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RESEARCH ARTICLE/ARAŞTIRMA MAKALESİ

The multifactor analysis (Environmental, educational and socioeconomic factors) on Turkish life expectancy

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Abstract

Although socioeconomic, environmental and medical factors have been improved over the past three decades in Türkiye, countrywide average expected life is still under 80 years today despite the fact that the life expectancy of newborn in the EU was 81.0 years as of 2018 (EUROSTAT, 2019). In this paper, we analyzed factors determining life expectancy in Türkiye. Education, population, forest area, traffic, water use, solid waste produced, economic growth, etc. are taken into account. The purpose of this study was to investigate the relationship between factors and life expectancy in provinces in Türkiye. It was concluded that three statistically significant factors (average year in education, air quality (SO_2), and tractor count) are exist and determine lifespan of Turkish people.

Keywords: Life expectancy, multifactor analysis, Türkiye, Turkish provinces, health

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1. INTRODUCTION

It is proved that environmental factors are important in life expectancy (Mariani et al., 2009). We also know that economic factors are also crucial at least to provide necessary health conditions to all citizens. It is rarely investigated economic, social, and environmental factors all together are taken into account to relate their roles in life expectancy, especially at a countrywide scale. Hollander and Staatsen (2003) noted that people lived in Catal Huyuk (in Anatolia) had a maximum life of 50 years and the median age was 20 years but today (1995 to 2000) maximum age is 100 years and mean age is 81 years in the Netherlands. In ancient times, the problems that cause decrease in life were different such as wars, malnutrition, food contamination, drinking water quality, etc. Today, on the other hand, water pollution, urban air pollution, land degradation, hazardous waste, etc. are the factors shortening life expectancy in a modern society (Hollander and Staatsen, 2003).

Pope et al. (2009) reported that each 0.01 mg m^{-3} increase in $PM_{2.5}$ decreases life expectancy by 5 to 10 months in the USA. In the EU, the same parameter is 8.6 months (WHO, 2006). Mariani et al. (2010) investigated the effect of environmental quality on life span and found that the longer the life, there is a higher investment in environmental care. Abo et al. (1997) reported that environmental factors affect lifespan of males and females in Japan despite the fact that men and women are not equally affected by the parameters examined (atmospheric pressure, temperature, the duration time of sunshine, and relative moisture). According to the results obtained for Japanese cities, the main determinant on long lifespan is low atmospheric pressure for males and high temperature for females (Abo et al., 1997).

In addition to air people breathe, water and soil are also important in determination of health status of citizens. The population and population density, happiness, works related to soil excavation and land degradation, solid waste produced per capita, etc. all might affect expected life in a country. In this study, we investigated the factors important in expected life in Turkish provinces.

It is also important note that a heat wave caused 719 sudden deaths in a week of summer 2021 in Canada (Risk Frontiers, 2021). Such climatic changes are responsible in increased infant deaths (Auger et al., 2015).

The life expectancy of some countries (including Türkiye) is listed in Table 1 (https://www.worldlifeexpectancy.com/). It is clear that Turkish life expectancy is significantly lower than that in other Mediterranean countries. When one compares countries, females live significantly longer than males in Türkiye and Portugal compared to that in other countries listed in Table 1. Note that these countries have not experienced a war or turmoil after the World War 2 and all of them are democratic countries. The top 20 countries in terms of their life expectancy are Monaco, Japan, Singapore, Macau, San Marino, Iceland, Hong Kong, Andorra, Guersney, Switzerland, Israel, South Korea, Luxembourg, Australia, Italy, Sweden, Liechtenstein, France, Canada, and Norway. The average life in these countries is 83.2 years (https://www.cbsnews.com/pictures/who-lives-

Table 1. Life expectancy in selected countries (2018)

Country	Males	Females	Mean	Difference
Cyprus	78.4	83.1	80.7	4.7
Greece	78.7	83.7	81.2	5.0
France	80.1	85.7	82.9	5.6
Italy	80.5	84.9	82.8	4.4
Malta	79.6	83.3	81.5	3.7
Spain	80.3	85.7	83.1	5.4
Portugal	78.3	84.5	81.5	6.2
Türkiye	73.3	79.4	76.4	6.1

longest-cias-top-20-nations-for-life-expectancy).

2. MATERIALS AND METHODS

There are 18 independent variables chosen to be included in statistical analyses. These are namely total forest area per province, percent forest area and forest cover change between 2000 and 2019 in provinces. This data set was obtained from a GIS system (www.globalforestwatch.org). Mean years of education and population data set were compiled from Turkish Statistical Institute (TUIK, 2021). Income per capita and real change in income was obtained from a reputable economic newspaper (Dunya, 2020). Traffic (car numbers, special purpose vehicles (such as bulldozers and excavators), and tractors) data was compiled from Turkish Statistical Institute (TUIK, 2020). Air quality (in terms of SO_2 and PM_{10} reflecting averages between 2005 and 2017) data was gathered from Turkish Ministry of Environment and Urbanization (TMEU, 2020). Mean capita per housing unit, solid waste produced per capita as well as wastewater produced per capita were gathered from Turkish Statistical Institute (TUIK, 2020). Finally, life satisfaction record was obtained from Turkish Statistical Institute (TUIK, 2015) note that this report is not updated after 2015. R statistics were used to obtain results. Multiple factors analysis was performed to explore the most important parameters affecting the Turkish lifespan. In addition, stepwise regression model was completed to see which factors best explain expected life of Turkish citizens.

Table 2. Statistical results of parameters examined in this study

Parameter	Minimum	Maximum	Mean	Median	Standard dev
Forest area (ha)	37.1 (Kilis-79)	631000 (Kastamonu-37)	111810	66000	127115
Forest lost % (2000 to 2019)	0.053 (Erzurum-25)	66.11 (Agri-04)	7.657	4.465	9.757
Population (count)	81910 (Bayburt-69)	15462452 (Istanbul-34)	1032272	537762	1872577
Population density (cap/km^2)	11 (Tunceli-62)	2976 (Istanbul-34)	133	64	333
Area (km^2)	798 (Yalova-77)	40838 (Konya-42)	9630	7659	6488
GDP per capita (USD)	3204 (Agri-04)	16791 (Istanbul-34)	7250	6745	2571
Percent change in GDP (%)	-2.81 (Giresun-28)	11.95 (Hakkari-30)	2.69	2.16	2.93
Total vehicles (count)	9096 (Hakkari-30)	4306532 (Istanbul-34)	294502	131664	561846
Special purpose vehicles (count)	89 (Bayburt-69)	8789 (Istanbul-34)	852	474	1352
Tractor (count)	140 (Rize-53)	92699 (Manisa-45)	23844	19951	20558
Household population (cap)	2.7 (Canakkale-17)	7.3 (Sirnak-73)	3.82	3.5	0.998
Education (yrs)	4.85 (Agri-04)	8.51 (Ankara-06)	6.65	6.75	0.688
PM_{10} (µg/m^3)	27 (Artvin-08)	120 (Igdir-76)	65	63	18
SO_2 (µg/m^3)	4.2 (Eskisehir-26)	153 (Yozgat-66)	25	17	27
Solid waste per capita (kg)	0.598 (Hakkari-30)	2.159 (Mugla-48)	1.207	1.208	0.25
Wastewater per capita (L)	81.3 (Sirnak-73)	392 (Mugla-48)	163.3	154.1	48.21
Happiness (unitless)	42.0 (Tunceli-62)	77.7 (Sinop-57)	61.2	60.4	7.53
Lifespan in females	73.5 (Gumushane-29)	84.2 (Tunceli-62)	81.0	81.0	1.34
Lifespan in males	72.9 (Kilis-79)	77.6 (Mugla-48)	75.3	75.4	1.36

3. RESULTS AND DISCUSSION

It was found that there is a big gap between Kilis and Kastamonu in term of forest cover. It is not surprising that this gap caused a difference in life expectancy in these provinces. Table 2 provides descriptive statistics.

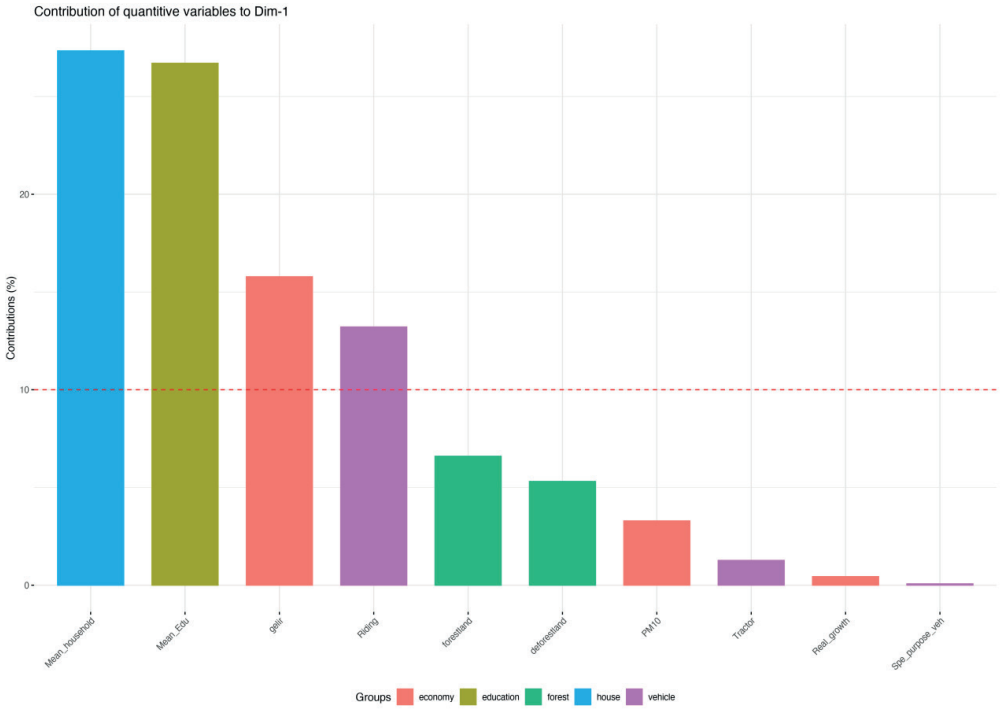

Figure 1. Factors and their contributions on Dimension 1.

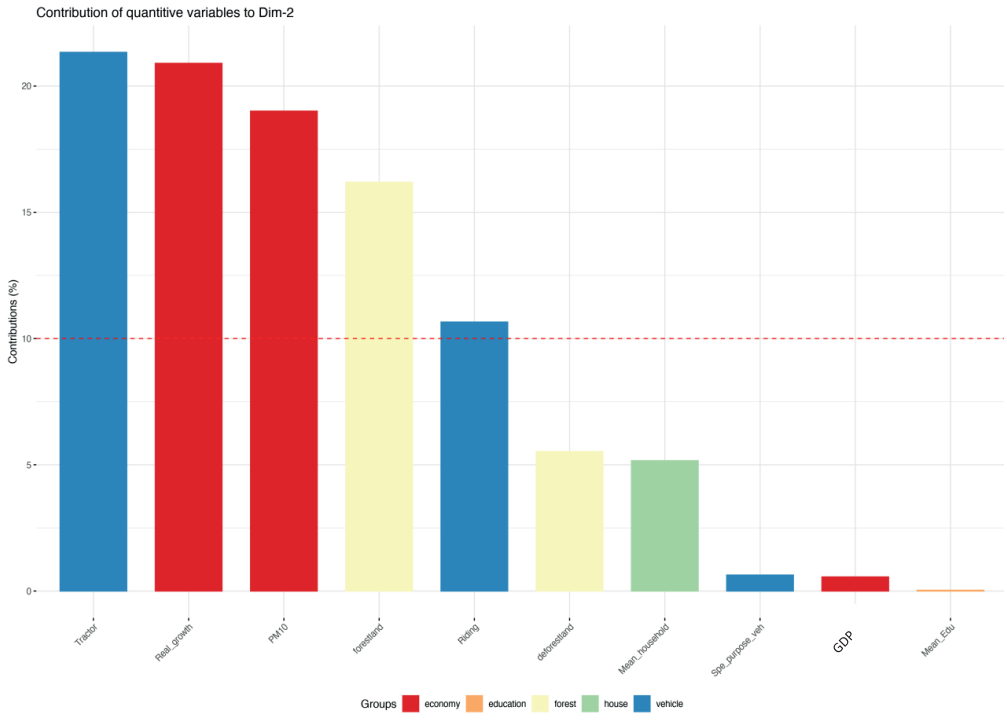

Figure 2. Factors and their contributions on Dimension 2.

Figures 1 and 2 provide factors on dimensions. Figure 3 provides two dimensional analysis.

When t-test was performed on the data presented in Table 1, the *t*-value is -4.69726. The *p*-value is .000171. The result is significant at $p < 0.05$. Two-way ANOVA also showed that both sexes and countries differ statistically differently in terms of life expectancy. The difference is really significant in Portugal and Türkiye. This was also proved by the analysis completed by Jaba et al. (2011). Within the European Union (Turkiye included in the analysis), there are four clusters (Jaba et al., 2011). The long lived countries are listed as Austria, Germany, Greece, Italy, Portugal; whereas ten countries have the shortest lifespan (Bulgaria, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovak Republic and Slovenia) (Jaba et al., 2011). On the other hand Türkiye does not belong to any clusters (it is in the 4th cluster alone) (Jaba et al., 2011).

We concluded that life span of an average Turkish citizen could be explained by three determinants (SO_2 in air, education in years, and tractor count per province).

$$\text{Life} = 73.41 - 0.00878*SO_2 + 0.03167*\text{Education} - 8.30925*\text{Tractor} \quad (1)$$

In this formula SO_2 is the ambient air sulfur dioxide concentration, education stands for total years in school, and tractor stands for number of tractors in agricultural sector in provinces. If the country can minimize air pollution, life expectancy will increase. If the country can increase education to over 12 years (instead of 6), there will be a possibility to increase 0.2 years in life expectancy.

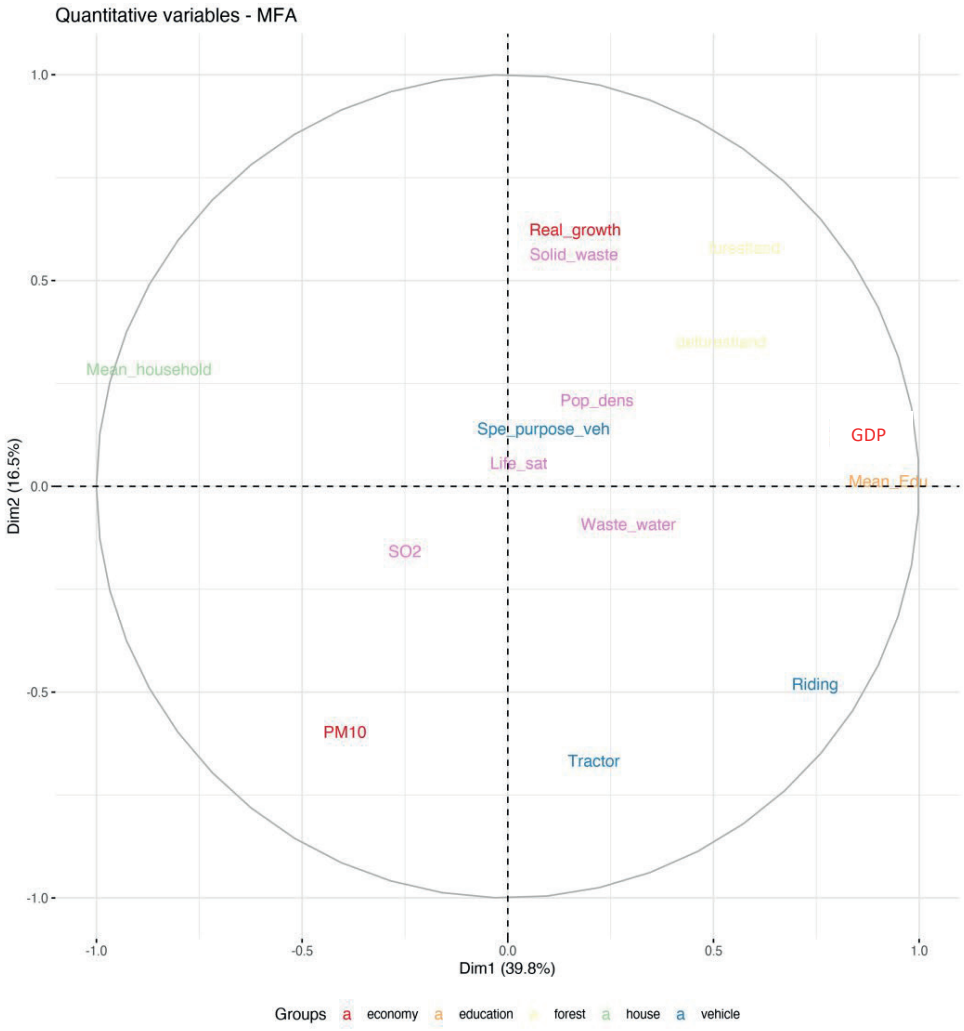

Figure 3. Two dimensional analysis of factors

It is reported that both COPD (5%) and pneumonia (3%) related deaths are higher in Türkiye compared to that (3% and 2% respectively) in the European Union (Turkish Health Almanac, 2019). Furthermore, respiratory system related deaths are higher as 13% in Türkiye compared to that (8%) in the European Union (Turkish Health Almanac, 2019). Both ambient air pollution and higher smoking rates in Türkiye might have caused this result. Since Ferrari et al. (2019) emphasized that air pollution is not only one negative factor in human health but also an important factor in genetics, especially in DNA methylation, the whole picture must be acknowledged appropriately.

Apte et al. (2018) stated that reducing $PM_{2.5}$ in ambient air will increase in life span of the residents living in all countries regardless of their development level. This conclusion is in agreement with our result presented here. Kara et al. (2021) reported that Nigde (a midsize province in Central Türkiye) suffers notable from ambient air problem and if this problem can be solved, more than 9 million US dollars could be saved from health expenses. If similar analyses

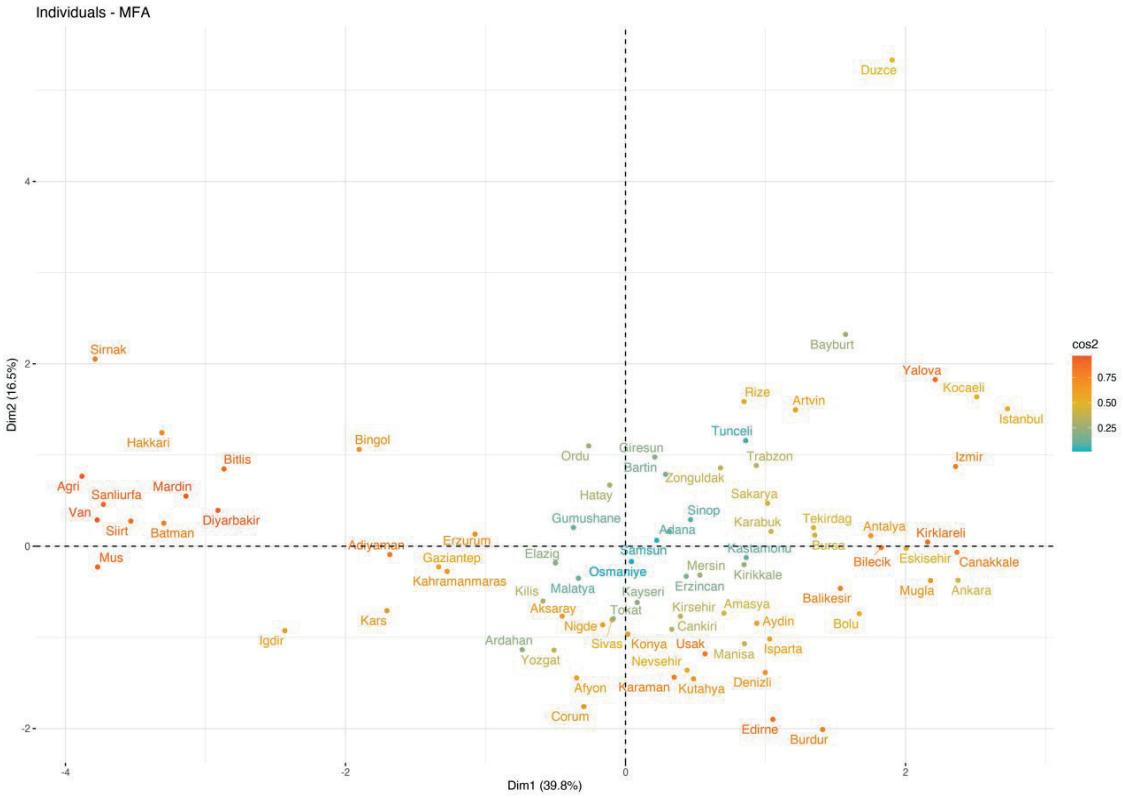

Figure 4. Separation of Turkish provinces according to dimensions

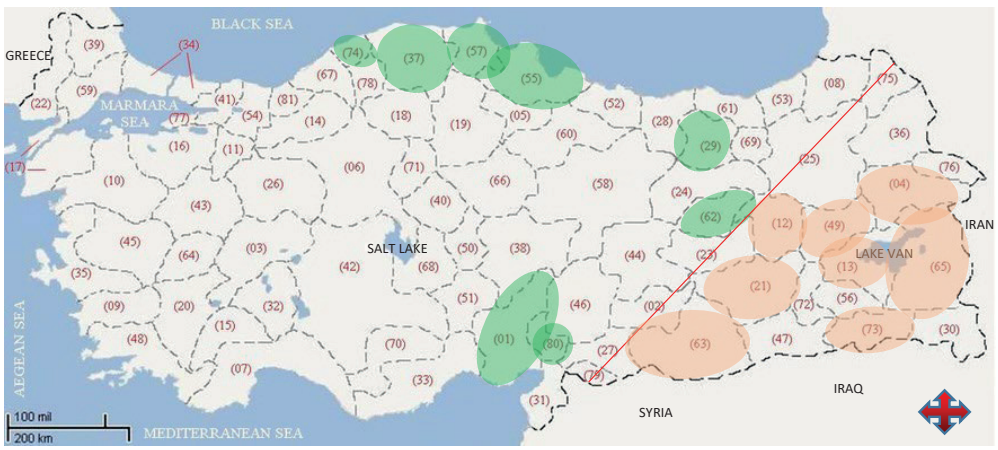

Figure 5. MFA on provincial map of Türkiye (numbers are traffic plate codes) (see Figure 4 for further details).

could be made in all provinces in Türkiye, the health related expenses can be saved more than 1 billion US dollars per year.

Figure 5 shows the difference between Eastern-Southeastern Türkiye and Northern and southern Türkiye. Green colored provinces showed a higher lifespan. While average SO_2 concentration in green colored provinces is 9.52 μg m^{-3}, the average SO_2 concentration in Eastern-Southeastern provinces is over 40 μg m^{-3}.

Kaplan et al. (2014) stated that education is the most important factor on lifespan. It is also found only positive factor in lifespan in Turkish provinces in this research. Strikingly, the years in education in long life span provinces is 7 years; whereas the same parameter is only 5 years in short lifespan provinces.

Surprisingly, tractor count is a significant factor in lifespan in Türkiye. It is not solely because of tractor accidents but more about chemicals sprayed by tractors and the wider effect of this activity. It is known that chemical use in agriculture is a common activity but due to disobedience in application dose as well as application time, harvesting of products before the recommended time are somehow unsuitable for human consumption. Lamberth et al. (2013) estimated that nowadays 10 grams of an active substance are applied in agriculture. However, Doğan and Karpuzcu (2019) stated that 1.66 kg of pesticides are applied on agricultural fields in Türkiye. This, alone, shows agrochemical use in Türkiye is notably high. Interestingly, it was found in this study that long lifespan provinces have more tractors (average over 25 thousands) than that of the short lifespan provinces (average close to 13 thousands).

Although three are four factors (air pollution, forest cover, noise, and waste) that were taken as independent variables on well-being of people, Taskaya (2018) noted that well-being is a produce of only forest cover in Türkiye based on her provincial analyses. It is not found in this research that forest cover per province as well as percent forest change did not seem have roles in lifespan in the provinces.

Alverez et al. (2018) investigated multiple factors on well being of citizens and they came up with synergistic effect from three main factor groups, namely (1) food environment, dietary behavior, obesity, (2) childhood adversity, inflammatory pathways, vulnerability of air pollution exposure, and (3) indoor air pollution and health disparities. It is known that indoor and ambient air quality are strongly related. Therefore, air quality is an indispensable factor in determination of lifespan as it was also found a crucial factor in lifespan in Türkiye.

4. CONCLUSION

One environmental (SO_2 in ambient air), one educational (average school years) and one economic factor were found the main predictors on average Turkish lifespan. While educational parameter has positive impact on lifespan in Turkiye, the other variables were found to have diminishing effect. Therefore, it is important to reduce air pollution in Turkish provinces and regulate operation of tractors (in terms of synthetic chemical use, maintenance to minimize exhaust gases and particulates, overloading, etc.) in acceptable manner to increase expected lifespan in Türkiye. Land use/land cover plans have to be applied to include at least 10 m^2 green area per capita in city and urban areas as emphasized by Besengi et al. (2014) and Kara et al. (2021).

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