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ESTIMATION OF THE INFLUENCE OF ALCOHOL CONSUMPTION ON MORTALITY IN UPPER SILESIA

The aim of the presented study was estimation of the range of influence of alcohol abuse on mortality level in Upper Silesia (Poland). For that purpose cause-elimination life tables, describing mortality processes of the populations of three big cities of the region, i.e. Katowice, Chorzów and Bytom, were applied. The presented estimates were based on average values from the years 1993-1994.

Katowice is the capital of the region (214,200 inhabitants in 1994); Chorzów (127,400) and Bytom (229,800 inhabitants in the same year) are situated nearby.

The whole region of Upper Silesia – including the three cities – are characterized by worse values of demographic parameters than in the other Polish cities, and in the whole country, for instance:

- higher (with exception of Bytom) general mortality rates (10.1 per 1000 inhabitants in the whole country, 10.8 in Katowice, 13.7 in Chorzów, and 9.9 in Bytom),
- much higher values of coefficient of infant death rates (16.6 in Poland, 19.3 in Katowice, 19.6 in Chorzów, 19.8 per 1000 of live births in Bytom),
- negative values of natural increase in Katowice (-1,1 per 1000 inhabitants) and Chorzów (-3.7), in comparison to the value equal to -0.2 in Poland in 1994.

Life tables are theoretical frameworks, which could be applied for the analysis and comparisons of overall mortality as well as for analysis of specific cause mortality in different populations.

In those tables a cohort of l_0 newborns (in the presented research 100,000 persons) is considered, and a hypothetical cohort is constructed with the use of mortality parameters of the living population – under assumptions that there are no new births, and also that there is no immigration and emigration.

On this basis a model of survival for the considered population is built, and the most important estimated parameters are:

l_x – expected number of survivors out of the initial number l_0 at the exact age x,

d_x – expected number of deaths in age class $[x, x+\Delta x)$ in the constructed, hypothetical cohort (the two above parameters should be considered only in conjunction with l_0),

e_x – life expectancy for a person at the age x; the most often used is estimate of life expectancy for newborns (e_0), which could be interpreted as an average number of years which a newborn person is expected to live given applied in estimation mortality rates.

Figures 1 and 2 illustrate the results of comparison of main mortality characteristics in Katowice. It can be observed that there are significant differences between men and women mortality rates in the same age classes, and that situation of men is much more disadvantageous than that of women. Similar observation can be made in the two other cities considered and generally in Poland.

Figures 3-6 illustrate the results of similar comparison in the three considered cities. It can be stated that the worst mortality conditions were observed in Chorzów, while the most advantageous ones – in Bytom.

Cause specific analysis of mortality in a population with the use of cause-elimination life tables is conducted under an additional assumption of non-existing in reality in the considered population mortality factors, i.e. given a certain cause of death is hypothetically eliminated. The basic estimated parameter in those kinds of life tables is a summary measure called "cause-elimination life table life expectancy gain", denoted $\Delta e_{x \cdot \lambda}$:

$$\Delta e_{x.\lambda} = e_{x.\lambda} - e_x \qquad /1/$$

where λ is theoretically eliminated cause of death.

Described by formula /1/ measure represents the hypothetical change in life expectancy that would be obtained, if the specified cause of death (e.g. chronic disease) was eliminated, under the additional assumption that the mortality risk represented by the specified cause of death is independent of all other mortality risks.

The most important for the evaluation of the hypothetical change in mortality process is life expectancy gain for newborns, that is $\Delta e_{0 \cdot \lambda}$.

The basic for the mortality analysis parameter e_x, that is average number of years a person at the age x is expected to live, is estimated (formula /2/) as a proportion of the expected total number of years lived beyond age x by the population (T_x) to the number of persons alive at that age (l_x).

$$e_x = \frac{\sum_{j=x}^{\omega-1} L_j}{l_x} = \frac{T_x}{l_x}, \qquad /2/$$

where ω denotes the last year of life ever observed in a population, so the time interval $[0, \omega]$ represents the lifespan of the cohort.

To estimate $\Delta e_{x \cdot \lambda}$ first of all number of deaths from the specified cause λ should be evaluated. Then, under the assumptions that the person was alive at the exact age *x,* and that the specified cause of death λ was eliminated, the conditional probability of death ($q_{x.\lambda}$) in the age $[x, x + \Delta x)$ could be estimated as follows:

$$q_{x.\lambda} = 1 - (1 - q_x)^{1 - \frac{d_{x.\lambda}}{d_x}} \qquad /3/$$

where:

$d_{x.\lambda}$ – denotes number of deaths from the considered cause λ among persons at the age *x*,

q_x – general mortality rates at the age $[x, x + \Delta x)$.

Alcohol is directly or indirectly related to many causes of death. Direct relation occurs in a situation where the death is caused exclusively by alcohol (in such sense that the specified cause of death could not take place, if there was no alcohol consumption) – for instance death of acute alcohol poisoning or death resulting from an accident under the influence of alcohol. Indirect relation occurs in a situation where alcohol abuse is only one of the significant factors contributing to the considered cause of death (e.g.: diseases of the circulatory, the digestive or the respiratory system).

It has been stated[1] that mortality level among alcoholics is much higher compared to the level of the whole population, so the mortality rates for alcoholics are usually 2-4 times higher – depending on gender/age class – than the general ones. Therefore it can be expected that the life table parameters estimated under the assumption of elimination of causes of death related to alcohol would take on more advantageous values than the ones based on existing mortality conditions.

It has been also observed many times [e.g. McDonnell, Maynard 1985, p.436] that statistical data concerning deaths related to alcohol are inaccurate – the number of reported deaths is usually underreported. It happens so because for instance, the doctor who drew up the death certificate might not know that the person was alcohol abuser, or even if he was aware of the fact, it could be

[1] See e.g.: [Adelstein, Wald 1976], [Brodniak, Moskalewicz, Rabczenko, Wojtyniak 2002], [Ravenholt 1984], [Schmidt, de Lint 1972], [Thorarinsson 1979].

very difficult (or simply not possible) to state the degree of alcohol contribution to the death. Not without meaning is the justifiable tendency of the family of the deceased to avoid mentioning alcohol as the cause of death.

Because of the shortcomings of the statistical data, in the presented study the conditional probability of death ($q_{x.\lambda}$), where mortality related to alcohol was excluded, was estimated in the indirect way – that means that coefficients γ_i were, applied describing observed to expected number of deaths of alcoholics[2] in gender/age class *i*.

Under the assumption that any population consists exclusively of alcoholics and non-alcoholics, and with the use of the coefficients γ_i, the hypothetical mortality rates m_{ni} – i.e. mortality rates given that nobody in the considered population was alcoholic – were estimated, according to the formula proposed by Mielecka-Kubień [2001, p. 203].

In that way mortality related to alcohol abuse was, in theory, eliminated:

$$m_{ni} = \frac{m_i}{1 + (\gamma_i - 1) \cdot p_i} \qquad /4/$$

where:

m_i – denotes general mortality rates observed in the population in gender/age class *i*,

m_{ni} – general mortality rates for non-alcoholics,

p_i – share of alcoholics in class *i*,

γ_i – ratio of the observed to expected number of deaths of alcoholics.

In the next step mortality rates m_{ni} were applied to estimate the conditional probability of death ($q_{x.\lambda}$).

To estimate the number of alcoholics in the populations of Katowice, Chorzów, and Bytom the Jellinek formula was applied[3] which gives rough estimate of the size of demanded populations of alcoholics:

2 [Schmidt, de Lint 1972], p.171.

3 [Report... 1951]. The method is also in detail described in [Mielecka-Kubień 2001].

$$A = \frac{PD}{K} \cdot R \qquad /5/$$

where:

A – number of alcoholics living in the considered population (the unknown value),
D – number of reported deaths of the liver cirrhosis mortality in the population,
P – the percentage of such deaths attributable to alcohol abuse,
K – the percentage of all alcoholics to the ones who died of cirrhosis of the liver,
R – ratio of all alcoholics to alcoholics with complications.

Combining the use of the Jellinek formula for estimation of the size of population of alcoholics as well as Schmidt and de Lint's coefficients γ_i (ratio of the observed to expected number of deaths of alcoholics) creates problem of comparability of definitions of "population of alcoholics" applied in both studies. While Schmidt and de Lint's study concerned clinically treated alcoholics, that is persons, who were heavy alcohol consumers during their lifetime and suffered from alcohol related diseases, in the Jellinek's study a class of alcoholics was understood in much broader sense; in contemporary terminology they would be rather called "alcohol abusers"[4] than "alcoholics", while Jellinek's population of "alcoholics with complications" corresponds to the population of alcoholics in Schmidt and de Lint's study.

In that context Schmidt and de Lint's coefficients γ_i correspond rather to Jellinek's population of "alcoholics with complications" than to the population of "alcoholics".

On the other hand – while it is not necessary to be a clinically treated alcoholic to die as a result of a traffic (or other) accident occurred under influence of alcohol, or to commit suicide under such influence – mortality among population of alcoholics in broader sense is certainly also higher than the one in general population, but the ratios γ_i of the observed to expected number of deaths of alcoholics (in broader sense) are not available.

For that reason in the presented study estimated life table parameters are given in interval form (though in the both cases Schmidt and de Lint's coefficients γ_i were applied):

[4] According to the Report on the First Session of the Alcoholism Subcommittee of Expert Committee on Mental Health [WHO, Geneva 1951], where E.M.Jellinek presented his formula, the term "alcoholism" the subcommittee used "…to signify any form of drinking which in its extent goes beyond the traditional and customary "dietary" use…" [Report... 1951], p.5.

– “high level” for population of alcoholics in the broader sense,
– “low level” for population of alcoholics in the narrower sense, corresponding to Jellinek’s population of “alcoholics with complication”, so the values of the estimated parameters are included in the defined above intervals.

To apply Jellinek’s formula for estimation of range of populations of “alcoholics”, and “alcoholics with complication” in the three cities of Upper Silesia, Jellinek’s estimates for the parameters *K* and *R* – as none of the two parameters were ever estimated for Poland – were used (*K=0,694, R=4*), and parameter *P* was estimated for the Polish population by the author [Mielecka-Kubień 2001, p.187] as equal to about 80% for men and about 50% for women. The results of estimation are presented in table 1:

Table 1

Estimated number of alcoholics in broad and narrow sense in three cities in Upper Silesia, years 1993-1994

City	Estimated number of alcoholics (in thousands, and as percent of population)			
	broad sense		narrow sense	
	men	women	men	women
Katowice	23.3 (14.06%)	9.9 (5.54%)	5.8 (3.50%)	2.5 (1.40%)
Chorzów	13.6 (22.38%)	3.5 (5.28%)	3.4 (5.60%)	0.9 (1.36%)
Bytom	11.0 (9.92%)	3.2 (2.73%)	2.7 (2.44%)	0.8 (0.68%)

The results of estimation[5] of the cause-elimination life table parameters under the above described assumptions are presented in tables 2-9, and are illustrated in figures 7-12.

[5] The applied method of estimation of the life table parameters is described in detail in [Dziembała at al. 2002].

Table 2

Expected number of survivors estimated on the basis of actual, empirical mortality rates and theoretical (given there were no deaths related to alcohol) mortality rates, high and low level, men, Katowice, Chorzów, Bytom, years 1993-1994

Age *x*	Expected numbers of survivors (l_x) at the age *x*								
	Katowice			Chorzów			Bytom		
	Actual	High level	Low level	Actual	High level	Low level	Actual	High level	Low level
0	100000	100000	100000	100000	100000	100000	100000	100000	100000
30	96484	96611	96514	95716	95993	95799	95847	95910	95862
40	94103	94828	94319	92946	94225	93377	93384	93906	93520
50	88306	91194	89275	86078	90645	87797	86604	89221	87438
60	75648	81269	77422	68824	78178	72017	72431	77338	73904
70	51474	57473	53238	42990	52452	45966	49379	54605	50969

Table 3

Expected number of survivors (l_x) estimated on the basis of actual, empirical mortality rates and theoretical (given there were no deaths related to alcohol) mortality rates, high and low level, women, Katowice, Chorzów, Bytom, years 1993-1994

Age *x*	Expected numbers of survivors (l_x) at the age *x*								
	Katowice			Chorzów			Bytom		
	Actual	High level	Low level	Actual	High level	Low level	Actual	High level	Low level
0	100000	100000	100000	100000	100000	100000	100000	100000	100000
30	97607	97696	97636	97889	97951	97907	97392	97441	97405
40	96639	97077	96788	97133	97490	97255	96393	96666	96473
50	93770	95128	94226	93791	95200	94263	93690	94512	93931
60	87304	89631	88056	86699	89056	87462	87984	89273	88349
70	62878	65011	63763	68760	71162	69727	71420	72589	71747

Table 4

Expected number of deaths (d_x) estimated on the basis of actual, empirical mortality rates and theoretical (given there were no deaths related to alcohol) mortality rates, high and low level, men, Katowice, Chorzów, Bytom, years 1993-1994

Age *x*	**Expected number of deaths ($d_{x,x+\Delta x}$)**								
	Katowice			**Chorzów**			**Bytom**		
	Actual	**High level**	**Low level**	**Actual**	**High level**	**Low level**	**Actual**	**High level**	**Low level**
20-29	1243	1108	1205	1840	1572	1766	965	902	950
30-39	2381	1783	2195	2770	1768	2422	2463	2004	2342
40-49	5797	3634	5044	6868	3580	5580	6780	4685	6082
50-59	12658	9925	11853	17254	12467	15780	14173	11883	13534
60-69	24174	23796	24184	25834	25726	26051	23052	22733	22935
70-79	30124	33585	31143	26034	31672	27810	29963	33081	30906

Table 5

Expected number of deaths (d_x) estimated on the basis of actual, empirical mortality rates and theoretical (given there were no deaths related to alcohol) mortality rates, high and low level, women, Katowice, Chorzów, Bytom, years 1993-1994

Age *x*	**Expected number of deaths ($d_{x,x+\Delta x}$)**								
	Katowice			**Chorzów**			**Bytom**		
	Actual	**High level**	**Low level**	**Actual**	**High level**	**Low level**	**Actual**	**High level**	**Low level**
20-29	423	334	394	348	286	330	440	390	426
30-39	968	619	848	756	461	652	999	775	932
40-49	2869	1949	2562	3342	2290	2992	2703	2154	2542
50-59	6466	5497	6170	7092	6144	6801	5706	5239	5582
60-69	24426	24620	24293	17939	17894	17735	16564	16684	16602
70-79	27669	27263	26740	35288	35033	34326	35137	35708	35294

Table 6

Life expectancy at the age x (e_x) estimated on the basis of actual, empirical mortality rates and theoretical (given there were no deaths related to alcohol) mortality rates, high and low level, men, Katowice, Chorzów, Bytom, years 1993-1994

Age *x*	**Life expectancy at the age *x* (e_x)**								
	Katowice			**Chorzów**			**Bytom**		
	Actual	**High level**	**Low level**	**Actual**	**High level**	**Low level**	**Actual**	**High level**	**Low level**
0	66.97	69.34	68.08	65.08	67.94	66.00	66.17	67.68	66.59
10	58.07	60.48	59.20	56.32	59.23	57.26	57.96	59.52	58.40
20	48.41	50.84	49.55	46.61	49.53	47.55	48.24	49.80	48.68
30	39.58	41.36	40.10	37.39	40.25	38.32	38.67	40.22	39.11
40	30.44	32.04	30.91	28.34	30.91	29.18	29.54	30.96	29.95
50	22.07	23.10	22.35	20.14	21.91	20.68	21.41	22.30	21.65
60	14.85	15.25	14.95	13.79	14.50	13.99	14.55	14.90	14.65
70	9.28	9.30	9.29	8.99	9.03	9.01	8.88	8.90	8.89

Table 7

Life expectancy at the age x (e_x) estimated on the basis of actual, empirical mortality rates and theoretical (given there were no deaths related to alcohol) mortality rates, high and low level, women, Katowice, Chorzów, Bytom, years 1993-1994

Age *x*	**Life expectancy at the age *x* (e_x)**								
	Katowice			**Chorzów**			**Bytom**		
	Actual	**High level**	**Low level**	**Actual**	**High level**	**Low level**	**Actual**	**High level**	**Low level**
0	72.95	73.45	73.45	72.73	73.69	73.19	73.25	73.61	73.30
10	64.25	65.27	64.76	63.75	64.72	64.22	64.63	64.99	64.68
20	54.37	55.40	54.88	53.95	54.93	54.42	54.82	55.18	54.87
30	44.58	45.57	45.08	44.13	45.08	44.59	45.04	45.38	45.08
40	34.97	35.82	35.43	34.42	35.26	34.85	35.44	35.69	35.46
50	25.87	26.44	26.24	25.43	25.96	25.76	26.31	26.38	26.31
60	17.36	17.71	17.69	17.03	17.36	17.32	17.64	17.64	17.64
70	11.51	11.94	11.94	10.01	10.34	10.34	10.41	10.41	10.41

It can be observed that alcohol abuse is a significant factor determining the survival pattern of the populations of the three cities. It influences the values of life expectancy – the values would be higher, if there was no alcohol-related mortality.

Table 8 presents the estimated life-expectancy gain, given there was no mortality related to alcohol, in the considered three cities of Upper Silesia:

Table 8

Life expectancy gain $\Delta e_{x \cdot \lambda}$ (in years) in three cities in Upper Silesia given there were no mortality related to alcohol (high level)

Age x	Life expectancy gain $\Delta e_{x \cdot \lambda}$ at the age x					
	Katowice		Chorzów		Bytom	
	men	women	men	women	men	women
0	2.37	0.50	2.86	0.96	1.51	0.36
10	2.41	1.02	2.91	0.97	1.56	0.36
20	2.43	1.03	2.92	0.98	1.56	0.36
30	1.78	0.99	2.86	0.95	1.55	0.34
40	1.60	0.85	2.57	0.84	1.42	0.25
50	1.03	0.57	1.77	0.53	0.89	0.07
60	0.40	0.35	0.71	0.33	0.35	0.00
70	0.02	0.43	0.04	0.33	0.02	0.00

The above numbers should be understood as estimates of average number of years which a person at the age x could live additionally, if deaths related to alcohol were eliminated – provided that the population was created on the basis of actual mortality parameters.

The values of the above estimates are influenced by actual, general mortality rates of the population as well as by the level of alcoholism prevalence in that population.

The most interesting are the estimated values of life expectancy gain for newborns (e_0). It can be observed that the hypothetical improvement would be the highest in Chorzów (2.86 years for men, 0.96 years for women), and then in Katowice (2.37 for men, 0.50 for women). The lowest possible gain could be expected in Bytom, the city of the best, out of the three cities, general mortality conditions, and the lowest number of alcoholics (see table 1 and figures 3-6).

On the basis of the presented results it is also possible to estimate a number of premature deaths related to alcohol (table 9):

Table 9

Estimated number of premature deaths related to alcohol per every 100,000 inhabitants (high level)

Age x	Estimated number of premature deaths at the age x					
	Katowice		Chorzów		Bytom	
	men	women	men	women	men	women
20-29	135	89	268	62	63	50
30-39	598	349	1002	295	459	224
40-49	2163	920	3288	1052	2095	549
50-59	2733	969	4787	948	2290	467
60-69	378	194	108	45	319	-120
Total:	6007	2133	9453	2402	5226	1170

The presented results indicate that the process of dying out of the populations of the three considered cities could be much slower given there was no mortality related to alcohol. This possible gain could be considered as one of possible positive influences of elimination of alcohol abuse on the demographic processes in the population.

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Source of all tables and figures: Authors' own calculation on the basis of the Statistical Yearbook of Demography 1994,1995, and data from the Central Statistical Office in Warsaw.

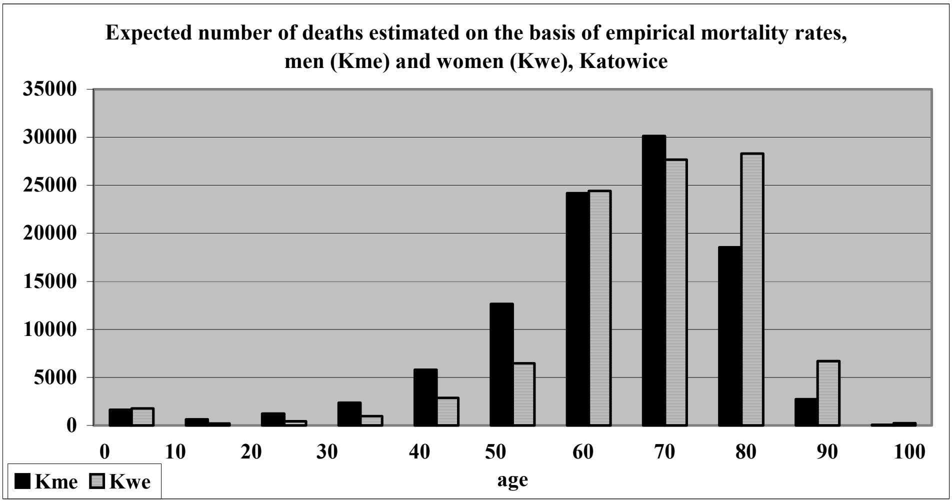


Figure 1

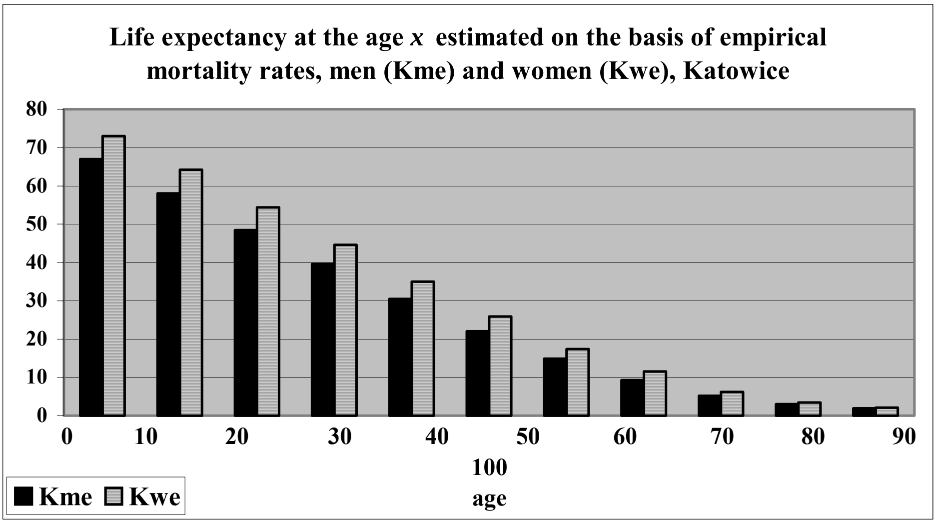
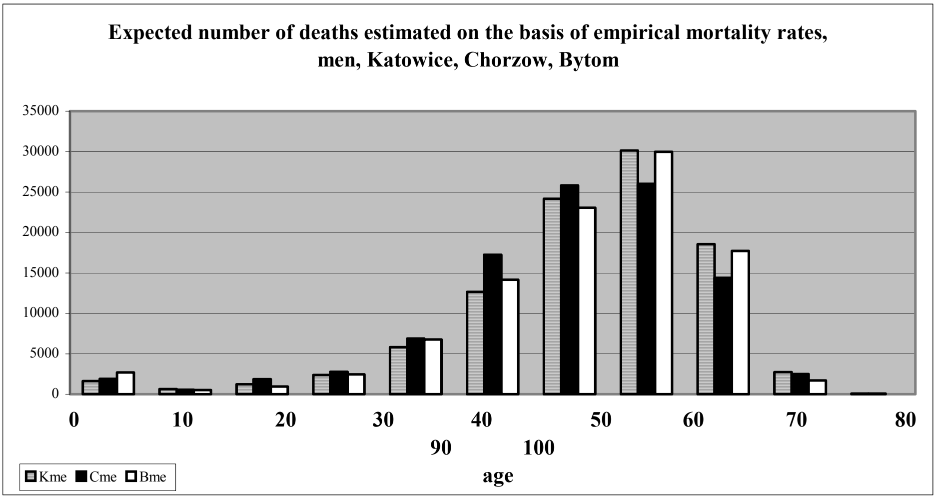


Figure 2



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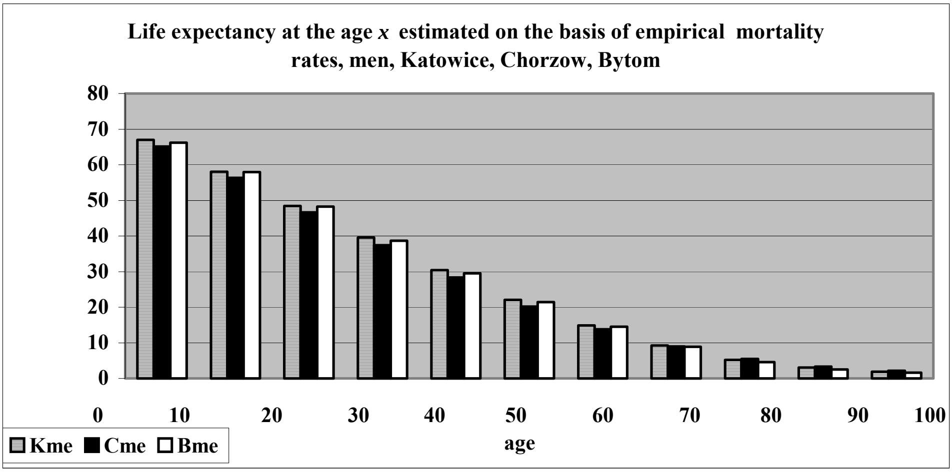

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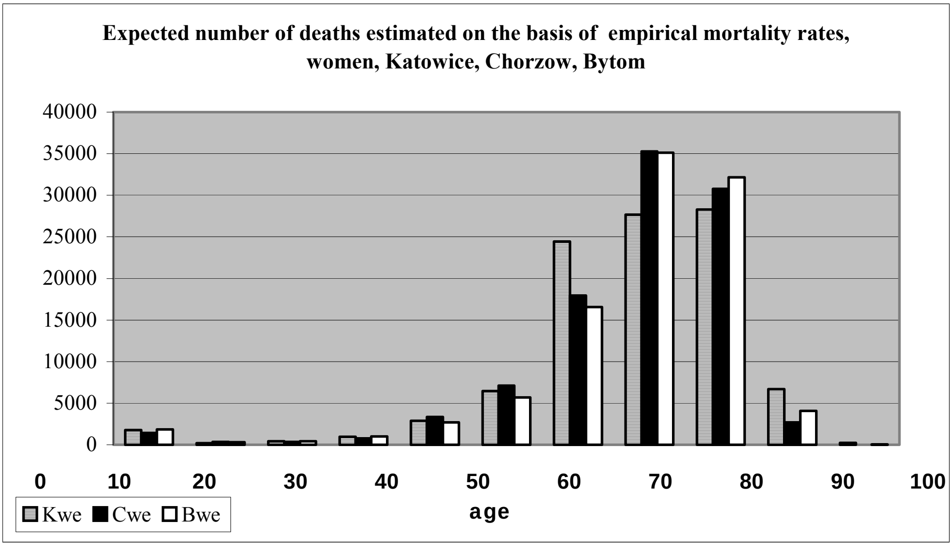

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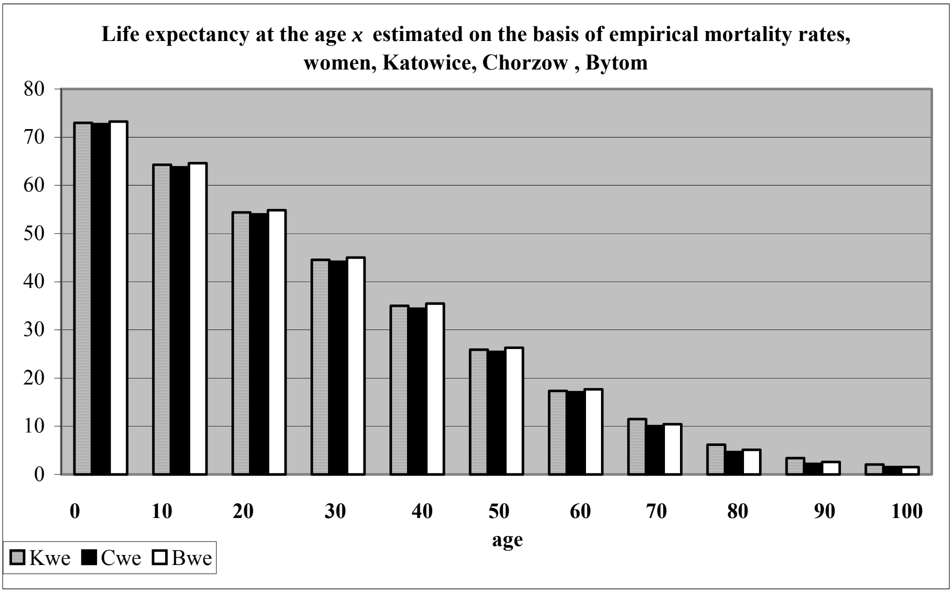

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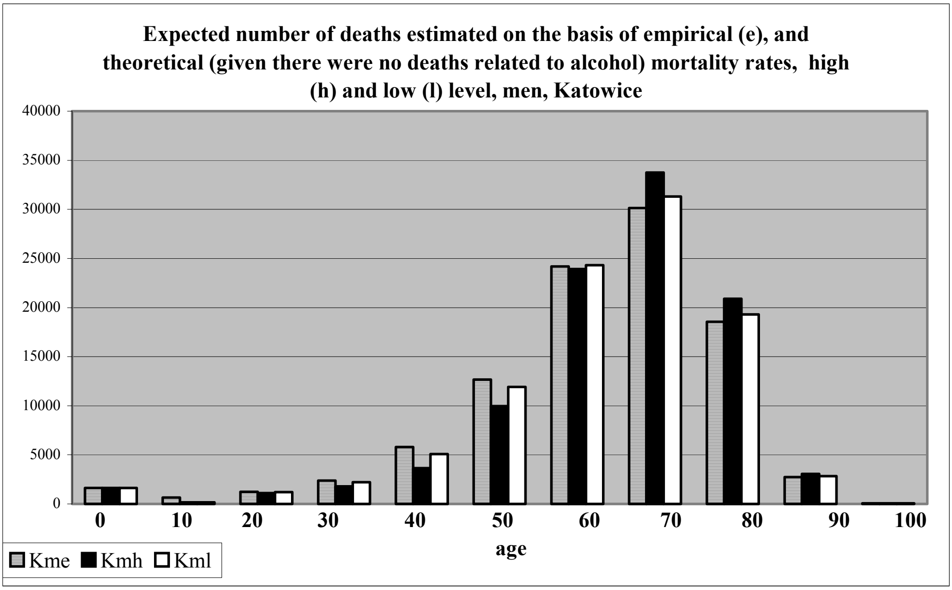

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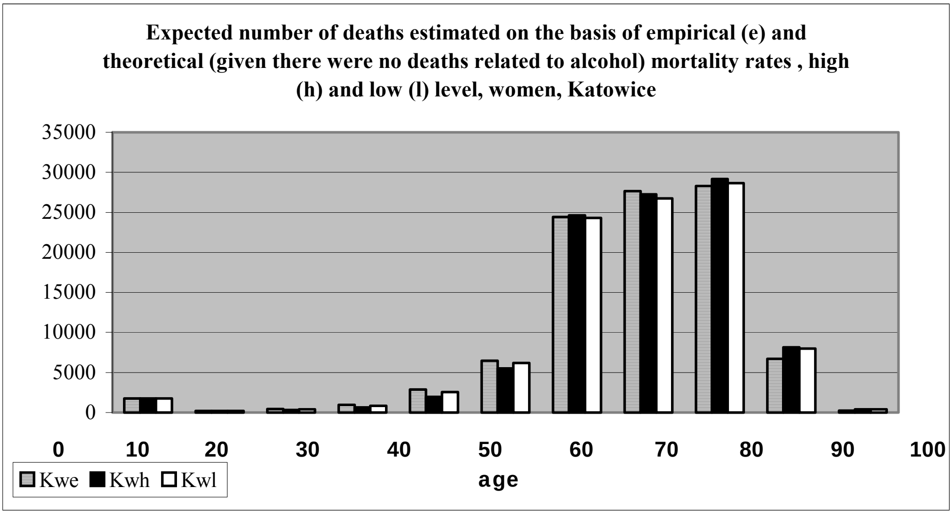

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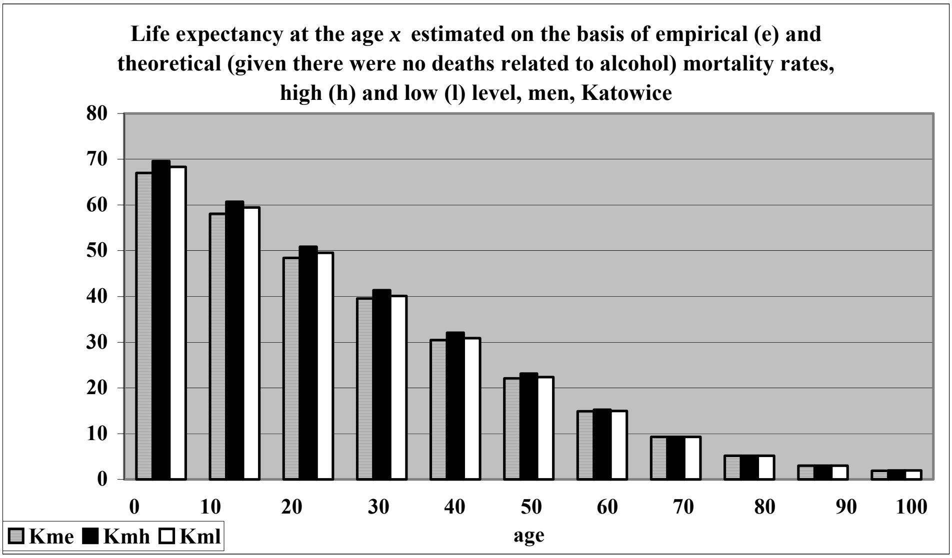


Figure 9

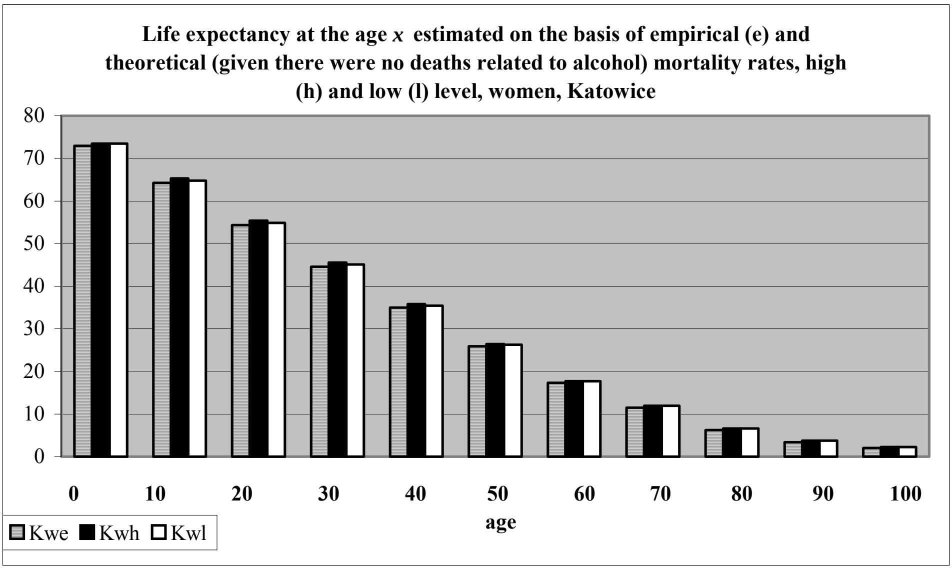
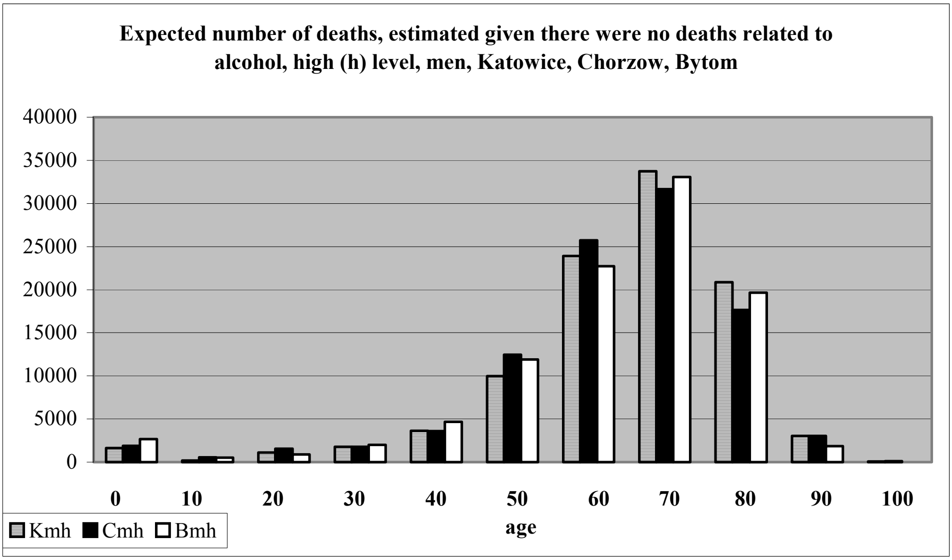


Figure 10



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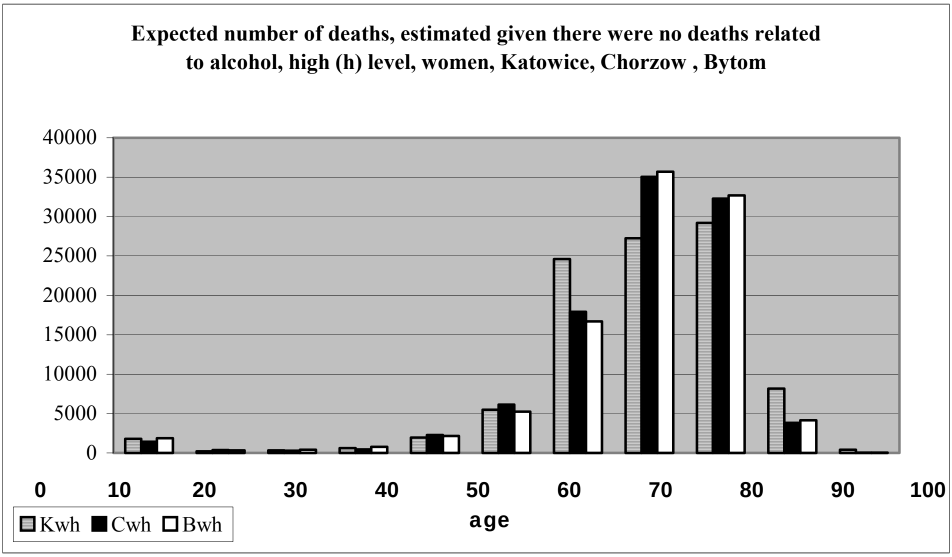

Figure 12