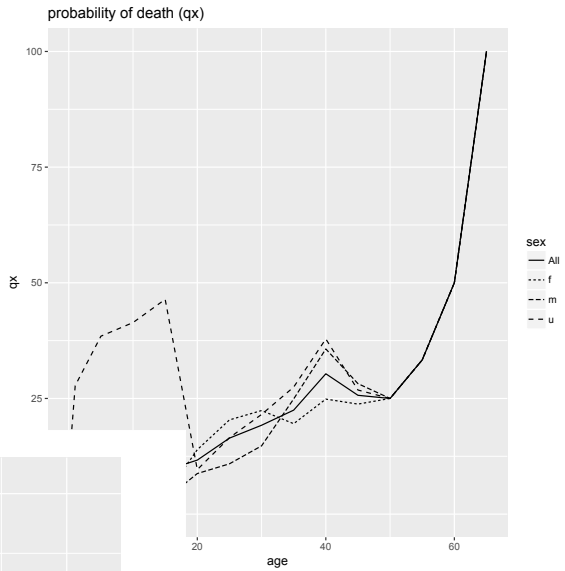

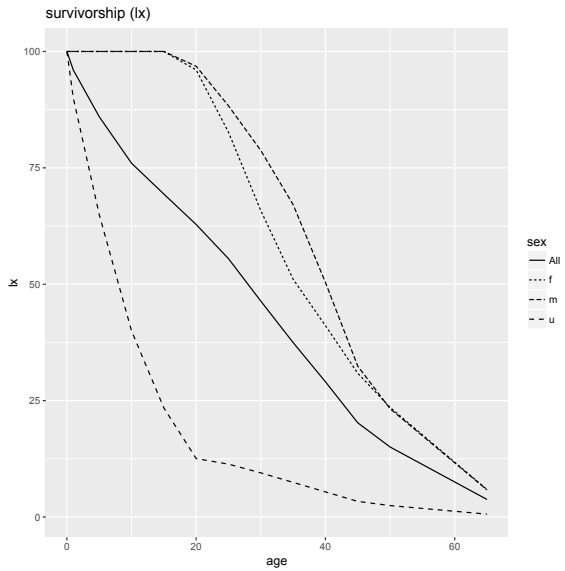

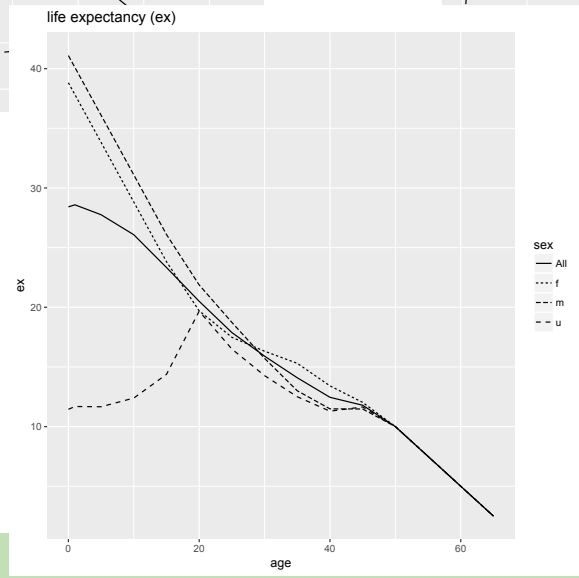

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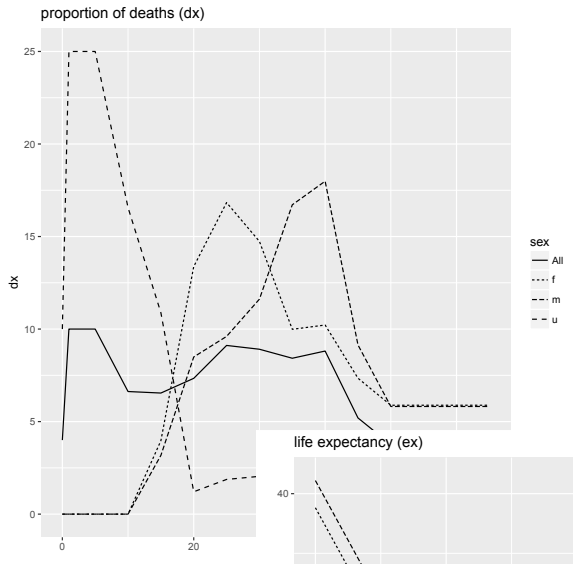

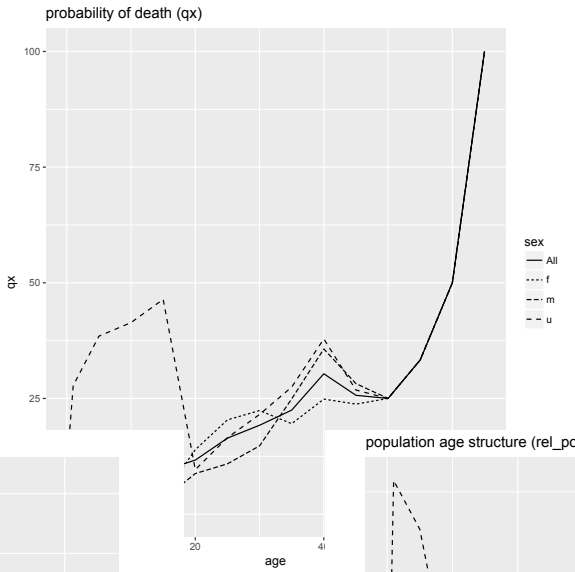

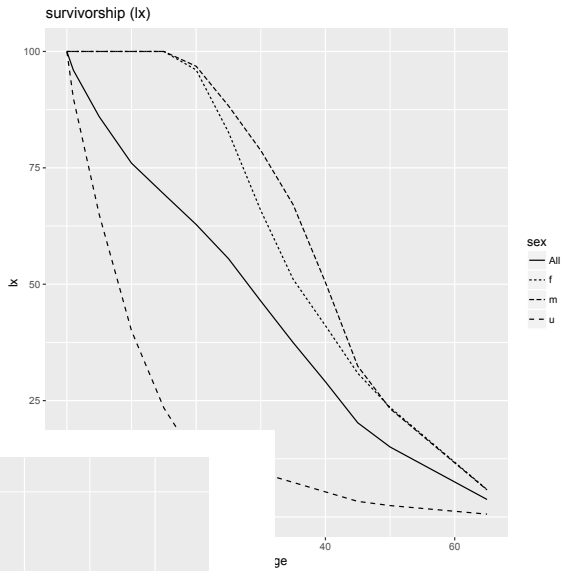

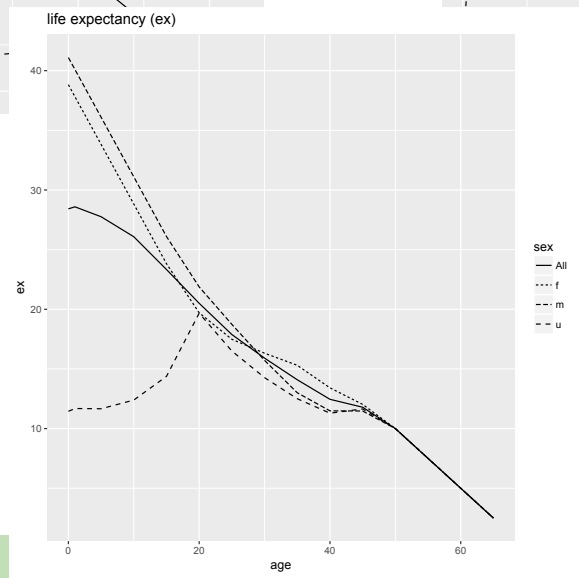

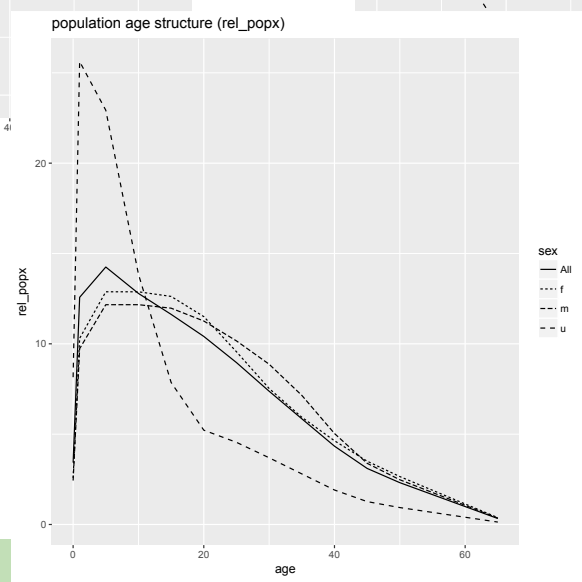

Life tables – Why are they still useful?

While we do not dismiss the problematics of life tables with their assumption of stationary populations, we still think that even in their simple form they provide useful information at least for the archaeologist. Even if the age-pattern is distorted, it still provides highly relevant information about cultural behaviour and preferences.
Archaeologists, anthropologists and paleodemographers should work closer together than they have in the past to get to grips with actual population developments, representation of burial data and possible sources of bias.

mortAAR

If our package helps in this process, we would be more than happy.

- on github:
  https://github.com/ISAAKiel/mortAAR
- on CRAN:
  https://CRAN.R-project.org/package=mortAAR