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Gender differences in the price elasticity of demand for waterpipe and cigarette smoking
in Lebanon, Jordan, and Palestine

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Gender differences in the price elasticity of demand for waterpipe and cigarette tobacco smoking in Lebanon, Jordan, and Palestine

Abstract

Objectives: This study assessed to what extent the elasticity of cigarette and waterpipe tobacco products is different between men and women. The study also explored the levels of substitution and complementarity in tobacco products amongst men and women.

Setting: The study examines tobacco elasticities in three Arab countries: Lebanon, Jordan and the West Bank of Palestine.

Participants: We used data from nationally representative surveys of adults (≥18 years old). The total number of respondents was 1680 in Lebanon, 1925 in Jordan and 1679 in Palestine. The share of women was 50.0% of the sample in Lebanon, 44.6% in Jordan and 50.0% in Palestine.

Primary and secondary outcome measures: A zero-inflated Poisson model was used to estimate own- and cross-price elasticities for seven variations of tobacco products – two variations of cigarettes and five variations of waterpipe tobacco.

Results: Overall, women had higher price elasticities of demand for tobacco products than men. For example, the price elasticity for premium cigarettes was -1.12 and -2.26 for Jordanian and Palestinian women, respectively as compared to -1.09 and -1.00 for their male counterparts. Demand for waterpipe tobacco products was elastic for both men and women. The cross-price elasticities of tobacco demand in the three countries indicate substitution between cigarettes and waterpipe products and by different varieties within each of the two tobacco products. Gender
differences varied across the three countries whereby higher cross-price elasticities were generally observed for women in Lebanon and Jordan.

**Conclusions**: Gender differences in own- and cross-price elasticities of waterpipe tobacco products should be taken into consideration in tobacco control strategies particularly those seeking to reduce the prevalence of tobacco smoking via taxation policies.

**Keywords**: Tobacco smoking; Waterpipe; Gender; Elasticity; Developing countries

**Word count**: 3334
Strengths and limitations of this study

- This study assessed own- and cross-price elasticity of waterpipe tobacco – a topic that has received little attention in the literature.

- The study accounts for gender differences in terms of their responsiveness to changes in prices of a variety of tobacco products based on eight scenarios.

- One potential limitation is that the study uses a choice experiment design to estimate elasticities of different tobacco products under eight sets of prices. Therefore, our figures may be underestimated as higher prices (taxes) may lead to higher elasticities.

- Another potential limitation is related to factors underlying differences across gender groups such as socioeconomic differences. We were not able to capture this effect using the current model as we have small sample sizes for most of tobacco products.
Funding

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Conflicts of interest

The authors declare no conflicts of interest.

Data availability statement

Data are available upon reasonable request.

Patient and public involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Ethics Approval

The institutional review boards at the American University of Beirut (ID: SBS-2019-0097), Jordan University of Science and Technology (ID: 14-119-2018), and Birzeit University (ID: 2019 (1-1)).

Patient consent for publication

Not applicable.
1 Introduction

Empirical evidence suggests that men have higher rates of tobacco smoking compared to women.\textsuperscript{1,2} In general, the prevalence of tobacco smoking amongst men is about ten-fold that of women in developing countries (32\% vs. 3.1\%) as compared to less than two-fold in developed countries (30\% vs. 17\%).\textsuperscript{3} Tobacco control policies seeking to reduce tobacco prevalence through tax increases, consumer education, the use of warning labels, restrictions on tobacco smoking in public spaces, bans on advertising and promotion, and smoking cessation programs.\textsuperscript{4–6} Increasing tobacco prices by imposing higher tobacco excise taxes is among the most effective policy tools to reduce the prevalence of tobacco smoking.\textsuperscript{7,8} Nevertheless, socioeconomic differences between men and women such as income differences may render women more vulnerable to changes in tobacco prices as compared to men. The degree of responsiveness in tobacco consumption in relation to changes in tobacco prices (i.e., price elasticity) might be higher amongst women in developing countries due to having less financial resources as compared to men. Moreover, higher tobacco prices may lead smokers to switch to lower-priced tobacco products.

The prevalence of non-cigarette tobacco smoking is increasing worldwide.\textsuperscript{9} In the Arab World, waterpipe tobacco smoking – also referred to as narghile, arghile, and shisha – is gaining popularity amongst both men and women.\textsuperscript{10} Further, Arab women tend to smoke waterpipe tobacco products more than cigarettes.\textsuperscript{11,12} Recent estimates based on representative surveys show that the prevalence of waterpipe tobacco smoking amongst women in Lebanon is more than twice that of cigarettes (54.7\% vs. 27.5\%).\textsuperscript{113} Recently, there is a growing literature to understand the waterpipe smoking patterns of both men and women in Arab countries.

\textsuperscript{1} These results are based on a recent work (in progress) conducted by some of the coauthors of this paper.
The assessment of the price elasticity of demand for tobacco has been largely addressed using a variety of econometric models such as linear regression models, two-part models, and the Zero-Inflated Poisson (ZIP) model.\textsuperscript{14–17} However, the estimation of waterpipe tobacco elasticities and cross-price elasticities of tobacco products has received less attention in the literature.\textsuperscript{13,18,19} Empirical evidence shows that results are rather mixed with some tobacco products being substitutes for cigarettes such as cigars and electronic cigarettes\textsuperscript{18} while others such as bidis are shown to be complementary to cigarettes.\textsuperscript{20} Studies investigating the price elasticities of demand for different tobacco products across gender groups are limited.\textsuperscript{21–23} Moreover, there were no previous attempts to assess gender differences in the price elasticities of waterpipe tobacco products. Existing empirical evidence concerning gender differences in the price elasticity of demand for tobacco, mainly cigarettes, is also mixed. For instance, using a two-part model, Tauras, Huang & Chaloupka (2013) showed that the price elasticity of young women in the United States was more than two-fold the price elasticity of their men counterparts (-0.63 vs. -0.25). However, Sweis & Chaloupka (2014) demonstrated that Jordanian men had a higher price elasticity of cigarettes as compared to women (-0.81 vs. -0.01).

A full analysis of the own- and cross-price elasticities of different tobacco products that account for gender differences is lacking. The objectives of this paper were thus two-fold. First, to assess how women and men tend to respond to changes in the prices of different tobacco products. Secondly, to explore the extents of substitution or complementarity across tobacco products amongst men and women. The current study focuses on both cigarettes and waterpipe tobacco smoking in Lebanon, Jordan, and the West Bank of Palestine.

2 Methods
2.1 Data

We used data from nationally representative surveys of adults (≥ 18 years old) that were conducted in Lebanon, Jordan and the West Bank of Palestine in 2019. The surveys assessed the use of two main varieties of cigarettes (premium and discount cigarettes) and five varieties of waterpipe tobacco (premium, discount, home-delivered waterpipe tobacco, and premium and discount waterpipe tobacco café smoking). The questionnaire included a discrete choice experiment (DCE) that modeled eight scenarios of different tobacco product prices. Respondents were asked to indicate the amount of tobacco they were willing to consume under each scenario. It is worth noting that the surveys assessed non-flavored waterpipe tobacco for Lebanon and Jordan and instead assessed roll-your-cigarette smoking for the West Bank. For the sake of consistency, these two categories of tobacco have been excluded in the current analysis. A comprehensive description of the data and the DCE was documented by Chalak et al. (2021).

The highest share of smokers is observed in Lebanon for both gender groups (75.8% of men and 66.0% of women). Results indicate a higher gender gap in terms of smoking in Jordan and Palestine as compared to Lebanon. For example, the prevalence of smoking in Palestine is 36.4% amongst men and about 10.1% amongst women. Women in Lebanon and Palestine tend to smoke waterpipe more than cigarettes with a prevalence rate of waterpipe smoking of 46.2% and 7.9% and a prevalence rate of cigarettes smoking of 21.5% and 3.1% in Lebanon and Palestine, respectively.

2.2 Statistical analysis

Akin to Chalak et al. (2021), we used a Zero-Inflated Poisson (ZIP) model to calculate the own- and cross-price elasticities of demand for tobacco products for each country. The ZIP model
was estimated first for each gender group for each of the seven tobacco products. Then the model was estimated for each gender for each tobacco product variety. Tobacco products were classified into three groups such that the within-group unit of measurement was homogenous. These groups were (i) cigarettes, which included premium and discount cigarettes – measured in packs; (ii) waterpipe tobacco (250g), which included premium and discount waterpipe tobacco and (iii) waterpipe sessions, which included delivered waterpipe and discount and premium waterpipe café smoking sessions. For each group, the quantity was calculated as the sum of all quantities reported by each respondent at each set of prices. The price of each product variety was calculated using the Stone index.\(^{24}\) For each product variety, \(j\), the stone index, \(P_j^S\), is defined as
\[
P_j^S = \prod_{m=1}^{M} (p_m)^{s_m}
\]
where \(M\) is the total quantity within each product variety, \(p_m\) is the price of tobacco product \(m = 1,\ldots, M\), and \(s_m\) is the expenditure weight of product \(m\) such that \(\sum_{m=1}^{M} s_m = 1\). The stone index is a weighted geometric mean of the price of tobacco products. It is worth noting that, some respondents reported zero quantities at certain price levels. Accordingly, calculating \(s_m\) for each respondent at each scenario of prices yielded many null weighted prices. We, therefore, calculated \(s_m\) as the average weight of all respondents for all price scenarios for each tobacco product variety \(m\).

Two binary variables were constructed for the regression analysis used to estimate the price elasticities of demand. The first equaled one if the individual smoked any type of cigarettes while the second equaled one if the individual smoked any type of waterpipe tobacco. The former binary variable was used as an inflation variable in the ZIP models of cigarette products while the latter binary variable was used in the ZIP models of waterpipe products. For all models, the set of
independent variables of the first part model included the logarithmic forms of the prices of all tobacco product varieties and a categorical variable of four income groups. The inclusion of the prices of all tobacco products allowed for calculating the cross-price elasticities between all tobacco products. In general, the set of independent variables of the inflation part of the ZIP model included the relevant binary variable of tobacco smoking, age (categorical variable), marital status (binary variable which takes one if the individual is married), a region variable (country-specific), employment status (unemployed, full-time and part-time employee), education level (less than university and with university education), and a binary variable that equaled one if the individual was responsible for taking decisions in the household. For some tobacco product varieties across genders, only a subset of these independent variables was used due to the small sample size of smokers. All analyses were conducted using Stata version 14.2.

3 Results

3.1 Own-price elasticities

The price elasticities were first calculated by gender groups for each type of tobacco smoking for each country. Results, which are summarized in Table 1, show that in Lebanon the price elasticity is significantly higher for women for the following types of tobacco; discount cigarettes (-0.75 for women vs. -0.58 for men), premium waterpipe (-2.02 for women vs. -1.90 for men), delivered waterpipe (-1.89 or women vs. -1.85 for men), premium café (-2.38 for women vs. -2.23 for men) and discount café (-1.74 for women vs. -1.66 for men). All elasticities of waterpipe products were greater than one indicating an elastic demand for waterpipe products for both men and women, as compared to cigarettes. Particularly, elasticities were the highest for
premium café sessions and premium waterpipe tobacco, which were relatively more expensive as compared to other varieties of waterpipe products.

In Jordan, with the exception of discount cigarettes, women generally had higher elasticities as compared to men. For example, the price elasticity of discount waterpipe for women was about two-fold the elasticity observed for men (-1.38 vs. -0.62). Moreover, the price elasticity of premium cigarettes for women was slightly higher than the price elasticity for men (-1.12 vs. -1.09). The highest elasticity is observed for discount waterpipe for women where a 10% increase in the price of discount waterpipe yielded a 13.76% increase in its quantity consumed.

As for the West Bank, the price elasticity of premium cigarettes for women was -2.26 as compared to -1.00 for men. It is worth noting that Palestinian women had the highest price elasticity of premium cigarettes as compared to Lebanon and Jordan. Furthermore, the price elasticities of home-delivered waterpipe and premium and discount café sessions were higher for women as compared to men. For example, the price elasticity of delivered waterpipe for women was slightly more than three-fold the price elasticity of delivered waterpipe for men (-2.05 vs. -0.61). The price elasticity of premium waterpipe was found to be positive for both men and women though they were not statistically significant.

Table 2 summarizes the price elasticities of tobacco product varieties by gender for each country. In Lebanon, all own-price elasticities were statistically different from zero with higher elasticities being observed for women for cigarettes and waterpipe products. For example, a 10% average increase in cigarettes prices would result in a decrease in the quantity of cigarettes consumed by about 7.37% for women and 5.68% for men indicating an inelastic demand for cigarettes. Nonetheless, results show that demand for waterpipe was elastic. As for Jordan, the price elasticities of the three tobacco product varieties were higher for women. For example, a
10% average increase in waterpipe prices would result in a decrease in the quantity of waterpipe consumed by about 6.20% for women and only 3.71% for men. It is worth noting that the demand for all tobacco product varieties was inelastic in Jordan. Different patterns were observed for the West Bank. The price elasticity of both cigarettes and waterpipe sessions were higher for women. However, the demand for cigarettes was elastic (-1.84 for women vs. -1.03 for men) while the demand for waterpipe session was inelastic (-0.60 for women vs. -0.33 for men).

3.2 Cross-price elasticities

Estimated cross-price elasticities of tobacco products and groups are summarized, respectively, in Table 1 and Table 2 for the three countries. In Lebanon, the cross-price elasticities of premium cigarettes with respect to other tobacco products were not statistically significant except for discount waterpipe and discount café sessions for women. The cross-price elasticity of discount cigarettes with respect to premium cigarettes was positive and statistically significant for both men and women indicating a substitution effect between the two types of cigarettes. The magnitude of the estimated cross-price elasticity of discount cigarettes with respect to premium cigarettes was higher for women (0.23) as compared to men (0.15). As for premium waterpipe, results show that cross-price elasticities were statistically significant and positive with respect to discount waterpipe and discount café and negative with respect to discount cigarettes and home-delivered waterpipe for both women and men. This result indicates that there was some level of substitution between premium waterpipe and the discounted waterpipe products (discount waterpipe tobacco and discount cafe) and some level of complementarity within the premium waterpipe products (premium waterpipe tobacco with home-delivered waterpipe). Results also indicate that premium waterpipe and discount cigarettes exhibited some substitution whereby a
10% increase in the price of discount cigarettes results in a 2.10% and 2.31% increase in the quantity consumed of premium waterpipe respectively for women and men. Also of note, that most cross-price elasticities of premium waterpipe were slightly higher for women as compared to men. This result is also confirmed with the cross-price elasticity of discount waterpipe with respect to other waterpipe products whereby complementarity was observed between discount waterpipe and discount café while substitution effect was observed between discount waterpipe and premium and delivered waterpipe. However, the cross-price elasticities of discount waterpipe were slightly higher for women as compared to men Furthermore, discount café sessions appear to be substitutes for premium café sessions with higher elasticities being observed for men (0.17 for women vs. 0.25 for men). Results show no statistical significance in the cross-price elasticities of tobacco product varieties, neither for women nor for men as shown in Table 2.

As for Jordan, results show a substitution effect between premium and discount cigarettes for men only with, for example, a cross-price elasticity of discount cigarettes with respect to premium cigarettes equal to 0.25. As for waterpipe products, the cross-price elasticity of discount waterpipe with respect to premium waterpipe was statistically significant and positive for both men and women with the elasticity for women being twice that of men (0.67 vs. 0.35). This may indicate that discount and premium waterpipe products were substitutes. Similar to Lebanon, results show no statistical significance of cross-price elasticities of tobacco groups neither for women nor for men.

Lastly, results on the cross-price elasticities of tobacco products for the West Bank were mixed. Only a few of the cross-price elasticities were statistically significant for men and women. There was some level of substitution between waterpipe products for women. For example, the cross-price elasticity of home-delivered waterpipe with respect to discount café sessions was
positive and close to one for women (0.98). Furthermore, a 10% increase in the price of discount waterpipe product would reduce the quantity consumed of waterpipe in premium cafes by 7.03%. For men, on the other hand, unlike Lebanon and Jordan, results show complementarity between cigarettes products. For example, a 10% increase in the price of premium cigarettes would reduce the quantity consumed of discount cigarettes by 6.4%. Once tobacco products were aggregated into groups, results indicate a substitution effect between cigarettes and waterpipe products for both men and women. Moreover, the cross-price elasticity of cigarettes with respect to waterpipe was higher for women (0.85) as compared to men (0.59).

4 Discussion

This study provides estimates of the responsiveness of women and men in tobacco consumption in relation to changes in the prices of different varieties of cigarettes and waterpipe tobacco products in Lebanon, Jordan and the West Bank. Several interesting findings emerging from our analysis are worth highlighting. First, women were generally more sensitive to changes in tobacco prices as compared to men. This result was reflected in higher own-price elasticities of demand for tobacco for women as compared to men in the three countries. This result may indicate that women smokers would reduce their tobacco consumption more than men smokers in response to similar increases in tobacco prices. That is, tobacco policy interventions might be more effective for women as compared to men. It is worth noting that empirical evidence shows that the effects of policy interventions may vary by gender whereby women are more responsive to policy changes.25–27 For example, using linear regression with states and years fixed effect, a study conducted in the United States show that a tobacco tax intervention appears to be beneficial for women, but not for men, in terms of reducing coronary heart disease mortality. 25
Second, the degree of responsiveness to changes in tobacco prices varied across the three countries. Different patterns of price elasticities were observed amongst the three countries once tobacco products were categorized into three groups: cigarettes, waterpipe tobacco (250g) and waterpipe sessions. For example, the demand for cigarettes was elastic in Lebanon and inelastic in the West Bank while the demand for waterpipe was inelastic in Lebanon and elastic in the West Bank. In Jordan, both the demand for cigarettes and for waterpipe appeared to be inelastic. Such differences might be related to the current prices of cigarettes and waterpipe products, as well as the overall socioeconomic status (e.g., average income per capita). Moreover, these differences may be related to the fact that for addicted and older smokers, a large increase in tobacco prices induces a smaller decrease in the quantity consumed of tobacco products. Such results reveal that tobacco smoking behavior is rather country-specific, thus tobacco control policies should also be tailored in each country to reflect the sensitivity of tobacco products to price changes.

Third, the degree of responsiveness to changes in prices was higher for waterpipe products as compared to cigarettes. Such observation is mostly prominent for Lebanon where own-price elasticities of waterpipe products were greater than one for both men and women. This indicates an elastic demand for waterpipe products as compared to cigarettes. Such result is very important especially with the increasing popularity of waterpipe products in the region. Accordingly, waterpipe products should be taxed in the same manner as other tobacco products.

Fourth, results on the cross-price elasticities in the three countries indicated some substitution between cigarettes and waterpipe products, and within each product variety. However, gender differences varied across the three countries whereby higher cross-price elasticities were generally observed for women in Lebanon and Jordan. Whereas in the West Bank results were mixed with some of the cross-price elasticities being higher for men. From a public health
perspective, it is crucial to tax all tobacco products equally to avoid any substitution between and within cigarettes and waterpipe product varieties. For example, the positive cross-price elasticity between premium and discount cigarettes could lead to switching towards discount cigarettes, which may pose a higher risk of adverse health effects.\textsuperscript{28,29}

In general, this paper adds to the literature that assesses the price elasticity of tobacco, particularly for waterpipe tobacco elasticities and cross-price elasticities of tobacco products. As mentioned in the outset, most of the related literature focuses on estimating own-price elasticities of cigarettes. The epidemic of waterpipe tobacco smoking is growing among women in low- and middle income countries.\textsuperscript{10} Such analysis could inform efforts in increasing taxation on waterpipe tobacco products in similar contexts. Moreover, the prevalence of tobacco smoking is likely to increase amongst women in the region as social restrictions placed on women are reduced. These restrictions include religious restrictions and socio-cultural acceptance of women smoking where people in the region believe that the practice of smoking reflect a “negative image” of women.\textsuperscript{30,31} As shown, in Lebanon, where smoking among women is more socially acceptable relative to other countries in the region, the prevalence of tobacco smoking amongst women is extremely high.\textsuperscript{31,32} Therefore, gender-based analyses are important to consider in the formulation of tobacco control policies. The differences in the own- and cross-price elasticities between men and women reveal the higher responsiveness of women to changes in tobacco prices as compared to men. The fact that some tobacco product varieties appear to be elastic particularly for women may reflect the effectiveness of increasing tobacco taxes, hence reducing tobacco prevalence and the associated economic burden. Akin to previous evidence that demonstrates a substitution effect between cigarettes and other tobacco products, such as cigars and electronic cigarettes,\textsuperscript{18} this paper shows that some waterpipe tobacco and cigarettes products act as substitutes. The fact that many tobacco
products appear to be substitutes reflect the importance of taxing all tobacco products to avoid any potential substitution that may occur between and within tobacco products.\textsuperscript{13,18,33}
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Table 1: Own- and cross-price elasticities of tobacco products in three Arab countries\textsuperscript{1}

|                  | Premium cig | Discount cig | Premium WTP | Discount WTP | Delivered WTP | Premium café | Discount café |
|------------------|-------------|--------------|-------------|--------------|---------------|--------------|---------------|
|                  | Woman       | Man          | Woman       | Man          | Woman         | Man          | Woman         |
| Lebanon          |             |              |             |              |               |              |               |
| Premium cig      | -0.919      | -1.205       | 0.230       | 0.146        | -0.019        | -0.104       | 0.206         | 0.028         | 0.001         | 0.010         | 0.047         |
|                  | (0.000)     | (0.000)      | (0.000)     | (0.718)      | (0.779)       | (0.063)      | (0.630)       | (0.158)       | (0.113)       | (0.697)       | (0.995)       |
| Discount cig     | -0.061      | 0.045        | -0.751      | -0.582       | -0.210        | -0.231       | 0.060         | 0.025         | 0.103         | -0.013        | -0.012        | -0.04         | 0.008         | -0.182        |
|                  | (0.606)     | (0.467)      | (0.000)     | (0.000)      | (0.001)       | (0.358)      | (0.752)       | (0.349)       | (0.927)       | (0.870)       | (0.672)       | (0.928)       | (0.042)       |
| Premium WTP      | 0.078       | -0.028       | -0.019      | -0.103       | -2.017        | -1.901       | 0.508         | 0.525         | 0.254         | 0.202         | -0.104        | 0.029         | 0.114         | -0.035        |
|                  | (0.495)     | (0.639)      | (0.747)     | (0.009)      | (0.000)       | (0.000)      | (0.000)       | (0.012)       | (0.137)       | (0.175)       | (0.766)       | (0.174)       | (0.692)       |
| Discount WTP     | 0.339       | 0.014        | 0.017       | -0.001       | 0.274         | 0.132        | -1.723        | -1.741        | -0.030        | 0.024         | 0.026         | 0.016         | 0.179         | -0.037        |
|                  | (0.001)     | (0.794)      | (0.739)     | (0.972)      | (0.000)       | (0.035)      | (0.000)       | (0.746)       | (0.840)       | (0.704)       | (0.846)       | (0.020)       | (0.641)       |
| Delivered WTP    | 0.056       | 0.006        | 0.035       | 0.058        | -0.244        | -0.162       | 0.094         | 0.184         | -1.894        | -1.847        | -0.029        | -0.017        | 0.005         | -0.121        |
|                  | (0.591)     | (0.909)      | (0.501)     | (0.101)      | (0.000)       | (0.010)      | (0.084)       | (0.006)       | (0.000)       | (0.000)       | (0.678)       | (0.845)       | (0.944)       | (0.128)       |
| Premium café     | -0.110      | 0.048        | -0.036      | -0.041       | 0.100         | 0.097        | -0.064        | 0.030         | -0.343        | -0.104        | -2.382        | -2.230        | 0.168         | 0.254         |
|                  | (0.295)     | (0.379)      | (0.482)     | (0.236)      | (0.041)       | (0.118)      | (0.246)       | (0.654)       | (0.001)       | (0.421)       | (0.000)       | (0.000)       | (0.029)       | (0.002)       |
| Discount café    | 0.331       | 0.024        | 0.007       | -0.036       | 0.166         | 0.142        | -0.230        | -0.254        | -0.068        | 0.061         | 0.347         | -0.203        | -1.736        | -1.655        |
|                  | (0.002)     | (0.657)      | (0.894)     | (0.306)      | (0.001)       | (0.025)      | (0.000)       | (0.000)       | (0.467)       | (0.624)       | (0.678)       | (0.019)       | (0.000)       | (0.000)       |

Jordan\textsuperscript{2}

\textsuperscript{1} All elasticities are significant at p < 0.05 unless otherwise specified.

\textsuperscript{2} Jordan data not available for premium café.
|                  | Premium cig       | Discount cig       | Premium WTP       | Discount WTP       | Delivered WTP   | Premium café       | Discount café       | The West Bank of Palestine |
|------------------|-------------------|--------------------|-------------------|--------------------|-----------------|-------------------|-------------------|------------------------|
|                  | -1.121 (0.000)    | -0.093 (0.653)     | 0.199 (0.319)     | -0.412 (0.028)     | 0.054 (0.771)   | 0.075 (0.686)     | -0.132 (0.482)     | -2.259 (0.000)         |
|                  | -1.089 (0.000)    | -0.657 (0.000)     | 0.199 (0.224)     | -0.007 (0.123)     | -0.005 (0.925)  | 0.006 (0.976)     | 0.048 (0.384)      | -1.001 (0.000)         |
|                  | 0.055 (0.665)     | 0.165 (0.140)      | 0.030 (0.815)     | -0.007 (0.956)     | 0.030 (0.851)   | 0.006 (0.960)     | 0.001 (0.997)      | -0.640 (0.000)         |
|                  | 0.253 (0.000)     | -0.707 (0.000)     | 0.019 (0.140)     | 0.067 (0.144)      | -0.031 (0.804)  | -0.033 (0.804)    | 0.004 (0.945)      | 0.160 (0.000)         |
|                  | -0.124 (0.533)    | 0.297 (0.261)      | 0.169 (0.804)     | -0.067 (0.783)     | -0.042 (0.875)  | 0.111 (0.976)     | -0.092 (0.772)     | -0.031 (0.991)        |
|                  | -0.286 (0.009)    | 0.134 (0.001)      | 0.015 (0.804)     | 0.055 (0.899)      | 0.012 (0.942)   | 0.224 (0.977)     | 0.001 (0.301)      | -0.033 (0.825)        |
|                  | -0.060 (0.768)    | -0.540 (0.027)     | 0.670 (0.971)     | -1.376 (0.000)     | 0.022 (0.926)   | 0.006 (0.984)     | -0.150 (0.742)     | -0.146 (0.000)        |
|                  | 0.001 (0.994)     | -0.267 (0.089)     | 0.347 (0.715)     | -0.616 (0.000)     | 0.214 (0.466)   | -0.185 (0.992)    | -0.099 (0.732)     | -0.354 (0.000)        |
|                  | 0.111 (0.827)     | -0.079 (0.173)     | 0.155 (0.715)     | -1.073 (0.000)     | -0.273 (0.436)  | -0.234 (0.976)    | -0.134 (0.935)     | -0.026 (0.905)        |
|                  | -0.467 (0.034)    | 0.137 (0.151)      | 0.218 (0.165)     | -0.586 (0.000)     | -0.273 (0.002)  | -1.038 (0.000)    | 0.030 (0.640)      | -0.062 (0.735)        |
|                  | -0.159 (0.339)    | -0.040 (0.151)     | 0.110 (0.296)     | 0.190 (0.427)      | 0.064 (0.227)   | 0.107 (0.814)     | 0.238 (0.107)      | 0.124 (0.000)         |
|                  | -0.084 (0.525)    | 0.068 (0.638)      | 0.047 (0.696)     | 0.211 (0.099)      | -0.385 (0.000)  | 0.029 (0.632)     | -0.354 (0.520)     | 0.043 (0.715)         |

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|                      | Discount WTP       | Delivered WTP  | Premium café   | Discount café  |
|----------------------|--------------------|----------------|----------------|----------------|
|                      | (0.681) (0.000)    | (0.000) (0.406) (0.135) | (0.086) (0.733) (0.072) (0.721) (0.580) (0.345) (0.034) |
| Discount WTP         | -0.004 -0.069      | -0.116 -0.148 -0.340 | -0.524 -0.288 -0.140 0.703 0.048 -0.195 0.211 |
| (0.988) (0.299)      | (0.241) (0.563) (0.063) | (0.122) (0.507) (0.841) (0.005) (0.786) (0.360) (0.105) |
| Delivered WTP        | -0.076 0.052       | -0.078 0.131 0.084 | -0.043 -2.045 -0.608 -0.012 0.612 0.463 0.251 |
| (0.817) (0.498)      | (0.407) (0.591) (0.659) | (0.898) (0.000) (0.244) (0.959) (0.000) (0.029) (0.053) |
| Premium café         | -0.104 -0.082      | 0.082 0.410 0.246 | 0.632 -0.023 1.726 -1.625 -0.922 -0.056 -0.172 |
| (0.731) (0.259)      | (0.397) (0.112) (0.186) | (0.084) (0.958) (0.000) (0.000) (0.000) (0.000) (0.803) (0.188) |
| Discount café        | 0.011 0.044        | -0.216 -0.249 -0.122 | -0.549 0.976 -0.655 -0.082 -0.447 -0.386 -0.371 |
| (0.972) (0.525)      | (0.029) (0.321) (0.509) | (0.106) (0.040) (0.271) (0.721) (0.014) (0.121) (0.009) |

1 Reported figures indicate the own-price elasticity of each tobacco product, while the values in parentheses indicate the p-value.

2 The ZIP model did not converge for some tobacco products in the case of Jordan and the West Bank of Palestine.
|                  | Cigarettes | Waterpipe (250 g) | Waterpipe (sessions) |
|------------------|------------|-------------------|----------------------|
|                  | Women      | Male              | Women                | Male              |
| Lebanon          |            |                   |                      |                   |
| Cigarettes       | -0.737     | -0.568            | 0.019                | -0.014            |
|                  | (0.000)    | (0.000)           | (0.694)              | (0.820)           |
| Waterpipe (250 g)| 0.058      | -0.042            | -1.215               | -1.198            |
|                  | (0.381)    | (0.312)           | (0.000)              | (0.000)           |
| Waterpipe (sessions)| 0.033  | 0.011             | -0.006               | 0.039             |
|                  | (0.629)    | (0.807)           | (0.919)              | (0.583)           |
|                  |            |                   |                      |                   |
| Jordan           |            |                   |                      |                   |
| Cigarettes       | -0.708     | -0.565            | -0.071               | -0.126            |
|                  | (0.000)    | (0.000)           | (0.702)              | (0.290)           |
| Waterpipe (250 g)| 0.065      | 0.056             | -0.620               | -0.371            |
|                  | (0.658)    | (0.227)           | (0.001)              | (0.003)           |
| Waterpipe (sessions)| -0.025 | -0.022            | -0.051               | 0.066             |
|                  | (0.864)    | (0.664)           | (0.785)              | (0.602)           |
|                  |            |                   |                      |                   |
| The West Bank of Palestine | |                   |                      |                   |
| Cigarettes       | -1.844     | -1.029            | 0.508                | 0.133             |
|                  | (0.000)    | (0.000)           | (0.010)              | (0.275)           |
| Waterpipe (250 g)| 0.853      | 0.593             | 0.124                | 0.140             |
|                  | (0.002)    | (0.000)           | (0.506)              | (0.246)           |
| Waterpipe (sessions)| -0.248 | -0.031            | -0.276               | -0.051            |
|                  | (0.365)    | (0.656)           | (0.215)              | (0.703)           |

1 Reported figures indicate the price elasticity of each tobacco product, while the values in parentheses indicate the p-value.
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Gender differences in the price elasticity of demand for waterpipe and cigarette smoking in Lebanon, Jordan, and Palestine: A volumetric choice experiment

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Gender differences in the price elasticity of demand for waterpipe and cigarette tobacco smoking in Lebanon, Jordan, and Palestine: A volumetric choice experiment

Abstract

Objectives: This study assessed the extent to which the elasticity of cigarette and waterpipe tobacco products differs between men and women. We also explored the levels of substitution and complementarity in tobacco products amongst men and women.

Setting: The study examines tobacco elasticities in three Arab countries: Lebanon, Jordan and the West Bank of Palestine.

Participants: We used data from nationally representative surveys of adults aged ≥18 years in Lebanon (n=1680), Jordan (n=1925), and Palestine (n=1679). The proportion of women was 50.0% of the sample in Lebanon and Palestine, and 44.6% in Jordan.

Primary and secondary outcome measures: A zero-inflated Poisson regression model estimated own- and cross-price elasticities for two variations of cigarettes and five variations of waterpipe tobacco products. Elasticities were measured based on eight scenarios of prices.

Results: Overall, women had higher price elasticities of demand for tobacco products than men. For example, the price elasticity for premium cigarettes was -1.12 and -2.26 for Jordanian and Palestinian women, respectively as compared to -1.09 and -1.00 for their male counterparts. Demand for waterpipe tobacco products was elastic for both men and women. The cross-price elasticities in the three countries indicate the existence of substitution between cigarettes and waterpipe products and by different varieties within each of the two tobacco products. Gender
differences varied across the three countries whereby higher cross-price elasticities were generally observed for women in Lebanon and Jordan.

**Conclusions:** Gender differences in own- and cross-price elasticities of waterpipe tobacco products should be taken into consideration in tobacco control strategies particularly when reducing tobacco consumption via taxation policies.

**Keywords:** Tobacco smoking; Waterpipe; Gender; Elasticity; Arab region
Strengths and limitations of this study

- We used a robust, volumetric choice experiment from nationally representative surveys to assess own- and cross-price elasticities of waterpipe tobacco – a topic that has received little attention in the literature.

- The study provided a comprehensive evaluation of price elasticities of different tobacco products and by gender using identical methodologies that allow cross-country comparisons.

- One limitation is that the data does not account for the effect of price differentials across the three neighboring countries. Thus, the impact of smuggling on tobacco consumption remains uncertain.

- Another limitation is related to the actual impact of price changes on tobacco consumption. Elasticities considered in this study measure the sensitivity of individuals to price changes adjusted for inflation but not for income.
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Conflicts of interest

The authors declare no conflicts of interest.

Data availability statement

Data are available upon reasonable request.

Patient and public involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Ethics Approval

The institutional review boards at the American University of Beirut (ID: SBS-2019-0097), Jordan University of Science and Technology (ID: 14-119-2018), and Birzeit University (ID: 2019 (1-1)).

Patient consent for publication

Not applicable.

Contributorship statement

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1 Introduction

Empirical evidence suggests that men have higher rates of tobacco smoking compared to women.\textsuperscript{1,2} In general, the prevalence of tobacco smoking amongst men is about ten-fold that of women in developing countries (32\% vs. 3.1\%) as compared to less than two-fold in developed countries (30\% vs. 17\%).\textsuperscript{3} Tobacco control policies seeking to reduce tobacco prevalence include tax policies, consumer education, using health warning labels, restrictions on tobacco smoking in public spaces, banning tobacco advertising and promotion, and smoking cessation programs.\textsuperscript{4–6}

Increasing tobacco prices by imposing higher tobacco excise taxes is among the most effective policy tools to reduce the prevalence of tobacco smoking.\textsuperscript{7,8} To assess the effectiveness of tobacco tax policies, it is imperative to evaluate how individuals would change their responsiveness of tobacco consumption to changes in the prices of each tobacco product and the possible trade-off between tobacco products. Higher tobacco prices may lead smokers to switch to lower-priced tobacco products. The bulk of available literature examining the price elasticity of demand for tobacco products has focused on cigarettes only. Studies which has focused on other tobacco products such as waterpipe are scarce.\textsuperscript{9,10} A recent review on the price elasticity of demand for non-cigarette tobacco products revealed that there is a lack of corresponding research in the Arab region where most of the included studies has been conducted in high-income settings.\textsuperscript{10}

The prevalence of non-cigarette tobacco smoking is increasing worldwide.\textsuperscript{11} In the Arab region, waterpipe tobacco smoking – also referred to as narghile, arghile, and shisha – is gaining popularity amongst both men and women.\textsuperscript{12} Further, Arab women tend to smoke waterpipe tobacco more than cigarettes.\textsuperscript{13,14} Recent estimates based on representative surveys show that the prevalence of waterpipe tobacco smoking amongst women in Lebanon is more than twice that of cigarettes (54.7\% vs. 27.5\%).\textsuperscript{15} Available evidence shows that tax policies might be unequal across
socioeconomic groups as it imposes higher burden on the worse-off segment of the population. Socioeconomic differences between men and women in the Arab region such as income differences may render women more vulnerable to changes in tobacco prices as compared to men. With women being endowed with lower financial resources, it is crucial to assess gender differences in terms of the degree of responsiveness in tobacco consumption in relation to changes in tobacco prices (taxes).

In the Arab region, taxation policies of waterpipe products as compared to cigarettes are absent. Moreover, in some countries tax rates on cigarettes are lower than the recommended rate of 75% of the retail price of tobacco products. Based on a recent report of the World Health Organization, the general tax structure of tobacco products in the region is composed of four different types of taxes: (i) import duty tax (%); (ii) ad valorem tax (%); (iii) value added tax (%) and (iv) specific excise tax (USD). In Jordan and Palestine, the overall tax rates on popular brands of cigarettes exceed 75% (78.0% in Jordan vs. 92.8% in Palestine) while in Lebanon the overall tax rates on cigarettes is 9.9%. As for waterpipe products, the overall tax rates are, respectively, 21.2%, 30.4% and 79.0% in Lebanon, Jordan and Palestine. These facts reveal that there is some room to increase taxation of different tobacco products in these countries as a tool to reduce the prevalence of smoking in the region.

The assessment of the price elasticity of demand for tobacco has been largely addressed using a variety of econometric models such as linear regression models, two-part models, and the Zero-Inflated Poisson (ZIP) model. However, the estimation of waterpipe tobacco elasticities and cross-price elasticities of tobacco products has received less attention in the literature. Empirical evidence shows that results are rather mixed with some tobacco products being substitutes for cigarettes such as cigars and electronic cigarettes while others such
as bidis are shown to be complementary to cigarettes.\textsuperscript{23} Regarding differences across groups, there is a bulk of literature which assessed the elasticity of demand for tobacco products, mainly cigarettes, across age and socioeconomic groups in low-income countries.\textsuperscript{7,20,24} To the best of our knowledge, there is only one study that quantified the elasticity in the Arab region (in Lebanon) across socioeconomic groups.\textsuperscript{7} The results of this study shows that demand for imported cigarettes is inelastic and that the corresponding own-price elasticities are higher for the poorest income quintile (-0.32) and lower for the richest quintile (-0.22).\textsuperscript{7}

Studies investigating the price elasticities of demand for different tobacco products across gender groups are, however, limited.\textsuperscript{25–27} Moreover, there were no previous attempts to assess gender differences in the price elasticities of waterpipe tobacco products. Existing empirical evidence concerning gender differences in the price elasticity of demand for tobacco, mainly cigarettes, is also mixed. For instance, using a two-part model, Tauras, Huang & Chaloupka (2013) showed that the price elasticity of young women in the United States was more than two-fold the price elasticity of their men counterparts (-0.63 vs. -0.25). However, Sweis & Chaloupka (2014) demonstrated that Jordanian men had a higher price elasticity of cigarettes as compared to women (-0.81 vs. -0.01).

A full analysis of the own- and cross-price elasticities of different tobacco products that account for gender differences is lacking. The aims of this paper, which focuses on Lebanon, Jordan, and the West Bank of Palestine, were thus two-fold. Firstly, we aimed to assess the extent to which the elasticity of cigarettes and waterpipe tobacco products differs between men and women. Secondly, we aimed to explore the substitution and complementarity in tobacco products amongst men and women.
2 Methods

2.1 Data

We used data from nationally representative surveys that were conducted in Lebanon, Jordan and the West Bank of Palestine in June-August 2019. The full methodological details of these surveys are published elsewhere. Briefly, eligible respondents included male and female adults (≥18 years old) residing in each country regardless of their nationality. The sample sizes were calculated to estimate the prevalence of current waterpipe smoking for both males and females in each country separately based on previously reported prevalence rates. A two-stage cluster sampling approach in which probability-proportional-to-size random selection methods was applied to choose clusters in each country. The first stage entailed selecting well-defined geopolitical areas (clusters) within the governorates in each country (8 governorates in Lebanon, 12 governorates in Jordan, 11 governorates in the West Bank). The second stage involved choosing a random sample of 30 households from each selected cluster using systematic random sampling. From each selected household, one eligible male and one female residents were selected. To ensure the inclusion of each selected household in the sample, the household was visited three times. If the household is marked as “Not at home”, the next household was selected. In Lebanon and the West Bank, a balanced sample of men and women was selected while in Jordan, the number of men was higher than women as additional households were selected based on their availability at home during the visits. All participants were provided with information about the study and were asked to provide consent to participate.

The surveys assessed the use of two main varieties of cigarettes (premium and discount cigarettes) and five varieties of waterpipe tobacco (premium, discount, home-delivered waterpipe tobacco, and premium and discount waterpipe tobacco café smoking). The questionnaire included
a volumetric choice experiment (VCE) that modeled eight scenarios of different tobacco product with varying prices in each scenario. Respondents were asked to indicate the amount of tobacco (cigarettes and waterpipe) they were willing to consume under each scenario. Respondents could choose to consume any possible combination of tobacco products within each scenario. The VCE allows to calculate the cross-price elasticity between different tobacco products based on consumers’ willingness to trade-off tobacco products under each scenario of prices. The surveys assessed non-flavored waterpipe tobacco for Lebanon and Jordan and roll-your-cigarette smoking for the West Bank. For consistency, these two categories of tobacco have been excluded in the current analysis.

As shown in Table 1, the highest share of smokers is observed in Lebanon for both gender groups (75.2% of men and 63.8% of women). Results indicate a higher gender gap in terms of smoking in Jordan and Palestine as compared to Lebanon. For example, the prevalence of smoking in Palestine is 36.0% amongst men and about 7.0% amongst women. Women in Lebanon and Palestine tend to smoke waterpipe more than cigarettes with a prevalence rate of waterpipe smoking of 46.3% and 5.1% and a prevalence rate of cigarettes smoking of 24.3% and 2.6% in Lebanon and Palestine, respectively.

### 2.2 Statistical analysis

Akin to Chalak et al. (2021), we used a Zero-Inflated Poisson (ZIP) regression model to calculate the own- and cross-price elasticities of demand for tobacco products for each country. The ZIP model is suitable for count data with excess zeros (non-smokers in our case). The ZIP model was estimated first for each gender group for each of the seven tobacco products. Then the model was estimated for each gender for each tobacco product variety. Tobacco products were
classified into three groups such that the within-group unit of measurement was homogenous. These groups were (i) cigarettes, which included premium and discount cigarettes – measured in packs; (ii) waterpipe tobacco (250g), which included premium and discount waterpipe tobacco and (iii) waterpipe sessions, which included delivered waterpipe and discount and premium waterpipe café smoking sessions. For each group, the quantity was calculated as the sum of all quantities reported by each respondent at each set of prices. The price of each product variety was calculated using the Stone index. For each product variety, \( j \), the stone index, \( P^S_j \), is defined as

\[
P^S_j = \prod_{m=1}^{M} (p_m)^{s_m}
\]

where \( M \) is the total quantity within each product variety, \( p_m \) is the price of tobacco product \( m = 1, \ldots, M \), and \( s_m \) is the expenditure weight of product \( m \) such that \( \sum_{m=1}^{M} s_m = 1 \). The stone index is a weighted geometric mean of the price of tobacco products. Some respondents reported zero quantities at certain price levels. So calculating \( s_m \) for each respondent at each scenario of prices yielded many null weighted prices. We therefore calculated \( s_m \) as the average weight of all respondents for all price scenarios for each tobacco product variety \( m \).

Two binary variables were constructed for the regression analysis used to estimate the price elasticities of demand. The first equaled one if the individual smoked any type of cigarettes while the second equaled one if the individual smoked any type of waterpipe tobacco. The former binary variable was used as an inflation variable in the ZIP models of cigarette products while the latter binary variable was used in the ZIP models of waterpipe products. For all models, the set of independent variables of the first part model included the logarithmic forms of the prices of all tobacco product varieties and a categorical variable of four income groups. The inclusion of the prices of all tobacco products allowed for calculating the cross-price elasticities between all
tobacco products. In general, the set of independent variables of the inflation part of the ZIP model included the relevant binary variable of tobacco smoking, age (categorical variable), marital status (binary variable which takes one if the individual is single), a region variable (country-specific), employment status (unemployed, full-time and part-time employee), education level (less than university and with university education), and a binary variable that equaled one if the individual was responsible for taking decisions in the household. For some tobacco product varieties across genders, only a subset of these independent variables was used due to the small sample size of smokers. All analyses were conducted using Stata version 14.2.

Table 1 summarizes the three sample characteristics. The number of respondents were 1680 (50% female) in Lebanon, 1925 (44.6% female) in Jordan and 1679 (50% female) in the West Bank. In general, the distribution of men and women across the different age groups was balanced across all countries. Regarding the marital status, the share of single men and women was less than the quarter across countries. Turning to employment status, the unemployment rate was higher amongst women as compared to men across all countries (72.3% in Lebanon, 78.4% in Jordan and 89.8% in the West Bank). As for income groups, similar patterns were observed across all countries with the population being concentrated in the second and third quartiles for both men and women.

3 Results

3.1 Own-price elasticities

The price elasticities were first calculated by gender groups for each type of tobacco smoking for each country. Aggregate price elasticities have been documented elsewhere. Results, which are summarized in Table 2, show that in Lebanon the price elasticity was significantly higher for women for the following types of tobacco; discount cigarettes (-0.75 for women vs. -0.58 for
men), premium waterpipe (-2.02 for women vs. -1.90 for men), delivered waterpipe (-1.89 or women vs. -1.85 for men), premium café (-2.38 for women vs. -2.23 for men) and discount café (-1.74 for women vs. -1.66 for men). All elasticities of waterpipe products were greater than one indicating an elastic demand for waterpipe products for both men and women, as compared to cigarettes. Particularly, elasticities were the highest for premium café sessions and premium waterpipe tobacco, which were relatively more expensive as compared to other varieties of waterpipe products.

In Jordan, with the exception of discount cigarettes, women generally had higher elasticities as compared to men. For example, the price elasticity of discount waterpipe for women was about two-fold the elasticity observed for men (-1.38 vs. -0.62). Moreover, the price elasticity of premium cigarettes for women was slightly higher than the price elasticity for men (-1.12 vs. -1.09). The highest elasticity was observed for discount waterpipe for women where a 10% increase in the price of discount waterpipe yielded a 13.8% decrease in its quantity consumed.

As for the West Bank, the price elasticity of premium cigarettes for women was -2.26 as compared to -1.00 for men. Palestinian women had the highest price elasticity of premium cigarettes as compared to Lebanon and Jordan. Furthermore, the price elasticities of home-delivered waterpipe and premium and discount café sessions were higher for women as compared to men. For example, the price elasticity of delivered waterpipe for women was slightly more than three-fold the price elasticity of delivered waterpipe for men (-2.05 vs. -0.61). The price elasticity of premium waterpipe was found to be positive for both men and women though they were not statistically significant.

Table 3 summarizes the price elasticities of tobacco product varieties by gender for each country. In Lebanon, all own-price elasticities were statistically different from zero with higher
elasticities being observed for women for cigarettes and waterpipe products. For example, a 10% average increase in cigarettes prices would result in a decrease in the quantity of cigarettes consumed by about 7.4% for women and 5.7% for men indicating an inelastic demand for cigarettes. Nonetheless, results show that demand for waterpipe was elastic. As for Jordan, the price elasticities of the three tobacco product varieties were higher for women. For example, a 10% average increase in waterpipe prices would result in a decrease in the quantity of waterpipe consumed by about 6.2% for women and only 3.7% for men. The demand for all tobacco product varieties was inelastic in Jordan. Different patterns were observed for the West Bank. The price elasticity of both cigarettes and waterpipe sessions were higher for women. However, the demand for cigarettes was elastic (-1.84 for women vs. -1.03 for men) while the demand for waterpipe session was inelastic (-0.60 for women vs. -0.33 for men).

3.2 Cross-price elasticities

Estimated cross-price elasticities of tobacco products are summarized in Table 2 for the three countries. In Lebanon, the cross-price elasticities of premium cigarettes with respect to other tobacco products were not statistically significant except for discount waterpipe and discount café sessions for women. The cross-price elasticity of discount cigarettes with respect to premium cigarettes was positive and statistically significant for both men and women indicating a substitution effect between the two types of cigarettes. The magnitude of the estimated cross-price elasticity of discount cigarettes with respect to premium cigarettes was higher for women (0.23) as compared to men (0.15). Such a result goes in line with the economic theory where a price increase in premium brands of a certain good leads consumers to switch to cheaper brands/products. As for premium waterpipe, results show that cross-price elasticities were
statistically significant and positive with respect to discount waterpipe and discount café and negative with respect to discount cigarettes and home-delivered waterpipe for both women and men. This result indicates that there was some level of substitution between premium waterpipe and the discounted waterpipe products (discount waterpipe tobacco and discount café) and some level of complementarity within the premium waterpipe products (premium waterpipe tobacco with home-delivered waterpipe). Results also indicate that premium waterpipe and discount cigarettes exhibited some substitution whereby a 10% increase in the price of discount cigarettes results in a 2.1% and 2.3% increase in the quantity consumed of premium waterpipe respectively for women and men. Also of note, that most cross-price elasticities of premium waterpipe were slightly higher for women as compared to men. This result is also confirmed with the cross-price elasticity of discount waterpipe with respect to other waterpipe products whereby complementarity was observed between discount waterpipe and discount café while substitution effect was observed between discount waterpipe and premium and delivered waterpipe. However, the cross-price elasticities of discount waterpipe were slightly higher for women as compared to men. Furthermore, discount café sessions appear to be substitutes for premium café sessions with higher elasticities being observed for men (0.17 for women vs. 0.25 for men).

As for Jordan, results show a substitution effect between premium and discount cigarettes for men only with, for example, a cross-price elasticity of discount cigarettes with respect to premium cigarettes equal to 0.25. As for waterpipe products, the cross-price elasticity of discount waterpipe with respect to premium waterpipe was statistically significant and positive for both men and women with the elasticity for women being twice that of men (0.67 vs. 0.35). This may indicate that discount and premium waterpipe products were substitutes.
Lastly, results on the cross-price elasticities of tobacco products for the West Bank were mixed. Only a few of the cross-price elasticities were statistically significant for men and women. There was some level of substitution between waterpipe products for women. For example, the cross-price elasticity of home-delivered waterpipe with respect to discount café sessions was positive and close to one for women (0.98). Furthermore, a 10% increase in the price of discount waterpipe product would reduce the quantity consumed of waterpipe in premium cafes by 7.03%. For men, on the other hand, unlike Lebanon and Jordan, results show complementarity between cigarettes products. For example, a 10% increase in the price of premium cigarettes would reduce the quantity consumed of discount cigarettes by 6.4%.

Once tobacco products were aggregated into groups, results indicate a substitution effect between cigarettes and waterpipe products for both men and women in the West Bank only as shown in Table 3. Moreover, the cross-price elasticity of cigarettes with respect to waterpipe was higher for women (0.9) as compared to men (0.6).

4 Discussion

This study provides estimates of the responsiveness in tobacco consumption in relation to changes in the prices of different varieties of cigarettes and waterpipe tobacco products among women and men in Lebanon, Jordan and the West Bank. In general, the study found that women are more responsive to changes in the prices of tobacco products particularly waterpipe products in the three countries. Given that women are generally worse-off as compared to men in these countries, such a result is in line with previous evidence where the poorest are found to be more sensitive to changes in tobacco prices. Results for Jordan were different from those obtained by Sweis & Chaloupka (2014) where the price elasticity of tobacco is found to be higher for men as
mentioned in the introduction. Such a difference may be attributed to several reasons. First, previous estimates were calculated for cigarettes only without including any difference between cigarettes’ products or waterpipe products. Second, previous estimates were based on actual consumption of cigarettes (number of packs smoked per week) while in our case we applied a choice experiment that measure the amount consumed by each individual for each scenario of prices. Third, previous estimates were calculated based on 2011 data were the prevalence of smoking among women was lower (5.1% in 2011 vs. 13.1% in 2019).

The following highlights several interesting findings emerging from our analysis and their implications to policymakers. First, women were generally more sensitive to changes in tobacco prices indicating that women smokers would reduce their tobacco consumption more than men smokers in response to similar increases in tobacco prices. Empirical evidence shows that the effects of policy interventions may vary by gender whereby women are more responsive to policy changes.\textsuperscript{30–32} For example, using linear regression with states and years fixed effects, a study conducted in the United States show that a tobacco tax intervention appears to be beneficial for women, but not for men, in terms of reducing coronary heart disease mortality.\textsuperscript{30} Such a result is of interest for policymakers for two main reasons. First, as mentioned in the outset, the prevalence of waterpipe smoking is increasing in the Arab region particularly amongst women. Thus, an effective policy intervention may play a major role in reducing the prevalence of smoking amongst women. The second point is related to the specific health impact of tobacco use on pregnant women since smoking during pregnancy can increase the risk of abnormal pregnancy and delivery, birth defects, etc.\textsuperscript{33} Reducing the prevalence of smoking amongst women would benefit both mothers and children by reducing the long-term health burden and the associated economic burden.
Second, the degree of responsiveness to changes in tobacco prices varied across the three countries. Different patterns of price elasticities were observed amongst the three countries once tobacco products were categorized into three groups: cigarettes, waterpipe tobacco (250g) and waterpipe sessions. For example, the demand for cigarettes was elastic in Lebanon and inelastic in the West Bank while the demand for waterpipe was inelastic in Lebanon and elastic in the West Bank. In Jordan, both the demand for cigarettes and for waterpipe appeared to be inelastic. Such differences might be related to the current prices of cigarettes and waterpipe products, as well as the overall socioeconomic status (e.g., average income per capita). Moreover, these differences may be related to the fact that for nicotine-dependent smokers, a large increase in tobacco prices induces a smaller decrease in the quantity consumed of tobacco products. Such results reveal that tobacco smoking behavior is rather country-specific, thus tobacco control policies should also be tailored in each country to reflect the sensitivity of tobacco products to price changes.

Third, the degree of responsiveness to changes in prices was higher for waterpipe products as compared to cigarettes. Such observation is mostly prominent for Lebanon where own-price elasticities of waterpipe products were greater than one for both men and women. This indicates an elastic demand for waterpipe products as compared to cigarettes. Such result is very important especially with the increasing popularity of waterpipe products in the region and the fact that waterpipe products are not taxed in the same manner as cigarettes.\textsuperscript{34}

Fourth, results on the cross-price elasticities in the three countries indicated some substitution between cigarettes and waterpipe products, and within each product variety. However, gender differences varied across the three countries whereby higher cross-price elasticities were generally observed for women in Lebanon and Jordan. Whereas in the West Bank results were mixed with some of the cross-price elasticities being higher for men. From a public health
perspective, it is crucial to tax all tobacco products equally to avoid any substitution between and within cigarettes and waterpipe product varieties. For example, the positive cross-price elasticity between premium and discount cigarettes could lead to switching towards discount cigarettes, which may pose a higher risk of adverse health effects.\textsuperscript{35,36}

In general, this paper adds to the literature that assesses the price elasticity of tobacco, particularly for waterpipe tobacco elasticities and cross-price elasticities of tobacco products. To the best of our knowledge, this is the first attempt that provides a comprehensive evaluation of price elasticities of different tobacco products and across gender groups in the region. As mentioned in the outset, previous estimates from Lebanon and Jordan were either aggregate estimates or were calculated for cigarettes only.\textsuperscript{9,10,26} Available literature in other regions which provides estimation of aggregate elasticities of non-cigarette products generally exclude waterpipe products while the other part of literature provide estimation across socioeconomic and age groups. Another key strength of the present article is the use of a harmonized methodology for three neighboring countries in the region in terms of data collection and data analysis. Such approach allows for cross-country comparisons of the prevalence of smoking as well as the own- and cross-price elasticities of different tobacco products. However, this is not without limitations. Our data does not account for the effect of price differentials across these three or other neighboring countries. For example, the price of cigarette products is the highest in Palestine. As a result, Palestinians living in the West Bank may illegally purchase premium cigarettes with cheaper prices from Jordan. Such behavior of smuggling may impact the effectiveness of tobacco policy interventions that seek to increase tobacco prices through taxation. Empirical evidence suggests that differences in tobacco prices across neighboring countries may increase the consumption of tobacco in areas where the price of tobacco in neighboring countries is lower.\textsuperscript{37} With the presence
of smuggling in the West Bank, the prevalence of tobacco smoking in the West Bank is expected to be different than that observed in the Gaza Strip. Indeed, available evidence shows that the prevalence rate of smoking is higher in the West Bank. Unfortunately, this study focuses on the West Bank only, thus it is difficult to conduct a comparison between the two Palestinian regions.

To sum up, price differentials across neighboring countries suggests that prices of both cigarettes and waterpipe products shall be harmonized in the three countries to achieve effective decrease in the prevalence of smoking.

Another limitation is related to the independent variables included in the model that may affect the level of consumption of tobacco products. With the exception of prices, all variables were measured at the individual level. The income effect was captured in the ZIP model by controlling for both income differences and differences in the employment status of individuals. Other factors that might affect tobacco consumption and shall be available at the country or regional levels were not included in the surveys. An example of such variables is related to variations in the business cycle. Empirical evidence shows that gross domestic product (GDP) and unemployment rates across regions are highly correlated with tobacco consumption where higher GDP growth rates and lower unemployment rates tend to reduce tobacco consumption.

Another limitation of the study is related to the actual impact of price changes on tobacco consumption. In our model, absolute prices were included in the analysis which allows to measure the price elasticities. Prices would affect tobacco consumption directly (substitution effect) and indirectly through reducing the purchasing power of individuals (income effect). However, if income increases, then the level of tobacco consumption will also increase. Accordingly, the prevalence and intensity of tobacco consumption might not be reduced if the tax increase was associated with income increase. To assess the effectiveness of tobacco tax policies, empirical
evidence suggests to calculate the so-called affordability elasticity which captures the changes of tobacco consumption to changes in the price and income simultaneously rather than separating the two effects. This is done by including the price-income ratio in the model instead of including both prices and income as two independent variables. Although we account for income effect in the current study, we could not calculate this ratio since income is available as a categorical variable.

Based on limitations raised above, future research could focus on the following three areas. First, the lack of data in this strand of literature calls for the collection of national comprehensive data for each country in the region. This data could include information about the source of purchase of tobacco products to account for the impact of illicit trade caused by price differentials across neighboring countries. Accounting for this in the analysis of price elasticities is crucial to assess the effectiveness of tobacco taxation policies. Second, although income data are relatively unreliable in low-income countries where individuals tend to underreport the level of their income, future surveys could also include questions about the level of income or consumption expenditure as a proxy for income. This allows us to calculate the affordability elasticity of tobacco consumption and compare results with those obtained from considering price and income elasticities separately. Third, future research could also benefit from results obtained at the micro level to assess the associated health benefits as well as macro-level impact of tax interventions on government revenues.

5 Conclusion

The epidemic of waterpipe tobacco smoking is growing among women in low- and middle income countries. Our analysis could inform efforts in increasing taxation on waterpipe tobacco
products in similar contexts. Moreover, the prevalence of tobacco smoking is likely to increase amongst women in the region as social restrictions placed on women are reduced. These restrictions include religious restrictions and socio-cultural acceptance of women smoking where people in the region believe that the practice of smoking reflect a “negative image” of women.\textsuperscript{42,43} As shown in Lebanon, where smoking among women is more socially acceptable relative to other countries in the region, the prevalence of tobacco smoking amongst women is extremely high.\textsuperscript{43,44} Therefore, gender-based analyses are important to consider the formulation of tobacco control policies. The differences in the own- and cross-price elasticities between men and women reveal the higher responsiveness of women to changes in tobacco prices as compared to men. The fact that some tobacco product varieties appear to be elastic particularly for women may reflect the effectiveness of increasing tobacco taxes, hence reducing tobacco prevalence and the associated economic burden. Akin to previous evidence that demonstrates a substitution effect between cigarettes and other tobacco products, such as cigars and electronic cigarettes,\textsuperscript{21} this paper shows that some waterpipe tobacco and cigarettes products act as substitutes. The fact that many tobacco products appear to be substitutes reflect the importance of taxing all tobacco products to avoid any potential substitution that may occur between and within tobacco products while increasing government revenues.\textsuperscript{15,21,45}
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| Age group, years | Lebanon (N=1680) | Jordan (N=1925) | West Bank (N=1679) |
|-----------------|------------------|-----------------|-------------------|
| < 25            | Women 840 (50.0%) | Women 858 (44.6%) | Women 840 (50.0%) |
|                 | Men 840 (50.0%)  | Men 1067 (55.4)  | Men 839 (50.0%)   |
| 26-35           | Women 162 (19.3%) | Women 203 (24.2%) | Women 188 (17.6%) |
|                 | Men 134 (16.0%)  | Men 203 (23.7%)  | Men 122 (14.5%)   |
| 36-45           | Women 188 (22.3%) | Women 187 (22.3%) | Women 200 (23.3%) |
|                 | Men 174 (20.7%)  | Men 203 (23.7%)  | Men 170 (20.2%)   |
| 46-55           | Women 197 (23.5%) | Women 170 (20.7%) | Women 198 (20.0%) |
|                 | Men 175 (20.8%)  | Men 172 (20.0%)  | Men 188 (17.6%)   |
| >56             | Women 90 (10.7%) | Women 175 (20.8%) | Women 131 (15.3%) |

| Marital status | Lebanon (N=1680) | Jordan (N=1925) | West Bank (N=1679) |
|----------------|------------------|-----------------|-------------------|
| Single         | Women 100 (11.9%) | Women 147 (17.5%) | Women 133 (15.5%) |
|                | Men 740 (88.1%)  | Men 639 (82.5%)  | Men 725 (84.5%)   |

| Employment status | Lebanon (N=1680) | Jordan (N=1925) | West Bank (N=1679) |
|-------------------|------------------|-----------------|-------------------|
| Unemployed        | Women 607 (72.3%) | Women 187 (22.3%) | Women 673 (78.4%) |
|                   | Men 187 (22.3%)  | Men 203 (23.7%)  | Men 372 (34.9%)   |
| Full-time employed| Women 174 (20.7%) | Women 574 (68.3%) | Women 137 (16.0%) |
|                   | Men 574 (68.3%)  | Men 137 (16.0%)  | Men 526 (49.3%)   |
| Part-time employed| Women 59 (7.0%)  | Women 79 (9.4%)  | Women 48 (5.6%)   |

| Education level | Lebanon (N=1680) | Jordan (N=1925) | West Bank (N=1679) |
|-----------------|------------------|-----------------|-------------------|
| Less than university | Women 669 (79.6%) | Women 664 (79.1%) | Women 639 (74.5%) |
| University education | Men 171 (20.4%) | Men 176 (20.9%) | Men 219 (25.5%) |

| Participation in decisions in the household | Lebanon (N=1680) | Jordan (N=1925) | West Bank (N=1679) |
|---------------------------------------------|------------------|-----------------|-------------------|
| Yes                                         | Women 706 (80.1%) | Women 489 (58.2%) | Women 692 (80.7%) |
| No                                          | Men 134 (19.9%)  | Men 351 (41.8%)  | Men 166 (19.3%)   |

| Income group | Lebanon (N=1680) | Jordan (N=1925) | West Bank (N=1679) |
|--------------|------------------|-----------------|-------------------|
| Lowest quartile | Women 75 (9.1%) | Women 62 (7.5%) | Women 207 (24.9%) |
|               | Men 62 (7.5%)    | Men 207 (24.9%) | Men 227 (21.7%)   |
| 2nd quartile  | Women 321 (38.8%) | Women 326 (39.5%) | Women 320 (38.5%) |
|               | Men 326 (39.5%)  | Men 320 (38.5%) | Men 411 (39.4%)   |
| 3rd quartile  | Women 320 (38.7%) | Women 323 (39.1%) | Women 197 (23.7%) |
|               | Men 323 (39.1%)  | Men 197 (23.7%) | Men 262 (25.1%)   |
| Highest quartile | Women 111 (13.4%) | Women 115 (13.9%) | Women 107 (12.9%) |
|               | Men 115 (13.9%)  | Men 107 (12.9%) | Men 144 (13.8%)   |

| Smoking cigarettes | Lebanon (N=1680) | Jordan (N=1925) | West Bank (N=1679) |
|--------------------|------------------|-----------------|-------------------|
| Yes                | Women 204 (24.3%) | Women 415 (49.4%) | Women 76 (8.9%)  |
| No                 | Men 636 (75.7%)  | Men 425 (50.6%)  | Men 496 (65.6%)  |

| Smoking waterpipe | Lebanon (N=1680) | Jordan (N=1925) | West Bank (N=1679) |
|-------------------|------------------|-----------------|-------------------|
| Yes               | Women 389 (46.3%) | Women 300 (35.7%) | Women 60 (7.0%) |
| No                | Men 451 (53.7%)  | Men 540 (64.3%)  | Men 169 (15.8%)  |

| Smoking any type of tobacco | Lebanon (N=1680) | Jordan (N=1925) | West Bank (N=1679) |
|----------------------------|------------------|-----------------|-------------------|
| Yes                        | Women 536 (63.8%) | Women 632 (75.2%) | Women 112 (13.1%) |
| No                         | Men 304 (36.2%)  | Men 208 (24.8%)  | Men 575 (53.9%)  |
Table 2: Own- and cross-price elasticities of tobacco products in three Arab countries

|                | Premium cig | Discount cig | Premium WTP | Discount WTP | Delivered WTP | Premium café | Discount café |
|----------------|-------------|--------------|-------------|--------------|---------------|--------------|---------------|
|                | Wome n | Men | Wome n | Men | Wome n | Men | Wome n | Men | Wome n | Men | Wome n | Men |
| Lebanon        |        |     |        |     |        |     |        |     |        |     |        |     |
| Premium cig    | -0.919  | **-1.205**  | 0.230      | 0.146       | -0.019        | -0.104       | 0.142       | 0.206       | 0.028       | 0.001       | 0.010       | 0.047       |
|                | (0.000) | (0.000) | (0.000) | (0.718) | (0.779) | (0.063) | (0.630) | (0.158) | (0.113) | (0.697) | (0.995) | (0.568) |
| Discount cig   | -0.061  | 0.045 | **-0.751**  | **-0.582**  | -0.210       | -0.231       | 0.060       | 0.025       | 0.103       | -0.013       | -0.012       | -0.04       | 0.008       | -0.182       |
|                | (0.606) | (0.467) | (0.000) | (0.000) | (0.001) | (0.358) | (0.752) | (0.349) | (0.927) | (0.870) | (0.672) | (0.928) | (0.042) |
| Premium WTP    | 0.078   | -0.028 | -0.019 | -0.103 | **-2.017**  | **-1.901**  | 0.508       | 0.525       | 0.254       | 0.202       | -0.104       | 0.029       | 0.114       | -0.035       |
|                | (0.495) | (0.639) | (0.747) | (0.009) | (0.000) | (0.000) | (0.000) | (0.012) | (0.137) | (0.175) | (0.766) | (0.174) | (0.692) |
| Discount WTP   | 0.339   | 0.014 | 0.017 | -0.001 | 0.274       | 0.132       | **-1.723**  | **-1.741**  | -0.030       | 0.024       | 0.026       | 0.016       | 0.179       | -0.037       |
|                | (0.001) | (0.794) | (0.739) | (0.972) | (0.000) | (0.035) | (0.000) | (0.000) | (0.013) | (0.175) | (0.766) | (0.174) | (0.692) |
| Delivered WTP  | 0.056   | 0.006 | 0.035 | 0.058 | -0.244       | -0.162       | 0.094       | 0.184       | **-1.894**  | **-1.847**  | -0.029       | -0.017       | 0.005       | -0.121       |
|                | (0.591) | (0.909) | (0.501) | (0.101) | (0.000) | (0.010) | (0.084) | (0.006) | (0.000) | (0.000) | (0.078) | (0.845) | (0.944) | (0.128) |
| Premium café   | -0.110  | 0.048 | -0.036 | -0.041 | 0.100       | 0.097       | -0.064       | 0.030       | -0.343       | -0.104       | **-2.382**  | **-2.230**  | 0.168       | 0.254       |
|                | (0.295) | (0.379) | (0.482) | (0.236) | (0.041) | (0.118) | (0.246) | (0.654) | (0.001) | (0.421) | (0.000) | (0.000) | (0.029) | (0.002) |
| Discount café  | 0.331   | 0.024 | 0.007 | -0.036 | 0.166       | 0.142       | -0.230       | -0.254       | -0.068       | 0.061       | 0.347       | -0.203       | **-1.736**  | **-1.655**  |
|                | (0.002) | (0.657) | (0.894) | (0.306) | (0.001) | (0.025) | (0.000) | (0.000) | (0.467) | (0.624) | (0.678) | (0.019) | (0.000) | (0.000) |

Jordan
| Premium cig | -1.121 | -1.089 | 0.055 | 0.253 | -0.124 | -0.286 | -0.060 | 0.001 | 0.111 | -0.467 | -0.159 | -0.084 |
|-----------|-------|-------|-------|-------|--------|--------|--------|-------|-------|--------|--------|-------|
|           | (0.000) | (0.000) | (0.665) | (0.000) | (0.533) | (0.009) | (0.768) | (0.994) | (0.827) | (0.173) | (0.339) | (0.525) |
| Discount cig | -0.093 | 0.165 | -0.657 | -0.707 | 0.297 | 0.134 | -0.540 | -0.267 | -0.079 | 0.137 | -0.040 | 0.068 |
|           | (0.653) | (0.008) | (0.000) | (0.000) | (0.177) | (0.261) | (0.027) | (0.089) | (0.847) | (0.719) | (0.825) | (0.638) |
| Premium WTP | 0.199 | -0.073 | 0.199 | 0.169 | -0.781 | -0.540 | 0.670 | 0.347 | 0.155 | 0.218 | -0.245 | 0.110 |
|           | (0.319) | (0.224) | (0.140) | (0.001) | (0.000) | (0.000) | (0.004) | (0.028) | (0.715) | (0.524) | (0.151) | (0.399) |
| Discount WTP | -0.412 | 0.085 | -0.007 | -0.067 | 0.055 | 0.015 | -1.376 | -0.616 | 0.422 | -0.147 | 0.104 | 0.022 |
|           | (0.028) | (0.123) | (0.956) | (0.144) | (0.783) | (0.889) | (0.000) | (0.000) | (0.215) | (0.670) | (0.506) | (0.852) |
| Delivered WTP | 0.054 | -0.005 | 0.030 | -0.031 | -0.042 | 0.012 | 0.022 | 0.173 | 0.214 | -0.150 | -0.227 | 0.047 |
|           | (0.771) | (0.925) | (0.815) | (0.505) | (0.839) | (0.915) | (0.916) | (0.204) | (0.466) | (0.657) | (0.165) | (0.696) |
| Premium café | 0.075 | -0.002 | 0.006 | 0.011 | -0.033 | 0.224 | 0.006 | -0.185 | -0.273 | -1.073 | -0.586 | 0.211 |
|           | (0.686) | (0.976) | (0.960) | (0.804) | (0.875) | (0.042) | (0.977) | (0.190) | (0.436) | (0.002) | (0.000) | (0.099) |
| Discount café | -0.132 | 0.048 | 0.001 | -0.092 | -0.150 | -0.099 | -0.134 | 0.109 | 0.030 | 0.238 | 0.107 | -0.385 |
|           | (0.482) | (0.384) | (0.997) | (0.045) | (0.463) | (0.363) | (0.527) | (0.435) | (0.935) | (0.490) | (0.520) | (0.005) |

The West Bank of Palestine

| Premium cig | -2.259 | -1.001 | -0.640 | 0.160 | -0.031 | 0.429 | -0.012 | -0.425 | -0.146 | -0.354 | -0.026 | 0.043 |
|-----------|-------|-------|-------|-------|--------|-------|--------|-------|--------|--------|-------|-------|
|           | (0.000) | (0.000) | (0.000) | (0.491) | (0.825) | (0.198) | (0.979) | (0.364) | (0.523) | (0.034) | (0.905) | (0.735) |
| Discount cig | -0.593 | -0.251 | -1.115 | -0.076 | 0.155 | -0.384 | -0.238 | 0.137 | 0.190 | 0.064 | 0.107 | -0.031 |
|           | (0.076) | (0.002) | (0.000) | (0.772) | (0.301) | (0.227) | (0.617) | (0.755) | (0.427) | (0.704) | (0.656) | (0.814) |
| Premium WTP | 0.124 | 0.292 | 0.640 | 0.184 | 0.201 | 0.518 | -0.155 | 0.684 | -0.085 | 0.089 | -0.190 | 0.239 |
| Tobacco Product | Discount WTP | Delivered WTP | Premium café | Discount café |
|-----------------|-------------|---------------|--------------|---------------|
|                 | (0.681) (0.000) | (0.000) (0.406) (0.135) | (0.086) (0.733) (0.072) (0.721) (0.580) (0.345) (0.034) | (-0.004) (-0.069) -0.116 -0.148 -0.340 -0.524 -0.288 -0.140 0.703 0.048 -0.195 0.211 |
|                 | (0.988) (0.299) | (0.241) (0.563) (0.063) (0.122) (0.507) (0.841) (0.005) (0.786) (0.360) (0.105) | (-0.076) 0.052 -0.078 0.131 0.084 -0.043 -2.045 -0.608 -0.012 0.612 0.463 0.251 |
|                 | (0.817) (0.498) | (0.407) (0.591) (0.659) (0.898) (0.000) (0.244) (0.959) (0.000) (0.029) (0.053) | (-0.104) -0.082 0.082 0.410 0.246 0.632 -0.023 1.726 -1.625 -0.922 -0.056 -0.172 |
|                 | (0.731) (0.259) | (0.397) (0.112) (0.186) (0.084) (0.958) (0.000) (0.000) (0.000) (0.000) (0.803) (0.188) | 0.011 0.044 -0.216 -0.249 -0.122 -0.549 0.976 -0.655 -0.082 -0.447 -0.386 -0.371 |
|                 | (0.972) (0.525) | (0.029) (0.321) (0.509) (0.106) (0.040) (0.271) (0.721) (0.014) (0.121) (0.009) | | 1

1 Reported figures indicate the own-price elasticity of each tobacco product, while the values in parentheses indicate the p-value.
2 Cig: cigarettes.
3 WTP: waterpipe
4 The ZIP model did not converge for some tobacco products in the case of Jordan and the West Bank of Palestine.
Table 3: Own- and cross-price elasticities of tobacco groups in three Arab countries

|                  | Cigarettes | Waterpipe (250g) | Waterpipe (sessions) |
|------------------|------------|-------------------|----------------------|
|                  | Women      | Men               | Women                | Men               |
| Lebanon          |            |                   |                      |
| Cigarettes       | -0.737     | -0.568            | 0.019                | -0.014            | 0.106              | -0.031             |
|                  | (0.000)    | (0.000)           | (0.694)              | (0.820)           | (0.086)            | (0.677)            |
| Waterpipe (250 g)| 0.058      | -0.042            | -1.215               | -1.198            | 0.120              | 0.072              |
|                  | (0.381)    | (0.312)           | (0.000)              | (0.000)           | (0.065)            | (0.360)            |
| Waterpipe (sessions) | 0.033   | 0.011             | -0.006               | 0.039             | -1.246             | -1.390             |
|                  | (0.629)    | (0.807)           | (0.919)              | (0.583)           | (0.000)            | (0.000)            |
| Jordan           |            |                   |                      |
| Cigarettes       | -0.708     | -0.565            | -0.071               | -0.126            | -0.011             | -0.027             |
|                  | (0.000)    | (0.000)           | (0.702)              | (0.290)           | (0.975)            | (0.817)            |
| Waterpipe (250 g)| 0.065      | 0.056             | -0.620               | -0.371            | 0.344              | 0.075              |
|                  | (0.658)    | (0.227)           | (0.001)              | (0.003)           | (0.339)            | (0.565)            |
| Waterpipe (sessions) | -0.025  | -0.022            | -0.051               | 0.066             | -0.465             | -0.202             |
|                  | (0.864)    | (0.664)           | (0.785)              | (0.602)           | (0.208)            | (0.105)            |
| The West Bank of Palestine |        |                   |                      |
| Cigarettes       | -1.844     | -1.029            | 0.508                | 0.133             | 0.011              | -0.134             |
|                  | (0.000)    | (0.000)           | (0.010)              | (0.275)           | (0.944)            | (0.140)            |
| Waterpipe (250 g)| 0.853      | 0.593             | 0.124                | 0.140             | -0.090             | 0.289              |
|                  | (0.002)    | (0.000)           | (0.506)              | (0.246)           | (0.561)            | (0.002)            |
| Waterpipe (sessions) | -0.248  | -0.031            | -0.276               | -0.051            | -0.603             | -0.326             |
|                  | (0.365)    | (0.656)           | (0.215)              | (0.703)           | (0.002)            | (0.003)            |

1 Reported figures indicate the price elasticity of each tobacco product, while the values in parentheses indicate the p-value.
Gender differences in the price elasticity of demand for waterpipe and cigarette smoking in Lebanon, Jordan, and Palestine: A volumetric choice experiment

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Gender differences in the price elasticity of demand for waterpipe and cigarette smoking in Lebanon, Jordan, and Palestine: A volumetric choice experiment

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Gender differences in the price elasticity of demand for waterpipe and cigarette tobacco smoking in Lebanon, Jordan, and Palestine: A volumetric choice experiment

Abstract

Objectives: This study assessed the extent to which the elasticity of cigarette and waterpipe tobacco products differs between men and women. We also explored the levels of substitution and complementarity in tobacco products amongst men and women.

Setting: The study examines tobacco elasticities in three Arab countries: Lebanon, Jordan and the West Bank of Palestine.

Participants: We used data from nationally representative surveys of adults aged ≥18 years in Lebanon (n=1680), Jordan (n=1925), and Palestine (n=1679). The proportion of women was 50.0% of the sample in Lebanon and Palestine, and 44.6% in Jordan.

Primary and secondary outcome measures: A zero-inflated Poisson regression model estimated own- and cross-price elasticities for two variations of cigarettes and five variations of waterpipe tobacco products. Elasticities were measured based on eight scenarios of prices.

Results: Overall, women had higher price elasticities of demand for tobacco products than men. For example, the price elasticity for premium cigarettes was -1.12 and -2.26 for Jordanian and Palestinian women, respectively as compared to -1.09 and -1.00 for their male counterparts. Demand for waterpipe tobacco products was elastic for both men and women. The cross-price elasticities in the three countries indicate the existence of substitution between cigarettes and waterpipe products and by different varieties within each of the two tobacco products. Gender
differences varied across the three countries whereby higher cross-price elasticities were generally observed for women in Lebanon and Jordan.

**Conclusions:** Gender differences in own- and cross-price elasticities of waterpipe tobacco products should be taken into consideration in tobacco control strategies particularly when reducing tobacco consumption via taxation policies.

**Keywords:** Tobacco smoking; Waterpipe; Gender; Elasticity; Arab region
Strengths and limitations of this study

- We used a robust, volumetric choice experiment from nationally representative surveys to assess own- and cross-price elasticities of waterpipe tobacco – a topic that has received little attention in the literature.

- The study provided a comprehensive evaluation of price elasticities of different tobacco products and by gender using identical methodologies that allow cross-country comparisons.

- One limitation is that the data does not account for the effect of price differentials across the three neighboring countries. Thus, the impact of smuggling on tobacco consumption remains uncertain.

- Another limitation is related to the actual impact of price changes on tobacco consumption. Elasticities considered in this study measure the sensitivity of individuals to price changes adjusted for inflation but not for income.
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Conflicts of interest

The authors declare no conflicts of interest.

Data availability statement

Data are available upon reasonable request.

Patient and public involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Ethics Approval

The institutional review boards at the American University of Beirut (ID: SBS-2019-0097), Jordan University of Science and Technology (ID: 14-119-2018), and Birzeit University (ID: 2019 (1-1)).

Patient consent for publication

Not applicable.

Contributorship statement

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1 Introduction

Empirical evidence suggests that men have higher rates of tobacco smoking compared to women.\textsuperscript{1,2} In general, the prevalence of tobacco smoking amongst men is about ten-fold that of women in developing countries (32\% vs. 3.1\%) as compared to less than two-fold in developed countries (30\% vs. 17\%).\textsuperscript{3} Tobacco control policies seeking to reduce tobacco prevalence include tax policies, consumer education, using health warning labels, restrictions on tobacco smoking in public spaces, banning tobacco advertising and promotion, and smoking cessation programs.\textsuperscript{4–6} Increasing tobacco prices by imposing higher tobacco excise taxes is among the most effective policy tools to reduce the prevalence of tobacco smoking.\textsuperscript{7,8} To assess the effectiveness of tobacco tax policies, it is imperative to evaluate how individuals would change their responsiveness of tobacco consumption to changes in the prices of each tobacco product and the possible trade-off between tobacco products. Higher tobacco prices may lead smokers to switch to lower-priced tobacco products. The bulk of available literature examining the price elasticity of demand for tobacco products has focused on cigarettes only. Studies which has focused on other tobacco products such as waterpipe are scarce.\textsuperscript{9,10} A recent review on the price elasticity of demand for non-cigarette tobacco products revealed that there is a lack of corresponding research in the Arab region where most of the included studies has been conducted in high-income settings.\textsuperscript{10}

The prevalence of non-cigarette tobacco smoking is increasing worldwide.\textsuperscript{11} In the Arab region, waterpipe tobacco smoking – also referred to as narghile, arghile, and shisha – is gaining popularity amongst both men and women.\textsuperscript{12} Further, Arab women tend to smoke waterpipe tobacco more than cigarettes.\textsuperscript{13,14} Recent estimates based on representative surveys show that the prevalence of waterpipe tobacco smoking amongst women in Lebanon is more than twice that of cigarettes (54.7\% vs. 27.5\%).\textsuperscript{15} Available evidence shows that tax policies might be unequal across
socioeconomic groups as it imposes higher burden on the worse-off segment of the population.\textsuperscript{16} Socioeconomic differences between men and women in the Arab region such as income differences may render women more vulnerable to changes in tobacco prices as compared to men. With women being endowed with lower financial resources, it is crucial to assess gender differences in terms of the degree of responsiveness in tobacco consumption in relation to changes in tobacco prices (taxes).

In the Arab region, taxation policies of waterpipe products as compared to cigarettes are absent. Moreover, in some countries tax rates on cigarettes are lower than the recommended rate of 75\% of the retail price of tobacco products.\textsuperscript{17} Based on a recent report of the World Health Organization, the general tax structure of tobacco products in the region is composed of three different types of taxes: (\textit{i}) import duty tax (\%), (\textit{ii}) value added tax (\%), and (\textit{iii}) excise tax (specific (USD) and ad valorem (\%)).\textsuperscript{17} In Jordan and Palestine, the overall tax rates on popular brands of cigarettes exceed 75\% (78.0\% in Jordan vs. 92.8\% in Palestine) while in Lebanon the overall tax rates on cigarettes is 9.9\%.\textsuperscript{17} As for waterpipe products, the overall tax rates are, respectively, 21.2\%, 30.4\% and 79.0\% in Lebanon, Jordan and Palestine.\textsuperscript{18} These facts reveal that there is some room to increase taxation of different tobacco products in these countries as a tool to reduce the prevalence of smoking in the region.

The assessment of the price elasticity of demand for tobacco has been largely addressed using a variety of econometric models such as linear regression models, two-part models, and the Zero-Inflated Poisson (ZIP) model.\textsuperscript{9,19,20,10} However, the estimation of waterpipe tobacco elasticities and cross-price elasticities of tobacco products has received less attention in the literature.\textsuperscript{15,21,22} Empirical evidence shows that results are rather mixed with some tobacco products being substitutes for cigarettes such as cigars and electronic cigarettes\textsuperscript{21} while others such
as bidis are shown to be complementary to cigarettes.\textsuperscript{23} Regarding differences across groups, there is a bulk of literature which assessed the elasticity of demand for tobacco products, mainly cigarettes, across age and socioeconomic groups in low-income countries.\textsuperscript{7,20,24} To the best of our knowledge, there is only one study that quantified the elasticity in the Arab region (in Lebanon) across socioeconomic groups.\textsuperscript{7} The results of this study shows that demand for imported cigarettes is inelastic and that the corresponding own-price elasticities are higher for the poorest income quintile (-0.32) and lower for the richest quintile (-0.22).\textsuperscript{7}

Studies investigating the price elasticities of demand for different tobacco products across gender groups are, however, limited.\textsuperscript{25–27} Moreover, there were no previous attempts to assess gender differences in the price elasticities of waterpipe tobacco products. Existing empirical evidence concerning gender differences in the price elasticity of demand for tobacco, mainly cigarettes, is also mixed. For instance, using a two-part model, Tauras, Huang & Chaloupka (2013) showed that the price elasticity of young women in the United States was more than two-fold the price elasticity of their men counterparts (-0.63 vs. -0.25). However, Sweis & Chaloupka (2014) demonstrated that Jordanian men had a higher price elasticity of cigarettes as compared to women (-0.81 vs. -0.01).

A full analysis of the own- and cross-price elasticities of different tobacco products that account for gender differences is lacking. The aims of this paper, which focuses on Lebanon, Jordan, and the West Bank of Palestine, were thus two-fold. Firstly, we aimed to assess the extent to which the elasticity of cigarettes and waterpipe tobacco products differs between men and women. Secondly, we aimed to explore the substitution and complementarity in tobacco products amongst men and women.
2 Methods

2.1 Data

We used data from nationally representative surveys that were conducted in Lebanon, Jordan and the West Bank of Palestine in June-August 2019. The full methodological details of these surveys are published elsewhere. Briefly, eligible respondents included male and female adults (≥18 years old) residing in each country regardless of their nationality. The sample sizes were calculated to estimate the prevalence of current waterpipe smoking for both males and females in each country separately based on previously reported prevalence rates. A two-stage cluster sampling approach in which probability-proportional-to-size random selection methods was applied to choose clusters in each country. The first stage entailed selecting well-defined geopolitical areas (clusters) within the governorates in each country (8 governorates in Lebanon, 12 governorates in Jordan, 11 governorates in the West Bank). The second stage involved choosing a random sample of 30 households from each selected cluster using systematic random sampling. From each selected household, one eligible male and one female residents were selected. To ensure the inclusion of each selected household in the sample, the household was visited three times. If the household is marked as “Not at home”, the next household was selected. In Lebanon and the West Bank, a balanced sample of men and women was selected while in Jordan, the number of men was higher than women as additional households were selected based on their availability at home during the visits. All participants were provided with information about the study and were asked to provide consent to participate.

The surveys assessed the use of two main varieties of cigarettes (premium and discount cigarettes) and five varieties of waterpipe tobacco (premium, discount, home-delivered waterpipe tobacco, and premium and discount waterpipe tobacco café smoking). The questionnaire included
a volumetric choice experiment (VCE) that modeled eight scenarios of different tobacco product with varying prices in each scenario. Respondents were asked to indicate the amount of tobacco (cigarettes and waterpipe) they were willing to consume under each scenario. Respondents could choose to consume any possible combination of tobacco products within each scenario. The VCE allows to calculate the cross-price elasticity between different tobacco products based on consumers’ willingness to trade-off tobacco products under each scenario of prices. The surveys assessed non-flavored waterpipe tobacco for Lebanon and Jordan and roll-your-cigarette smoking for the West Bank. For consistency, these two categories of tobacco have been excluded in the current analysis.

2.2 Statistical analysis

Akin to Chalak et al. (2021), we used a Zero-Inflated Poisson (ZIP) regression model to calculate the own- and cross-price elasticities of demand for tobacco products for each country. The ZIP model is suitable for count data with excess zeros (non-smokers in our case). The ZIP model was estimated first for each gender group for each of the seven tobacco products. Then the model was estimated for each gender for each tobacco product variety. Tobacco products were classified into three groups such that the within-group unit of measurement was homogenous. These groups were (i) cigarettes, which included premium and discount cigarettes – measured in packs; (ii) waterpipe tobacco (250g), which included premium and discount waterpipe tobacco and (iii) waterpipe sessions, which included delivered waterpipe and discount and premium waterpipe café smoking sessions. For each group, the quantity was calculated as the sum of all quantities reported by each respondent at each set of prices. The price of each product variety was calculated using the Stone index. For each product variety, $j$, the stone index, $P_{j}^{S}$, is defined as
\[ P_j^* = \prod_{m=1}^{M} (p_m)^{s_m} \]

where \( M \) is the total quantity within each product variety, \( p_m \) is the price of tobacco product \( m = 1, \ldots, M \), and \( s_m \) is the expenditure weight of product \( m \) such that \( \sum_{m=1}^{M} s_m = 1 \). The stone index is a weighted geometric mean of the price of tobacco products. Some respondents reported zero quantities at certain price levels. So calculating \( s_m \) for each respondent at each scenario of prices yielded many null weighted prices. We therefore calculated \( s_m \) as the average weight of all respondents for all price scenarios for each tobacco product variety \( m \).

Two binary variables were constructed for the regression analysis used to estimate the price elasticities of demand. The first equaled one if the individual smoked any type of cigarettes while the second equaled one if the individual smoked any type of waterpipe tobacco. The former binary variable was used as an inflation variable in the ZIP models of cigarette products while the latter binary variable was used in the ZIP models of waterpipe products. For all models, the set of independent variables of the first part model included the logarithmic forms of the prices of all tobacco product varieties and a categorical variable of four income groups. The inclusion of the prices of all tobacco products allowed for calculating the cross-price elasticities between all tobacco products. In general, the set of independent variables of the inflation part of the ZIP model included the relevant binary variable of tobacco smoking, age (categorical variable), marital status (binary variable which takes one if the individual is single), a region variable (country-specific), employment status (unemployed, full-time and part-time employee), education level (less than university and with university education), and a binary variable that equaled one if the individual was responsible for taking decisions in the household. For some tobacco product varieties across
genders, only a subset of these independent variables was used due to the small sample size of smokers. All analyses were conducted using Stata version 14.2.

3 Results

3.1 Sample characteristics

Table 1 summarizes the three sample characteristics. The number of respondents were 1680 (50% female) in Lebanon, 1925 (44.6% female) in Jordan and 1679 (50% female) in the West Bank. In general, the distribution of men and women across the different age groups was balanced across all countries. Regarding the marital status, the share of single men and women was less than the quarter across countries. Turning to employment status, the unemployment rate was higher amongst women as compared to men across all countries (72.3% in Lebanon, 78.4% in Jordan and 89.8% in the West Bank). As for income groups, similar patterns were observed across all countries with the population being concentrated in the second and third quartiles for both men and women. As shown in Table 1, the highest share of smokers is observed in Lebanon for both gender groups (75.2% of men and 63.8% of women). Results indicate a higher gender gap in terms of smoking in Jordan and Palestine as compared to Lebanon. For example, the prevalence of smoking in Palestine is 36.0% amongst men and about 7.0% amongst women. Women in Lebanon and Palestine tend to smoke waterpipe more than cigarettes with a prevalence rate of waterpipe smoking of 46.3% and 5.1% and a prevalence rate of cigarettes smoking of 24.3% and 2.6% in Lebanon and Palestine, respectively.

3.2 Own-price elasticities
The price elasticities were first calculated by gender groups for each type of tobacco smoking for each country. Aggregate price elasticities have been documented elsewhere. Results, which are summarized in Table 2, show that in Lebanon the price elasticity was significantly higher for women for the following types of tobacco; discount cigarettes (-0.75 for women vs. -0.58 for men), premium waterpipe (-2.02 for women vs. -1.90 for men), delivered waterpipe (-1.89 or women vs. -1.85 for men), premium café (-2.38 for women vs. -2.23 for men) and discount café (-1.74 for women vs. -1.66 for men). All elasticities of waterpipe products were greater than one indicating an elastic demand for waterpipe products for both men and women, as compared to cigarettes. Particularly, elasticities were the highest for premium café sessions and premium waterpipe tobacco, which were relatively more expensive as compared to other varieties of waterpipe products.

In Jordan, with the exception of discount cigarettes, women generally had higher elasticities as compared to men. For example, the price elasticity of discount waterpipe for women was about two-fold the elasticity observed for men (-1.38 vs. -0.62). Moreover, the price elasticity of premium cigarettes for women was slightly higher than the price elasticity for men (-1.12 vs. -1.09). The highest elasticity was observed for discount waterpipe for women where a 10% increase in the price of discount waterpipe yielded a 13.8% decrease in its quantity consumed.

As for the West Bank, the price elasticity of premium cigarettes for women was -2.26 as compared to -1.00 for men. Palestinian women had the highest price elasticity of premium cigarettes as compared to Lebanon and Jordan. Furthermore, the price elasticities of home-delivered waterpipe and premium and discount café sessions were higher for women as compared

1 The z-scores calculated for the differences of elasticities between men and women were greater than 1.96 for premium and discount cigarettes.
2 The z-score calculated for the difference of elasticities of discount waterpipe between men and women was 2.7.
to men. For example, the price elasticity of delivered waterpipe for women was slightly more than three-fold the price elasticity of delivered waterpipe for men (-2.05 vs. -0.61). The price elasticity of premium waterpipe was found to be positive for both men and women though they were not statistically significant.

Table 3 summarizes the price elasticities of tobacco product varieties by gender for each country. In Lebanon, all own-price elasticities were statistically different from zero with higher elasticities being observed for women for cigarettes and waterpipe products. For example, a 10% average increase in cigarettes prices would result in a decrease in the quantity of cigarettes consumed by about 7.4% for women and 5.7% for men indicating an inelastic demand for cigarettes. Nonetheless, results show that demand for waterpipe was elastic. As for Jordan, the price elasticities of the three tobacco product varieties were higher for women. For example, a 10% average increase in waterpipe prices would result in a decrease in the quantity of waterpipe consumed by about 6.2% for women and only 3.7% for men. The demand for all tobacco product varieties was inelastic in Jordan. Different patterns were observed for the West Bank. The price elasticity of both cigarettes and waterpipe sessions were higher for women. However, the demand for cigarettes was elastic (-1.84 for women vs. -1.03 for men) while the demand for waterpipe session was inelastic (-0.60 for women vs. -0.33 for men).³

3.3 Cross-price elasticities

Estimated cross-price elasticities of tobacco products are summarized in Table 2 for the three countries. In Lebanon, the cross-price elasticities of premium cigarettes with respect to other tobacco products were not statistically significant except for discount waterpipe and discount café

³ The z-scores calculated for the differences of elasticities between men and women were greater than 1.96 for premium cigarettes and premium cafe.
sessions for women. The cross-price elasticity of discount cigarettes with respect to premium cigarettes was positive and statistically significant for both men and women indicating a substitution effect between the two types of cigarettes. The magnitude of the estimated cross-price elasticity of discount cigarettes with respect to premium cigarettes was higher for women (0.23) as compared to men (0.15). Such a result goes in line with the economic theory where a price increase in premium brands of a certain good leads consumers to switch to cheaper brands/products. As for premium waterpipe, results show that cross-price elasticities were statistically significant and positive with respect to discount waterpipe and discount café and negative with respect to discount cigarettes and home-delivered waterpipe for both women and men. This result indicates that there was some level of substitution between premium waterpipe and the discounted waterpipe products (discount waterpipe tobacco and discount cafe) and some level of complementarity within the premium waterpipe products (premium waterpipe tobacco with home-delivered waterpipe). Results also indicate that premium waterpipe and discount cigarettes exhibited some substitution whereby a 10% increase in the price of discount cigarettes results in a 2.1% and 2.3% increase in the quantity consumed of premium waterpipe respectively for women and men. Also of note, that most cross-price elasticities of premium waterpipe were slightly higher for women as compared to men. This result is also confirmed with the cross-price elasticity of discount waterpipe with respect to other waterpipe products whereby complementarity was observed between discount waterpipe and discount café while substitution effect was observed between discount waterpipe and premium and delivered waterpipe. However, the cross-price elasticities of discount waterpipe were slightly higher for women as compared to men. Furthermore, discount café sessions appear to be substitutes for premium café sessions with higher elasticities being observed for men (0.17 for women vs. 0.25 for men).
As for Jordan, results show a substitution effect between premium and discount cigarettes for men only with, for example, a cross-price elasticity of discount cigarettes with respect to premium cigarettes equal to 0.25. As for waterpipe products, the cross-price elasticity of discount waterpipe with respect to premium waterpipe was statistically significant and positive for both men and women with the elasticity for women being twice that of men (0.67 vs. 0.35). This may indicate that discount and premium waterpipe products were substitutes.

Lastly, results on the cross-price elasticities of tobacco products for the West Bank were mixed. Only a few of the cross-price elasticities were statistically significant for men and women. There was some level of substitution between waterpipe products for women. For example, the cross-price elasticity of home-delivered waterpipe with respect to discount café sessions was positive and close to one for women (0.98). Furthermore, a 10% increase in the price of discount waterpipe product would reduce the quantity consumed of waterpipe in premium cafes by 7.03%. For men, on the other hand, unlike Lebanon and Jordan, results show complementarity between cigarettes products. For example, a 10% increase in the price of premium cigarettes would reduce the quantity consumed of discount cigarettes by 6.4%.

Once tobacco products were aggregated into groups, results indicate a substitution effect between cigarettes and waterpipe products for both men and women in the West Bank only as shown in Table 3. Moreover, the cross-price elasticity of cigarettes with respect to waterpipe was higher for women (0.9) as compared to men (0.6).

4 Discussion

This study provides estimates of the responsiveness in tobacco consumption in relation to changes in the prices of different varieties of cigarettes and waterpipe tobacco products among
women and men in Lebanon, Jordan and the West Bank. In general, the study found that women are more responsive to changes in the prices of tobacco products particularly waterpipe products in the three countries. Given that women are generally worse-off as compared to men in these countries, such a result is in line with previous evidence where the poorest are found to be more sensitive to changes in tobacco prices.\textsuperscript{7} Results for Jordan were different from those obtained by Sweis & Chaloupka (2014) where the price elasticity of tobacco is found to be higher for men as mentioned in the introduction. Such a difference may be attributed to several reasons. First, previous estimates were calculated for cigarettes only without including any difference between cigarettes’ products or waterpipe products. Second, previous estimates were based on actual consumption of cigarettes (number of packs smoked per week) while in our case we applied a choice experiment that measure the amount consumed by each individual for each scenario of prices. Third, previous estimates were calculated based on 2011 data were the prevalence of smoking among women was lower (5.1\% in 2011 vs. 13.1\% in 2019).

The following highlights several interesting findings emerging from our analysis and their implications to policymakers. First, women were generally more sensitive to changes in tobacco prices indicating that women smokers would reduce their tobacco consumption more than men smokers in response to similar increases in tobacco prices. Empirical evidence shows that the effects of policy interventions may vary by gender whereby women are more responsive to policy changes.\textsuperscript{30–32} For example, using linear regression with states and years fixed effects, a study conducted in the United States show that a tobacco tax intervention appears to be beneficial for women, but not for men, in terms of reducing coronary heart disease mortality.\textsuperscript{30} Such a result is of interest for policymakers for two main reasons. First, as mentioned in the outset, the prevalence of waterpipe smoking is increasing in the Arab region particularly amongst women. Thus, an
effective policy intervention may play a major role in reducing the prevalence of smoking amongst women. The second point is related to the specific health impact of tobacco use on pregnant women since smoking during pregnancy can increase the risk of abnormal pregnancy and delivery, birth defects, etc. Reducing the prevalence of smoking amongst women would benefit both mothers and children by reducing the long-term health burden and the associated economic burden.

Second, the degree of responsiveness to changes in tobacco prices varied across the three countries. Different patterns of price elasticities were observed amongst the three countries once tobacco products were categorized into three groups: cigarettes, waterpipe tobacco (250g) and waterpipe sessions. For example, the demand for cigarettes was elastic in Lebanon and inelastic in the West Bank while the demand for waterpipe was inelastic in Lebanon and elastic in the West Bank. In Jordan, both the demand for cigarettes and for waterpipe appeared to be inelastic. Such differences might be related to the current prices of cigarettes and waterpipe products, as well as the overall socioeconomic status (e.g., average income per capita). Moreover, these differences may be related to the fact that for nicotine-dependent smokers, a large increase in tobacco prices induces a smaller decrease in the quantity consumed of tobacco products. Such results reveal that tobacco smoking behavior is rather country-specific, thus tobacco control policies should also be tailored in each country to reflect the sensitivity of tobacco products to price changes.

Third, the degree of responsiveness to changes in prices was higher for waterpipe products as compared to cigarettes. Such observation is mostly prominent for Lebanon where own-price elasticities of waterpipe products were greater than one for both men and women. This indicates an elastic demand for waterpipe products as compared to cigarettes. Such result is very important especially with the increasing popularity of waterpipe products in the region and the fact that waterpipe products are not taxed in the same manner as cigarettes.
Fourth, results on the cross-price elasticities in the three countries indicated some substitution between cigarettes and waterpipe products, and within each product variety. However, gender differences varied across the three countries whereby higher cross-price elasticities were generally observed for women in Lebanon and Jordan. Whereas in the West Bank results were mixed with some of the cross-price elasticities being higher for men. From a public health perspective, it is crucial to tax all tobacco products equally to avoid any substitution between and within cigarettes and waterpipe product varieties. For example, the positive cross-price elasticity between premium and discount cigarettes could lead to switching towards discount cigarettes, which may pose a higher risk of adverse health effects.35,36

In general, this paper adds to the literature that assesses the price elasticity of tobacco, particularly for waterpipe tobacco elasticities and cross-price elasticities of tobacco products. To the best of our knowledge, this is the first attempt that provides a comprehensive evaluation of price elasticities of different tobacco products and across gender groups in the region. As mentioned in the outset, previous estimates from Lebanon and Jordan were either aggregate estimates or were calculated for cigarettes only.9,10,26 Available literature in other regions which provides estimation of aggregate elasticities of non-cigarette products generally exclude waterpipe products while the other part of literature provide estimation across socioeconomic and age groups. Another key strength of the present article is the use of a harmonized methodology for three neighboring countries in the region in terms of data collection and data analysis. Such approach allows for cross-country comparisons of the prevalence of smoking as well as the own- and cross-price elasticities of different tobacco products. However, this is not without limitations. Our data does not account for the effect of price differentials across these three or other neighboring countries. For example, the price of cigarette products is the highest in Palestine. As a result,
Palestinians living in the West Bank may illegally purchase premium cigarettes with cheaper prices from Jordan. Such behavior of smuggling may impact the effectiveness of tobacco policy interventions that seek to increase tobacco prices through taxation. Empirical evidence suggests that differences in tobacco prices across neighboring countries may increase the consumption of tobacco in areas where the price of tobacco in neighboring countries is lower.\textsuperscript{37} With the presence of smuggling in the West Bank, the prevalence of tobacco smoking in the West Bank is expected to be different than that observed in the Gaza Strip. Indeed, available evidence shows that the prevalence rate of smoking is higher in the West Bank.\textsuperscript{38} Unfortunately, this study focuses on the West Bank only, thus it is difficult to conduct a comparison between the two Palestinian regions.

To sum up, price differentials across neighboring countries suggests that prices of both cigarettes and waterpipe products shall be harmonized in the three countries to achieve effective decrease in the prevalence of smoking.

Another limitation is related to the independent variables included in the model that may affect the level of consumption of tobacco products. With the exception of prices, all variables were measured at the individual level. The income effect was captured in the ZIP model by controlling for both income differences and differences in the employment status of individuals. Other factors that might affect tobacco consumption and shall be available at the country or regional levels were not included in the surveys. An example of such variables is related to variations in the business cycle. Empirical evidence shows that gross domestic product (GDP) and unemployment rates across regions are highly correlated with tobacco consumption where higher GDP growth rates and lower unemployment rates tend to reduce tobacco consumption.\textsuperscript{39,40}

Another limitation of the study is related to the actual impact of price changes on tobacco consumption. In our model, absolute prices were included in the analysis which allows to measure
the price elasticities. Prices would affect tobacco consumption directly (substitution effect) and indirectly through reducing the purchasing power of individuals (income effect). However, if income increases, then the level of tobacco consumption will also increase. Accordingly, the prevalence and intensity of tobacco consumption might not be reduced if the tax increase was associated with income increase. To assess the effectiveness of tobacco tax policies, empirical evidence suggests to calculate the so-called affordability elasticity which captures the changes of tobacco consumption to changes in the price and income simultaneously rather than separating the two effects. This is done by including the price-income ratio in the model instead of including both prices and income as two independent variables. Although we account for income effect in the current study, we could not calculate this ratio since income is available as a categorical variable.

Based on limitations raised above, future research could focus on the following three areas. First, the lack of data in this strand of literature calls for the collection of national comprehensive data for each country in the region. This data could include information about the source of purchase of tobacco products to account for the impact of illicit trade caused by price differentials across neighboring countries. Accounting for this in the analysis of price elasticities is crucial to assess the effectiveness of tobacco taxation policies. Second, although income data are relatively unreliable in low-income countries where individuals tend to underreport the level of their income, future surveys could also include questions about the level of income or consumption expenditure as a proxy for income. This allows us to calculate the affordability elasticity of tobacco consumption and compare results with those obtained from considering price and income elasticities separately. Third, future research could also benefit from results obtained at the micro
level to assess the associated health benefits as well as macro-level impact of tax interventions on government revenues.

5 Conclusion

The epidemic of waterpipe tobacco smoking is growing among women in low- and middle income countries. Our analysis could inform efforts in increasing taxation on waterpipe tobacco products in similar contexts. Moreover, the prevalence of tobacco smoking is likely to increase amongst women in the region as social restrictions placed on women are reduced. These restrictions include religious restrictions and socio-cultural acceptance of women smoking where people in the region believe that the practice of smoking reflect a “negative image” of women. As shown in Lebanon, where smoking among women is more socially acceptable relative to other countries in the region, the prevalence of tobacco smoking amongst women is extremely high. Therefore, gender-based analyses are important to consider the formulation of tobacco control policies. The differences in the own- and cross-price elasticities between men and women reveal the higher responsiveness of women to changes in tobacco prices as compared to men. The fact that some tobacco product varieties appear to be elastic particularly for women may reflect the effectiveness of increasing tobacco taxes, hence reducing tobacco prevalence and the associated economic burden. Akin to previous evidence that demonstrates a substitution effect between cigarettes and other tobacco products, such as cigars and electronic cigarettes, this paper shows that some waterpipe tobacco and cigarettes products act as substitutes. The fact that many tobacco products appear to be substitutes reflect the importance of taxing all tobacco products to avoid any potential substitution that may occur between and within tobacco products while increasing government revenues.\textsuperscript{15,21,45}
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Table 1: Sample characteristics

|                      | Lebanon (N=1680) |     | Jordan (N=1925) |     | West Bank (N=1679) |     |
|----------------------|------------------|-----|-----------------|-----|-------------------|-----|
|                      | Women            | Men | Women           | Men | Women             | Men |
| Age group, years     |                  |     |                 |     |                   |     |
| < 25                 | 162 (19.3%)      | 134 (16.0%) | 152 (17.7%)    | 188 (17.6%) | 122 (14.5%)       | 177 (21.1%) |
| 26-35                | 203 (24.2%)      | 174 (20.7%) | 203 (23.7%)    | 237 (22.2%) | 206 (24.5%)       | 205 (24.4%) |
| 36-45                | 188 (22.3%)      | 187 (22.3%) | 200 (23.3%)    | 256 (24.0%) | 184 (21.9%)       | 160 (19.1%) |
| 46-55                | 197 (23.5%)      | 170 (20.2%) | 172 (20.0%)    | 198 (18.6%) | 215 (25.6%)       | 148 (17.6%) |
| >56                  | 90 (10.7%)       | 175 (20.8%) | 131 (15.3%)    | 188 (17.6%) | 113 (13.5%)       | 149 (17.8%) |
| Marital status       |                  |     |                 |     |                   |     |
| Single               | 100 (11.9%)      | 147 (17.5%) | 133 (15.5%)    | 278 (26.1%) | 69 (8.2%)        | 185 (22.1%) |
| Otherwise            | 740 (88.1%)      | 639 (72.5%) | 725 (84.5%)    | 789 (73.9%) | 770 (91.8%)       | 653 (77.9%) |
| Employment status    |                  |     |                 |     |                   |     |
| Unemployed           | 607 (72.3%)      | 187 (22.3%) | 673 (78.4%)    | 372 (34.9%) | 754 (89.8%)       | 189 (22.5%) |
| Full-time employed   | 174 (20.7%)      | 574 (68.3%) | 137 (16.0%)    | 526 (49.3%) | 57 (6.8%)        | 513 (61.1%) |
| Part-time employed   | 59 (7.0%)        | 79 (9.4%)     | 48 (5.6%)     | 169 (15.8%) | 29 (3.4%)        | 137 (16.4%) |
| Education level      |                  |     |                 |     |                   |     |
| Less than university | 669 (79.6%)      | 664 (79.1%) | 639 (74.5%)    | 805 (75.4%) | 690 (82.1%)       | 718 (85.6%) |
| University education | 171 (20.4%)      | 176 (20.9%) | 219 (25.5%)    | 262 (24.6%) | 150 (17.9%)       | 121 (14.4%) |
| Participation in decisions in the household | | | | | | |
| Yes                  | 706 (80.1%)      | 489 (58.2%) | 692 (80.7%)    | 793 (74.3%) | 616 (73.4%)       | 536 (64.0%) |
| No                   | 134 (19.9%)      | 351 (41.8%) | 166 (19.3%)    | 274 (25.7%) | 223 (26.6%)       | 302 (36.0%) |
| Income group         |                  |     |                 |     |                   |     |
| Lowest quartile      | 75 (9.1%)        | 62 (7.5%)     | 207 (24.9%)   | 227 (21.7%) | 214 (26.6%)       | 174 (21.1%) |
| 2nd quartile         | 321 (38.8%)      | 326 (39.5%) | 320 (38.5%)    | 411 (39.4%) | 355 (44.0%)       | 344 (41.9%) |
| 3rd quartile         | 320 (38.7%)      | 323 (39.1%) | 197 (23.7%)    | 262 (25.1%) | 133 (16.5%)       | 163 (19.9%) |
| Highest quartile     | 111 (13.4%)      | 115 (13.9%) | 107 (12.9%)    | 144 (13.8%) | 104 (12.9%)       | 140 (17.1%) |
| Smoking cigarettes   |                  |     |                 |     |                   |     |
| Yes                  | 204 (24.3%)      | 415 (49.4%) | 76 (8.9%)      | 496 (46.5%) | 22 (2.6%)        | 249 (29.7%) |
| No                   | 636 (75.7%)      | 425 (50.6%) | 782 (91.1%)    | 571 (53.5%) | 818 (97.4%)       | 590 (70.3%) |
| Smoking waterpipe    |                  |     |                 |     |                   |     |
| Yes                  | 389 (46.3%)      | 300 (35.7%) | 60 (7.0%)      | 169 (15.8%) | 43 (5.1%)        | 103 (12.3%) |
| No                   | 451 (53.7%)      | 540 (64.3%) | 798 (93.0%)    | 898 (84.2%) | 797 (94.9%)       | 736 (87.7%) |
| Smoking any type of tobacco | | | | | | |
| Yes                  | 536 (63.8%)      | 632 (75.2%) | 112 (13.1%)    | 575 (53.9%) | 59 (7.0%)        | 302 (36.0%) |
| No                   | 304 (36.2%)      | 208 (24.8%) | 746 (86.9%)    | 492 (46.1%) | 781 (93.0%)       | 537 (64.0%) |
Table 2: Own- and cross-price elasticities of tobacco products in three Arab countries

|                     | Premium cig | Discount cig | Premium WTP | Discount WTP | Delivered WTP | Premium café | Discount café |
|---------------------|-------------|--------------|-------------|--------------|---------------|--------------|---------------|
|                     | Wome n      | Men          | Wome n      | Men          | Wome n        | Men          | Wome n        | Men          |
| Lebanon             |             |              |             |              |               |              |               |              |
| Premium cig         | -0.919      | -1.205       | 0.230       | 0.146        | -0.019        | -0.019       | -0.104        | -0.034       |
|                     | (0.000)     | (0.000)      | (0.000)     | (0.000)      | (0.000)       | (0.000)      | (0.000)       | (0.000)      |
| Discount cig        | -0.061      | 0.045        | -0.751      | -0.582       | -0.210        | -0.231       | 0.060         | 0.025        |
|                     | (0.606)     | (0.467)      | (0.000)     | (0.000)      | (0.000)       | (0.000)      | (0.000)       | (0.000)      |
| Premium WTP         | 0.078       | -0.028       | -0.019      | -0.103       | -2.017        | -1.901       | 0.508         | 0.525        |
|                     | (0.495)     | (0.394)      | (0.000)     | (0.000)      | (0.000)       | (0.000)      | (0.000)       | (0.000)      |
| Discount WTP        | 0.339       | 0.014        | 0.017       | -0.001       | 0.274         | 0.132        | -1.723        | -1.741       |
|                     | (0.001)     | (0.794)      | (0.000)     | (0.000)      | (0.000)       | (0.000)      | (0.000)       | (0.000)      |
| Delivered WTP       | 0.056       | 0.006        | 0.035       | 0.058        | -0.244        | -0.162       | 0.094         | 0.184        |
|                     | (0.591)     | (0.909)      | (0.501)     | (0.101)      | (0.000)       | (0.010)      | (0.000)       | (0.006)      |
| Premium café        | -0.110      | 0.048        | -0.036      | -0.041       | 0.100         | 0.097        | -0.064        | 0.030        |
|                     | (0.295)     | (0.379)      | (0.482)     | (0.236)      | (0.041)       | (0.118)      | (0.246)       | (0.654)      |
| Discount café       | 0.331       | 0.024        | 0.007       | -0.036       | 0.166         | 0.142        | -0.230        | -0.254       |
|                     | (0.002)     | (0.657)      | (0.894)     | (0.306)      | (0.000)       | (0.025)      | (0.000)       | (0.000)      |
| Jordan              |             |              |             |              |               |              |               |              |
| Premium cig         | -1.121      | -1.089       | 0.055       | 0.253        | -0.124        | -0.286       | -0.060        | 0.001        |
|                     | (0.000)     | (0.000)      | (0.065)     | (0.533)      | (0.009)       | (0.768)      | (0.827)       | (0.173)      |
| Discount cig        | -0.093      | 0.165        | -0.657      | -0.707       | 0.297         | 0.134        | -0.540        | 0.267        |
|                     | (0.653)     | (0.008)      | (0.000)     | (0.000)      | (0.017)       | (0.261)      | (0.027)       | (0.089)      |
| Premium WTP         | 0.199       | -0.073       | 0.199       | 0.169        | -0.781        | -0.540       | 0.670         | 0.347        |
|                     | (0.319)     | (0.224)      | (0.140)     | (0.000)      | (0.000)       | (0.000)      | (0.004)       | (0.028)      |
| Discount WTP        | -0.412      | 0.085        | -0.007      | -0.067       | 0.055         | 0.015        | -1.376        | -0.616       |
|                     | (0.028)     | (0.123)      | (0.956)     | (0.144)      | (0.783)       | (0.889)      | (0.000)       | (0.000)      |
| Delivered WTP       | 0.054       | -0.005       | 0.030       | -0.031       | 0.012         | 0.022        | 0.022         | 0.173        |
|                     | (0.771)     | (0.925)      | (0.815)     | (0.505)      | (0.839)       | (0.915)      | (0.916)       | (0.204)      |
| Premium café        | 0.075       | -0.002       | 0.006       | 0.011        | -0.033        | 0.224        | 0.006         | -0.185       |
|                     | (0.686)     | (0.976)      | (0.960)     | (0.804)      | (0.875)       | (0.042)      | (0.977)       | (0.190)      |
| Discount café       | -0.132      | 0.048        | 0.001       | -0.092       | -0.150        | -0.099       | -0.134        | 0.109        |
|                     | (0.482)     | (0.384)      | (0.997)     | (0.045)      | (0.463)       | (0.363)      | (0.527)       | (0.435)      |
| The West Bank of Palestine |         |              |             |              |               |              |               |              |
| Premium cig         | -2.259      | -1.001       | -0.640      | 0.160        | -0.031        | 0.429        | -0.012        | -0.425       |
|                     | (0.000)     | (0.000)      | (0.000)     | (0.491)      | (0.825)       | (0.198)      | (0.979)       | (0.364)      |
| Discount cig        | -0.593      | -0.251       | -1.115      | -0.076       | 0.155         | -0.384       | -0.238        | 0.137        |
|                     | (0.076)     | (0.002)      | (0.000)     | (0.772)      | (0.301)       | (0.227)      | (0.617)       | (0.755)      |
| Premium WTP         | 0.124       | 0.292        | 0.640       | 0.184        | 0.201         | 0.518        | -0.155        | 0.684        |
| Tobacco Product | Discount WTP | Delivered WTP | Premium café | Discount café |
|-----------------|-------------|--------------|--------------|---------------|
|                  | (0.681) (0.000) | (0.406) (0.135) | (0.086) (0.733) | (0.000) (0.000) |
|                  | -0.004 (0.988) | -0.116 (0.241) | -0.524 (0.507) | 0.011 (0.972) |
|                  | -0.069 (0.299) | -0.148 (0.563) | -0.288 (0.841) | 0.044 (0.525) |
|                  | -0.340 (0.063) | -0.140 (0.005) | -0.140 (0.005) | -0.216 (0.509) |
|                  | -0.288 (0.721) | -0.048 (0.786) | -0.048 (0.786) | -0.249 (0.721) |
| Discount café    | -0.116 (0.005) | -0.012 (0.841) | -0.608 (0.360) | -0.122 (0.786) |
| Premium café     | (0.000) (0.000) | -2.045 (0.000) | -0.012 (0.000) | -0.549 (0.000) |
| Discount café    | -0.140 (0.005) | -0.608 (0.360) | -0.048 (0.786) | -0.082 (0.786) |
| Premium café     | -0.048 (0.000) | -0.012 (0.000) | -0.048 (0.000) | -0.082 (0.786) |

1. Reported figures indicate the own-price elasticity of each tobacco product, while the values in parentheses indicate the p-value.
2. Cig: cigarettes.
3. WTP: waterpipe.
4. The ZIP model did not converge for some tobacco products in the case of Jordan and the West Bank of Palestine.
|                        | Cigarettes | Waterpipe (250g) | Waterpipe (sessions) |
|------------------------|------------|------------------|---------------------|
|                        | Women      | Men              | Women               | Men      | Women | Men              |
| Lebanon                |            |                  |                     |          |       |                  |
| Cigarettes             | -0.737     | -0.568           | 0.019               | -0.014   | 0.106 | -0.031          |
|                        | (0.000)    | (0.000)          | (0.694)             | (0.820)  | (0.086)| (0.677)         |
| Waterpipe (250 g)      | 0.058      | -0.042           | -1.215              | -1.198   | 0.120 | 0.072           |
|                        | (0.381)    | (0.312)          | (0.000)             | (0.000)  | (0.065)| (0.360)         |
| Waterpipe (sessions)   | 0.033      | 0.011            | -0.006              | 0.039    | -1.246| -1.390          |
|                        | (0.629)    | (0.807)          | (0.919)             | (0.583)  | (0.000)| (0.000)         |
| Jordan                 |            |                  |                     |          |       |                  |
| Cigarettes             | -0.708     | -0.565           | -0.071              | -0.126   | -0.011| -0.027          |
|                        | (0.000)    | (0.000)          | (0.702)             | (0.290)  | (0.975)| (0.817)         |
| Waterpipe (250 g)      | 0.065      | 0.056            | -0.620              | -0.371   | 0.344 | 0.075           |
|                        | (0.658)    | (0.227)          | (0.001)             | (0.003)  | (0.339)| (0.565)         |
| Waterpipe (sessions)   | -0.025     | -0.022           | -0.051              | 0.066    | -0.465| -0.202          |
|                        | (0.864)    | (0.664)          | (0.785)             | (0.602)  | (0.208)| (0.105)         |
| The West Bank of Palestine |        |                  |                     |          |       |                  |
| Cigarettes             | -1.844     | -1.029           | 0.508               | 0.133    | 0.011 | -0.134          |
|                        | (0.000)    | (0.000)          | (0.010)             | (0.275)  | (0.944)| (0.140)         |
| Waterpipe (250 g)      | 0.853      | 0.593            | le-0.124            | le-0.140 | -0.090| 0.289           |
|                        | (0.002)    | (0.000)          | (0.506)             | (0.246)  | (0.561)| (0.002)         |
| Waterpipe (sessions)   | -0.248     | -0.031           | -0.276              | -0.051   | -0.603| -0.326          |
|                        | (0.365)    | (0.656)          | (0.215)             | (0.703)  | (0.002)| (0.003)         |

1 Reported figures indicate the price elasticity of each tobacco product, while the values in parentheses indicate the p-value.
Gender differences in the price elasticity of demand for waterpipe and cigarette smoking in Lebanon, Jordan, and Palestine: A volumetric choice experiment

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Gender differences in the price elasticity of demand for waterpipe and cigarette smoking in Lebanon, Jordan, and Palestine: A volumetric choice experiment

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Gender differences in the price elasticity of demand for waterpipe and cigarette tobacco smoking in Lebanon, Jordan, and Palestine: A volumetric choice experiment

Abstract

Objectives: This study assessed the extent to which the elasticity of cigarette and waterpipe tobacco products differs between men and women. We also explored the levels of substitution and complementarity in tobacco products amongst men and women.

Setting: The study examines tobacco elasticities in three Arab countries: Lebanon, Jordan and the West Bank of Palestine.

Participants: We used data from nationally representative surveys of adults aged ≥18 years in Lebanon (n=1680), Jordan (n=1925), and Palestine (n=1679). The proportion of women was 50.0% of the sample in Lebanon and Palestine, and 44.6% in Jordan.

Primary and secondary outcome measures: A zero-inflated Poisson regression model estimated own- and cross-price elasticities for two variations of cigarettes and five variations of waterpipe tobacco products. Elasticities were measured based on eight scenarios of prices.

Results: Demand for waterpipe tobacco products was elastic for both men and women. The cross-price elasticities in the three countries indicate the existence of substitution between cigarettes and waterpipe products and by different varieties within each of the two tobacco products. Gender differences varied across the three countries whereby higher cross-price elasticities were observed for women in Jordan and Palestine. For example, the price elasticity for discount waterpipe was -1.4 and -0.6 for women and men in Jordan, respectively.
Conclusions: Results on the elasticity of demand for tobacco products and the existence of substitution between tobacco products reveal the higher responsiveness of men and women to changes in tobacco prices. This should be taken into consideration in tobacco control strategies particularly when reducing tobacco consumption via taxation policies.

Keywords: Tobacco smoking; Waterpipe; Gender; Elasticity; Arab region
Strengths and limitations of this study

- We used a robust, volumetric choice experiment from nationally representative surveys to assess own- and cross-price elasticities of waterpipe tobacco – a topic that has received little attention in the literature.

- The study provided a comprehensive evaluation of price elasticities of different tobacco products and by gender using identical methodologies that allow cross-country comparisons.

- One limitation is that the data does not account for the effect of price differentials across the three neighboring countries. Thus, the impact of smuggling on tobacco consumption remains uncertain.

- Another limitation is related to the actual impact of price changes on tobacco consumption. Elasticities considered in this study measure the sensitivity of individuals to price changes adjusted for inflation but not for income.
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**Conflicts of interest**

The authors declare no conflicts of interest.

**Data availability statement**

Data are available upon reasonable request.

**Patient and public involvement**

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

**Ethics Approval**

The institutional review boards at the American University of Beirut (ID: SBS-2019-0097), Jordan University of Science and Technology (ID: 14-119-2018), and Birzeit University (ID: 2019 (1-1)).

**Patient consent for publication**

Not applicable.

**Contributorship statement**

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1 Introduction

Empirical evidence suggests that men have higher rates of tobacco smoking compared to women.[1], [2] In general, the prevalence of tobacco smoking amongst men is about ten-fold that of women in developing countries (32% vs. 3.1%) as compared to less than two-fold in developed countries (30% vs. 17%).[3] Tobacco control policies seeking to reduce tobacco prevalence include tax policies, consumer education, using health warning labels, restrictions on tobacco smoking in public spaces, banning tobacco advertising and promotion, and smoking cessation programs.[4]–[6] Increasing tobacco prices by imposing higher tobacco excise taxes is among the most effective policy tools to reduce the prevalence of tobacco smoking.[7], [8] To assess the effectiveness of tobacco tax policies, it is imperative to evaluate how individuals would change their responsiveness of tobacco consumption to changes in the prices of each tobacco product and the possible trade-off between tobacco products. Higher tobacco prices may lead smokers to switch to lower-priced tobacco products. The bulk of available literature examining the price elasticity of demand for tobacco products has focused on cigarettes only. Studies which has focused on other tobacco products such as waterpipe are scarce.[9], [10] A recent review on the price elasticity of demand for non-cigarette tobacco products revealed that there is a lack of corresponding research in the Arab region where most of the included studies has been conducted in high-income settings.[10]

The prevalence of non-cigarette tobacco smoking is increasing worldwide.[11] In the Arab region, waterpipe tobacco smoking – also referred to as narghile, arghile, and shisha – is gaining popularity amongst both men and women.[12] Further, Arab women tend to smoke waterpipe tobacco more than cigarettes.[13], [14] Recent estimates based on representative surveys show that the prevalence of waterpipe tobacco smoking amongst women in Lebanon is more than twice that
of cigarettes (54.7% vs. 27.5%).[15] Available evidence shows that tax policies might be unequal across socioeconomic groups as it imposes higher burden on the worse-off segment of the population.[16] Socioeconomic differences between men and women in the Arab region such as income differences may render women more vulnerable to changes in tobacco prices as compared to men. With women being endowed with lower financial resources, it is crucial to assess gender differences in terms of the degree of responsiveness in tobacco consumption in relation to changes in tobacco prices (taxes).

In the Arab region, taxation policies of waterpipe products as compared to cigarettes are absent. Moreover, in some countries tax rates on cigarettes are lower than the recommended rate of 75% of the retail price of tobacco products.[17] Based on a recent report of the World Health Organization, the general tax structure of tobacco products in the region is composed of three different types of taxes: (i) import duty tax (%); (ii) value added tax (%), and (iii) excise tax (specific (USD) and ad valorem (%)).[17] In Jordan and Palestine, the overall tax rates on cigarettes exceed 75% (78.0% in Jordan vs. 92.8% in Palestine) while in Lebanon the overall tax rates on cigarettes is 9.9%.[17] As for waterpipe products, the overall tax rates are, respectively, 21.2%, 30.4% and 79.0% in Lebanon, Jordan and Palestine.[18] These facts reveal that there is some room to increase taxation of different tobacco products in these countries as a tool to reduce the prevalence of smoking in the region.

The assessment of the price elasticity of demand for tobacco has been largely addressed using a variety of econometric models such as linear regression models, two-part models, and the Zero-Inflated Poisson (ZIP) model.[9], [19], [20], [10] However, the estimation of waterpipe tobacco elasticities and cross-price elasticities of tobacco products has received less attention in the literature.[15], [21], [22] Empirical evidence shows that results are rather mixed with some
tobacco products being substitutes for cigarettes such as cigars and electronic cigarettes[21] while
others such as bidis are shown to be complementary to cigarettes.[23] Regarding differences across
groups, there is a bulk of literature which assessed the elasticity of demand for tobacco products,
mainly cigarettes, across age and socioeconomic groups in low-income countries.[7], [20], [24]
To the best of our knowledge, there is only one study that quantified the elasticity in the Arab
region (in Lebanon) across socioeconomic groups.[7] The results of this study shows that demand
for imported cigarettes is inelastic and that the corresponding own-price elasticities are higher for
the poorest income quintile (-0.32) and lower for the richest quintile (-0.22).[7]

Studies investigating the price elasticities of demand for different tobacco products across
gender groups are, however, limited.[25]–[27] Moreover, there were no previous attempts to assess
gender differences in the price elasticities of waterpipe tobacco products. Existing empirical
evidence concerning gender differences in the price elasticity of demand for tobacco, mainly
cigarettes, is also mixed. For instance, using a two-part model, Tauras, Huang & Chaloupka (2013)
showed that the price elasticity of young women in the United States was more than two-fold the
price elasticity of their men counterparts (-0.63 vs. -0.25). However, Sweis & Chaloupka (2014)
demonstrated that Jordanian men had a higher price elasticity of cigarettes as compared to women
(-0.81 vs. -0.01).

A full analysis of the own- and cross-price elasticities of different tobacco products that
account for gender differences is lacking. The aims of this paper, which focuses on Lebanon,
Jordan, and the West Bank of Palestine, were thus two-fold. Firstly, we aimed to assess the extent
to which the elasticity of cigarettes and waterpipe tobacco products differs between men and
women. Secondly, we aimed to explore the substitution and complementarity in tobacco products
amongst men and women.
2 Methods

2.1 Data

We used data from nationally representative surveys that were conducted in Lebanon, Jordan and the West Bank of Palestine in June-August 2019. The full methodological details of these surveys are published elsewhere.[9], [28] Briefly, eligible respondents included male and female adults (≥18 years old) residing in each country regardless of their nationality. The sample sizes were calculated to estimate the prevalence of current waterpipe smoking for both males and females in each country separately based on previously reported prevalence rates. A two-stage cluster sampling approach in which probability-proportional-to-size random selection methods was applied to choose clusters in each country. The first stage entailed selecting well-defined geopolitical areas (clusters) within the governorates in each country (8 governorates in Lebanon, 12 governorates in Jordan, 11 governorates in the West Bank). The second stage involved choosing a random sample of 30 households from each selected cluster using systematic random sampling. From each selected household, one eligible male and one female residents were selected. To ensure the inclusion of each selected household in the sample, the household was visited three times. If the household is marked as “Not at home”, the next household was selected. In Lebanon and the West Bank, a balanced sample of men and women was selected while in Jordan, the number of men was higher than women as additional households were selected based on their availability at home during the visits. All participants were provided with information about the study and were asked to provide consent to participate.

The surveys assessed the use of two main varieties of cigarettes (premium and discount cigarettes) and five varieties of waterpipe tobacco (premium, discount, home-delivered waterpipe
tobacco, and premium and discount waterpipe tobacco café smoking). The questionnaire included a volumetric choice experiment (VCE) that modeled eight scenarios of different tobacco product with varying prices in each scenario. Respondents were asked to indicate the amount of tobacco (cigarettes and waterpipe) they were willing to consume under each scenario. Respondents could choose to consume any possible combination of tobacco products within each scenario. The VCE allows to calculate the cross-price elasticity between different tobacco products based on consumers’ willingness to trade-off tobacco products under each scenario of prices. The surveys assessed non-flavored waterpipe tobacco for Lebanon and Jordan and roll-your-cigarette smoking for the West Bank. For consistency, these two categories of tobacco have been excluded in the current analysis.

2.2 Statistical analysis

Akin to Chalak et al. (2021), we used a Zero-Inflated Poisson (ZIP) regression model to calculate the own- and cross-price elasticities of demand for tobacco products for each country. The ZIP model is suitable for count data with excess zeros (non-smokers in our case). The ZIP model was estimated first for each gender group for each of the seven tobacco products. Then the model was estimated for each gender for each tobacco product variety. Tobacco products were classified into three groups such that the within-group unit of measurement was homogenous. These groups were (i) cigarettes, which included premium and discount cigarettes – measured in packs; (ii) waterpipe tobacco (250g), which included premium and discount waterpipe tobacco and (iii) waterpipe sessions, which included delivered waterpipe and discount and premium waterpipe café smoking sessions. For each group, the quantity was calculated as the sum of all quantities
reported by each respondent at each set of prices. The price of each product variety was calculated using the Stone index.\textsuperscript{[29]} For each product variety, $j$, the stone index, $P^S_j$, is defined as

$$P^S_j = \prod_{m=1}^{M} (p_m)^{s_m}$$

where $M$ is the total quantity within each product variety, $p_m$ is the price of tobacco product $m = 1, ..., M$, and $s_m$ is the expenditure weight of product $m$ such that $\sum_{m=1}^{M} s_m = 1$. The stone index is a weighted geometric mean of the price of tobacco products. Some respondents reported zero quantities at certain price levels. So calculating $s_m$ for each respondent at each scenario of prices yielded many null weighted prices. We therefore calculated $s_m$ as the average weight of all respondents for all price scenarios for each tobacco product variety $m$.

Two binary variables were constructed for the regression analysis used to estimate the price elasticities of demand. The first equaled one if the individual smoked any type of cigarettes while the second equaled one if the individual smoked any type of waterpipe tobacco. The former binary variable was used as an inflation variable in the ZIP models of cigarette products while the latter binary variable was used in the ZIP models of waterpipe products. For all models, the set of independent variables of the first part model included the logarithmic forms of the prices of all tobacco product varieties and a categorical variable of four income groups. The inclusion of the prices of all tobacco products allowed for calculating the cross-price elasticities between all tobacco products. In general, the set of independent variables of the inflation part of the ZIP model included the relevant binary variable of tobacco smoking, age (categorical variable), marital status (binary variable which takes one if the individual is single), a region variable (country-specific), employment status (unemployed, full-time and part-time employee), education level (less than university and with university education), and a binary variable that equaled one if the individual
was responsible for taking decisions in the household. For some tobacco product varieties across genders, only a subset of these independent variables was used due to the small sample size of smokers. All analyses were conducted using Stata version 14.2.

3 Results

3.1 Sample characteristics

Table 1 summarizes the three sample characteristics. The number of respondents were 1680 (50% female) in Lebanon, 1925 (44.6% female) in Jordan and 1679 (50% female) in the West Bank. In general, the distribution of men and women across the different age groups was balanced across all countries. Regarding the marital status, the share of single men and women was less than the quarter across countries. Turning to employment status, the unemployment rate was higher amongst women as compared to men across all countries (72.3% in Lebanon, 78.4% in Jordan and 89.8% in the West Bank). As for income groups, similar patterns were observed across all countries with the population being concentrated in the second and third quartiles for both men and women. As shown in Table 1, the highest share of smokers is observed in Lebanon for both gender groups (75.2% of men and 63.8% of women). Results indicate a higher gender gap in terms of smoking in Jordan and Palestine as compared to Lebanon. For example, the prevalence of smoking in Palestine is 36.0% amongst men and about 7.0% amongst women. Women in Lebanon and Palestine tend to smoke waterpipe more than cigarettes with a prevalence rate of waterpipe smoking of 46.3% and 5.1% and a prevalence rate of cigarettes smoking of 24.3% and 2.6% in Lebanon and Palestine, respectively.

3.2 Own-price elasticities
The price elasticities were first calculated by gender groups for each type of tobacco smoking for each country. Aggregate price elasticities have been documented elsewhere.[9] Results, which are summarized in Table 2, show that in Lebanon all elasticities of waterpipe products were greater than one indicating an elastic demand for waterpipe products for both men and women, as compared to cigarettes. Particularly, elasticities were the highest for premium café sessions and premium waterpipe tobacco, which were relatively more expensive as compared to other varieties of waterpipe products. The price elasticity was higher for women for the following types of tobacco; discount cigarettes (-0.75 for women vs. -0.58 for men), premium waterpipe (-2.02 for women vs. -1.90 for men), delivered waterpipe (-1.89 for women vs. -1.85 for men), premium café (-2.38 for women vs. -2.23 for men) and discount café (-1.74 for women vs. -1.66 for men). However, using the confidence interval (CI) approach based on the standard errors estimates (Table 3) no statistical significant difference exists between men and women for these elasticities.

In Jordan, with the exception of discount cigarettes, women generally had higher elasticities as compared to men. For example, the price elasticity of discount waterpipe for women was about two-fold the elasticity observed for men (-1.38 vs. -0.62). Moreover, the price elasticity of premium cigarettes for women was slightly higher than the price elasticity for men (-1.12 vs. -1.09). The highest elasticity was observed for discount waterpipe for women where a 10% increase in the price of discount waterpipe yielded a 13.8% decrease in its quantity consumed. Using the CI values, a significant difference between men and women exists for discount waterpipe only whereby the CIs for women and men were (-1.84, -0.91) and (-0.91, -0.32), respectively.

As for the West Bank, the price elasticity of premium cigarettes for women was -2.26 as compared to -1.00 for men. Palestinian women had the highest price elasticity of premium
cigarettes as compared to Lebanon and Jordan. Furthermore, the price elasticities of home-delivered waterpipe and premium and discount café sessions were higher for women as compared to men. For example, the price elasticity of delivered waterpipe for women was slightly more than three-fold the price elasticity of delivered waterpipe for men (-2.05 vs. -0.61). The price elasticity of premium waterpipe was found to be positive for both men and women though they were not statistically significant.

Table 4 summarizes the price elasticities of tobacco product varieties by gender for each country. In Lebanon, all own-price elasticities were statistically different from zero with higher elasticities being observed for women for cigarettes and waterpipe products. For example, a 10% average increase in cigarettes prices would result in a decrease in the quantity of cigarettes consumed by about 7.4% for women and 5.7% for men indicating an inelastic demand for cigarettes. Nonetheless, results show that demand for waterpipe was elastic. As for Jordan, the price elasticities of the three tobacco product varieties were higher for women. For example, a 10% average increase in waterpipe prices would result in a decrease in the quantity of waterpipe consumed by about 6.2% for women and only 3.7% for men. The demand for all tobacco product varieties was inelastic in Jordan. Different patterns were observed for the West Bank. The price elasticity of both cigarettes and waterpipe sessions were higher for women. However, the demand for cigarettes was elastic (-1.84 for women vs. -1.03 for men) while the demand for waterpipe session was inelastic (-0.60 for women vs. -0.33 for men).

3.3 Cross-price elasticities

Estimated cross-price elasticities of tobacco products are summarized in Table 2 for the three countries. In Lebanon, the cross-price elasticities of premium cigarettes with respect to other
tobacco products were not statistically significant except for discount waterpipe and discount café sessions for women. The cross-price elasticity of discount cigarettes with respect to premium cigarettes was positive and statistically significant for both men and women indicating a substitution effect between the two types of cigarettes. The magnitude of the estimated cross-price elasticity of discount cigarettes with respect to premium cigarettes was higher for women (0.23) as compared to men (0.15). Such a result goes in line with the economic theory where a price increase in premium brands of a certain good leads consumers to switch to cheaper brands/products. As for premium waterpipe, results show that cross-price elasticities were statistically significant and positive with respect to discount waterpipe and discount café and negative with respect to discount cigarettes and home-delivered waterpipe for both women and men. This result indicates that there was some level of substitution between premium waterpipe and the discounted waterpipe products (discount waterpipe tobacco and discount cafe) and some level of complementarity within the premium waterpipe products (premium waterpipe tobacco with home-delivered waterpipe). Results also indicate that premium waterpipe and discount cigarettes exhibited some substitution whereby a 10% increase in the price of discount cigarettes results in a 2.1% and 2.3% increase in the quantity consumed of premium waterpipe respectively for women and men. Also of note, that most cross-price elasticities of premium waterpipe were slightly higher for women as compared to men. This result is also confirmed with the cross-price elasticity of discount waterpipe with respect to other waterpipe products whereby complementarity was observed between discount waterpipe and discount café while substitution effect was observed between discount waterpipe and premium and delivered waterpipe. However, the cross-price elasticities of discount waterpipe were slightly higher for women as compared to men Furthermore,
discount café sessions appear to be substitutes for premium café sessions with higher elasticities being observed for men (0.17 for women vs. 0.25 for men).

As for Jordan, results show a substitution effect between premium and discount cigarettes for men only with, for example, a cross-price elasticity of discount cigarettes with respect to premium cigarettes equal to 0.25. As for waterpipe products, the cross-price elasticity of discount waterpipe with respect to premium waterpipe was statistically significant and positive for both men and women with the elasticity for women being twice that of men (0.67 vs. 0.35). This may indicate that discount and premium waterpipe products were substitutes.

Lastly, results on the cross-price elasticities of tobacco products for the West Bank were mixed. Only a few of the cross-price elasticities were statistically significant for men and women. There was some level of substitution between waterpipe products for women. For example, the cross-price elasticity of home-delivered waterpipe with respect to discount café sessions was positive and close to one for women (0.98). Furthermore, a 10% increase in the price of discount waterpipe product would reduce the quantity consumed of waterpipe in premium cafes by 7.03%. For men, on the other hand, unlike Lebanon and Jordan, results show complementarity between cigarettes products. For example, a 10% increase in the price of premium cigarettes would reduce the quantity consumed of discount cigarettes by 6.4%.

Once tobacco products were aggregated into groups, results indicate a substitution effect between cigarettes and waterpipe products for both men and women in the West Bank only as shown in Table 4. Moreover, the cross-price elasticity of cigarettes with respect to waterpipe was higher for women (0.9) as compared to men (0.6).

4 Discussion
This study provides estimates of the responsiveness in tobacco consumption in relation to changes in the prices of different varieties of cigarettes and waterpipe tobacco products among women and men in Lebanon, Jordan and the West Bank. The study found that women are more responsive to changes in the prices of tobacco products particularly discount waterpipe in Jordan and premium cigarettes in the West Bank of Palestine. Given that women are generally worse-off as compared to men in these countries, such a result is in line with previous evidence where the poorest are found to be more sensitive to changes in tobacco prices.[7] Results for Jordan were different from those obtained by Sweis & Chaloupka (2014) where the price elasticity of tobacco is found to be higher for men as mentioned in the introduction. Such a difference may be attributed to several reasons. First, previous estimates were calculated for cigarettes only without including any difference between cigarettes’ products or waterpipe products. Second, previous estimates were based on actual consumption of cigarettes (number of packs smoked per week) while in our case we applied a choice experiment that measure the amount consumed by each individual for each scenario of prices. Third, previous estimates were calculated based on 2011 data were the prevalence of smoking among women was lower (5.1% in 2011 vs. 13.1% in 2019).

The following highlights several interesting findings emerging from our analysis and their implications to policymakers. First, for some tobacco products, women were more sensitive to changes in tobacco prices indicating that women smokers would reduce their tobacco consumption more than men smokers in response to similar increases in tobacco prices. Empirical evidence shows that the effects of policy interventions may vary by gender whereby women are more responsive to policy changes.[30]–[32] For example, using linear regression with states and years fixed effects, a study conducted in the United States show that a tobacco tax intervention appears to be beneficial for women, but not for men, in terms of reducing coronary heart disease mortality.
Such a result is of interest for policymakers for two main reasons. First, as mentioned in the outset, the prevalence of waterpipe smoking is increasing in the Arab region particularly amongst women. Thus, an effective policy intervention may play a major role in reducing the prevalence of smoking amongst women. The second point is related to the specific health impact of tobacco use on pregnant women since smoking during pregnancy can increase the risk of abnormal pregnancy and delivery, birth defects, etc.

Reducing the prevalence of smoking amongst women would benefit both mothers and children by reducing the long-term health burden and the associated economic burden.

Second, the degree of responsiveness to changes in tobacco prices varied across the three countries. Different patterns of price elasticities were observed amongst the three countries once tobacco products were categorized into three groups: cigarettes, waterpipe tobacco (250g) and waterpipe sessions. For example, the demand for cigarettes was elastic in Lebanon and inelastic in the West Bank while the demand for waterpipe was inelastic in Lebanon and elastic in the West Bank. In Jordan, both the demand for cigarettes and for waterpipe appeared to be inelastic. Such differences might be related to the current prices of cigarettes and waterpipe products, as well as the overall socioeconomic status (e.g., average income per capita). Moreover, these differences may be related to the fact that for nicotine-dependent smokers, a large increase in tobacco prices induces a smaller decrease in the quantity consumed of tobacco products. Such results reveal that tobacco smoking behavior is rather country-specific, thus tobacco control policies should also be tailored in each country to reflect the sensitivity of tobacco products to price changes.

Third, the degree of responsiveness to changes in prices was higher for waterpipe products as compared to cigarettes. Such observation is mostly prominent for Lebanon where own-price elasticities of waterpipe products were greater than one for both men and women. This indicates
an elastic demand for waterpipe products as compared to cigarettes. Such result is very important especially with the increasing popularity of waterpipe products in the region and the fact that waterpipe products are not taxed in the same manner as cigarettes.[34]

Fourth, results on the cross-price elasticities in the three countries indicated some substitution between cigarettes and waterpipe products, and within each product variety. However, gender differences varied across the three countries whereby higher cross-price elasticities were generally observed for women in Lebanon and Jordan. Whereas in the West Bank results were mixed with some of the cross-price elasticities being higher for men. From a public health perspective, it is crucial to tax all tobacco products equally to avoid any substitution between and within cigarettes and waterpipe product varieties. For example, the positive cross-price elasticity between premium and discount cigarettes could lead to switching towards discount cigarettes, which may pose a higher risk of adverse health effects.[35], [36]

In general, this paper adds to the literature that assesses the price elasticity of tobacco, particularly for waterpipe tobacco elasticities and cross-price elasticities of tobacco products. To the best of our knowledge, this is the first attempt that provides a comprehensive evaluation of price elasticities of different tobacco products and across gender groups in the region. As mentioned in the outset, previous estimates from Lebanon and Jordan were either aggregate estimates or were calculated for cigarettes only.[9], [10], [26] Available literature in other regions which provides estimation of aggregate elasticities of non-cigarette products generally exclude waterpipe products while the other part of literature provide estimation across socioeconomic and age groups. Another key strength of the present article is the use of a harmonized methodology for three neighboring countries in the region in terms of data collection and data analysis. Such approach allows for cross-country comparisons of the prevalence of smoking as well as the own-
and cross-price elasticities of different tobacco products. However, this is not without limitations. Our data does not account for the effect of price differentials across these three or other neighboring countries. For example, the price of cigarette products is the highest in Palestine. As a result, Palestinians living in the West Bank may illegally purchase premium cigarettes with cheaper prices from Jordan. Such behavior of smuggling may impact the effectiveness of tobacco policy interventions that seek to increase tobacco prices through taxation. Empirical evidence suggests that differences in tobacco prices across neighboring countries may increase the consumption of tobacco in areas where the price of tobacco in neighboring countries is lower.\[37\] With the presence of smuggling in the West Bank, the prevalence of tobacco smoking in the West Bank is expected to be different than that observed in the Gaza Strip. Indeed, available evidence shows that the prevalence rate of smoking is higher in the West Bank. [38] Unfortunately, this study focuses on the West Bank only, thus it is difficult to conduct a comparison between the two Palestinian regions. To sum up, price differentials across neighboring countries suggests that prices of both cigarettes and waterpipe products shall be harmonized in the three countries to achieve effective decrease in the prevalence of smoking.

Another limitation is related to the independent variables included in the model that may affect the level of consumption of tobacco products. With the exception of prices, all variables were measured at the individual level. The income effect was captured in the ZIP model by controlling for both income differences and differences in the employment status of individuals. Other factors that might affect tobacco consumption and shall be available at the country or regional levels were not included in the surveys. An example of such variables is related to variations in the business cycle. Empirical evidence shows that gross domestic product (GDP) and
unemployment rates across regions are highly correlated with tobacco consumption where higher GDP growth rates and lower unemployment rates tend to reduce tobacco consumption.[39], [40]

Another limitation of the study is related to the actual impact of price changes on tobacco consumption. In our model, absolute prices were included in the analysis which allows to measure the price elasticities. Prices would affect tobacco consumption directly (substitution effect) and indirectly through reducing the purchasing power of individuals (income effect). However, if income increases, then the level of tobacco consumption will also increase. Accordingly, the prevalence and intensity of tobacco consumption might not be reduced if the tax increase was associated with income increase. To assess the effectiveness of tobacco tax policies, empirical evidence suggests to calculate the so-called affordability elasticity which captures the changes of tobacco consumption to changes in the price and income simultaneously rather than separating the two effects.[41] This is done by including the price-income ratio in the model instead of including both prices and income as two independent variables. Although we account for income effect in the current study, we could not calculate this ratio since income is available as a categorical variable.

Based on limitations raised above, future research could focus on the following three areas. First, the lack of data in this strand of literature calls for the collection of national comprehensive data for each country in the region. This data could include information about the source of purchase of tobacco products to account for the impact of illicit trade caused by price differentials across neighboring countries. Accounting for this in the analysis of price elasticities is crucial to assess the effectiveness of tobacco taxation policies. Second, although income data are relatively unreliable in low-income countries where individuals tend to underreport the level of their income, future surveys could also include questions about the level of income or consumption expenditure
as a proxy for income. This allows us to calculate the affordability elasticity of tobacco consumption and compare results with those obtained from considering price and income elasticities separately. Third, future research could also benefit from results obtained at the micro level to assess the associated health benefits as well as macro-level impact of tax interventions on government revenues.

5 Conclusion

The epidemic of waterpipe tobacco smoking is growing among women in low- and middle income countries.[12] Our analysis could inform efforts in increasing taxation on waterpipe tobacco products in similar contexts. Moreover, the prevalence of tobacco smoking is likely to increase amongst women in the region as social restrictions placed on women are reduced. These restrictions include religious restrictions and socio-cultural acceptance of women smoking where people in the region believe that the practice of smoking reflect a “negative image” of women.[42], [43] As shown in Lebanon, where smoking among women is more socially acceptable relative to other countries in the region, the prevalence of tobacco smoking amongst women is extremely high.[43], [44] Therefore, gender-based analyses are important to consider the formulation of tobacco control policies. The differences in the own- and cross-price elasticities between men and women for some tobacco products in Jordan and the West Bank of Palestine reveal the higher responsiveness of women to changes in tobacco prices as compared to men. This fact reflect the effectiveness of increasing tobacco taxes, hence reducing tobacco prevalence and the associated economic burden. Akin to previous evidence that demonstrates a substitution effect between cigarettes and other tobacco products, such as cigars and electronic cigarettes,[21] this paper shows that some waterpipe tobacco and cigarettes products act as substitutes. The fact that many tobacco
products appear to be substitutes reflect the importance of taxing all tobacco products to avoid any potential substitution that may occur between and within tobacco products while increasing government revenues.[15], [21], [45]
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| Age group, years | Lebanon (N=1680) | Jordan (N=1925) | West Bank (N=1679) |
|------------------|------------------|------------------|---------------------|
| < 25             | 162 (19.3%)      | 134 (16.0%)      | 152 (17.7%)        |
| 26-35            | 203 (24.2%)      | 174 (20.7%)      | 203 (23.7%)        |
| 36-45            | 188 (22.3%)      | 187 (22.3%)      | 200 (23.3%)        |
| 46-55            | 197 (23.5%)      | 170 (20.2%)      | 172 (20.0%)        |
| >56              | 90 (10.7%)       | 175 (20.8%)      | 131 (15.3%)        |

| Marital status  | Lebanon (N=1680) | Jordan (N=1925) | West Bank (N=1679) |
|------------------|------------------|------------------|---------------------|
| Single           | 100 (11.9%)      | 147 (17.5%)      | 133 (15.5%)        |
| Otherwise        | 740 (88.1%)      | 639 (82.5%)      | 725 (84.5%)        |

| Employment status | Lebanon (N=1680) | Jordan (N=1925) | West Bank (N=1679) |
|-------------------|------------------|------------------|---------------------|
| Unemployed        | 607 (72.3%)      | 187 (22.3%)      | 673 (78.4%)        |
| Full-time employed| 174 (20.7%)      | 574 (68.3%)      | 137 (16.0%)        |
| Part-time employed| 59 (7.0%)        | 79 (9.4%)        | 48 (5.6%)          |

| Education level   | Lebanon (N=1680) | Jordan (N=1925) | West Bank (N=1679) |
|-------------------|------------------|------------------|---------------------|
| Less than university | 669 (79.6%)   | 664 (79.1%)      | 639 (74.5%)        |
| University education | 171 (20.4%)   | 176 (20.9%)      | 219 (25.5%)        |

| Participation in decisions in the household | Lebanon (N=1680) | Jordan (N=1925) | West Bank (N=1679) |
|---------------------------------------------|------------------|------------------|---------------------|
| Yes                                        | 706 (80.1%) | 489 (58.2%) | 692 (80.7%) |
| No                                         | 134 (19.9%) | 351 (41.8%) | 166 (19.3%) |

| Income group    | Lebanon (N=1680) | Jordan (N=1925) | West Bank (N=1679) |
|-----------------|------------------|------------------|---------------------|
| Lowest quartile | 75 (9.1%)        | 62 (7.5%)        | 207 (24.9%)        |
| 2nd quartile    | 321 (38.8%)      | 326 (39.5%)      | 320 (38.5%)        |
| 3rd quartile    | 320 (38.7%)      | 323 (39.1%)      | 197 (23.7%)        |
| Highest quartile| 111 (13.4%)      | 115 (13.9%)      | 107 (12.9%)        |

| Smoking cigarettes | Lebanon (N=1680) | Jordan (N=1925) | West Bank (N=1679) |
|--------------------|------------------|------------------|---------------------|
| Yes                | 204 (24.3%)      | 415 (49.4%)      | 76 (8.9%)          |
| No                 | 636 (75.7%)      | 425 (50.6%)      | 496 (64.5%)        |

| Smoking waterpipe | Lebanon (N=1680) | Jordan (N=1925) | West Bank (N=1679) |
|-------------------|------------------|------------------|---------------------|
| Yes               | 389 (46.3%)      | 300 (35.7%)      | 60 (7.0%)          |
| No                | 451 (53.7%)      | 540 (64.3%)      | 169 (15.8%)        |

| Smoking any type of tobacco | Lebanon (N=1680) | Jordan (N=1925) | West Bank (N=1679) |
|-----------------------------|------------------|------------------|---------------------|
| Yes                         | 536 (63.8%)      | 632 (75.2%)      | 112 (13.1%)        |
| No                          | 304 (36.2%)      | 208 (24.8%)      | 746 (86.9%)        |
Table 2: Own- and cross-price elasticities of tobacco products in three Arab countries

|                  | Premium cig | Discount cig | Premium WTP | Discount WTP | Delivered WTP | Premium café | Discount café |
|------------------|-------------|-------------|-------------|--------------|---------------|--------------|---------------|
| Wome n           | -0.919      | -1.205      | 0.230       | -0.019       | -0.104        | 0.142        | 0.028         |
| Men              | (0.000)     | (0.000)     | (0.000)     | (0.718)      | (0.063)       | (0.158)      | (0.095)       |
| Lebanon          |             |             |             |              |               |              |               |
| Premium cig      | -0.061      | 0.045       | -0.751      | -0.582       | -0.210        | -0.600       | -0.130        |
| Discount cig     | (0.606)     | (0.467)     | (0.000)     | (0.000)      | (0.001)       | (0.358)      | (0.600)       |
| Premium WTP      | 0.078       | -0.028      | -0.019      | -0.103       | -2.017        | -0.508       | 0.254         |
| Discount WTP     | (0.001)     | 0.014       | 0.017       | -0.001       | 0.274         | 0.132        | -1.723        |
| Delivered WTP    | 0.056       | 0.006       | 0.035       | 0.058        | -0.244        | 0.094        | 0.184         |
| Premium café     | (0.591)     | (0.909)     | (0.501)     | (0.101)      | (0.000)       | (0.084)      | (0.006)       |
| Discount café    | -0.110      | 0.048       | -0.036      | -0.041       | 0.100         | 0.097        | -0.064        |
| Jordan           | (0.653)     | (0.008)     | (0.000)     | (0.000)      | (0.177)       | (0.027)      | (0.004)       |
| Premium WTP      | 0.199       | -0.073      | 0.199       | 0.169        | -0.781        | 0.670        | 0.347         |
| Discount WTP     | (0.319)     | (0.224)     | (0.140)     | (0.000)      | (0.000)       | (0.004)      | (0.028)       |
| Delivered WTP    | -0.412      | 0.085       | -0.007      | -0.067       | 0.055         | 0.015        | -1.376        |
| Premium café     | (0.028)     | (0.123)     | 0.956       | (0.144)      | (0.783)       | (0.889)      | (0.000)       |
| Discount café    | 0.054       | -0.005      | 0.030       | -0.031       | 0.012         | 0.022        | 0.173         |
| The West Bank of Palestine | 0.075 | -0.002 | 0.006 | 0.011 | -0.033 | 0.224 | 0.006 | -0.273 | -1.073 | 0.211 | -0.385 |
| Premium WTP      | -0.132      | 0.048       | 0.001       | -0.092       | -0.150        | -0.099       | -0.134        |
| Premium café     | (0.482)     | (0.384)     | (0.997)     | (0.045)      | (0.463)       | (0.363)      | (0.435)       |
| Discount café    | 0.124       | 0.292       | 0.640       | 0.184        | 0.201         | 0.518        | -0.155        |

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| Tobacco Product       | Discount WTP | Delivered WTP | Premium café | Discount café |
|----------------------|--------------|---------------|--------------|---------------|
|                      | (0.681)      | (0.000)       | (0.406)      | (0.135)       |
|                      | (0.988)      | (0.299)       | (0.241)      | (0.563)       |
|                      | (0.000)      | (0.000)       | (0.063)      | (0.063)       |
|                      | (0.086)      | (0.135)       | (0.507)      | (0.122)       |
|                      | (0.733)      | (0.072)       | (0.841)      | (0.005)       |
|                      | (0.721)      | (0.048)       | (0.786)      | (0.360)       |
|                      | (0.580)      | (0.195)       | (0.360)      | (0.105)       |
|                      | (0.345)      | (0.211)       | (0.251)      | (0.733)       |
|                      | (0.034)      | (0.721)       | (0.721)      | (0.580)       |
|                      | (0.000)      | (0.072)       | (0.721)      | (0.580)       |
|                      | (0.000)      | (0.072)       | (0.721)      | (0.580)       |
|                      | (0.000)      | (0.072)       | (0.721)      | (0.580)       |
|                      | (0.000)      | (0.072)       | (0.721)      | (0.580)       |
|                      | (0.000)      | (0.072)       | (0.721)      | (0.580)       |
|                      | (0.000)      | (0.072)       | (0.721)      | (0.580)       |
|                      | (0.000)      | (0.072)       | (0.721)      | (0.580)       |

1. Reported figures indicate the own-price elasticity of each tobacco product, while the values in parentheses indicate the p-value.
2. Cig: cigarettes.
3. WTP: waterpipe.
4. The ZIP model did not converge for some tobacco products in the case of Jordan and the West Bank of Palestine.
| Country          | Premium cig | Discount cig | Premium WTP | Discount WTP | Delivered WTP | Premium café | Discount café |
|------------------|-------------|--------------|-------------|--------------|---------------|--------------|---------------|
| Lebanon          |             |              |             |              |                |              |                |
| Women            | 0.125       | 0.066        | 0.055       | 0.039        |                |              |                |
| Men              | 0.119       | 0.062        | 0.059       | 0.040        |                |              |                |
| Premium WTP      | 0.114       | 0.061        | 0.058       | 0.039        | 0.066         | 0.082        |                |
| Discount WTP     | 0.105       | 0.054        | 0.051       | 0.035        | 0.050         | 0.063        | 0.066         | 0.082        |
| Delivered WTP    | 0.105       | 0.055        | 0.051       | 0.035        | 0.050         | 0.063        | 0.054         | 0.067        | 0.269       | 0.152        |
| Premium café     | 0.105       | 0.054        | 0.051       | 0.035        | 0.049         | 0.062        | 0.055         | 0.068        | 0.211       | 0.157        | 0.100       | 0.129        |
| Discount café    | 0.106       | 0.054        | 0.051       | 0.035        | 0.051         | 0.064        | 0.055         | 0.068        | 0.211       | 0.172        | 0.094       | 0.124        | 0.069       | 0.086        |
| Jordan           |             |              |             |              |                |              |                |
| Women            | 0.196       | 0.061        | 0.127       | 0.048        | 0.199         | 0.119        | 0.204         | 0.138        | 0.316       | 0.343        | 0.510       | 0.166        |
| Men              | 0.207       | 0.062        | 0.145       | 0.054        | 0.220         | 0.119        | 0.244         | 0.157        | 0.332       | 0.382        | 0.410       | 0.182        |
| Premium WTP      | 0.200       | 0.060        | 0.135       | 0.050        | 0.216         | 0.122        | 0.230         | 0.158        | 0.244       | 0.342        | 0.424        | 0.170        |
| Discount WTP     | 0.187       | 0.055        | 0.126       | 0.046        | 0.201         | 0.107        | 0.237         | 0.149        | 0.275       | 0.346        | 0.340        | 0.156        |
| Delivered WTP    | 0.186       | 0.055        | 0.127       | 0.046        | 0.208         | 0.107        | 0.208         | 0.136        | 0.258       | 0.338        | 0.293        | 0.164        |
| Premium café     | 0.186       | 0.055        | 0.127       | 0.046        | 0.211         | 0.110        | 0.210         | 0.141        | 0.307       | 0.353        | 0.350        | 0.165        |
| Discount café    | 0.187       | 0.055        | 0.128       | 0.046        | 0.204         | 0.109        | 0.212         | 0.140        | 0.273       | 0.344        | 0.364        | 0.166        |
| The West Bank of Palestine |        |              |             |              |                |              |                |
| Women            | 0.403       | 0.077        | 0.128       | 0.046        | 0.231         | 0.141        | 0.334         | 0.456        | 0.468       | 0.229        | 0.167        | 0.220        | 0.126        |
| Men              | 0.334       | 0.080        | 0.134       | 0.150        | 0.263         | 0.150        | 0.318         | 0.476        | 0.438       | 0.239        | 0.169        | 0.241        | 0.133        |
| Premium WTP      | 0.302       | 0.069        | 0.221       | 0.135        | 0.302         | 0.380        | 0.273         | 0.161        | 0.201        | 0.213        | 0.130        |
| Discount WTP     | 0.295       | 0.067        | 0.257       | 0.183        | 0.339         | 0.700        | 0.247         | 0.177        | 0.213        | 0.212        | 0.130        |
| Delivered WTP    | 0.330       | 0.076        | 0.243       | 0.191        | 0.340         | 0.564        | 0.522         | 0.231        | 0.157        | 0.212        | 0.130        |
| Premium café     | 0.302       | 0.073        | 0.258       | 0.186        | 0.366         | 0.428        | 0.433         | 0.266        | 0.165        | 0.225        | 0.131        |
| Discount café    | 0.309       | 0.069        | 0.250       | 0.185        | 0.339         | 0.476        | 0.595         | 0.230        | 0.183        | 0.249        | 0.142        |
Table 4: Own- and cross-price elasticities of tobacco groups in three Arab countries

|                        | Cigarettes | Waterpipe (250g) | Waterpipe (sessions) |
|------------------------|------------|-------------------|----------------------|
|                        | Women      | Men               | Women                | Men               | Women               | Men               |
| Lebanon                |            |                   |                      |                   |                    |                   |
| Cigarettes             | -0.737     | -0.568            | 0.019                | -0.014            | 0.106              | -0.031            |
|                        | (0.000)    | (0.000)           | (0.694)              | (0.820)           | (0.086)            | (0.677)           |
| Waterpipe (250 g)      | 0.058      | -0.042            | -1.215               | -1.198            | 0.120              | 0.072             |
|                        | (0.381)    | (0.312)           | (0.000)              | (0.000)           | (0.065)            | (0.360)           |
| Waterpipe (sessions)   | 0.033      | 0.011             | -0.006               | 0.039             | -1.246             | -1.390            |
|                        | (0.629)    | (0.807)           | (0.919)              | (0.583)           | (0.000)            | (0.000)           |
| Jordan                 |            |                   |                      |                   |                    |                   |
| Cigarettes             | -0.708     | -0.565            | -0.071               | -0.126            | -0.011             | -0.027            |
|                        | (0.000)    | (0.000)           | (0.702)              | (0.290)           | (0.975)            | (0.817)           |
| Waterpipe (250 g)      | 0.065      | 0.056             | -0.620               | -0.371            | 0.344              | 0.075             |
|                        | (0.658)    | (0.227)           | (0.001)              | (0.003)           | (0.339)            | (0.565)           |
| Waterpipe (sessions)   | -0.025     | -0.022            | -0.051               | 0.066             | -0.465             | -0.202            |
|                        | (0.864)    | (0.664)           | (0.785)              | (0.602)           | (0.208)            | (0.105)           |
| The West Bank of Palestine |      |                   |                      |                   |                    |                   |
| Cigarettes             | -1.844     | -1.029            | 0.508                | 0.133             | 0.011              | -0.134            |
|                        | (0.000)    | (0.000)           | (0.010)              | (0.275)           | (0.944)            | (0.140)           |
| Waterpipe (250 g)      | 0.853      | 0.593             | 0.124                | 0.140             | -0.090             | 0.289             |
|                        | (0.002)    | (0.000)           | (0.506)              | (0.246)           | (0.561)            | (0.002)           |
| Waterpipe (sessions)   | -0.248     | -0.031            | -0.276               | -0.051            | -0.603             | -0.326            |
|                        | (0.365)    | (0.656)           | (0.215)              | (0.703)           | (0.002)            | (0.003)           |

1. Reported figures indicate the price elasticity of each tobacco product, while the values in parentheses indicate the p-value.
