

# Determinants Number of Cigarette Smoked with Iranian Adolescents: A Multilevel Zero Inflated Poisson Regression Model

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## Abstract

**Background:** The present study was conducted to know about the association between amount of smoking and mental health plus demographic factors in the Iranian adolescents.

**Methods:** Data of this research was drawn from the National Health Survey in Iran from April 1999-March 2000. All 1745 adolescents aged 15-20 yr that were residence in the eight northwest provinces of Iran, were included in this study. In order to evident zero-inflation and because of sampling design, multilevel zero-inflated Poisson (ZIP) regression applied for analysis of data. We analyzed data with programs written with s-plus.

**Results:** Zero-inflated part of ZIP model shows that gender of female effects to increase the chance of "not to smoke cigarette at all" ( $P < 0.001$ ) and older adolescents are less at risk of smoking than younger ( $P = 0.036$ ). It also shows that, unemployed ( $P = 0.028$ ) and Housewife ( $P = 0.003$ ), adolescents are more at risk of smoking compare with student adolescents. Under Poisson part of this model, depression ( $P = 0.012$ ) and gender of female ( $P < 0.001$ ) are indirectly associated with number of cigarette smoked per day by adolescents.

**Conclusion:** Among adolescent smokers, males smoke more number of cigarettes than females, younger teenager are more at risk of being a smoker than older ones and dropping out of high school is an important risk factor for smoking. We did not find any relation between mental disorders and being a smoker while we did for the relation between Number of Smoked Cigarette (NSC) and depression.

**Keywords:** Adolescents cigarette smoking, Demographic factors, Mental health disorder, Zero-inflation poisson, Iran

## Introduction

Behavior-related diseases and conditions, such as cancer and heart disease, are the leading causes of morbidity and mortality (1), accounting for almost half of all health care costs (2). Smoking, in particular, has been described as the most preventable cause of death and disease. A strong link has been found between tobacco use and cancer, and smoking is responsible for almost one in five deaths (3). Consequences of smoking are serious, even in adolescence. Young smokers experience decreased lung growth, frequent respiratory illness, and increased coughing (4). They are also more likely to have psychological complaints and to engage in high-risk behaviors (5). Further, most teens who smoke will continue to use tobacco into adulthood, incurring greater health risks as they continue to smoke (6), such as heart disease, stroke, and lung cancer (4). For these reasons, better identify-

ing risk factors for cigarette smoking during adolescence is necessary to develop programs that may prevent Iranian youth from engaging in this health compromising and addictive behavior.

Several researches were conducted in different area of Iran. All of these tried to expect prevalence of smoking in adolescent or to find relation between smoking and some factors (7-16). In this study a zero inflation Poisson (ZIP) regression model is used to identify factors related to Number of Cigarette Smoked (NCS) per day by adolescents in northwest of Iran. For independent counts Lambert (17) proposed a ZIP regression model to examine the effects of risk factors or confounders by allowing both log-linear and logistic regression to be linear functions of some covariates. This statistical method for analysis of zero-inflated count data has been rapidly developed during recent years. For clustered count data and multi-level clustered count data appropriate ZIP models are considered (18-21).

In this paper we identify the factors that cause to become a smoker and then those that are related to adolescence NCS per day by a multilevel ZIP regression model. Details of multilevel ZIP model and its parameter estimation are described in Reference (21).

## Material and Methods

### Sample

Data for this research was drawn from the National Health Survey in Iran from April 1999 to March 2000. National Health Survey which was carried out by Iranian Ministry of Health and Medical Education included all provinces in Iran. Sampling method of this survey was cluster sampling in all of the provinces. Questionnaire of this survey included questions about demographic, medical and health status of household members. Interviewers have collected information of demographics, mental health and smoking questions by samples self-reporting. All adolescents in the sample of eight provinces (Azarbaijan Shrgi, Azarbaijan Gharbi, Kurdistan, Kerman shah, Ilam, Ardabil, Hamedan, Zanjan, Gilan), all located in northwest of Iran, were included in this study. They were 1745 teens aged between 15-20 yr.

### Measures

Number of cigarette smoked (NCS) by an adolescent per day is dependent variable. Hence smoking zero number of cigarettes does mean that the adolescent does not smoke at all. Factors such as adolescents education (number of grades) and employment (0: student, 1: unemployment, 2: housewife 3: employed) together with them mental health situation are independent factors. Mental health was assessed by Goldberg questionnaire (22). This questionnaire consists 4 sets of 7 questions (in total 28 questions), each set measures one of indices, somatization, anxiety, social dysfunction, and depression. Some demographic covariates such as residential region (0: Urban 1: Rural), age (yr), gender (0: Male, 1: Female), and marital status (1: Married, 2: Single, 3: Separated or Widowed), are also considered in the analysis.

### Statistical analysis

The ZIP distribution may be regarded as mixture of Poisson distribution and degenerate component placing all its mass at zeros. For counts, ZIP regression model is to examine the effects of risk factors or confounders by allowing both log-linear and the logistic regression to be linear functions of some covariates. Table 1 shows the frequency distribution of Number of Cigarette Smoked (NCS) per day in the sample adolescents. There is a clear spike of extra zeros representing the non-use cigarette, comparing Poisson distribution. Nevertheless, the line of argument that the number of cigarette smoking is a count variable, suggests to consider a Poisson distributions to analyze such count data. This finally leads to a log-linear model to include covariates. However, in this case, the Poisson distribution does not fit well at all. If the Poisson assumption would be true, then the mean and variance of the number of cigarette used should coincide. Assuming a Poisson distribution for NCS per day for sample adolescents, the expected number of zeros is 1291. Therefore compared with 1567 observed, 254 extra zero are observed relative to those expected under the Poisson assumption. The zero-inflation is also evident in table 1 according to the  $\chi^2$  score test statistics ( $\chi^2 = 155122.40$ , DF= 5) for Poisson distribution. Additionally, with cluster random effect, Xiang et al. (2006) (23) score test value shows significantly zero-inflation against Poisson distribution ( $P < 0.001$ ). In this cross-sectional study, because of sampling design that adolescents nested within clusters (random cluster) and clusters nested within provinces, multilevel zero-inflated Poisson regression applied for analysis the data. We did analysis of data with programs written with s-plus.

## Results

Table 1 shows that the overall prevalence of current smoking between northwest adolescents of Iran was 10.2% (95% CI 0.088, 0.109). Males had more than a two-fold higher rate of current smoking than females, respectively 12.3% and 4.9%. Data analysis showed also that 10.7%, 14.2%, 14.2% and 21.8% of adolescents suffered,

respectively, from somatization, anxiety, social dysfunction and depression disorders. 48.7%, 18.2% and 16.8% of adolescents were student, unemployment and housewife.

Table 2 shows the result of fitting multilevel ZIP model to number of cigarette smoked by adolescents in northwest of Iran. At first, we considered full model with interactions between covariates. However, since interaction terms and other factors were not significant, at Table 2 the model with main effects for significant factors is only presented. All factors were candidate to enter to this model. Hence region, education, somatization, anxiety and social dysfunction are not included in the model i.e. they are not related to NCS by adolescents. Zero-inflated part of this model shows that gender of female effects to increase the chance of "not to smoke cigarette at all" (Adj. OR= 2.986; 95% CI 1.790, 4.981;  $P < 0.001$ ). In addition, this

part of model indicates that older adolescents are less at risk of smoking than younger are (Adj. OR=1.122; 95% CI 1.007, 1.250;  $P = 0.036$ ). The model also shows that When employment status indicators were added in model, unemployed (Adj. OR=0.598; 95% CI 0.377, 0.947;  $P = 0.028$ ) and Housewife (Adj. OR= 0.382; 95% CI 0.203, 0.718;  $P = 0.003$ ) adolescents are less at risk of not smoke (or has more chance of smoking) compare with student adolescents.

Under Poisson part of this model, depression (Adj. RR=0.705; 95% CI 0.537, 0.926;  $P = 0.012$ ) and gender (Adj. RR= 0.253; 95% CI 0.168, 0.383;  $P < 0.001$ ) associated with number of cigarette smoked per day by adolescents.

Furthermore a Pearson statistic for mixed effect of ZIP yields 1127.707 on 1728 degree of freedom ( $P = 0.99$ ). Again, there is no evidence of lack of fit for the fitted model.

**Table 1:** The frequency distribution of Number of Cigarette Smoked (NCS) per day in the sample adolescents

	Male		Female		Total	
	n	%	n	%	n	%
Do you smoke cigarettes?						
Not at all	677	83.7	890	95.1	1567	89.8
1-5 cigarettes per day	17	2.1	23	2.5	40	2.3
6-10 cigarettes per day	22	2.7	23	2.5	45	2.6
11-15 cigarettes per day	18	2.2	0	0	18	1.0
16-20 cigarettes per day	63	7.8	0	0	63	3.6
>1 pack per day	12	1.5	0	0	12	0.7
Total	809	100	936	100	1745	100
Prevalence of smoking	-	12.3	-	4.9	-	10.2

**Table 2:** Result of fitting multilevel ZIP regression model to number of cigarette smoked by adolescents in northwest of Iran

variable	Poisson part		Zero-inflation part	
	Adj. RR* (95% CI)	P-value	Adj. OR** (95% CI)	P-value
Female (reference: Male)	0.253 (0.168, 0.383)	0.000	2.986 (1.790, 4.981)	0.000
Age	0.989 (0.931, 1.051)	0.717	1.122 (1.007, 1.250)	0.036
Employed (reference: student)				
Unemployed	1.043 (0.799, 1.361)	0.760	0.598 (0.377, 0.947)	0.028
House wife	1.050 (0.765, 1.443)	0.763	0.382(0.203, 0.718)	0.003
With any employment	0.970 (0.743, 1.267)	0.823	1.038 (0.655, 1.645)	0.874
Depression	0.705 (0.537, 0.926)	0.012	0.751 (0.494, 1.139)	0.178
$\sigma^2$ (Province)	0.002		0.001	
$\sigma^2$ (Cluster)	0.006		0.012	
Chi-square test statistics		87.971		
Pearson statistic (DF)		1127.707 ( 1728)**		
-2log-likelihood		1634.838		

\*Adjusted Relative Risk

\*\*Adjusted Odds Ratio

\*\*\* Degree of Freedom computed with Lee and Nedler

## Discussion

This research is one of the few studies conducted of its kind in the Iran. A number of studies have investigated some aspects of smoking behavior among Iranian adolescents and adults focusing mostly on prevalence rates as well as prevention, control and determinants of smoking (7-13). This study investigates the factors related to number of smoked cigarettes by adolescents with using ZIP regression model.

Our study shows that young males are more at risk of being smoker than females. It is consistent with national (8-13) and many international studies (24, 25). Additionally, the daily number of smoking of boys is more than girls. This is agreement with other studies (12, 16).

A notable concern is that higher adolescent age is protective for smoking. In other words, lower aged adolescents have a high risk of starting experiment with smoking than do higher aged adolescents. This is similar to many other studies (12, 26-31) and it is in contrast to findings of other national studies revealing a direct association between ages and smoking behavior (7, 9-12, 14). We did not find any relation between being a smoker and education level for Iranian adolescents. This result is similar to (32) and in contrast with other study (13).

In addition, number of smoked cigarettes (NCS) was not related to education grade level. This is while others have reported significant relation between smoking behavior and education level in adolescents (13, 24, 33).

This research shows that student adolescents are less at risk of smoking cigarette than housewife or unemployed adolescents. Because almost of aged 15-20 younger are in the school age, it indicates that the student who drop out of the school are more at risk of being a smoker than those who continue their education in high school i.e. dropping out of high school is an important risk factor for smoking. This is similar to many national and international studies (13, 33).

In this research, we did not find any relation between smoking and mental disorders. While other

studies have reported smoking and mental health symptoms have a related psychological state and this relationship is bi-directional (34-36).

We also found indirect relation between number of smoked cigarette and depression. Other study reported that there is not significant relation between development of depression, and increasing number of smoking (37).

Additionally, our study showed that among adolescent smokers, males smoke more number of cigarettes than females, younger teenager are more at risk of being a smoker than older ones and dropping out of high school is an important risk factor for smoking. We did not find any relation between mental disorders and being a smoker while we did for the relation between Number of Smoked Cigarette (NSC) and depression.

The most important limitation of this study was using self-reported questionnaire that increases the possibility of underreporting by smokers. In addition, we did not assess the family smoking behavior and others factors that might influence the adolescents smoking behavior.

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## References

1. Sells CW, Blum RW (1996). Morbidity and mortality among US adolescents: An overview of data and trends. *Am J Public Health*, 86: 513-19.
2. Gillis AJ (1993). Determinants of health-promoting lifestyles in adolescent females. *Can J Nurs Res*, 26:13-28.
3. American Cancer Society (2000). Cancer Facts and Figures. Atlanta, GA: American Cancer Society. Available from: [www.cancer.org/downloads/STT](http://www.cancer.org/downloads/STT)
4. U.S. Department of Health and Human Services (2004). The Health Consequences

- of Smoking: A Report of the Surgeon General. Atlanta, GA: U.S. Dept. of Health and Human Services, Available from: [www.surgeongeneral.gov/library/smokingconsequences/](http://www.surgeongeneral.gov/library/smokingconsequences/)
5. Willoughby T, Chalmers H, Busseri MA (2004). Where is the syndrome? Examining co-occurrence among multiple problem behaviors in adolescence. *J Consult Clin Psychol*, 72: 1022-37.
  6. Pierce JP, Gilpin E (1996). How long will today's new adolescent smoker be addicted to cigarettes? *Am J Public Health*, 86: 253-56.
  7. Sarraf-Zadegan N, Boshtam M, Rafiei M (1999). Risk factors for coronary artery disease in Isfahan, Iran. *Eur J Publ Health*, 9: 20-6.
  8. Mohammad K, Noorbala AA, Majdzadeh SR, Karimloo M (2001). Trend of smoking prevalence in Iran from 1991 to 1999 based on two national health surveys. *Hakim*, 4: 290-97 [in Farsi].
  9. Kelishadi R, Sadry G, Sarraf-Zadegan N, Hashemipour M, Sabet B, Bashardoust N, et al. (2004). Smoking, adolescents and health: Isfahan Healthy Heart Program-Heart Health Promotion from Childhood. *Asia Pac J Publ Health*, 16: 15-22.
  10. Mosavi-jarrahi A, Mohagheghi M, Yazdizadeh B, Kolahi AA, Tahmasebi S, Sharifi S (2004). Analysis of smoking behaviour among Iranian population: a cohort and period analysis. *Asian Pac J Cancer Prev*, 5: 66-9.
  11. Sarraf-Zadegan N, Boshtam M, Shahrokhi S, Naderi GA, Asgary S, Shahparian M, et al. (2004). Tobacco use among Iranian men, women, and adolescents. *Eur J Publ Health*, 14: 76-8.
  12. Kelishadi R, Ardalan G, Gheiratmand R, Majdzadeh R, Delavari A, Heshmat R, et al. (2006). Smoking behavior and its influencing factors in a national representative sample of Iranian adolescents: CASPIAN study. *Prev Med*, 42: 423-26.
  13. Kelishadi R, Mokhtari MR, Tavasoli AA, Khosravi A, Ahangar-Nazari I, Sabet B, et al (2007). A determinant of tobacco use among youths in Isfahan, Iran, *Int J Publ Health*, 52: 173-79.
  14. Roohafza HR, Sadeghi M, Kelishadi R (2005). Cardiovascular risk factors in Iranian adults according educational levels: Isfahan Healthy Heart Program. *Asia Pac J Publ Health*, 17: 9-14.
  15. Emami H, Ghazinour M, Rezaei shiraz H, Richter J (2007). Mental health of adolescents in Tehran, Iran. *J Adolesc Health*, 41: 571-56.
  16. Kavari SHO (2006). Study of Evaluation of Outbreak of Cigarette Smoking and Age Distribution of First smoking Experience among High School and Pre-University Students. *Middle East J Family Med*, 4(2).
  17. Lambert D (1992). Zero-inflated Poisson regression, with an application to defects in manufacturing. *Technometrics*, 34: 1-14.
  18. Hall DB (2000). Zero-inflated Poisson and binomial regression with random effects: A case study. *Biometrics*, 56: 1030-39.
  19. Wang K, Yau KKW, Lee AH (2002). A zero-inflated Poisson mixed model to analyze diagnosis related groups with majority of same-day hospital stays. *Comp Meth Pro Biomed*, 68:195-203.
  20. Hur K, Hedeker D, Henderson W, Khuri S, Daley J (2002). Modeling clustered count data with excess zeros in health care outcomes research. *Health Serv Outcome Res Meth*, 3: 5-20.
  21. Lee AH, Wang K, Scott JA, Yau KKW, McLachlan GJ (2006). Multilevel zero-inflated Poisson regression modeling of correlated count data with excess zeros. *Stat Meth Med Res*, 15: 47-61
  22. Goldberg DP (1978). Manual of the General Health Questionnaire. Windsor, England, NFER Publishing.
  23. Xiang L, Lee AH, Yau KKW, McLachlan GJ (2006). A score test for zero-inflation in

- correlated count data. *Stat Med*, 25: 1660-71.
24. Jarallah JS, Al-Rubeaan KA, Al-Nuaim ARA, Al-Ruhaily AA, Kalantan KA (1999). Prevalence and determinants of smoking in three regions of Saudi Arabia. *Tobacco Cont*, 8: 53-6
  25. Alikasifoglu M (2002). Cigarette Smoking Among Turkish High School Students. *J Adolesc Health*, 30:7-8.
  26. Sun W, Andreeva VA, Unger J, Conti D, Chou C, Palmer P, et al. (2006). Age-Related smoking Progression among adolescents in China. *J Adolesc Health*, 39: 686-93.
  27. Breslau N, Peterson EL (1996). Smoking cessation in young adults: age at initiation of cigarette smoking and other suspected influences. *Am J Publ Health*, 86: 214-20.
  28. Jackson C, Henriksen L, Dickinson D, Messer L, Robertson SB (1998). A longitudinal study predicting patterns of cigarette smoking in late childhood. *Health Educ Behav*, 25: 436-47.
  29. Khuder SA, Dayal HH, Mutgi AB (1999). Age at smoking onset and its effect on smoking cessation. *Addict Behav*, 24: 673-77.
  30. Lando HA, Thai DT, Murray DM, Robinson LA, Jeffery RW, Sherwood NE, et al. (1999). Age of initiation, smoking patterns, and risk in a population of working adults. *Prev Med*, 29: 590-98.
  31. Park SM, Son KY, Lee YJ, Lee HCS, Kang JH, Lee YJ, et al. (2004). A preliminary investigation of early smoking initiation and nicotine dependence in Korean adults. *Drug Alcohol Depend*, 74:197-203.
  32. LeMaster PL, Connell CM, Mithchell CM, Manson SM (2002). Tobacco use among American Indian adolescents: Protective and risk factors. *J Adolesc Health*, 30: 426-32.
  33. Glendinning A, Shucksmith J, Hendry L (1994). Social class and adolescent smoking behaviour. *Soc Sci Med*, 38:1449-60.
  34. Goodman E, Capitman J (2000). Depressive symptoms and cigarette smoking among teens. *Pediatrics*, 106: 748-55.
  35. Windle M, Windle RC (2001). Depressive symptoms and cigarette smoking among middle adolescents: prospective associations and intrapersonal and interpersonal influences. *J Consult Clin Psychol*, 69: 215-26.
  36. Chang G, Sherritt L, Knight JR (2005). Adolescent cigarette smoking and mental health symptoms. *J Adolesc Health*, 36: 517-522.
  37. Duncan B, Rees DI (2005). Effect of smoking on depressive symptomatology: a reexamination of data from the National Longitudinal Study of Adolescent Health. *Am J Epidemiol*, 162: 461-70.