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Abstract:

Tobacco use remains a formidable global public health concern, exerting significant adverse effects on individual health, healthcare systems, and society at large. Although diverse strategies have been employed to mitigate tobacco consumption, taxation has emerged as a potent policy instrument for discouraging smoking and promoting public health. Nevertheless, the precise magnitude of the influence of tax increases on tobacco consumption patterns remains inadequately understood, creating a critical knowledge gap that necessitates urgent attention.

In line with other nations, taxes on tobacco products in Turkey constitute one of the foremost tools in combatting tobacco use. Prior to 2002, taxes levied on cigarettes, the most prevalent tobacco product in Turkey, encompassed several components such as value-added tax, defense industry fund, education fund, and additional taxes. However, in 2002, these taxes were consolidated into a singular levy known as the "Special Consumption Tax." Notably, between 1970 and 2001, tax rates fluctuated between 33.33% and 60.47% of the selling prices. Subsequently, tax rates experienced gradual increments, ultimately the tax rate is reaching over 81.40 % of the selling price in 2022. Consequently, the objective of the present study is to scrutinize the effects of average tax rates individuals have been subjected to on their smoking behavior and smoking cessation endeavors.

Two primary sources of data are employed for analysis. First, the study utilized the 2010, 2012, 2014, 2016, 2019 and 2022 rounds of the Turkish Health Surveys, which provide valuable information on individuals' smoking behavior and demographic characteristics. These surveys are very broad, including age of starting smoking for current and former smokers and quitting age for quitters. Second, data on tax rates for tobacco products were obtained from the Turkish Revenue Administration and Ministry of Treasury and Finance.

The study utilized a difference-in-differences approach to exploit the variation in taxation rates experienced by individuals across different cohorts. Specifically, the average tax rate on tobacco products during individuals' youth period (age 14-17) and adulthood (age 18

and onwards) were examined to assess the impact of tax rates on smoking behavior. Control and treatment groups were formed by defining birth cohorts based on the tax exposure years. For example, those affected by the low tax rate and were in the 14-17 age group before 2002 was used as a control group. After 2002, those aged 14–17 who were affected by the high tax rate were used as the treatment group.

The impact of exposure to high tax rate during the adulthood for women on daily smoking and occasionally smoking is higher than the impact of exposure to high tax rate during adulthood for men on daily smoking and occasionally smoking. The study also shows that the effect of the average tax rate faced during youth (ages 14 – 17) is also statistically significant for both women and men and reduces the likelihood of tobacco product use daily or occasionally.

Considering this outcome, this study provides insights into the optimal tax rates and structures for achieving the desired reductions in tobacco consumption, it can aid policymakers in designing tax policies that strike a balance between discouraging smoking and minimizing potential negative economic consequences, such as illicit trade or significant disruptions in the tobacco market.

Moreover, by examining the effects of tax increases on different population groups, the study sheds light on potential disparities in smoking behavior and cessation efforts. Policymakers can utilize these findings to develop targeted interventions and support mechanisms that cater to vulnerable populations, ensuring that the burden of tobacco-related health risks is mitigated equitably.

Ultimately, the policy implications of this study aim to guide evidence-based decision-making and assist policymakers in formulating comprehensive tobacco control strategies that leverage the power of taxation to reduce tobacco consumption and improve public health outcomes in Turkey.

Introduction

Tobacco use remains a serious global public health concern, applying significant adverse effects on individual health, healthcare systems, and society at large. Although many countries have implemented a range of policy instruments to reduce tobacco consumption, more than 1 billion people worldwide continue to use tobacco products (WHO, 2023). Consequently, tobacco use imposes a significant burden on health systems. Türkiye has the highest tobacco prevalence in the OECD countries in 2021. Over the past 15 years, smoking prevalence has been reported at 27.4% in 2008, 23.8% in 2012, 29.6% in 2016, %28,0 in 2019 (GATS, 2008–

2012–2016), and 28,3% in 2022 (GATS, 2022). These figures highlight a persistent and urgent need to identify and implement effective strategies to curb smoking.

In order to reduce or eliminate the use of tobacco and tobacco products, which pose enormous risks to both public health and economies of countries, the World Health Organization and many other organizations have developed effective campaigns and policies against tobacco and tobacco products. In this approach, WHO has introduced a set of precautionary tools known as MPOWER. These tools are designed to: M – monitor tobacco use and prevention policies; P – protect people from tobacco smoke; O – offer help to quit tobacco use; W – warn about the dangers of tobacco; E – enforce bans on tobacco advertising, promotion and sponsorship; and R – raise taxes on tobacco. Although various strategies have been employed to reduce tobacco consumption, taxation has emerged as a strong policy instrument for discouraging smoking and promoting public health. Nevertheless, the precise magnitude of the influence of tax increases on tobacco consumption patterns remains inadequately understood, creating a critical knowledge gap that necessitates urgent attention.

Like many other countries, the taxation of tobacco products are used effectively in Turkey. Taxes on tobacco products in Turkey constitute one of the foremost tools in combatting tobacco use. Prior to 2002, taxes levied on cigarettes, the most prevalent tobacco product in Turkey, encompassed several components such as value-added tax, defense industry fund, education fund, and additional taxes. However, in 2002, these taxes were consolidated into a singular levy known as the "Special Consumption Tax." Notably, between 1970 and 2001, tax rates fluctuated between 33.33% and 60.47% of the selling prices. Subsequently, tax rates experienced gradual increases, ultimately the tax rate is reaching over 81.40 % of the selling price in 2022. Consequently, the objective of the present study is to scrutinize the effects of average tax rates individuals have been subjected to on their smoking behavior and smoking cessation endeavors.

The smoking taxation is used by countries both to increase tax revenue and to decrease prevalence of smoking. Much scientific research demonstrates that the taxation on tobacco products is highly effective policy tools for reducing and preventing tobacco consumptions (Lewit, E. M., and Coate, D., 1982; Hamilton, V. H., Levinton, C., St-Pierre, Y., ve Grimard, F., 1997;Forster, M., and Jones, A. M., 2001; Carpenter, C., and Cook, P. J., 2008; Callison, K., and Kaestner, R., 2014; Wilkinson, A. L., Scollo, M. etc., 2019; Robert L. Ohsfeldt, Raymond G. Boyle, and Eli I. Capilouto, 1999).

Early empirical frameworks estimated the price elasticity of tobacco products, and they imply that by higher tobacco excise tax, reduce smoking prevalence and intensity Lewit, and

Coate, 1982). Lewit, and Coate (1982) estimated price elasticity of cigarettes as -0,42 and found that younger men were particularly affected by price and tax changes. Besides that, their study also showed that long-run effects of tax increases were substantially larger than short-run effects of tax increases.

Many studies from different countries have demonstrated that taxes on tobacco products impact not only using tobacco products but also initiation behavior or quitting behavior, smoking intensity and initiation age. Hamilton et.al (1997) indicated that for Canada, the region with higher tax rates had lower smoking prevalence, higher quit rates compared with the region with lower tax rates. Forster and Jones (2001) also showed that higher reel tax rates tend to delay cigarette initiation age, increase the probability of quitting, and these results are different for men and women. They also demonstrated that these findings also demonstrate that tax policy is more responsive for low-income social groups than high- income social groups.

Numerous scientific studies also have shown that the effects of taxation on tobacco products are different for female and male (Azagba, S., and Sharaf, M., 2011; Forster, M., and Jones, A. M., 2001). Forster and Jones (2001), reported that tax elasticity of cigarettes for quitting behaviors was stronger for men than for women and they also indicated that lower socio-economic groups were responsive to tax increases on cigarettes. Azagba and Sharaf (2011), using Canadian Health Survey data from 1998 – 2008, estimated a tax elasticity of cigarette demand around -0.23 for the overall population, but it also more stronger responses among men (-0.32) than women (-0.12). These findings also mention that when tobacco taxes were designed carefully and effectively, taxation can contribute to reducing health risks because of using cigarettes and they also cause to avoid using cigarettes.

The effects of taxation on tobacco products differ not only by gender and income group but also across cohorts. Carpenter and Cook's (2008) research indicates that higher state tobacco tax rates significantly reduced smoking participation among adolescents. DeCicca, Kenkel and Mathios (2008) focused on young adults and found that higher cigarettes taxes have relatively stronger effects on smoking cessation among young adults than on initiation and they also showed that cigarette taxes may be particularly effective at encouraging quitting rather than preventing from all aspects.

In addition, several studies examine whether the taxes individuals are exposed to before the age of 18 affect their smoking behavior in adulthood, and their findings indicate that exposure to higher tobacco taxes at younger ages reduces the likelihood of smoking in adulthood (Friedson, A. I., Li, M., Meckel, K., Rees, D. I., & Sacks, D. W., 2021).

Friedson, Li, Meckel, Rees and Sacks (2021), examined whether exposure to higher cigarette tax rates during younger ages affects using smoking, mortality results in adulthood. They showed that the individuals who faced higher cigarette tax rate in adolescence were less likely to smoke in adulthood, tended to start smoking later at ages and had different long-term smoking behavior. These estimates also indicate that an additional price in youth cigarette taxes is associated with significant reduction in probability of adult smoking, also underlying the long-run preventive effects of tax policy.

Several studies have examined how large and unexpected tax increase affects smoking patterns and substitution effects between combustible and other tobacco products (Wilkinson et al. ,2019; Ohsfeldt, Boyle, and Capilouto,1999). Wilkinson et al. (2019) examined several huge and major unexpected tax hikes in Australia, including a sudden %25 rise in 2010 and a series of pre-announced 12.5% increasing stating in 2013. They found that this kind of major tax increase reduces total cigarette consumption. Although some smokers change cigarette types such as combustible cigarettes to roll-your-own cigarettes this effect was temporary. However, after tax increases, reduced using both types of cigarettes and increased cessations. Similarly, Ohsfeldt, Boyle, and Capilouto (1999) showed that higher tax rates were negatively associated with the probability of smoking among men aged 16–24. However, in some cases, higher taxes also led to substitution toward other tobacco products, which did not fully offset the reduction in cigarette use.

Some evidence from the literature showed that the effects of taxation on tobacco and tobacco products were insignificant or almost zero. Callison and Kaestner (2014), analyzed U.S adults and indicated that the relatively small and often insignificant effects of cigarette taxes on smoking prevalence and cigarette intensity. They suggested that among adult smokers, larger tax rates on tobacco and tobacco products can be more effective policy for encourage cessation and avoid initiation. They also suggested that tax increases were getting more effective with complimentary tobacco fighting policy such as smoking bans in closed and opened areas, cessation support and media campaigns.

Generally, tax policy on tobacco and tobacco products are highly effective policy tools for reducing prevalence of smoking, promoting cessation, delaying initiating age and preventing initiation. Besides that, there is no consensus about tobacco product taxation among age, gender, socio-economic status, region, etc. At the same time, heterogeneity by age, gender, social class, and product type highlights the need for context-specific analyses. In this sense, micro-level-data based studies that examine how exposure to tobacco taxes at different ages, across different subgroups can make a valuable contribution to design of effective and equitable

tobacco control policies, particularly in countries such as Turkey where tobacco prevalence is high.

In this study, our aim is to determine whether exposure tobacco taxation at ages between 14-17 and post-adolescence affects the use of tobacco and tobacco products. For this purpose, we use on the study average tax rates on tobacco products faced by individuals between ages 14 and 17 and ages between 18 and current age. We also examine the effects of taxation on tobacco products across different genders, regions, income levels, and cohorts, as well as the interactions between these factors which are known to affect the tobacco product use decisions.

Two primary sources of data are employed for analysis. First, the study uses the 2010, 2012, 2014, 2016, 2019 and 2022 rounds of the Turkish Health Surveys which are created by Turkish Statistical Institute, which provide valuable information on individuals' smoking behavior and demographic characteristics. These surveys are very broad, including age of starting smoking for current and former smokers and quitting age for quitters. Second, data on tax rates for tobacco products were obtained from the Turkish Revenue Administration and Ministry of Treasury and Finance.

The study shows that higher average tax rate incurred during both youth and adulthood reduces the likelihood of tobacco product use for both sexes and increases the likelihood of quitting for women. The higher average tax rate faced during youth and adulthood periods cause to delay smoking initiation age for women in addition that for men the higher average tax rate faced during adulthood is effects to smoking initiation age.

Data and Empirical Analysis

In this study, two main data were used for the analysis. First the Turkey Health Survey Data for 2010, 2012, 2014, 2016, 2019 and 2022 years. The THS data include precious information such as initiation smoking age for current and former smokers, age of cessation, region, age, income level, education level, marital status, etc. The THS were nationwide surveys and very broad. Second, tobacco tax data were collected from Turkish Revenue Administration and Ministry of Treasury and Finance.

We merged the 2010, 2012, 2014, 2016, 2019 and 2022 TSA data. The merged data includes information about age, marital status, level of education, level of income, region, current and former smoking status, initial and cessation age, etc. We dropped observations aged below 18 and elder 74 and some observations which did not give necessary information for this study. After observation dropped, the final data's information is showed Table 1 and the final data had 105,886 observations (57,418 women and 48,468 men). The 54.23% percentage of

women and 45.77% percentage of men are married. Although the age distribution is similar across genders, regarding education, a significant gap is observed. The share of women who are illiterate is 13.07%, compared with 2.03%. for men. Primary school graduates account for 41.23% of women and 42.05% of men, high school graduates make up 17.36% of women and 23.92% of men. The proportion of individuals with university graduate or above is 14.23% for women and 19.26% for men.

Table 1: Descriptive Statistics

		All Participant		Women		Men	
		#	%	#	%	#	%
N		105,886		57,418	54.23	48,468	45.77
Education							
	Illiterate	8,488	8.02	7,506	13.07	982	2.03
	Literate but Not graduate	5,061	4.78	3,695	6.44	1,366	2.82
	Primary school (5 years)	38,805	36.65	21,540	37.51	17,265	35.62
	Primary school (8 years)	6,402	6.05	3,287	5.72	3,115	6.43
	Secondary School (8 years)	8,063	7.61	3,251	5.66	4,812	9.93
	High School	21,564	20.37	9,970	17.36	11,594	23.92
	University	15,935	15.05	7,496	13.06	8,439	17.41
	Master Degree or Higher	1,568	1.48	673	1.17	895	1.85
Marital Status							
	Not Married	19,330	18.26	8,690	15.13	10,640	21.95
	Married	78,237	73.89	42,021	73.18	36,216	74.72
	Widowed	4,313	4.07	3,300	5.75	1,013	2.09
	Separated	4,006	3.78	3,407	5.93	599	1.24
Employment Status							
	Employed	44,360	41.89	13,228	23.04	31,132	64.23
	Searched	3,881	3.67	1,187	2.07	2,694	5.56
	Unemployed	57,645	54.44	43,003	74.89	14,642	30.21
Region							
	Istanbul	5,922	12.22	7,211	12.56	13,133	12.40
	West Marmara	5,181	10.69	6,105	10.63	11,286	10.66
	Aegean	2,720	5.61	3,372	5.87	6,092	5.75
	East Marmara	2,443	5.04	2,592	4.51	5,035	4.76
	West Anatolia	1,313	2.71	1,693	2.95	3,006	2.84
	Mediterranean	4,867	10.04	5,673	9.88	10,540	9.95
	Central Anatolia	7,238	14.93	8,388	14.61	15,626	14.76
	West Black Sea	3,469	7.16	4,549	7.92	8,018	7.57
	East black Sea	10,052	20.74	11,118	19.36	21,170	19.99
	Northeast Anatolia	1,031	2.13	1,359	2.37	2,390	2.26
	Central east Anatolia	2,434	5.02	2,980	5.19	5,414	5.11
	Southeast Anatolia	1,798	3.71	2,378	4.14	4,176	3.94

In terms of employment, 23.04% of women and 64.23% of men are employed (calculated as a share of the total population, not the labor force).

The regional distribution is largely similar between genders, with the highest representation in Istanbul, Central Anatolia, and Eastern Black Sea regions.

Table 2 showed that smoking information for participants. It showed that among years the percentage of daily smokers did not decrease, insomuch as it has been increasing recently (daily tobacco use is 42.05% among men and 15.45% among women).

Table 2: Descriptive Statistics for Smoking Behaviors

		All Participant		**Women**		**Men**	
		#	%	#	%	#	%
N		105,886		57,418	54.23	48,468	45.77
Daily Smoker							
	1: Daily Smoker	29,254	27.63	8,872	15.45	20,382	42.05
	0: Non Daily or Non-Smoker	76,632	15.45	48,546	84.55	28,086	57.95
Occasionally Smoker							
	1: Daily or Occasionally Smoker	33,732	31.86	11,177	19.47	22,555	46.54
	0: Non-Smoker	72,154	68.14	46,241	80.53	25,913	53.46
Cessation							
	1: Quit	16,015	32.19	5,387	32.52	10,628	32.03
	0: Currently Smoker	33,732	67.81	11,177	67.48	22,555	67.97
	#	49,747		16,564		33,183	
Intensity							
	0-10	11,874	40.57	5,319	59.12	6,555	32.34
	11-20	14,171	48.42	3,280	36.46	10,891	53.72
	21-30	1,629	5.57	240	2.67	1,389	6.85
	31 or above	1,595	5.45	158	1.76	1,437	7.09
	#	29,269		8,997		20,272	
Age Of Initiation							
	Before 14	3,790	8.95	563	4.41	3,227	10.91
	Ages 14 – 17	12,865	30.39	3,042	23.85	9,823	33.21
	Ages 17 – 25	21,645	51.13	6,855	53.75	14,790	50.00
	Above 25	4,032	9.52	2,293	17.98	1,739	5.88
	#	42,332		12,753		29,579	

The age of initiation to regular smoking is concentrated between 15 and 25 years for both genders. The peak initiation ages is 17-25 both for men (50.00%) and for women (53.75%).

Early initiation (age ≤14) is observed among 10.91% of men and 4.41% of women. Late initiation (age ≥25) is much more common among women (17.98%) than men (5.88%).

Tobacco taxation in Turkey has undergone substantial changes over the years and major effects on cigarette retail prices. Before 2002, many types of tax were applied on cigarette under different named, including the Additional Tax, Education Fund, Defense Industry Fund, Tobacco Fund, Pasture Fund, Veterans Fund, and Value Added Tax (VAT). In 2002, these different kinds of tobacco products tax consolidated under a single scheme known as Special Consumption Tax.

Table 3. Tax rates on tobacco products at 1970-2001

	Additional Tax	**Education Fund**	**Defense Industry Fund**	**VAT**	**Total Tax Burden**
1970 -82	41.18%	-	-	-	41.18%
1983	33.33%	-	-	-	33.33%
1984	44.44%	-	-	-	44.44%
1985	42.11%	-	-	5.26%	47.37%
1986	39.16%	-	6.99%	4.90%	51.05%
1987	39.57%	-	6.01%	4.95%	50.53%
1988	39.49%	-	5.23%	5.92%	50.64%
1989	39.28%	-	6.70%	4.91%	50.90%
1990	39.78%	-	4.53%	5.97%	50.28%
1991	40.12%	-	3.72%	6.02%	49.85%
1992	41.26%	-	0.98%	6.19%	48.43%
1993	40.79%	-	0.57%	7.65%	49.01%
1994	43.69%	-	0.49%	7.28%	51.46%
1995	45.45%	-	2.27%	6.82%	54.55%
1996	45.45%	-	2.27%	6.82%	54.55%
1997	43.48%	4.35%	2.17%	6.52%	56.52%
1998	43.48%	4.35%	2.17%	6.52%	56.52%
1999	47.62%	3.97%	1.98%	6.75%	60.32%
2000	47.43%	3.95%	1.98%	7.11%	60.47%
2001	47.43%	3.95%	1.98%	7.11%	60.47%

Between 1970 and 2001, the total tax burden on cigarette retail prices fluctuated considerably. The tobacco tax ratios were calculated as share of the retail prices and based on data from Ministry Treasury and Finance and the Turkish Revenue administration indicate that the total tax share in the retail price was approximately 41.2% between 1970 and 1982.

Although the rate decreased to 33.3% in 1983, the tax burden on cigarette retail price reached to 60.5% in 2001 with Defense Industry Fund, the Education Fund and VAT.

After 2002, the various types of taxes were merged into the Special Consumption Tax framework. In addition to Special Consumption Tax showed in Table 3, a specific unit tax and VAT have continued to be apply on tobacco products. Among the years with multiple legislative changes, weighted averages were calculated according to the months each rate was in effect. In Turkiye the Value Added Tax was equal to 15,25% and when this rate added to Special Consumption Tax (SPT), fixed tax, minimum fixed tax, total tax burden reached to 81.39% in 2022.

Table 4: Tax rates on tobacco products at 2002-2022

Year	SCT	Fixed Tax	Min. Fixed Tax	VAT	Total Tax Burden
2002	49.50%	-	-	15.25%	64.75%
2003	55.30%	-	-	15.25%	70.55%
2004	28.00%	0.35 TL– 1.00 TL	-	15.25%	71.60%
2005	58.00%	-	1.20 TL	15.25%	73.25%
2006	58.00%	-	1.20 TL	15.25%	73.25%
2007	58.00%	-	1.55 TL	15.25%	73.25%
2008	58.00%	-	1.50 TL	15.25%	73.25%
2009	58.00%	-	2.05 TL	15.25%	73.25%
2010	63.00%	-	2.65 TL	15.25%	78.25%
2011	65.00%	-	2.90 TL	15.25%	80.25%
2012	65.00%	-	2.90 TL	15.25%	80.25%
2013	65.25%	0.0922 TL	3.23 TL	15.25%	81.71%***
2014	65.25%	0.1300 TL	3.75 TL	15.25%	82.23%***
2015	65.25%	0.1866 TL	3.94 TL	15.25%	82.82%***
2016	65.25%	0.2468 TL	4.42 TL	15.25%	82.80%***
2017	65.25%	0.3246 TL	4.56 TL	15.25%	83.46%***
2018	63.00%	0.4200 TL	5.60 TL	15.25%	82.59%***
2019	67.00%	0.4539 TL	7.79 TL	15.25%	85.52%***
2020	63.00%	-	2.90%	15.25%	85.06%***
2021	63.00%	-	2.98%	15.25%	81.23%***
2022	63.00%	-	3.14%	15.25%	81.39%***

*The relevant rates are calculated over the sales price.
**The rates that changed in the same year were calculated by proportioning them to the month in which they remained in force in the relevant year.
*** The total tax burden rate was calculated by the author by calculating the minimum cigarette prices in the month in which the minimum lump sum tax rates were changed

As shown in Tables 3 and 4, the maximum tax burden on cigarette prices amounted to 60.47% in the pre-2002 period, while it rose dramatically to about 86% in the post-2002 period, following the introduction of the Special Consumption Tax (SCT) framework.

Average Tax Calculation

This study examined the association between taxation on cigarette and smoking behaviors such current or former smoking, cessation among smokers, initiation age, cessation age and intensity of smoking. To exhibit that two average tobacco taxes were calculated as tax of tobacco based on the tax of tobacco after ages 18 and youth-tax of tobacco based on the tax of tobacco faced at ages 14 to 17.

To calculate average youth tax rate named *Teen Tax*$_i$ the following equation was used to calculate. *Teen Tax*$_i$ showed that the tax of tobacco for participants i's faced with the tax burden of tobacco retail prices at ages 14 to 17.

$$Teen\_tax = \sum_{t=14}^{t=17} Teen\_tax_{it} /4$$

To calculate average tax rate after ages 18 named *Tax*$_i$ the following equation was used to calculate. *Tax*$_i$ showed that the tax of tobacco for participants i's faced with the tax burden of tobacco retail prices at ages 18 and later.

$$Tax = (\sum_{t=18}^{t=current\ age_i} tax_{it})/(current\ age_i - 18)$$

Table 4 shows descriptive statistics about both Teen tax and Tax. The table showed that the average tax of tobacco faced at after 18 was strictly higher than the average tax of tobacco faced ages 14-17.

Method

In this study, the five different dependent variables which were daily smoking, daily or occasionally smoking, cessation for former smokers, smoking intensity for current smokers and age of initiation for former and current smokers were estimated. Binary outcomes which were daily smoking, occasionally smoking, cessation behavior were estimated with logistic regression, whereas continuous outcomes which were daily cigarette consumption and age of initiation were estimated using ordinary least squares (OLS) method.

For the estimation two main models which are below used:

Model-1

$$\text{Xji} = \beta 1_i + \beta 2_i * \text{Tax}_i + \beta 3_i * (\text{Employment}) + \beta 4_i * (\text{Marital Status}) + \beta 5_i * (\text{Region}) + \beta 6_i * (\text{Age}) + \beta 7_i * (\text{Survey Year}) + \varepsilon i$$

Model-2

$$X_{ji} = \beta 1_i + \beta 2_i * \text{Tax}_i + \beta 3i * \text{Teen}_{\text{tax}_{it}} + \beta 4_i * (\text{Employment}) + \beta 5_i * (\text{Marital Status}) + \beta 6 * (\text{Region}) + \beta 7_i * (\text{Age}) + \beta 8_i * (\text{Survey Year}) + \varepsilon i$$

We also controlled for individual i's age, marital status and employment status at current year. We also controlled with region fixed effects account for persistent difference of region in smoking behaviors and survey year fixed effects control for tobacco control policies introduced in specific year.

The study utilized a difference-in-differences approach to exploit the variation in taxation rates experienced by individuals across different cohorts. Specifically, the average tax rate on tobacco products during individuals' youth period (age 14-17) and adulthood (age 18 and onwards) were examined to assess the impact of tax rates on smoking behavior.

Control and treatment groups were formed by defining birth cohorts based on the tax exposure years. For example, those affected by the low tax rate and were in the 14-17 age group before 2002 were used as a control group. After 2002, those aged 14–17 who were affected by the high tax rate were used as the treatment group. The control and treatment groups compare smoking behavior for individuals who have similar age cohorts but face different levels of taxation in adolescence because of birth year. It is providing a powerful framework to infer how taxation at ages 14-17 affects smoking behavior.

The Did model is estimated by interacting with an indicator for being exposed to the post-2002 high-tax regime with cohort eligibility, following specification:

$$Y_{ic} = \propto_1 + \propto_2 (\text{Teen Treated}_i) + \propto_3 (\text{Teen\_Tax}_i) + \propto_4 (\text{Adult Treated}_i) + \propto_5 (\text{Tax}_i) + X'_{ic}\gamma + \epsilon_{ic}$$

The coefficient $\propto_2$ captures the causal effect of exposure to higher tobacco taxs during adolescence on later smoking outcomes. Teen Treated_i is equals 1 when for participant who exposure high tax regimes (post 2002) during adolescence and it equals 0 when for participant who exposure low tax regimes (pre-2002) during adolescence. The coefficient $\propto_4$ captures the causal effect of exposure to higher tobacco taxs during adulthood on current smoking outcomes.

Adult Treated_i is equals 1 when for participant who exposure high tax regimes (post-2002) during adulthood and it equals 0 when for participant who exposure low tax regimes (pre-2002) during adulthood.

Finally teen treated coefficient is equal to 1 for the participant born before 1984 and is equal to 0 for the participant born after 1987. Teen treated coefficient is equal to mixed for the participant born between 1985 and 1987. We omit the teen treated coefficient which is equals to mixed because this participant effected by both high and low tax regimes.

It is noteworthy that recent research has highlighted potential biases in standard difference-in-differences estimators when there are heterogeneous treatment effects (e.g., Goodman-Bacon, 2021; de Chaisemartin and d'Haultfoeuille, 2020). To address this concern, the study employed heterogeneity-robust estimators to account for potential variations in treatment effects across different population groups. This approach ensures that the analysis produces reliable and unbiased estimates of the impact of tax rates on smoking behavior.

Empirical Results

Table 5 shows the effects of tax rates on cigarette at adult periods for all participants, women and men separately and Table 6 shows that the effects of tax rates on cigarette at both young period (14-17 ages) and adult periods. Two tables show that the effects of taxation on tobacco products at adult period results for daily smokers, daily and occasionally smokers, cessation behavior, initiation age for current or former smokers and smoking intensity for current smokers.

Table 5 implies that higher tax exposure at adulthood significantly reduces the probability of both being daily smoker and being occasionally smoker (the coefficient for daily smoker and occasionally smoker -0.08 and p-value < 0.01). The effect of tax exposure at adulthood period for daily or occasionally smoker women (the coefficients are -0.14 and p-values < 0.01) is stronger than daily or occasionally smoker men (the coefficients are -0.05 and p-values < 0.01). Higher tax exposure in adulthood also increases the probability of cessation significantly (the coefficient is 0.14 and p-value < 0.01). This effect is also higher for women than for men (the coefficient is 0.06 and p-value < 0.01). The higher tax exposure in adulthood period delays being regular smokers. The estimates coefficient is -0.27 represents that individuals who were exposed to higher tobacco tax after ages 18 being smokers at later ages. Similar to daily and occasionally smoker and cessation behavior results, this effect is much stronger for women than men. The effect of high tax regimes on the smoking intensity is not

significant for all participants and has very small effects on smoking intensity. However, this effect is significant and positive for women and men.

Table 5 : The effects of tax on tobacco products at adult periods

	Daily Smoker	Occasionally Smoker	Cessation	Initiation Age	Smoking Intensity
For All Participants					
Tax at Adult Period	-0.082***	-0.080***	0.095***	-0.270***	-0.019
	(0.005)	(0.005)	(0.007)	(0.040)	(0.019)
N	105,886	105,886	49,747	29,269	42,332
For Women					
Tax at Adult Period	-0.143***	-0.138***	0.142***	-0.324***	0.113**
	(0.008)	(0.007)	(0.013)	(0.064)	(0.043)
N	57,418	57,418	16,564	8,997	12,753
For Men					
Tax at Adult Period	-0.052***	-0.048***	0.057***	-0.234***	0.036*
	(0.006)	(0.006)	(0.009)	(0.050)	(0.020)
N	48,468	48,468	33,183	20,272	29,579

Notes: Coefficient estimates from logit for daily smoker, ocassionally smoker and cessation, estimates from ordinary least squares regressions for initiation age and smoking intensity. Regressions control for age, region, gender, income, individual's education level, marital status and employment status. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

When the added the tax exposure on young period ages 14 – 17 the results are the quite same as tax exposure on adulthood periods among the significancy and sign of estimates coefficients. However, there are some differences in the magnitude of coefficients. Just as the effects of tax exposure in the adult periods, the higher taxation on tobacco products at young periods reduces the probability of being daily smoker (the coefficient is -0.04 and p-value < 0.01) and occasionally smoker (the coefficient is -0.04 and p-value < 0.01). For these estimates results also are stronger for women (the coefficient is -0.06 and p-value < 0.01) than men (the coefficient is -0.03 and p-value < 0.01). Besides, the participants who got exposed to higher tax rate in young periods are more likely to quit smoking than the participants who got exposed to lower tax rate in young periods, although this effect is significant, the magnitude of the estimated coefficient (0.009) is relatively small. Interestingly this effect is insignificant for men and relatively small (0.04) although this effect is strong and significant for women (0.019). As expected, the effect of high taxation on youth is negative and significant (-0.031) for whole population. However, significance of this coefficient disappears for women who got exposed to high tax regimes at youth. The exposure of higher taxation on youth is significant and

negative in contrast to exposure to higher taxation on adulthood. Though this effect is also the same for men in terms of significance and direction of action, significance of this effect disappears for women.

Table 6 : The effects of tax on tobacco products at young and adult periods

	Daily Smoker	Occasionally Smoker	Cessation	Initiation Age	Smoking Intensity
For All Participants					
Tax at Young Period	-0.038***	-0.040***	0.009***	-0.031*	-0.027***
	(0.002)	(0.002)	(0.003)	(0.013)	(0.007)
Tax at Adult Period	-0.046***	-0.041***	0.079***	-0.242***	0.018
	(0.005)	(0.005)	(0.009)	(0.041)	(0.021)
N	105,886	105,886	49,747	29,269	42,332
For Women					
Tax at Young Period	-0.058***	-0.059***	0.019***	-0.038	0.023
	(0.003)	(0.003)	(0.004)	(0.020)	(0.014)
Tax at Adult Period	-0.097***	-0.089***	0.113***	-0.289***	0.083*
	(0.008)	(0.008)	(0.015)	(0.066)	(0.046)
N	57,418	57,418	16,564	8,997	12,753
For Men					
Tax at Young Period	-0.029***	-0.028***	0.004	-0.031*	-0.028***
	(0.002)	(0.002)	(0.004)	(0.016)	(0.007)
Tax at Adult Period	-0.023***	-0.018**	0.051***	-0.208***	0.073**
	(0.007)	(0.006)	(0.011)	(0.052)	(0.022)
N	48,468	48,468	33,183	20,272	29,579

Notes: Coefficient estimates from logit for daily smoker, ocassionally smoker and cessation, estimates from ordinary least squares regressions for initiation age and smoking intensity. Regressions control for age, region, gender, income, individual's education level, marital status and employment status. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 7 shows the result of Difference in Difference (DiD) models for all participants, women and men separately. In addition to Table 5 and Table 6 results Table 7 shows the causal effect of exposure to higher tobacco taxes during adolescence on later smoking outcomes and the casual effects of exposure higher tobacco taxes during adulthood on current smoking outcomes. The estimation results also show the cohort base treatment variables (teen treated and adult treated). This addition allows us to explain the difference between the effects of actual tax rates faced by individuals and the effect of changing tax regime based on birth cohort. These treatment variables added to the models; the impacts of higher taxation faced on youth and

higher taxation faced on adolescence are quietly consistent with results reported before. The sign and significance of coefficients are also robust with before.

Table 7 : The results of DiD Models

	Daily Smoker	Occasionally Smoker	Cessation	Initiation Age	Smoking Intensity
For All Participants					
Teen Treated	-0.0460	-0.0895	-0.0256	0.6863	-0.4357*
	(0.0590)	(0.0566)	(0.0907)	(0.4362)	(0.2311)
Adult Treated	0.0019	-0.0139	0.0094	0.1880	-0.0829
	(0.0528)	(0.0508)	(0.0812)	(0.3876)	(0.2067)
Teen Tax	-0.0394***	-0.0392***	0.0047	-0.0461*	-0.0181*
	(0.0025)	(0.0024)	(0.0039)	(0.0195)	(0.0097)
Tax	-0.0314***	-0.0258***	0.0945***	-0.3207***	0.0660*
	(0.0065)	(0.0062)	(0.0124)	(0.0548)	(0.0279)
N	99,412	99,412	46,746	27,215	39,842
For Women					
Teen Treated	-0.1782*	-0.2158**	-0.0490	0.8801	0.2788
	(0.0919)	(0.0837)	(0.1397)	(0.6473)	(0.4715)
Adult Treated	-0.1190	-0.1287*	-0.0117	0.2129	-0.3088
	(0.0804)	(0.0735)	(0.1230)	(0.5656)	(0.4146)
Teen Tax	-0.0531***	-0.0539***	0.0156*	-0.0741*	0.0188
	(0.0042)	(0.0038)	(0.0066)	(0.0307)	(0.0216)
Tax	-0.0628***	-0.0538***	0.1336***	-0.3343***	0.1086*
	(0.0109)	(0.0100)	(0.0218)	(0.0922)	(0.0656)
N	53,776	53,776	15,395	8,327	11,879
For Men					
Teen Treated	0.0762	0.0608	-0.0469	0.5893	-1.0360***
	(0.0781)	(0.0780)	(0.1215)	(0.5619)	(0.2547)
Adult Treated	0.1178*	0.1161	0.0034	0.2068	-0.0365
	(0.0705)	(0.0706)	(0.1095)	(0.5031)	(0.2294)
Teen Tax	-0.0349***	-0.0338***	-0.0013	-0.0370	-0.0013
	(0.0032)	(0.0032)	(0.0050)	(0.0245)	(0.0104)
Tax	-0.0248**	-0.0203*	0.0726***	-0.2952***	0.1223***
	(0.0082)	(0.0081)	(0.0153)	(0.0674)	(0.0291)
N	45,636	45,636	31,351	18,888	27,963

Notes: Coefficient estimates from logit for daily smoker, ocassionally smoker and cessation, estimates from ordinary least squares regressions for initiation age and smoking intensity. Regressions control for age, region, gender, income, individual's education level, marital status and employment status. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

The teen treatment effects results are very limited and have an insignificant effect on smoking behaviors such as smoking daily, smoking occasionally, cessation and initiation age and initiation age and it just affect smoking intensity. Although for men who faced post-2002

high tax policy during the ages 14 -17 the results for being daily smoker and occasionally smoker are also insignificant, for women who faced post-2002 tax policy during the ages 14 – 17 reduces the probability of being daily smoker (the coefficient -0.18 and p-value < 0.05) and occasionally smoker (the coefficient -0.22 and p-value < 0.01). The only statistically significant coefficient for men is smoking intensity. For men, exposure the post-2002 high tax regime reduces using number of cigarettes. The estimates results shows that exposure the high tax regime policy more effective for women than for men. The results also show that actual tax rate is more effective on people's smoking behaviors.

Contrary to common belief, the result of daily smokers is significant and positive. The probability of being a daily smoker of men facing pre-2002 relatively low tax policy after age 18 increase the probability of being daily smoker higher than the men who faced pre-2002 relatively low tax policy. This effect is negative and insignificant for women. However, when the dependent variable is being occasionally smoker the significance of adult treatment effect disappears for men, but it turns into significant and negative effect for women (-0.22 and p-value < 0,05). To conclude, the cohort-based treatment effects are weaker than actual tax exposure.

Discussion

The adverse effects of tobacco products are serious public health issue in globally and Türkiye. Although there are strict policies against tobacco and Türkiye has the highest tobacco prevalence in the OECD countries in 2021, this prevalence has not decreased over the years. Türkiye applies World Health Organization's set of precautionary tools known as MPOWER. In Türkiye taxation of tobacco products have been applied for many years effectively. The tax rates have been increasing over the years, especially after 2002.

In this study, we investigate how exposure to high taxation during the youth and during the adolescence influences tobacco behaviors (being daily smoker, being occasional smokers, cessation, age of initiation and smoking intensity). We calculated the average tax rate for adolescents aged 14 – 17 and tax rate for adulthood.

The study shows that higher average tax rate during adulthood reduces the likelihood of tobacco product use for both sexes, and our results are consistent with the related literature (Lewit, E. M., and Coate, D., 1982; Hamilton, V. H., Levinton, C., St-Pierre, Y., and Grimard, F., 1997; Forster, M., and Jones, A. M., 2001; Carpenter, C., and Cook, P. J., 2008; Callison, K., and Kaestner, R., 2014; Wilkinson, A. L., Scollo, M. etc., 2019; Robert L. Ohsfeldt, Raymond G. Boyle, and Eli I. Capilouto, 1999). Moreover, the impact of exposure to high tax rate during

the adulthood for women on daily smoking and occasionally smoking is higher than the impact of exposure to high tax rate during adulthood for men on daily smoking and occasionally smoking. The study also shows that the effect of the average tax rate faced during youth (ages 14 – 17) is also statistically significant for both women and men, and reduces the likelihood of tobacco product use daily or occasionally, similar to other studies in the literature (Friedson, A. I., Li, M., Meckel, K., Rees, D. I., and Sacks, D. W., 2021).

Our results also shows that higher tax rate increases the likelihood of quitting for women. The higher average tax rate faced during youth and adulthood periods delay smoking initiation age for women in addition that for men the higher average tax rate faced during adulthood is effects to smoking initiation age. There are also studies in the literature showing that the increase in tax rates increases the likelihood of quitting smoking for both women and men (Wilkinson, A. L., Scollo, M. etc., 2019; DeCicca, P., Kenkel, D., and Mathios, A., 2008; Forster, M., etc. Jones, A. M., 2001).

The DiD model results indicate that facing post-2002 high tax regimes during youth and adulthood has an insignificant and weak effect relative to facing actual tax levels. For women, facing pos-2002 tax policy during youth reduces likelihood of smoking daily or occasionally but this effect disappears for men. These findings provide useful tools for tobacco tax policy. First, they suggest that maintaining actual high tax levels during adulthood and adolescence is more important than jumping tax changes. Second, they highlight gender differences in responsiveness: women appear more likely to reduce or quit smoking and to delay initiation in response to higher taxes, whereas men seem to adjust primarily through smoking intensity. Tax policy may therefore be particularly powerful when combined with gender-sensitive cessation support and targeted communication campaigns.

Considering this outcome, this study provides insights into the optimal tax rates and structures for achieving the desired reductions in tobacco consumption, it can aid policymakers in designing tax policies that strike a balance between discouraging smoking and minimizing potential negative economic consequences, such as illicit trade or significant disruptions in the tobacco market.

Moreover, by examining the effects of tax increases on different population groups, the study sheds light on potential disparities in smoking behavior and cessation efforts. Policymakers can utilize these findings to develop targeted interventions and support mechanisms that address vulnerable populations, ensuring that the burden of tobacco-related health risks is reduced equitably.

Ultimately, the policy implications of this study aim to guide evidence-based decision-making and assist policymakers in formulating comprehensive tobacco control strategies that strengthen the effect of taxation on reducing tobacco consumption and improving public health outcomes in Turkey.

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