YOUNG ADULTS' EXCESS MORTALITY: COHORT PERSPECTIVE

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Abstract

Young adults' excess mortality - between age of adolescence and young adult - is well known fact. In some literature this excess is called "mortality bump" and reason why we can find it in the development of mortality is usually justified just theoretically and measured for males only. This article describes development of the "bump" in cohort perspective of males in the Czech Republic. In time we can observe changes and shift of the excess to the lower level for younger generations. It seems that younger cohorts have lower mortality risk but the question is if the increase in the period of 18-21 years is decreasing also or not.

Keywords: *mortality, cohort, young adult, Czech Republic*

JEL Codes: *J11, J19*

1. Introduction

Young adults' excess mortality is phenomenon which is known for long time as mortality is deeply studied. In the last period the most cited author is Adrien Remund, which based part of his research on this topic and he started in 2012 with the article "*Is young adults' excess mortality a universal phenomenon*?" (Remund, 2012). His ideas were developed in next contribution at European Population Conference where (Remund, 2014) and in his dissertation (Remund, 2015a).

The Remund's idea is that the population is not homogenous and there are many heterogeneous sub-populations. One of the populations (relatively small to compare it with the main population) is very inclined to risky behavior and its mortality is very high (to compare it to the main or general population). The increase in the mortality in general is then combination of stable (and low) mortality of the main population and increasing (and very high) level of mortality of that sub-population with very risky behavior (Remund, 2015a).

Discussion about the cause of the mortality excess is very wide and mainly is connected with the distribution to external and internal causes. As it is known mortality to internal causes in the young adult age is very low and the attention should be oriented to the external causes (Remund at al., 2016). That is why sometime the excess is called "*Accident hump*" but as Remund at al. (2016) stress the cause of death is external but motivation to the risky behavior could be and usually is internal.

The other problem is with the definition of the period "*Young Adult*". As Remund (2015a) defined the analyzed period by age 10 at its beginning the period ends between age 20 and 30. As it is necessary to find not only the peak and beginning of the excess in this article the period is extend to age 31.

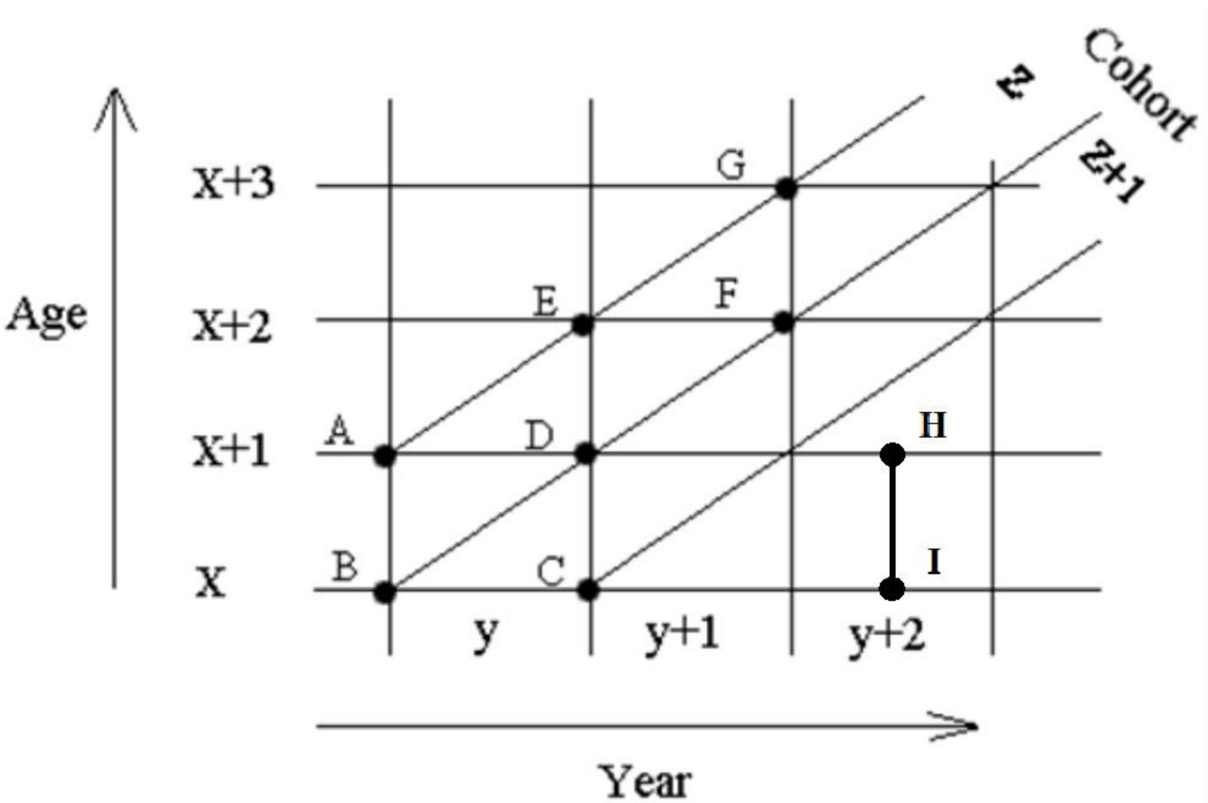
The aim of the paper is to introduce the last development of mortality increase in young adult age of males. For the description basic statistics will be used and to contrary to previous studies cohort perspective will be analyzed. Cohort perspective can help to understand the cohort effect but on the other hand is affected by period effect (see Bell and Jones (2013) or Robertson and Boyle (1986)). Results should show if the existing peak from the past is still remarkable in the new (and the newest) generations and if its increase is changing in time. The second part after this introduction describes data and basic methodology used in the analysis, then results of analysis are described and discussed. At the end the conclusion includes future development of next research is presented.

2. Data and Methodology

Data analyzed in this article is based on the Human Mortality Database (HMD, 2018) for years 1950-2014 and on data from Czech Statistical Office (CZSO, 2018) for years 1946-1949. For the analysis cohort exposures to risk (or probability of dying) for cohorts 1936-1984 were used. Age interval for all cohorts is 10-31 years of age (from the day of 10^{th} birthday to day of 31^{st} birthday). As the aim of the article is about the Young adults' excess mortality only males' cohorts are analyzed.

Cohort perspective means that number of deaths is defined for one year age group and one cohort (one year of birth) which covers two years intervals. This is expressed in the Fig. 1, where the number of deaths for one cohort and one age interval can be defined by points *A*, *D*, *F* and *E*.

Figure 1: Lexis diagram



Source: Hulikova Tesarkova, Kurtinova (2014)

Probability of dying for cohort then can be expressed as modified formula according to Pavlík et al. (1986):

$$q_x^z = \frac{D_x^z}{{}^{31.12.z+x}P_x^z + {}^{z+x}D_x^z}, \tag{1}$$

where q_x^z is probability of dying of cohort *z* at age *x*, D_x^z is number of deaths of cohort *z* at age *x* (in Fig. 1 can be defined as area defined by points *A*, *D*, *F* and *E*), ${}^{31.12.z+x}P_x^z$ is number of population of cohort *z* at age *x* at the moment 31.12. of the year *z*+*x* (can be defined in Fig. 1 as line segment between *D* and *E*) and ${}^{z+x}D_x^z$ is number of deaths of cohort *z* at age *x* in calendar year *z*+*x* (in the Fig. 1 area defined by points *A*, *D*, *E*). The denominator in formula (1) can be expressed as line segment between *A* and *D* in Fig. 1.

Because of some disadvantages of cohort perspective analysis, not the classical life expectancy can be used to analyze the impact of change in mortality level. For that reason indicator of Temporary life expectancy is developed according to Pavlík et al. (1986) :

$${}_ne_x = \frac{T_x - T_{z+n}}{l_x}, \tag{2}$$

where ${}_ne_x$ is Temporary life expectancy for age interval <*x*;*x*+*n*) which means average length of life between exact age *x* and exact age *x*+*n*, T_x is the number of person-years lived after exact age *x* and l_x is the number of persons surviving to exact age *x*.

Another possible way how to express different mortality level is by indicator “Life tables number of deaths” between some ages (Pavlík at al., 1986):

$${}_nd_x = \sum_{a=x}^{n} d_a = \sum_{a=x}^{n} q_a \cdot l_a, \tag{3}$$

where ${}_nd_x$ is life tables number of deaths between age <*x*;*x*+*n*>, d_x is life tables number of deaths at age *x*, q_x is probability of dying at age *x* and l_x is the number of persons surviving to exact age *x*.

For describing increase or decrease of mortality level for one cohort coefficients were constructed to measure mortality change during the life time. To eliminate influence of some period effect or another source of variability probability of dying was expressed as interval of three years of age.

$$\frac{{}_3q_{18}^z}{{}_3q_{10}^z}, \tag{4}$$

where ${}_3q_{18}^z$ is probability of dying in age interval (18;21> for cohort *z*.

As the variability of the results was still high (because of low number of deaths in this age interval and very high sensitivity to small changes) moving averages for five generations was created:

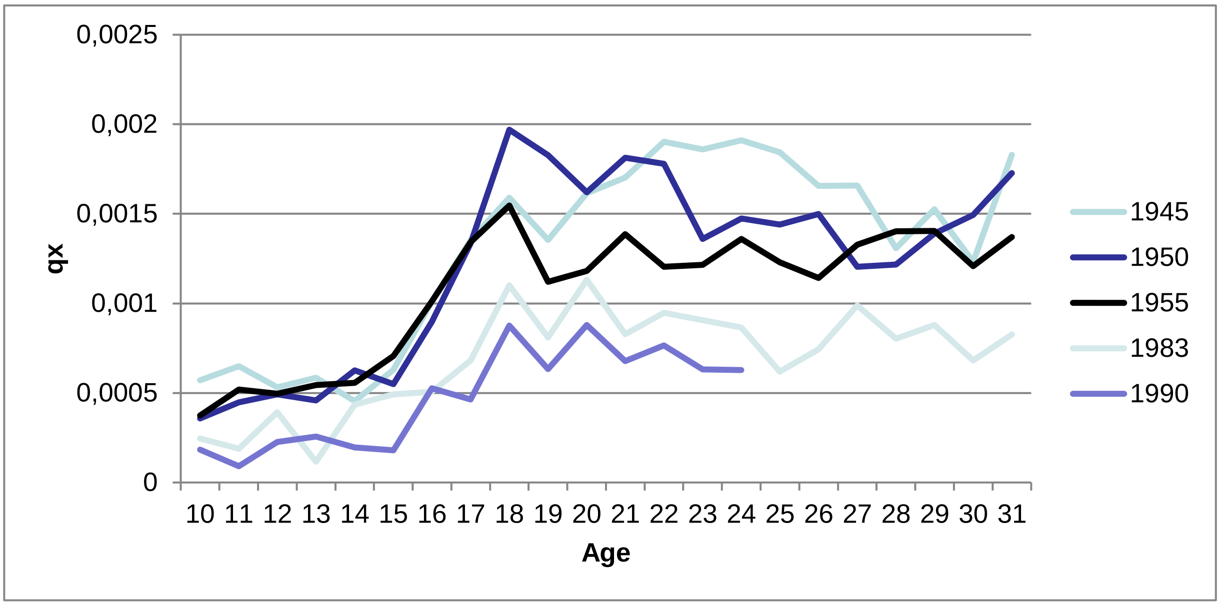
$$\overline{{}_3q_{18}^{z,z+n}} = \frac{{}_3q_{18}^z + {}_3q_{18}^{z+1} + \cdots + {}_3q_{18}^{z+n}}{n}. \tag{5}$$

3. Results

Development of mortality between cohorts is declining in the time. Younger cohorts have better mortality levels than older cohorts. This could be visible form Fig. 2, where general level of mortality for younger cohorts is lower. Another remarkable point is that for all cohorts there is increase of mortality in the period around 17 or 18 years but it seems that increase is less intensive for younger cohorts.

On Fig. 2 there are selected cohorts for demonstration of some period effect which can affect the cohort during its life. For example cohort 1950 has the highest peak form the other cohorts. This is caused by the period (for cohort 1950 the members were 18 around year 1968 when mortality to external causes was very high according to Srb (2004)). Cohort 1945 was affected by year of 1968 in older period and it seems that the peak for this cohort is around age 23 or 24, maybe 25 but not at age 18 as it was for other cohorts. For cohort 1983 and 1990 the development is "stable" after period of the lowest mortality which is in period from 10 to around 15 or 16 intensive increase follows and after this increase stable (almost constant) period follows (for some cohorts the level of mortality around age 30 is lower than around age 18).

Figure 2: Probability of dying, CZ, males, cohorts 1945, 1950, 1955, 1983, 1990

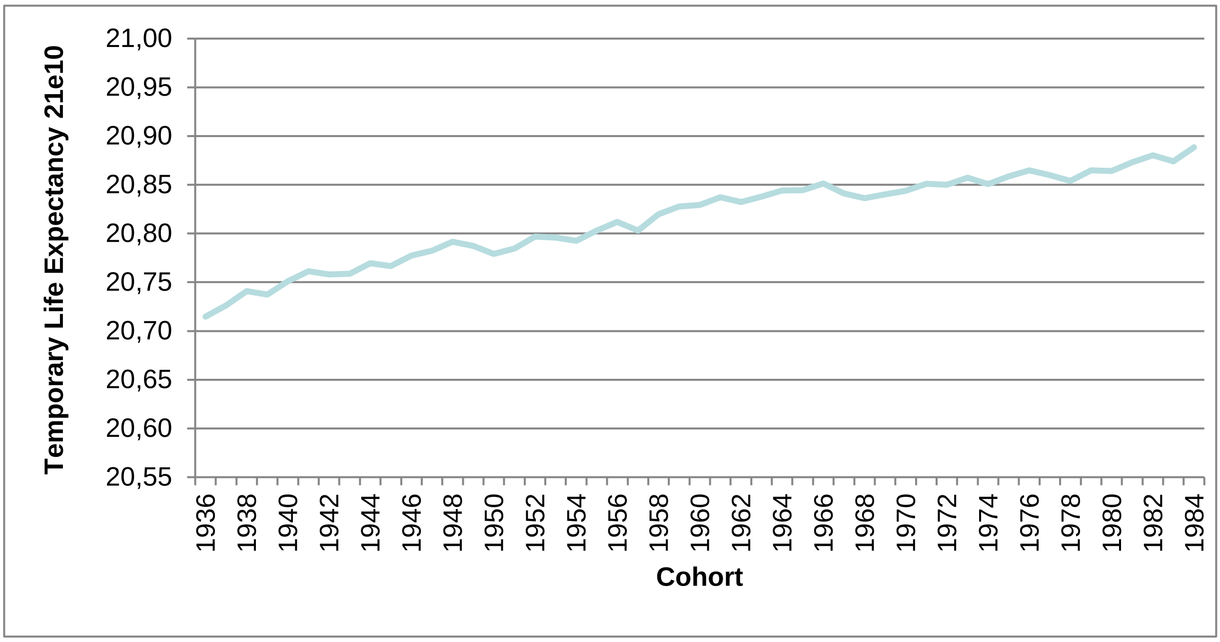


Source: Own calculation based on data from CZSO (2018) and HMD (2018).

General development of mortality level in the age period can be expressed by the Temporary life expectancy (see formula (2)). In Fig. 3 there is development of Temporary Life Expectancy ${}_{21}e_{10}$, which means the average years lived by the cohort between the 10th birthday and 31st birthday when maximum is 21 years (in the situation of no mortality – no person would die in this age period).

Temporary life expectancy for cohort born in 1936 was 20,72 years and each following cohort has longer life expectancy when the cohort born in 1984 has 20,89 years. Loss decreases from 0,28 to 0,11 years. The biggest drops were around cohorts born in 1949-1951 and 1967-1969 where some period effects influenced the length of the Temporary life expectancy.

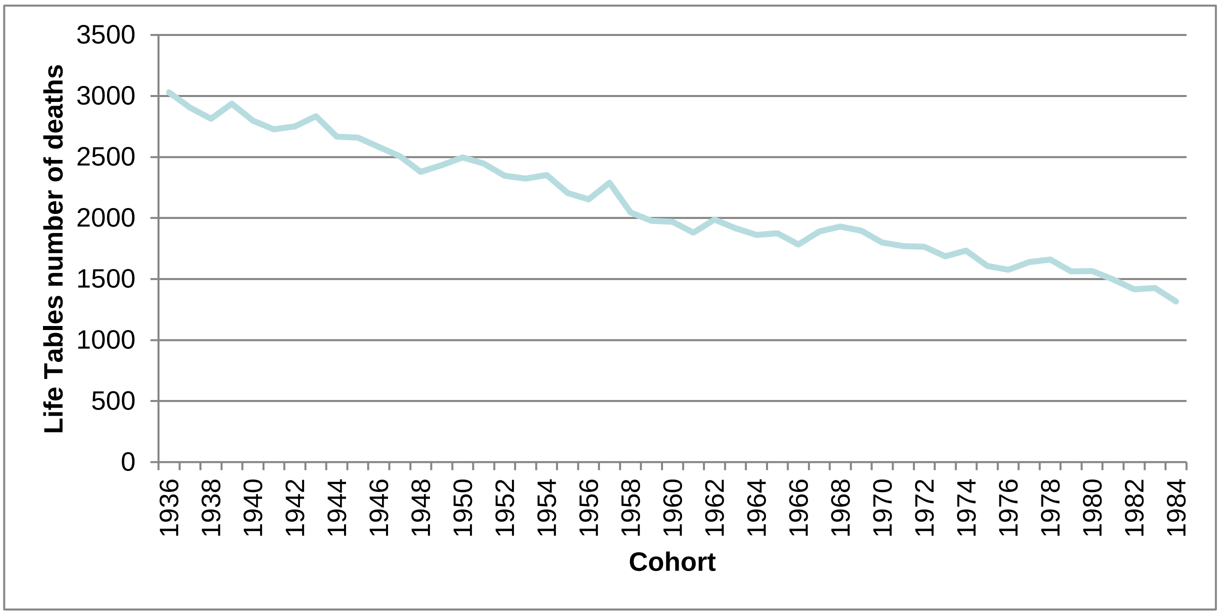
Figure 3: Temporary Life Expectancy ${}_{21}e_{10}$, males, CZ, cohorts 1936-1984



Source: Own calculation based on data from CZSO (2018) and HMD (2018).

Expression in years as the average can be supplemented by value expressed in persons. Life Tables number of deaths (formula (3) above) shows that for cohort born in 1936 the loss was more than 3,000 males (when the root of Life table is 100,000) it is more than 3 %. The trend is (logically) opposite to the trend of Life Expectancy and we can see continuous decline when cohort born in 1984 "lost" only 1,300 males. This is expression of general decline of mortality level between exact age 10 and 31, but it does not answer question if there is still that increase which was remarkable on Fig. 2 for ages around 18 years or the decline of mortality in general is also caused by smoothing of the peak.

Figure 4: Life Tables number of deaths between age 10 and 31, l_{10}=100,000, CZ, males, cohorts 1936-1984



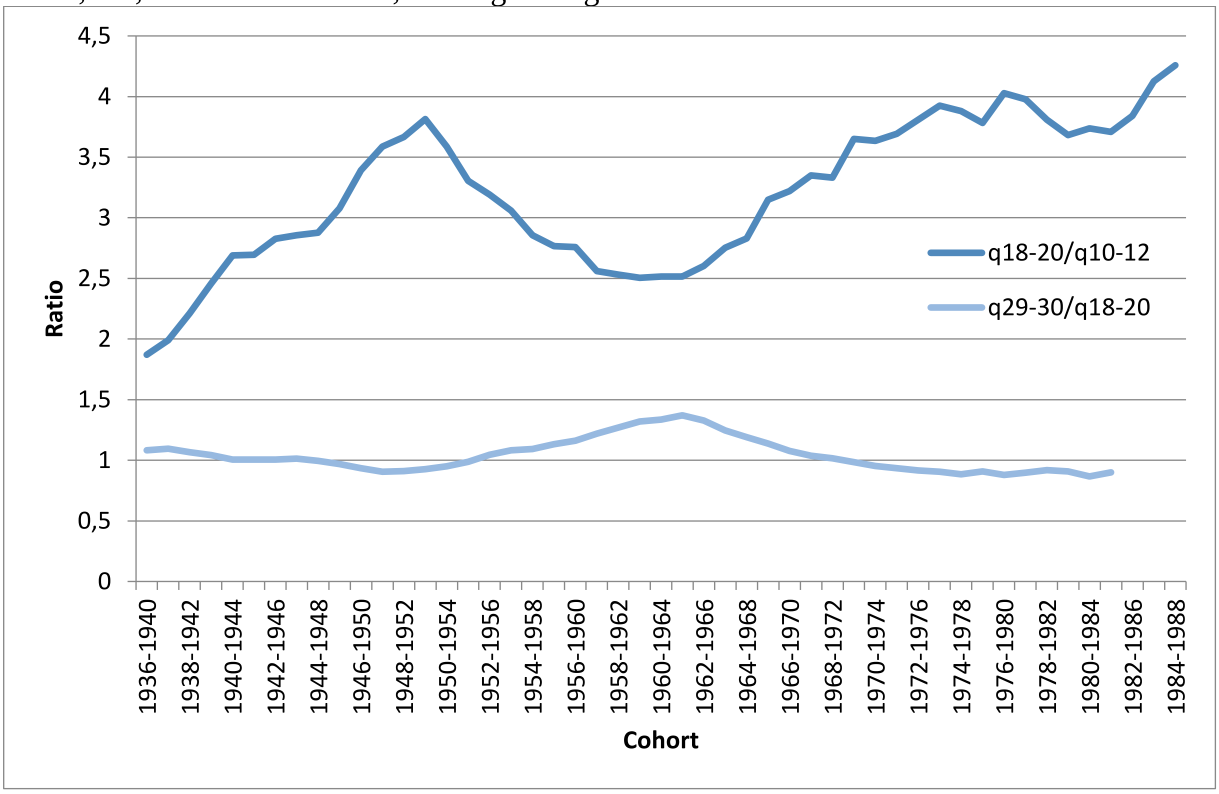
Source: Own calculation based on data from CZSO (2018) and HMD (2018).

To find right answer we can use measure from formula (4) (or modification from formula (5) as is in Fig. 5) where comparison of mortality level at the age intervals 10-12 and 18-20 is done and the same for age intervals 18-20 and 28-30. Results show that ratio is changing in time and it has no visible trend (or if the trend is not declining). The ratio for age intervals 10-12 and 18-20 expresses the high of the peak. For the youngest cohorts the peak was around two times higher level of mortality than at age 10-12. For next generations the peak was increasing rapidly to the highest level around 3,8. Then for nest generations the ratio was declining to the level around 2,5 for cohorts between years 1955 and 1965. From that period the level of ratio increased back to level up to 4 and for the youngest cohort it is higher than 4.

On the other hand the ratio between age intervals 18-20 and 28-30 is more stable and the level is around 1 (or 100 %) which means that there is almost no increase of mortality between those age intervals. In some periods there is even decline – the ratio is bellow one and it means that mortality is in the higher age lower than in younger ages.

It is clear that both curves are connected and with increase of mortality at age 18-20 the first ratio increases and the second (comparison with the higher age group) ratio decreases. The only period when the ratio between age intervals 18-20 and 28-30 is somehow higher (the mortality increases around 1,35 times) is when the ratio for the age intervals 10-12 and 18-20 is low (the increase is around 2,5 times).

Figure 5: Index of increase of mortality between age 10-12 to 18-20 and 18-20 and 28-30, males, CZ, cohorts 1936-1984, moving average



Source: Own calculation based on data from CZSO (2018) and HMD (2018).

4. Discussion

Development of mortality in young adult (or before young adult) period seems that this is mortality excess as it is called in Remund (2012). Excess means that the "natural" development of the mortality should be different – according to for example Makenam's law (Makeham, 1860) or Gompertz-Makeham law (Koschin, 1981) where mortality (except very early stage of life after birth where mortality declines) increases in the exponential trend smoothly through all ages. At the first stage of young adult mortality excess period the mortality increase rapidly and then is stable for next ten years (or in some cases decreases) which is in the contrast with the exponential growth of function described in Makeham (1860) or Koschin (1981).

Results presented in this article are in general comparable with results of Remund (2015a), which compared group of countries and tries to identify the peak of the mortality excess. Czech Republic was also covered in the analysis but as the analysis was based on transversal data results are not comparable completely. The transversal data could describe better the period effect and the technique which could be used for the analysis is wider but on the other hand cohort perspective leads to better understanding of long term development and can uncover direct effect of the excess to the cohort.

5. Conclusion

It is clear that analysis of the young adults' excess mortality (from any perspective not from cohort only) needs deeper insight. The aim of this article was to introduce the last development of this phenomenon and to answer if the increase is still here or not and is smoothing with decrease of general level of mortality. The increase is still here it is under no discussion and now we should focus on the causes which lead to that extreme increase of mortality in very short age interval.

Future research will be split to several topics connected with this phenomenon: 1) it would be necessary to analyze causes of death to see what causes are the strongest impulse which increases the mortality (some analysis were done by Roh at al. 2018 or Burdette at al. 2017), 2) to analyze how big the influence of the increase is to the life expectancy and what would happened if there would not be any increase (this could be solved according to Remund (2015b)), and finally 3) to find, if this phenomenon is problem of males only or we can find this increase also in cohorts of females (as is indicated in Canetto and Sakinofsky, 1998).

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