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Estimation of Smoking Index for Male Smokers in Multan City

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Abstract: Smoking index measures the present burden of smoking in terms of cigarette-years or pack-years smoked. The present article is about estimation of smoking index for male smokers in Multan city. We used Indrayan's smoking index that accounts for different characteristics like cigarettes smoked per day, duration of smoking, passive smoking, smoking of filter cigarettes, age at start and duration elapsed since quitting by ex-smokers etc. It is estimated that the average smoking index is 10.48±0.34 while the 25th, 50th and 75th percentiles are 5.81, 9.51 and 13.66, respectively. Furthermore, the Weibull distribution is found to be the best fitted empirical distribution for the obtained dataset of smoking index with estimates of shape parameter and scale parameter as 1.6407 and 11.7049, respectively.

Key words: Environmental tobacco smoke, Indrayan's smoking index, kolmogrov-smirnov test, mann-whitney test, passive smoking, secondhand smoke, Weibull distribution

INTRODUCTION

Smoking, in simple words, means drawing and exhaling smoke from a cigarette, cigar, or pipe etc. It is one of the most common forms of recreational drug use. According to World Health Organization (WHO, 2005, 2010), tobacco smoking is today the most popular form of smoking and is practiced by over one billion people in the majority of all human societies and approximately 47% of men and 12% of women smoke worldwide.

There is no doubt about the adverse effects of smoking on health. Dwivedi *et al*. (2006) and Tomas (2007) reported that tobacco smoking in any form is a strong and common risk factor for coronary artery disease, hypertension, chronic obstructive pulmonary disease, oral, nasopharyngeal, alveolar bone loss and tooth loss, bronchial and other visceral malignancies. Zafar *et al*. (2003) exposed a significant association of erythrocytes and leukocytes count and haemoglobin level with cigarette smoking. See also Clark *et al*. (1967), Coondy and Sonden (1975), Collishaw and Lopez (1996) and Geng *et al*. (1996), to study similar detrimental effects of smoking. Thus, smoking is considered as one of the leading causes of preventable deaths and use of tobacco causes 5 million premature deaths each year worldwide (see also Guindon and Boisclair, 2003; Diethelm *et al*., 2005; Ahmed *et al*., 2008; Chu *et al*., 2009).

Common forms of smoking are smoking cigarettes, cigars and pipes. In addition to these in the Sub-continent region, tobacco is smoked in the forms of "Beedi" (tobacco rolled in dry leaves) and "Huqqa" (Kazi, 1990; Malik *et al*., 2010). But these different forms of smoking carry the same risk as cigarettes, cigars or pipes do. Tobacco smoke contains a stimulant, "nicotine" which is as highly an addictive drug as heroin or cocaine. Nicotine creates a pleasant feeling which makes the smoker want to smoke more. Moreover, when a smoker tries to quit, he suffers from physical withdrawal symptoms such as nervousness, headaches and trouble sleeping. It also affects the chemistry of the brain and central nervous system. Ultimately, the smoker finds it hard to quit (Lock *et al*., 1998).

For the year 2015, WHO (2010) projected 6.4 million deaths attributable to tobacco consumption which would be 10.0% of all deaths. It is also alarming to note that approximately 7 million of these will be from developing countries. Overall, the mortality and morbidity from tobacco use incur an economic cost of US$ 200 billion annually (WHO, 2010).

Ezzati and Lopez (2003) reported that the consumption of cigarette and other tobacco products is relatively high mostly in poor countries and poor population. In developing countries including Pakistan with weak anti-tobacco legislation, the use of tobacco products and cigarette smoking is rising, alarmingly. Ahmad *et al*. (2005) reported that one out of every two to three middle-aged men in Pakistan smoke cigarettes. The common ways to use tobacco in Pakistan include, cigarette smoking, chewing tobacco, use of beedi and huqqa (Kazi, 1990).

In Pakistan, it is estimated that the prevalence of tobacco smoking is 36% for males and 9% for females (Zaman *et al*., 2002; Shaikh and Kamal, 2004). Shah *et al*. (2001) reported the percentage of smoking cigarette was 43.7% among males and 5.5% among females in northern areas of Pakistan. Numerous authors have addressed the same issue for Pakistan e.g., Alam (1998); Rozi and Akhtar (2004); Mahesar *et al*. (2009); Ahmed *et al*. (2008) and Malik *et al*. (2010) etc.

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Smoking is a complex exposure with several important characteristics like number of cigarettes smoked per day, duration of smoking, passive smoking, smoking of filter cigarettes, age at start and duration elapsed since quitting by ex-smokers that are difficult to account for in epidemiologic models of disease (Morabia and Wynder, 1991; Indrayan, 2008). So there is needed to have a measure that incorporates these dimensions of smoking. Indrayan *et al*. (2008) established a Smoking Index (SI) that accounted for such characteristics. The estimation of such SI becomes to be fruitful to study the smoking burden in a society. This fact motivates the present article that addresses the computation of SI of male smokers of Pakistan, taking Multan city as a case study.

Smoking index: SI is a parameter used to express cumulative smoking exposure quantitatively. It is generally defined as the number of cigarette-years (or pack-years) smoked. The ultimate measure of the magnitude of smoking is cigarettes smoked per day. The magnitude of smoking is commonly divided into light (less than 20 cigarettes smoked per day) and heavy (more than 20 cigarettes smoked per day) smoking (Baired and Wilcox, 1985). The cigarettes smoked per day and the duration of smoking is often combined into pack-years.

Indrayan *et al*. (2008) exposed the exact number of cigarettes smoked per day and the duration for which specific number was smoked to calculate cigarette-years and thus presented their initial measure of burden of smoking in terms of cigarette-years:

$$S_1 = \sum n_i x_i \qquad (1)$$

Where x_i is the number of cigarettes smoked for n_i years (i = 1, 2, …, I) and I is the number of segments in life with different smoking pattern.

The cigarette-years S_1 is the cumulative dose for "active smokers" who directly smoke the cigarettes. This can be adjusted for passive smokers also. It is important to note that indirect or passive smoking has also similar hazards to health as direct smoking has. According to Hackshaw (1998), "Passive smoking is the inhalation of smoke, called Secondhand Smoke (SHS) or Environmental Tobacco Smoke (ETS), from tobacco products used by others. It occurs when tobacco smoke permeates any environment, causing its inhalation by people within that environment". Scientific evidence shows that exposures to secondhand tobacco smoke can also cause disease, disability and death. See also Rapiti *et al*. (1999) and David *et al*. (2005), for more details.

Indrayan *et al*. (2008) suggested that a proportion p could possibly be estimated that quantified the smoker's smoke inhaled by a person in the inhalation zone. Thus, the dose of smoking for a passive smoker is pS_1, where S_1 now is the cigarette-years for which passive smoker is exposed. Indrayan *et al*. (2008) proposed p to be 0.15. In other words, if 15% burden is assumed, the dose of passive exposure to 10 cigarettes a day for 8 years amounts to the dose of 12 cigarette-years of active smoking. The constant p can also be used as an adjustment for smoking filter cigarettes with p = 0.67.

Indrayan *et al*. (2008) suggested many other adjustments, proposing different values of p, for beedi, cigar and pipe etc. and formulated the following three indices:

$$S_2 = \begin{cases} \sum p_i n_i x_i - 0.5, & \sum p_i n_i x_i \geq 0.5 \\ 0 & \text{otherwise} \end{cases} \qquad (2)$$

$$S_3 = 0.5\sqrt{S_2} \qquad (3)$$

$$S_4 = \begin{cases} (3 - a/15)S_3 & \text{for } a < 30 \\ S_3 & \text{for } a \geq 30 \end{cases} \qquad (4)$$

Where, "a" is the age in years at start of smoking.

The final version of SI (Indrayan *et al*., 2008) is developed under a series of natural assumptions. These are:

- The effect of smoking monotonically increases with the cigarette-years but it is more severe in the beginning
- Start of smoking early in life is more effected than a late start and
- The effect gradually reverses as the duration elapsed since cessation by ex-smokers increases.

The final SI [using (2) - (4)] is:

$$S = \begin{cases} \frac{1}{2}(3 - a/15)\sqrt{\sum p_i n_i x_i - 0.5} - y; & \sum p_i n_i x_i \geq 0.5, y < S_4 \\ 0 & \text{otherwise} \end{cases} \qquad (5)$$

Where:

a = Age in years at start of smoking (use a = 30 for a $\geq$30)

p_i = Proportion of smoke inhaled by passive smokers, or regular cigarette equivalent to one filter cigarette when filter cigarettes are smoked (or similar equivalence for other forms of smoking)

x_i = Number of cigarettes smoked (or exposure in case of passive smoking) for n_i years (i = 1, 2, …, I) and I is the number of segments with smoking of different numbers or type of cigarettes)

y = Years elapsed since stopped by ex-smokers

Negative values of *S* are to be considered equal to zero.

MATERIALS AND METHODS

In the present study, the target population consists of those males (aged 14 years or more) who are smokers or have quit the smoking in Multan city. A sample of 360 individuals from the target population was collected during January to March, 2009. Thus, a cross-sectional dataset was obtained through self-administered questionnaire about current age (in years, rounded to next year) of the respondent, marital status (1 = married and 2 = unmarried) and the smoking status along with its various factors that might influence the smoking index. These factors are, number of cigarettes smoked per day, filter and non-filter cigarettes, duration of smoking, duration elapsed since quitting by ex-smokers, age when started smoking, influence/inspiration for starting smoking, reason for smoking and type of smoking etc. After having descriptive statistics for different variable under study, the SI is measured using (5). Frequency distribution of SI along with different percentiles is given. A statistical distribution is fitted to the data of SI and the parameters are estimated by maximum likelihood method. Kolmogrov-Smirnov's test for goodness of fit is reported. Furthermore, the Mann-Whitney test (Corder and Foreman, 2009) is also applied to test whether or not both the married and the unmarried respondents have equal median SI.

RESULTS AND DISCUSSION

The data set of 360 male smokers or ex-smokers (aged 14 and above) yielded the mean age 21±0.22 (S.E). Among these respondents, 37.5% were unmarried and 62.5% were married.

Figure 1 displays the percentages of the respondents according to age when they started smoking. It is reported that majority of the respondents (about 57.94%) started smoking at age of 15-20 years. Only 3.05% of the respondents started smoking when they were aged 30 or above and 3.05% were below 15 when they started smoking.

When it was asked about the motivation towards start smoking, majority of the respondents (58.89%) were motivated to start smoking as their friends were smokers. It is reported that 2% of the respondents inclined to smoke due to their fathers, 8% due to brothers, 23% due to other family members and 3.89% due to others. Only 3.89% of the respondents started smoking at their own. The main reason for smoking is "smoking as a habit" as told by 41.67% of the respondents. The other reasons include, "smoking as a fashion" and "smoking to feel comfort" with percentages, 34.44% and 23.89%, respectively.

Figure 2 displays percentages of the respondents according to frequency of cigarettes smoked per day. It is reported that there is no hefty disparity among the smokers who smoke 1-5, 6-10 or 11-20 cigarettes per day but only 5% of them smoke more than 20 cigarettes a day. Among all the cigarettes smokers, 85.55% smoke filtered while 14.44% smoke non-filtered cigarettes. In addition to smoking cigarettes, 20.28% of the smoker smoke beedi and 14.44% smoke huqqa also. As much as 38.36% of the smokers smoke more than one beedi per day and 51.92% smoke huqqa more than one time a day while 17.22% smoke all the three, cigarettes, beedi and huqqa. Duration of smoking i.e., since how long a smoker has been smoking is given in Table 1.

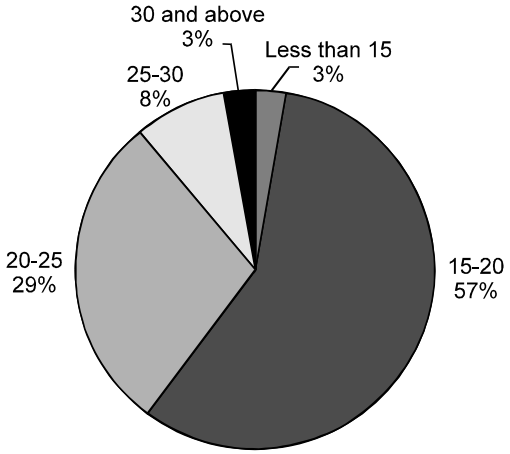

Fig. 1: Percentage of the respondents according to age when start smoking

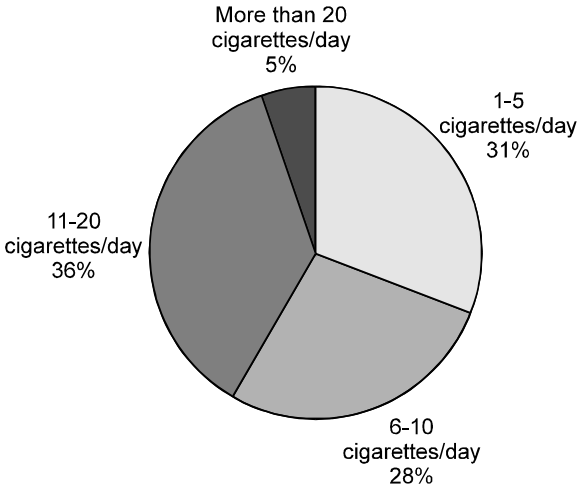

Fig. 2: Percentage of the respondents according to frequency of cigarettes smoked per day

Table 1: Duration of smoking

No. of years	No. of smokers	Age (%)
0-5	172	47.78
5-10	138	38.33
10-15	32	08.89
15-20	12	03.33
20-25	6	01.67
Total	360	100.00

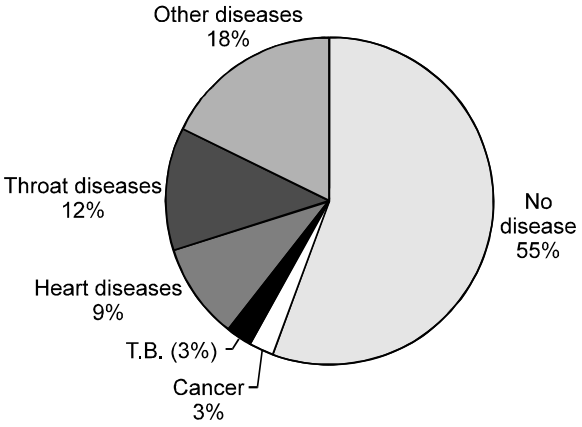

Fig. 3: Percentage of different diseases in the respondents

Table 2: Summary statistics of SI

			Percentiles		
Mean	Std Dev	Std. Err of mean	25	50	75
10.48	6.54	0.34	5.81	9.51	13.66

When it was asked whether smoking had some adverse effects on the health of the respondents, 44.44% admitted injurious effects on their health while 55.56% either did not know or had reported no such effects. Figure 3 exposes the percentages of different diseases reported by the smokers. However, from these figures, it is not possible to explain that whether these diseases initiated, solely due to smoking. Moreover, whether persuasive or not, 85.28% of the smokers tried to quit smoking at least once and among them who tried, 65.28% tried to quit more than three times but 14.72% never tried. Only 22.78% of the smokers succeeded to renounce smoking.

Table 2 displays the summary statistics for SI. It is reported that the average smoking burden by male smokers in Multan city is 10.48±0.34 cigarette-years smoked. Fifty percent of the male smokers have smoking burden below 9.51 cigarette-years while 50% above than this index. Upto 75% of the male smokers have SI 13.66 that means 25% of the smokers have smoked more than 13.66 cigarette-years. These figures, no doubt, portray a serious situation to attend the issue of smoking.

The equality of two median SIs' obtained from married (median SI = 9.74) and unmarried (median SI = 9.29) male smokers is also tested using Mann-Whitney test. The value of test statistic W = 23541.5 (with p-value = 0.3878) leads to the conclusion that marital status has no significant impact on smoking burden.

Finally, the interest lies in to fit some suitable empirical distribution to the obtained values of SI. Since SI can hold positive values, three potential distributions, namely

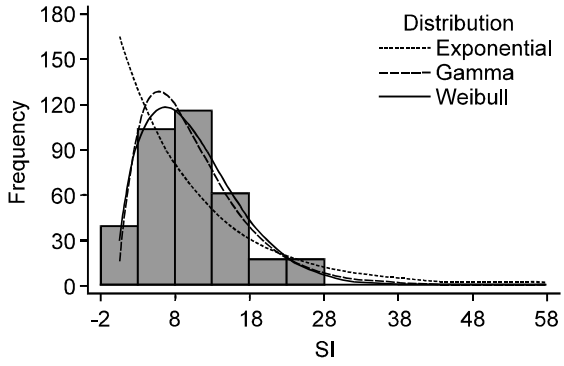

Fig. 4: Histogram of SI

Table 3: Comparison of alternative distributions for SI

Distribution	Est. Parameters	Log likelihood	KSD
Weibull	2	-1148.68	0.0409 (0.5826)
Gamma	2	-1152.9	0.0581 (0.1767)
Exponential	1	-1205.86	0.1875 (0.0000)

exponential, gamma and Weibull were fitted after having histogram (Fig. 4) of the dataset. Table 3 gives the comparison of these three distributions while reporting log likelihood and Kolmogrov-Smirnaov D (KSD) statistic along with relevant p-values given in parentheses. According to this table, Weibull distribution is the best fitted empirical distribution to the SI dataset.

Following is the density function of Weibull distribution:

$$f(x,\lambda,k) = \begin{cases} \frac{k}{\lambda}\left(\frac{x}{\lambda}\right)^{k-1} e^{-(x/\lambda)k} & x \geq 0 \\ 0 & \text{otherwise} \end{cases} \quad (6)$$

Where, x denotes the values of SI, k > 0 is the shape parameter and $\lambda > 0$ is the scale parameter of the distribution.

We obtain the maximum likelihood estimates of the parameters of (5) as $\hat{k} = 1.6407$ and $\hat{\lambda} = 11.7049$.

Conclusion: There is no doubt about the adverse effects of smoking on health. Previous studies show that one out of every two to three middle-aged men in Pakistan smoke cigarettes. In addition to smoking cigarettes, smoking beedi and huqqa are also common forms of smoking in Pakistan. Since intensity of smoking has several important characteristics therefore, it becomes necessary to account for all these through some index. For this, Indrayan's smoking index that combines the qualitative and quantitative dimensions into a single figure and allows to measure burden of smoking across various categories of tobacco use. A rich literature is available on the issue of smoking about Pakistan but some commendable efforts have not been made to

measure smoking burden through smoking index. The present article addresses the same measure taking Multan city as a case study. A sample of 360 smokers and ex-smokers (aged 14 and above) yielded an average smoking index to be 10.48±0.34. It was concluded that there was more likelihood to start smoking in teenage and mostly friends or company became source of smoking inspiration. Majority of the smokers took smoking as a habit. Among smokers, 20.28% used to smoke beedi and 14.44% smoked huqqa in addition to cigarette smoking while 17.22% used to smoke all the three smoking variants. A majority of smokers tried to give up smoking at least once but only 22.78% succeeded. For the empirical distribution of the smoking index, the Weibull distribution remained the most suitable candidate distribution with the maximum likelihood estimates; 1.6407 for the shape parameter and 11.7049 for the scale parameter.

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