DISPARITIES IN POST-RETIREMENT MORTALITY BY SOCIO ECONOMIC STATUS IN TURKEY

TÜRKİYE'DE SOSYO EKONOMİK SEVİYEYE GÖRE EMEKLİLİK SONRASI ÖLÜMLÜLÜK FARKLILIKLARI

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ABSTRACT

Socio economic inequalities in the life course and their implications in life expectancy, brings with unjust lifelong earned pension acquisitions among pensioners. In this study, we aim to determine the differences in mortality of retired employees according to their pension level in Turkey. Single decrement life tables for pensioners from Turkish regime, who have retired as employees, are constructed by socioeconomic status (SES). Graduation is done with Whittaker-Henderson method. Relative ages by different SES categories are also presented. Finally, the life tables calculated in the study are used to get present value of future pension flows to individuals. Our results show that on average there is 3.3 years gap in life expectancy for pensioners with high and low SES. Relative ages imply that those in higher SES, are relatively younger than those in lower SES levels. A 60 year old pensioner with low SES receives 7.3 percentage points lower lifetime value of benefits than a pensioner with high SES. Overcoming socioeconomic disparities in life expectancy requires comprehensive policies for diminishing lifelong income inequalities. However, a means tested state supplementary pension only covering the "unfair" part of life time value of benefits is also valuable. Moreover, a fictive increment to accrual rates of low earners or a more generous valorisation of past earnings to the date of pension calculation are among policies that can be designed in the current defined benefit regime.

KEYWORDS: retirement mortality, relative ages, socioeconomic status.

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ÖZET

Yaşam döngüsündeki sosyoekonomik eşitsizlikler ve bunların yaşam beklentisine etkisi, emekliler arasında ömür boyu kazanılan emeklilik edinimlerinin adaletsizliğini de beraberinde getirmektedir. Bu çalışmada, emekli aylığı seviyelerine göre, Türkiye'de işçi emeklilerinin ölümlülük farklarını belirlemeyi amaçlıyoruz. Türkiye emeklilik sisteminden işçi emeklisi statüsünde aylık alanlar için sosyoekonomik seviyeye (SES) göre tek azalanlı yaşam tablosu oluşturulmuştur. Whittaker-Henderson düzeltme yöntemi kullanılmıştır. Farklı SES düzeyleri için göreli yaşlar da sunulmaktadır. Bu çalışmada elde edilen yaşam tabloları, bireylere gelecekte yapılacak emekli aylığı ödemelerinin peşin değerinin hesaplanmasında da kullanılmıştır. Sonuçlar, beklenen ömür açısından yüksek ve düşük düzey SES seviyelerine göre ortalama 3.3 yıl fark olduğunu ortaya koymaktadır. Göreli yaşlar, daha yüksek SES'de olanların daha düşük SES'de olanlara kıyasla göreli olarak daha genç olduklarını işaret etmektedir. 60 yaşında düşük SES'deki bir emekli, yüksek SES'deki bir emekliye nazaran ömür boyu 7.3 yüzdelik puan kadar az seviyede fayda elde etmektedir. Yaşam beklentisindeki sosyoekonomik farklılıkların üstesinden gelmede, ömür boyu gelir eşitsizliğini azaltmada kayda değer politikalara ihtiyaç bulunmaktadır. Öte yandan, sadece "adaletsiz" olan farklı telafi edecek ve gelir testine bağlı olan tamamlayıcı devlet emekli aylığı benzeri bir yapı da kayda değerdir. Bunun yanında, düşük kazançlılar için aylık bağlama oranlarının fiktif olarark arttırılması, veya geçmiş yıl kazançlarının emekli aylığı hesabında daha bonkörce güncellenmesi, belirlenmiş fayda esaslı mevcut rejimde uygulanabilecek politikalar arasındadır.

ANAHTAR KELİMELER: emekli ölümlülüğü, göreli yaşlar, sosyoekonomik seviye.

INTRODUCTION

Socio economic inequalities start early in the lifecourse and compounding effects of early life disadvantages in health, education, income and employment status are experienced as differential life expectancy (LE) after retirement (OECD, 2017b).

Later labour market experiences, employment and wages are closely related with education opportunities in childhood. Deprivation in the early years of life is likely to affect health in adulthood (Case et al. 2002). Pensioners with high mortality receive less lifelong benefits from the social insurance, as eligibility rules for a pension depend on averages. Retirement age implicitly denotes the average years of pension payment that is agreed upon at national level. Although national pension ages are determined by taking overall mortality indicators into account, influences of inequalities in length of life

is unignorable (Brown and McDaid, 2003; OECD, 2017a; Whitehouse and Zaidi, 2008). Heterogenous mortality is more often pronounced in designing pension policies. In that sense, to revise pension policies, analysis of mortality patterns of retirees has crucial importance. National statistics institutions and pension providers are more eager to obtain life tables (LTs) by different factors. We hereby depict current inequality in post retirement life expectancies by socieconomic status (SES) in Turkey and give clues on the possible road map in tackling the issue.

Among the factors, understanding socioeconomic background is nominated as the paramount instrument for reducing mortality disparities. A strong relation between SES and mortality is observed, where men are more affected than woman and excess male mortality is higher in low income groups (Cheng and Kindig, 2012; Millar, 1983; Mustard and Etches, 2003; Whitehouse and Zaidi, 2008).

Kunst et al. (2004) studied eight European countries and their results demonstrate that inequalities regarding adult mortality are widening across socioeconomic groups. A previous study which also included France, Italy and Switzerland identifies relatively equal socioeconomic inequlities in total mortality for middle aged men (45-59) in Europe. Finland and France were exceptions with larger inequality among occupational classes (Kunst et al. 1998). Findings of Huisman et al. (2005) for western Europe, denote persisting mortality differences into old age by level of education for both sexes. Lynch et al. (1998) also show that higher income inequality is associated with higher mortality in the US. However, Hoffmann's findings denote stability on the socioeconomic mortality differences across ages for those aged 59 and over for the USA (Hoffmann, 2005). For Denmark, on the other hand, more pronounced differences by income groups are visible (Hoffmann, 2006).

The differential mortality between manual workers and skilled workers in highly qualified occupations, and the disadvantageous circumstance of the former is typical in industrialised countries (Cambois et al. 2011; Elo et al. 2006; Kunst et al.1998). Mackenbach et al. (1997) describe the higher mortality in manual classes compared to non-manual classes in the selected Western European countries. A study that was done by the Austrian Social Security Administration also demonstrates that LE at 60 differs by 2.5 years between manual and non manual workers in favour of the latter (Doblhammer et al. 2005).

Shkolnikov et al. (2004), provide evidence to the association between circulatory disease mortality and heavy drinking patterns among Russian men of working age. The authors, name alcohol as a 'mediator' to depict the link between adverse socioeconomic conditions and mortality from circulatory disease. Similarly, Gu et al. (2013) where GDP per capita, urbanization and educational level are selected socioeconomic indicators, have supporting

findings on the contribution of SES to the decline in old age mortality in the Asian context. Kaplan et al. (1996) show that, income distribution inequalities between states of the United States are associated with the health outcomes as well as all cause mortality in the concerned districts. For Italian pensioners, Belloni et al. (2013) present the decrease in old age mortality risk with income; a negative but weak association that is stable over time was observed. Likewise, from age 50 to 74, mortality differentials by SES for Austrian men increase when education and occupation are proxies (Doblhammer et al. 2005). Czech experience also designates persisting mortality differences by educational attainment at all ages in adulthood (Tesárková, 2012). Contradictory to such results, Edvinsson and Broström (2012) do not find any proof of better survival among elderly above age 60 as social position increases in northern Sweden during the 19th century.

This is the first research in Turkish context looking into post-retirement mortality by SES. In Turkey major life table studies rely on indirect methods on account of the deficient death registration in the country. Incompleteness of death counts was estimated to be around 17% in 2005 (Hoşgör 2005). According to Yayla (2016), completeness ratio for males over 75 is 95% in 2015. For females, the same ratio is 88%. The dataset that is used in studies before 2010 is either Turkey Demographic and Health Survey (Coşkun, 2002; Eryurt and Koç, 2006; Hancıoğlu, 1991; Kırkbeşoğlu, 2006; Kırkbeşoğlu and Koç, 2010), population census data (Gjonça, 2006; Hoşgör 1992, 1997) of Turkish Statistical Institute (TurkStat) and/or burial records (Demirbüken, 2001). All authors who have used the TDHS data estimate adult mortality with the "orphanhood" method which is popular when death records are substandard.

There are examples of life tables which are constructed by using direct techniques with deaths records of pensioners or employees of Social Security Institution (SSI). In 2005, Tuzgöl (2005) constructs a life table for pensioners beyond age 30, with four years (2000-2003) of SSI administrative data. Death rates are graduated by the method proposed by Whittaker (1923). In addition, she borrows the rates from Turkish national data of TurkStat or apply specific constant increment coefficients for crude death rates for female beyond 90 and male 75+ respectively. Other life table technique applications with SSI data in recent native literature include, multiple increment-decrement life tables for the actively insured employees (Tuzgöl et al. 2010; Ündemir et al. 2010) and the 2008 SSI table which was prepared under Life and Annuity Life Table Construction Project of the Turkish Treasury. Mixed groups of insured persons (retirees, invalidity pensioners, active contribuors) are used as units of analysis for deaths during life table calculations. Taylan and Yapar (2013) use address based population register system data of Turkey and obtain period life tables for 2009, 2010 and 2011. However, all the mentioned studies are far from reflecting mortality in the near term.

This study aims to analyse the differences in retirement mortality of employees according to their socioeconomic status, measured by pension level. Using SSI pensioner data for years 2012-2016; current pension age, pros and cons of a single pension age will be discussed. The focus will be on heterogenous mortality regarding level of pension.

In this article we shall (i) explain how post retirement mortality changes according to level of pensions, (ii) determine the threshold ages[1] with equal remaining life expectancy (RLE) for retirees of different socioeconomic groups and (iii) describe the actuarial infairness by calculating life long pension benefits for different socioeconomic categories.

DATA AND METHODS

Retirement Pension Provision

Pension plans that provide benefits to their members can be classified by several properties. The Organisation for Economic Co-operation and Development (OECD) defines poverty prevention programmes as 'first tier schemes'. The Law Nr. 2022 in Turkey serves a similar type of pension provision to Turkish citizens above 65 that are needy, weak or lonely. The second type of schemes are mandatory, earnings related 'second tier schemes'. Four types of second tier schemes exist in OECD countries: Defined benefit (DB) plans, point schemes, defined contribution (DC) plans and notional defined contribution (NDC) plans (OECD, 2017a).

DB plans have a pre determined pension calculation formula or a promise to the insured people. In this sense, the benefit is defined and the pension provider undertakes the risk to have enough sources to sustain post retirement pension flows. France, Germany, Estonia and Slovakia are some country examples for point schemes. Every year, workers accumulate or earn points according to their earning. After retirement, points are converted to regular annuity payments. In DC pension systems, contributions of plan members accumulate in their individual accounts. The total accumulated value at retirement depends on the investment preferences of individuals. Thus, the plan member bears the risk of adequate pensions after retirement. Among OECD countries, Norway, Poland, Sweden, Italy and Latvia have NDC systems. The accounts are notional and a fictive accumulated capital at retirement is converted to annuity payments according to life expectancy.

Turkish second tier is the compulsory publicly managed DB social insurance system of SSI. According to OECD taxonomy, the last type of pension plans are 'third tier' voluntary saving systems (OECD, 2017a). Since 2001, the 'third tier' also exists in Turkey as the private pension system started with the

Private Pension System Law Nr. 4632. Private pension scheme in Turkey is a DC based voluntary system.

The retirement mortality study in this article is carried out with data on pensioners from workers' regime, which is the DB 'second tier' according to the taxonomy described in this section. The pension formula is a function of valorised life long earnings and total accrual rate.

The first legislative arrangement for a pension in Turkey goes back to 1950s. The Law Nr. 5417 'Law for Old Age Insurances' which was published in the Official Journal (Nr. 7227) on 08.06.1949, almost 70 years ago, accepts retirement age as 60. In addition, a man or woman needs 25 years of service (YoS) and 200 average annual days of contributions (DoC) for pension benefits. However, age, which is the most affective instrument among eligibility criteria, is subject to alterations nearly four times during the period. Since 1965, there is a positive discrimination for women. Women can retire 2 to 5 years earlier than men can considering the date that their insurance begins for the first time.

Turkey softened pension eligibility rules several times in the past, denoting more generous pensions compared to that is at force at 1950s. According to United Nations estimates, a 60 years old man in Turkey had a remaining life expectancy of 13.07 years for the period 1950-1955. However, for 2010-2015, the same indicator is 18.78 years (United Nations, 2017b). Therefore, comparison of official pension ages between 1950 and 2010 implies that average pension payment duration has inceased more than 5 years for men. But in contradiction to the increase in expected life at selected ages, pension ages were diminished due to political reasons and to impress voters.

In Turkish pension system, a person legally retires in case that age, DoC and YoS requirements are simultaneously fulfilled. For 24 years in the second half of the 20th century, people could retire only with the required YoS and DoC. The Law Nr. 1186 (1969 to 1976), The Law Nr. 1992 (1976 to 1981), The Law Nr. 2422 (1981 to 1986) and The Law Nr. 3774 (1992 to 1999) abolished the age criterion for four times.

Data Sources, Variables and Graduation Method

Social Security Institution (SSI) is the main service provider for the public mandatory pension regime in Turkey. Employees in the public and private sector, self-employed and civil servants are covered under the defined benefit (DB) retirement system. SSI provides benefits to those fulfilling the eligibility criteria for a pension. The Institution has the data of those receiving old age or invalidity pensions. Mid-year number of pensioners (exposure) and number of deaths within the year while receiving pensions (event) can be obtained from the data warehouse. SSI has information on the life events (including

deaths) of the retired, as the institution pays the monthly benefits to the pensioners.

The primary data source of the study is the administrative records of Turkey Social Security Institution. SSI provides pension payments to those who have satisfied the conditions to be officially retired. The institution has information whether the pensioner continues to have the right to get the benefits. Main events that require the cessation of benefits is tracked. Therefore SSI has data on, in-year deaths and mid-year number of beneficiaries, which is the key material when constructing period life tables. In this article, deaths and pensioner figures for 2012 to 2016 is used to depict post-retirement mortality of workers by SES. Life tables are prepared by analysing big data. In total, more than 22.8 million lines of information for event and exposure is loaded to SSI server and data is prepared by SAS Enterprise Guide.

Mortality is a function of age and life tables provide summary visualisation of probability of death at specified ages. In this study, age is defined as "age at last birthday". Completed age at death is calculated by the exact date of death and the exact date of birth. Similarly, exact date of birth and mid-year data of pensioners (1 July) gives the age at mid-year for a specific year, which is needed to get pensioners that are exposed to the risk of death.

For the workers regime, amount of the pension in Turkey is a function of previous earnings before retirement and accumulated accrual rate during career. Therefore, level of pension implicitly describes life time income of the individual. Similarly, Belloni et al. (2013) propose that, 'pensions are good proxy variables' especially of males' SES, regarding the private sector employees when Italian retirement system is taken into account. We define SES with the level of pension and it is operationalised as low-mid-high considering the lower quartile and upper quartile (i.e. 25th percentile and 75th percentile). 25th percentile is the value at which 25 % of the observations are below that level (van Belle et al. 2004). Pensioners with a level of benefit in the 25th percentile, are considered as those with "Low" SES. Those between 25th and 75th percentile are denoted as "Mid". Finally the 75th percentile and above are pensioners with "High" SES.

Due to insufficient observations at some single ages by sex and SES, sex specific differences by pension level could not be reflected in results. Therefore, all the information presented in this study imply total pensioner mortality.

The life table method of this study depends on the number of decrements from the original state "old-age pensioner". Old-age pensioners are only exposed to the risk of death. In other words, there is a single decrement in charge for the retired when modelling post-retirement mortality. Age specific death rates are calculated with standard LT functions (Preston et al. 2001) and raw probabilities are smoothed with the non-parametric Whittaker-

Henderson (WH) graduation method (Whittaker, 1923; Whittaker and Robinson, 1924).

Graduation is the process by which raw rates of occurence and exposure are converted to smoothed values of estimates that reflect the unknown rate in reality (Gavin et al. 1995). Actuaries pioneered the graduation of death rates (Wang, 2003). Smoothness and goodness of fit are the basic concepts of graduation. There is a trade off between smoothness and goodness of fit (Society of Actuaries 2014).

According to Society of Actuaries (2014), WH is one of the most common graduation technique that is used in the United States and Canada for constructing pension related mortality tables. To get comparable LTs with recent work in Turkey, WH is preferred in this study, as well. It was the method chosen by Life and Annuity Life Table Construction Project of the Turkish Treasury in 2008 and by Tuzgöl (2005). Weinert (2007) discusses the evolution of the method in depth, provides a useful bibliography and summarises the refinements that are made. The graduation process is finalised by the sample soft ware in Excel that is provided by Howard (2007).

Calculation of Annuity Factors

The value of a pension for different sub-groups of population can be compared with annuity factors. Annuity factors are the present value of life long unit payments and they depend on the survival probability and the rate of discount in the long term. In other words, the payment continues on the condition that the person survives. Actuarial present value of whole life annuity due for a unit amount is given by the equation;

$$\ddot{a}_x = \sum_{k=0}^{\infty} v^k \; {}_kp_x,$$

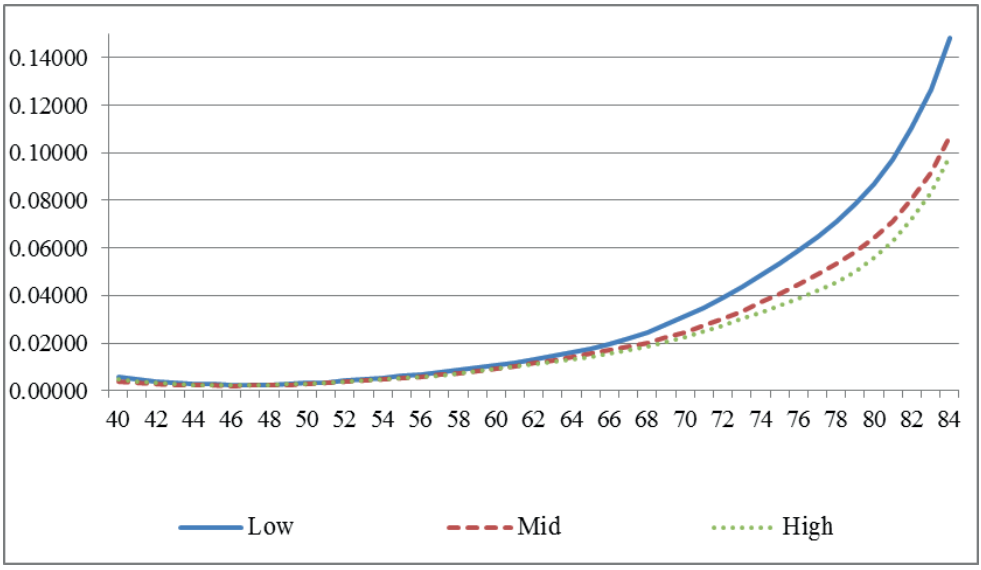
v, is defined with $v = \left[\left(\frac{1}{1+i}\right)^k\right]$ and is the discount rate under i rate of interest. ${}_kp_x$ is the probability that the person at age x will survive within k years. The amounts are annually paid at the beginning of each year (Bowers et al. 1997). The rate of discount which is also called as technical rate of interest is taken 1.8% . In 2015, Turkish Treasury determined the discount rate as 1.8% for calculating compensation amounts for lack of support claims in General Terms of Highway Motor Vehicles Compulsory Liability Insurance.

RESULTS

The recent situation as regards post retirement mortality by SES in Turkey can be seen in Figure 1. Results refer to the aggregated data for 2012 to 2016, therefore reflect the mid period i.e. 2014.

As mentioned in the second section, SES is defined with level of pension and it is operationalised as low-mid-high. Age and SES specific observed and graduated probabilities of death are shown in Appendix. There is considerable consistency between observed and graduated probabilities of death by levels of SES. Age specific probability of death by levels of SES indicates that especially after 65, the gap between low SES and the other two categories widens. The same is visible also for the gap between mid and high levels of SES (Figure 1).

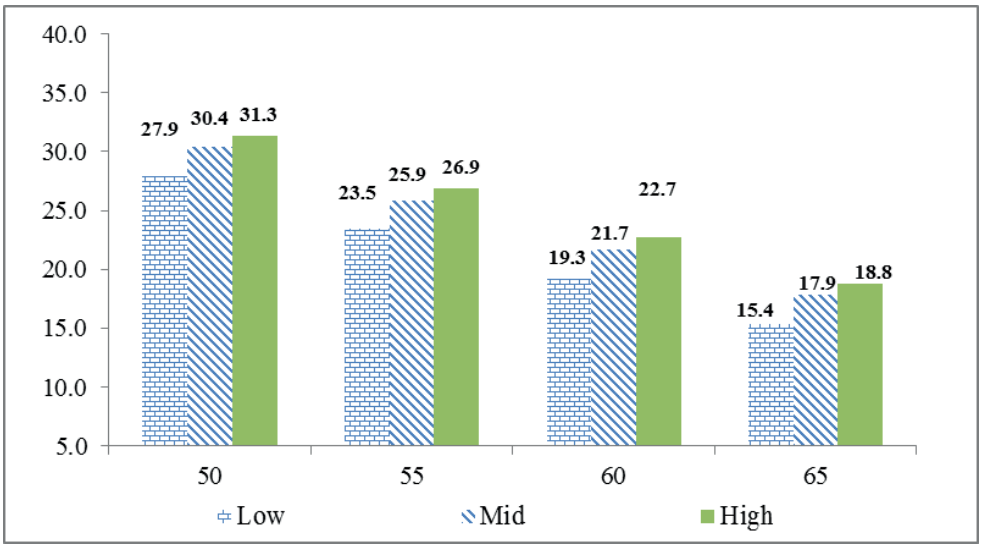
Figure 1: Graduated probabilities of death by levels of SES in Turkey (2012-2016)



Source: Study results based on SSI data.

Those in middle SES category are expected to live around 2.5 years higher than those with low SES. Besides, the gap between low and high SES groups is almost 3.3 years which reflects the heterogenity in life expectancy (Figure 2).

Figure 2: Life expectancy* at selected ages by SES in Turkey (2012-2016)



Source: Study results based on SSI data. *Bars show remaining life expectancies at specific ages.

In Figure 3 threshold ages according to three levels of SES and corresponding equal length of expected remaining life is presented. The reference is "low SES". From the life table "low SES" we constructed, life expectancy is determined. Then, threshold ages in other life tables for "mid SES" and "high SES" with same remaining life expectancy is figured.

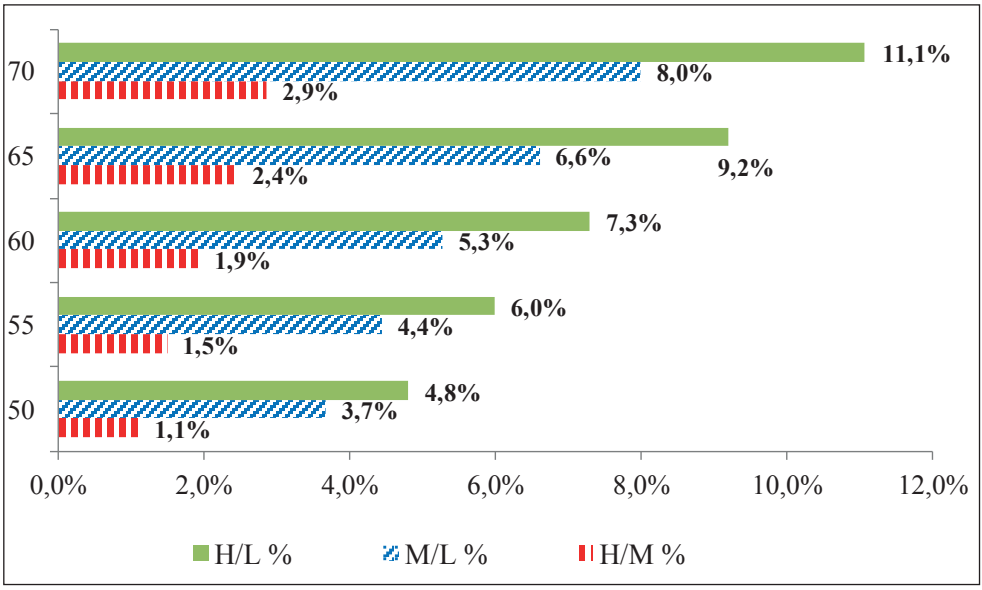
Figure 3: Relative ages by SES in Turkey (2012-2016).

Years Lived (Threshold Ages)	Remaining Life Expectancy
50 Years - Low	27.93 Years
52 Years - Mid	27.93 Years
53 Years - High	27.93 Years
55 Years - Low	23. 46 Years
57 Years - Mid	23. 46 Years
59 Years - High	23. 46 Years
60 Years - Low	19.29 Years
63 Years - Mid	19.29 Years
64 Years - High	19.29 Years

Source: Study results based on SSI data.

A high SES pensioner at 53 has the youth of a 50 year old low SES pensioner. There is 2 to 3 years gap between low&mid and 3 to 4 years gap between low&high. Results are naturally similar to that obtained by life expectancy at selected ages and different levels of pension benefits. The alternative visualisation to depict heterogenous mortality with repect to SES after retirement shows that higher SES in retirement, brings with relative "youth".

Figure 4: Difference in life time value of pensions by age and benefit level.



Source: Study results based on SSI data.

Annuity factors, which imply the present value of future pension payments under a pre-determined discount rate, give information on the total life time socioeconomic difference between low-mid and high level of pensions. As mentioned in Section 2.3 the discount rate is 1.8 % in this study. Figure 4 shows that a 60 year old pensioner (sexes combined) with a low level of pension, receives 7.3 percentage points lower pension value during the remaing life when compared to a high level pensioner in 2002-2016 period. At each age, there is a difference in total life time gain between successive pension levels. Results are obtained by using constructed LTs. Annuity factors given in this section shed light on how heterogenous mortality is reflected in lifelong gain from public pensions by the individual.

CONCLUSION & DISCUSSION

This study analysed the retirement mortality in Turkey, in order to depict the differences therein by various factors. According to existing literature, age, sex, health behaviour, life style, region, socioeconomic status are among important factors that affect retirement mortality. Data of this research consists of administrative records of old age pensioners and survivor pensioners of Social Security Institution between 2012 and 2016. Period life tables for old-age pensioners are calculated by SES. Raw rates of death are smoothed with the non parametric method Whittaker and Henderson (Henderson, 1924; Whittaker, 1923) which has a successful reputation for graduating death rates above certain ages. The life tables calculated in this study are also used to get present value of future pension flows to individuals, which depict life long unfairness considering heterogeneous mortality between various pensioner groups.

Similar to the results achieved by Belloni et al. (2013), Gu et al. (2013), Kunst et al. (1998, 2004) and other literature touched upon denoting negative association with socioeconomic status and mortality, life tables in this study support the negative association with 3.3 years gap for those with high and low SES. Relative ages imply that higher SES in retirement brings with relative "youth". A 60 year old pensioner with low SES receives 7.3% less lifetime value of benefits than a pensioner with high SES. The inequality is considerable but below the level that is presented (13%) in the recent OECD report (OECD 2017b). The amount of pension in the defined benefit old age insurance system in Turkey is a function of individual earnings and pension accrual rate. In that sense the system has an actuarial relation between contributions, benefits and earnings. Therefore a non contributory compensation payment to low earners from the insurance regime will have a disruptive effect on actuarial sustainability of retirement pensions. A probable solution to compensate the unfairness between SES groups is using non contributory first tier i.e. existing system organised under the law Nr. 2022. The gap can be covered by means of state supplementary pension payments financed from general revenues. If pensions that are received from the contributory social insurance is below a threshold level, then the state allowance may support the pensioner. A means tested supplementary payment which only covers the "unfair" part of life time value of benefits can be implemented. On the other hand, there is an intention of employers in Turkey to register workers below their real wages. By this way employers lower their contribution amounts to SSI which is a function of declared wage. A state subsidised pension system has the risk of decreasing wage declaration of employers which means transfering their burden to the state.

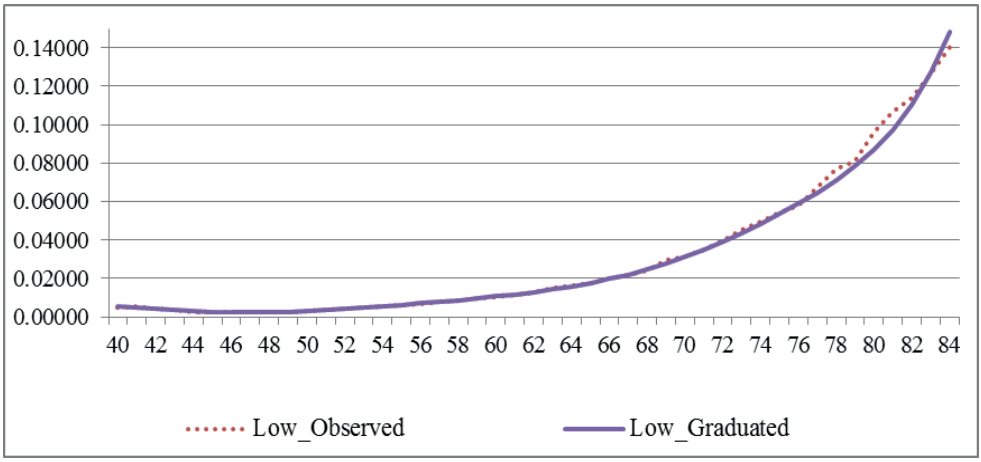
A solution within the defined benefit social insurances to alleviate the reflection of SES differences as heterogenous mortality at old age is,

manuplating the pension benefit calculation formula. An enlarged benefit amount can be sustained via fictive increment to accrual rates of low earners or a more generous valorisation of past earnings to the date of pension calculation. Besides, pensions are indexed two times a year in January and July according to realised Consumer Price Index in the previous six months. A higher rate of increase to the existing pension for those with lower SES can be a policy measure. On the other hand, all such kind of measures have the risk of depreciating the belief of both employers and employees on the equilibrium of the system as regards recieved burden and attained benefit for workers in higher SES. However, as discussed in the literature review, post retirement inequalities rise from early life circumstances. A more comprehensive policy should take diminishing life long income inequalities into account. Promoting school attendance, decreasing poverty during childhood, sustaining equal opportunities to reach education and growing a more skilled youth for jobs, are among some priority areas that likely diminish inequalities in future.

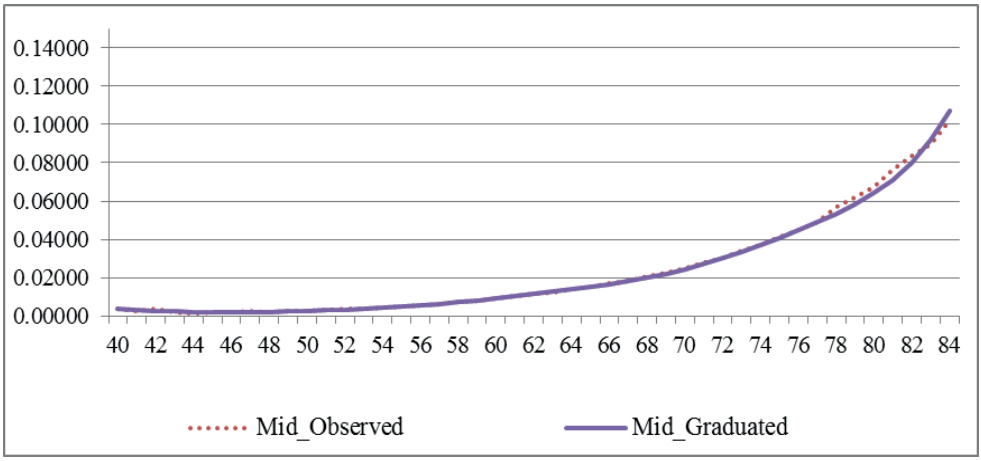
Further research with multivariate approach can give more information on pensioner mortality by factors other than SES as well. A combination of pension and universal health insurance data of SSI may provide mortality analysis by obesity or other specific sicknesses. Besides, a refined investigation of the relation between income and mortality when controlling for other selected variables such as sex and marital status, can give more clues for future retirement policies. However, rigid protection rules especially for health data, remains as an obstacle.

APPENDIX A Observed and Graduated Probabilities of Death by SES

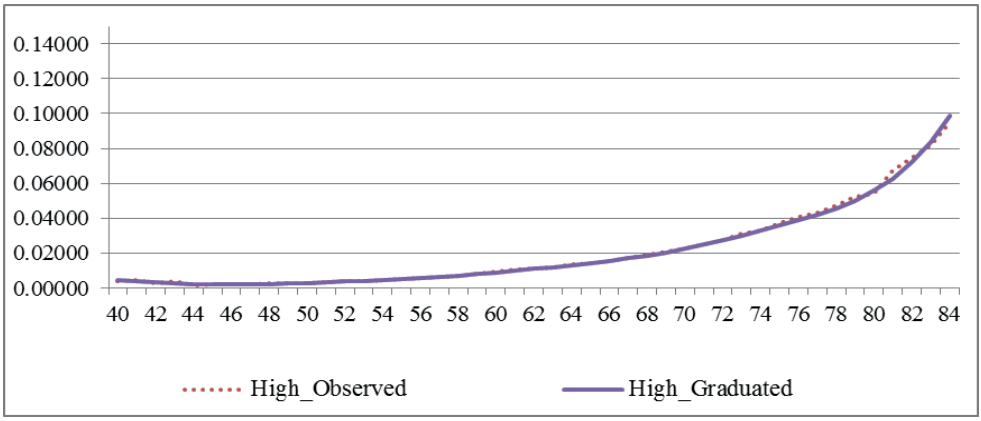
Appendix A Figure 1. Observed and graduated probabilities of death for low SES



Appendix A Figure 2. Observed and graduated probabilities of death for mid SES



Appendix A Figure 3. Observed and graduated probabilities of death for high SES



NOTES

Chronological ages present duration since birth and show full years of survival. However, expected remaining life years that can be lived up to death, is another way of measuring age. A different way of approaching age is (see Sanderson and Scherbov, 2008) taking a level of life expectancy constant and then determining threshold ages corresponding to that constant remaining life expectancy. Relative ages instead of chronological ages can be calculated for different variables taken as reference.

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