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Gender-based Differences in Associations between Attitude and Self-esteem with Smoking Behavior among Adolescents: A Secondary Analysis Applying Bayesian Nonparametric Functional Latent Variable Model

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Abstract

Background: Different patterns of gender-based relationships between attitude toward smoking and self-esteem with smoking behavior have reported. However, such associations may be much more complex than a simply supposed linear relationship. We aimed to propose a method of providing hand details on the total and gender-based scenarios of the relationships between attitude toward smoking and self-esteem with smoking.

Materials and Methods: A secondary analysis conducted on a data set obtained for a cross-sectional study among 4,905 male and female high school students in Tabriz, Iran (2012). We randomly selected 196 classes in a clustering process and invited all the students in the classes to participate in the study; then, investigated the relationship between smoking with attitude and self-esteem, as explanatory variables. We also found the data to fit a nonlinear functional relationship and to be free from normal condition due to applying Bayesian nonparametric functional latent variable model.

Results: Among all the students, attitude was found as the only variable with conceptual effect on smoking ($p<0.05$). Among boys, self-esteem showed no conceptual effect on smoking which was in contrast to those found among girls. Smoking among male students with low self-esteem was high, but it was gradually decreasing by rising self-esteem. Among girls, in contrast, smoking was descending by decreasing self-esteem.

Conclusion: The relationships between self-esteem and attitude with smoking may not be necessarily linear. Being at the high levels of self-esteem among boys may lead to the reduced levels of smoking, and among girls may result in the increased level of the behavior.

Key Words: Attitude, Bayesian Method, Cigarette Smoking, Self- Esteem.

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1- INTRODUCTION

Nowadays, smoking is one of the most important social hazards and high-risk behaviors among adolescents. In fact, it is a public health challenge worldwide due to its public accessibility (1, 2). Early smoking onset leads to severe nicotine dependence and early manifestation of chronic smoking-related illness (3). People who initiate smoking at a younger age are more likely to fall into nicotine addiction compared to those who start at an older age (4). A majority of smokers initiate smoking before 18 years of age, and 39% smoke their first cigarette before 16 (3). The initiation of smoking seems to be from school age due to the same age of students and their regular communication with different cultures and/or subcultures (5). Smoking during childhood and adolescence produces significant health problems among young people, including an increase in the respiratory illnesses. It may also affect physical fitness and lung growth (6). It can cause coughing and throat irritation and an increase in the heart rate, blood pressure, bronchitis and emphysema (6).

An international collaborative study among schoolchildren from 131 countries showed adolescents as the group with the highest risk for smoking initiation, and the overall prevalence of schoolchildren who were active smokers was 8.9% (7). In this study, the higher rates of smoking among schoolchildren were from the Americas (17.5%), and Europe (17.9%). The rate was less than 10% in other regions. A meta-analysis of 58 studies showed the overall estimates for cigarette smoking among Iranian adolescents to be 16.8% (8). In this meta-analysis, the risk of smoking among boys was considerably greater than the girls. In many low- and middle-income countries, the rate of smoking among women is less than that among men. According to a worldwide survey, men smoke nearly five times as much as women (9). The reason for such a difference may generally be the strong and persistent social norms against female smoking (10). In most countries, boys tend to engage more frequently in adverse health-related behaviors than girls (11). Therefore, the underlying factors may be different by gender. Smoking among adolescents has been associated with various factors including demographic characteristics, interpersonal (e.g., social norms and social influence of smoking), and environmental factors (e.g., availability of cigarettes and space for smoking). The proximal and distal psychological risk factors for smoking behavior and intention may vary based on cultural context (12, 13).

Researchers have long focused on the socio-psychological predictors of smoking initiation among adolescents. They assessed three kinds of variables: attitudes toward smoking; personality scores on factors related to tolerance for and likelihood of engaging in deviant behaviors; and social environment, including parent and peer attitudes and beliefs in general and specific to smoking (14). Several previous studies have investigated associations between psychological factors (like attitude, self-esteem and self-efficacy), and smoking behavior in different populations (14, 15).

There are reports that attitude toward smoking and self-esteem is associated with smoking behaviors among adolescents (16, 17). Attitude refers to people's positive or negative evaluations of performing a behavior (18), and self-esteem (as a personality trait) refers to one's overall subjective emotional evaluation of his or her own worth (19). Xu et al. compared attitude scores between young adult smokers and non-smoker using nonparametric Chi-square tests (20). They also applied logistic regression and reported contributions between attitude and smoking. In another study, applying

Structural Equation Modeling (SEM), there were relationships between attitude and other psychological factors with adolescent smoking (21). Some other studies have reported the role of low self-esteem in adolescents' inclination toward smoking (22-24). Mohammadpoorasl et al., in another study (2012) proposed an appropriate instrument to categorize smokers with different smoking status using latent class analysis (LCA) model (25). They considered the effects of attitude toward smoking and self-esteem on smoking behavior as linear and reported the significant relationships.

Mohammadpoorasl et al. (2012) applied ordinal logistic regression model and found significant associations between attitude toward smoking and self-esteem with smoking behavior. However, they did not provide details on the pattern of associations (26, 27). Sahib and Badri (2016) in another study in Baghdad assessed the knowledge and attitude of preliminary school students toward smoking and found that 34.6% of the students considered smoking as a result from low self-esteem (28). Wang et al., (2015) also evaluated the effective factors on smoking among new undergraduates in China, using logistic regression method and found attitude as one of the significant factors. They also reported the risk of smoking among boys to be 11 times higher than those the girls. They, however, did not investigate the associations between attitude and self-esteem with smoking behavior by gender (20).

Various studies investigated gender-based associations between attitude and self-esteem with the risk of smoking behavior (26, 28-40). These studies have reported different patterns of relationships by gender. Although gender-based differences may be studied using common statistical methods, the extraction details of the relationship patterns need new methods. Moreover, the most of abovementioned studies defined the associations under the linear relationship assumption, which may be much more complex than a simply supposed linear relationship. Sometimes, the effect of an independent variable may be increasing or decreasing on a dependent variable and may reverse from a section to the next. On the other hand, the most of such studies have inference their model under normal assumption. Therefore, it is essential to use a method free from normal assumption, nonparametric methods, and powerful in clarifying the relationships between attitude and self-esteem with smoking behavior with more details.

Our aim in the present study was to propose a method of providing hand details on the total and gender-based scenarios of the relationships between attitude and self-esteem with smoking behavior, in a situation that all three factors are latent variables. We tried in the present study to show that the correlations between attitude and self-esteem with smoking behavior are complicated and the investigation of linear patterns between them is insufficient. We, finally, proposed a method to investigate the relationships with more details.

2- MATERIALS AND METHODS

2.1 Study design, data Source and participants

In the present study, we used data from a cross-sectional study conducted among 5,106 junior and senior secondary students (boys and girls) who were randomly cluster sampled from 57 high schools in Tabriz, Iran. At first, based on the type of schools, we classified the high schools in each region (both genders) into public schools, private schools, technical and vocational training schools and work-knowledge schools. Next, 57 high schools (25 female and 32 male high schools) were randomly selected. With considerations on the school type, the number of students in each school and the education major, we

randomly selected 196 classes (82 male and 114 female classes) as clusters and invited all the students in these classes to participate in the study. The total number of students in the selected classes was 5106. We invited them to participate in completing a self-administered multiple-choice questionnaire (27). After manipulating the data and deleting the data with missing, the information on 4,905 students was included in data analysis. Due to the high level of sample size, there was no need to adjust for design effect. In the primary study in 2012, to evaluate the content validity, the questionnaire sent to five experts in smoking use, six methodologist, four health educationists and teachers and five lay experts (alert students). The experts reported their point of views regarding the relevance and clarity of the items.

The mean of relevancy in the questionnaire among the experts and the lay experts were 94% and 98%, respectively. The mean of clarity in the questionnaire among the experts and lay experts were 78% and 93%, respectively. To measure reliability, the questionnaire was completed by a small sample of the students (n=23) twice with a two- weeks interval and the internal consistency (Cronbach's alpha) was determined. In order to eliminate the effects of confounding variables, we elected the students in both genders from public and private schools. We also elected the students in a random manner in the schools.

2-2. Variables and Measurements

2-2-1.Cigarette Smoking

In the analyzed data, we treated cigarette-smoking status as latent variable and measured it using six items. The characteristics of the scale are available in the literature (26). We also used the stages of cigarette smoking applying a valid algorithm. In order to consider the factors related to cigarette smoking, we classified the respondents into three stages based on their level of cigarette smoking:

- Never Smokers: adolescents with no history of smoking (even a puff),
- Experimenters: adolescents who tried cigarette (even a puff), but smoked less than 100 cigarettes in lifetime,
- Regular smokers: adolescents smoked 100 cigarettes and more in their lifetime, with no consideration on their present consumption.

The general risk taking behavior was measured using the question "Do you enjoy doing a little risky behavior?" with "Yes" and "No" response. Also, to determine the reliability of the stages for cigarette smoking, the questionnaires were presented to a sample of 154 students twice with a two-week interval and the Intra-class correlation coefficient was obtained to be 0.929 (95% confidence interval [95%CI]: 0.903-0.948).

2-2-2. Attitude toward Smoking

Attitude toward cigarette smoking was a standard scale (41), and an explanatory variable including six items with 5-point Likert-type response format. A main sentence was "I think that for me, smoking cigarette is ..." We presented the scale to the students and asked them to check one of the options among the six pairs of bipolar answers: "disagreeable–agreeable, bad–good, annoying–interesting, unpleasant–pleasant, unhealthy–healthy, and disadvantageous–advantageous". We considered each pair of the options as a separate item and scored the responses to each item as either +2 or -2. The characteristics of the scale are available in the literature. The Pearson correlation coefficient of attitude toward smoking after a test-retest with two-weeks of interval was 0.78 and the Cronbach's alpha coefficient was 0.89.

2-2-3. Smoking Self-esteem

Smoking self-esteem (42) measured applying a 10-item scale with a 4-option Likert-type response format ranged from one "completely agree" to three "completely disagree". The characteristics of the scale are available in the literature. We considered the confounding effects of factors known to be associated with adolescent smoking, including age, school grade, educational status, pocket money, friends and parental smoking, parental educational level, and family composition. The main issue in the present study was that the responses of observed variables had ordinal scale and it may take effect on the results. The standard methods of factor analysis (i.e., those based on a matrix of Pearson's correlations) assume that the variables are continuous and follow a multivariate normal distribution. If a model includes variables that are dichotomous or ordinal, factor analysis is applicable using a polychoric correlation matrix. Therefore, this study used polychoric correlation at fitting Bayesian nonparametric structural equation modeling to solve the problem (43). We assessed the relationship between attitude and self-esteem on smoking using the Bayesian nonparametric structural equation modeling. Since the variables had a Likert-type scaling format, we used the polychoric correlation matrix instead of the common Pearson correlation matrix.

2-3. Statistical methods

In the current study, we used a latent variable model to investigate the relationships between cigarette smoking as an outcome variable and two independent variables, attitude toward smoking and self-esteem, as explanatory variables. We treated the three variables as latent, and fitted the study to a nonlinear functional relationship and free from normal condition due to applying Bayesian nonparametric functional latent variable model. In these models, we used the Bayesian P-splines approach and Markov Chain Mount Carlo (MCMC) algorithm to estimate smooth functions, unknown parameters, and latent variables in the model. Considering the nature of this method, we firstly divided the entire relationship function into small parts called nodes. Then, using Bayesian P-splines approach and MCMC algorithm, we estimated a cubic function for each section. The details of the models are available in the literature (44). Based on the model proposed by Song and Lee (44), we characterized the functional effects of self-esteem and attitude toward smoking, as explanatory latent variables, on the outcome latent variable, smoking status, (η_i), by the following nonparametric structural equation:

$$\eta_i = f_1(\xi_{i1}) + f_2(\xi_{i2}) + +\delta_i$$

Where, f_1 *and* f_2 are the unspecified univariate smooth functions, which were estimated via MCMC process and will show the relationships between self-esteem and attitude with smoking status, and ξs are explanatory latent variables (here self-esteem and attitude), and δ_i is the residual error independent of ξ_i and distributed as normal. In the present study, we provided R code for fitting and evaluation of the proposed model (**Appendix.1**).

We used the main two packages RtoBayesx (45), and Lavaan (46) to write the code. We conducted a secondary analysis on a data set obtained from 4,905 students who completed a self-administered multiple-choice questionnaire in 2012 to 2013. Among 4,905 students participated in the study, 2800 (57.1%) students were female. A majority of the respondents was 15 and 16 years old (**Table.1**). The other demographic characteristics of the respondents exist in the literature (27).

Appendix.1: R code for fitting proposed model.

```
library(lavaan)
library(BayesXsrc)
library(nlme)
library(maptools)
library(foreign)
library(shapefiles)
library(BayesX)
library(colorspace)
library(mgcv)
library(R2BayesX)
library(akima)
library(foreign)
setwd("C:\\data source")     #read observation data file
mdat <- read.spss("data.sav",use.value.labels = FALSE, to.data.frame = TRUE)
model <- 'smoking_stage=~q24.1+q24.2+q25+q26     #introduce sem model
self_esteem=~q1+q2+q3+q4+q5+q6+q7+q8+q9+q10
attitude=~q11+q12+q13+q14+q15+q16
smoking_stage~ self_esteem+ attitude'
fit<-fsr(model,data=mdat, fsr.method="skrondal-laake")
summary(fit)
cfamodel <- 'smoking_stage=~q24.1+q24.2+q25+q26
self_esteem=~q1+q2+q3+q4+q5+q6+q7+q8+q9+q10
attitude=~q11+q12+q13+q14+q15+q16
smoking_stage~ attitude+ self_esteem'
fit <- cfa(cfamodel, data=mdat,ordered =c("q24.1","q24.2","q25","q26","q1","q2",
"q3","q4","q5","q6","q7","q8","q9","q10","q11","q12","q13","q14","q15","q16"),
zero.cell.warn=TRUE,zero.add = c(0, 0.5))
lavPredict(fit, type = "lv", newdata = mdat, label = TRUE)
a=lavPredict(fit,type="lv",newdata=mdat,label=TRUE)    #created latent score data file
View(a)
write.table(a,'d:/lavPredict.txt')
data<-read.table("d:/lavPredict.txt",h=T)    #introduce scores
data=as.data.frame(data)
fix(data)
f <- smoking_stage ~ sx(self_esteem,bs="rw1")+sx(attitude,bs="rw1")   #run bayesX
b1 <- bayesx(f, method="mcmc",family= "gaussian", data = data)
summary(b1)
plot(b1, model = 1, term = "sx(attitude)", xlab = "attitude", ylab = "f(attitude)") #drowing plot
plot(b1, model = 1, term = "sx(self_esteem)", xlab = "self esteem", ylab = "f(self esteem)").
```

Table-1: Gender and age characteristics of the students

	Sub-group	Number (percent)
Gender	Male	2105 (42.9)
	Female	2800 (57.1)
Age (year)	14	14(0.3)
	15	2105 (42.9)
	16	2267 (46.2)
	17	379 (7.7)
	18	96 (2.0)
	19	18 (0.4)

Analyzing the effects of all the questions on their related latent variables, we found the entire coefficients as significant smoking behavior ($p < 0.0001$); which mean that all the questions are effective in measuring the scores for attitude toward smoking, self-esteem.

3-1. The main effects of two observational variables on smoking behavior in the total sample

Table.2 shows the linear effect of the structural model. In the total data, we investigated the main effects of self-esteem and attitude toward smoking on the outcome variable. Attitude toward smoking was the only variable with conceptual effect on smoking behavior among all the students.

Table-2: Parameter estimates of main effects under structural equation model (Linear effects).

Smoking behavior (Outcome)					
Factor	Estimation	SE	Z statistics	P- value	95% Confidence Interval
Self-esteem	-0.010	0.036	-0.268	0.789	(-0.08, 0.06)
Attitude toward smoking	0.687	0.021	32.613	<0.0001	(0.65, 0.73)

SE: Standard error mean.

3-2. The main effects of two observational variables on smoking behavior by gender

We separately investigated the main effects of self-esteem and attitude toward smoking on smoking behavior among boys and girls (**Table.3**). Self-esteem showed no conceptual effect on smoking behavior among boys. In contrast, the conceptual effect of self-esteem on smoking behavior was significant among girls, which means that there may be different patterns of relationships between self-esteem and smoking behavior by gender.

Table-3: Parameter estimates of main effects under structural equation model (Linear effects) by gender.

Smoking behavior (Outcome)						
Factor	Group	Estimation	SE	Z statistics	P-value	95% Confidence Interval
Self-esteem						
Gender	Male	0.090	0.074	1.220	0.222	(-0.05, 0.23)
	Female	0.072	0.025	2.907	0.004	(0.02, 0.12)
Attitude toward smoking						
	Male	0.850	0.037	23.106	<0.0001	(0.78, 0.92)
	Female	0.393	0.018	21.689	<0.0001	(0.36, 0.43)

SE: Standard error mean.

3-3. The main effects of two observational variables on smoking behavior applying Bayesian nonparametric method

Table.4 shows the estimations of parametric coefficients, when the second order random walk was a prior. **Figure.1** shows the estimates of unknown smooth functions relationship between self-esteem with smoking behavior. The solid curves show the pointwise posterior mean curves, while the bold part represent the 2.5% and97.5% pointwise quintiles. The lither parts represent max and min pointwise in Bayesian MCMC methods. The smaller are the smooth terms variances, the higher are the smoothness of the curves.

Table-4: Estimates of unknown smooth functions relationship between self-esteem with smoking behavior, and attitude toward smoking in total sample. Results show posterior mean, standard deviations and 2.5%, 50% and 97.5% pointwise quintiles. These estimations are the results of using second order random walk as a prior in Bayesian MCMC methods.

Smoking behavior (Outcome)							
Parametric coefficients	Mean	SD	2.5%	50%	97.5%	Min	Max
Smooth terms variances							
f (attitude toward smoking)	0.5170	0.1841	0.2293	0.4898	0.9821	0.0936	1.2949
f (self esteem)	0.0002	0.0001	0.0001	0.0001	0.0004	0.0000	0.0007
Scale estimate (sigma2)	0.2256	0.0047	0.2158	0.2256	0.2344		

F: Function; SD: Standard deviation.

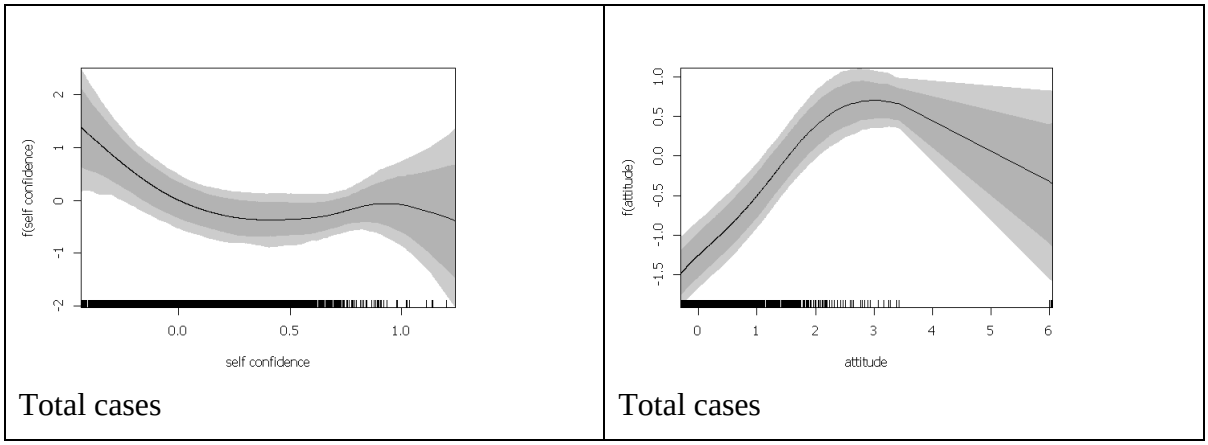

Fig.1: Estimates of unknown smooth functions' relationships between self-esteem and attitude toward smoking and smoking behavior. The solid curves show the pointwise posterior mean curves, while the bold part represent the 2.5% and 97.5% pointwise quintiles. The lither parts represent max and min pointwise when using second order random walk as a prior in Bayesian MCMC methods.

3-4. The main effects of two observational variables on smoking behavior by gender applying Bayesian nonparametric method

Table.5 shows the gender-based parameter coefficients. Although the means of smoking behavior were near zero in both attitude toward smoking and self-esteem, there were meaningful nonlinear relationships between the two observational variables and smoking behavior. **Figure.2** shows gender-based estimates of unknown smooth functions relationships between self-esteem and attitude toward smoking and smoking behavior. In this Figure, the upper left illustration shows that smoking behavior among male students with low self-esteem is high, but it gradually decreases by rising self-esteem. Among female students, in contrast, smoking behavior decreases by decreasing self-esteem. These two illustrations together are look like a cubic form. On the other hand, the smooth functions relationships between attitude toward smoking and smoking behavior among both male and female students are almost identically decreasing. In this way, the shapes of illustrations showing the relationships between attitude toward smoking and smoking behavior are look like a quadratic form between the two groups of students. Among female students, the variance of smoking behavior was high by changes in attitude toward the behavior.

Table-5: Gender-based Estimates of unknown smooth functions relationships between self-esteem and attitude toward smoking with smoking behavior. We showed posterior mean, standard deviations and 2.5%, 50% and 97.5% pointwise quintiles. We found these estimations after using second order random walk as a prior in Bayesian MCMC methods.

Smoking behavior (Outcome)								
Group	Parametric coefficients	Mean	SD	2.5%	50%	97.5%	Min	Max
Male	Smooth terms variances							
	f (Attitude toward smoking)	0.0024	0.0033	0.0004	0.0015	0.0109	0.0002	0.0542
	f (Self-esteem)	0.0003	0.0002	0.0001	0.0003	0.0009	0.0001	0.0014
	Scale estimate (sigma2)	0.3826	0.0119	0.3602	0.3820	0.4075		
Female	Smooth terms variances							
	f (Attitude toward smoking)	0.3333	0.0978	0.1789	0.3220	0.5587	0.1095	0.7572
	f (Self-esteem)	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0002
	Scale estimate (sigma2)	0.0345	0.0009	0.0327	0.0344	0.0364		

SD: Standard deviation.

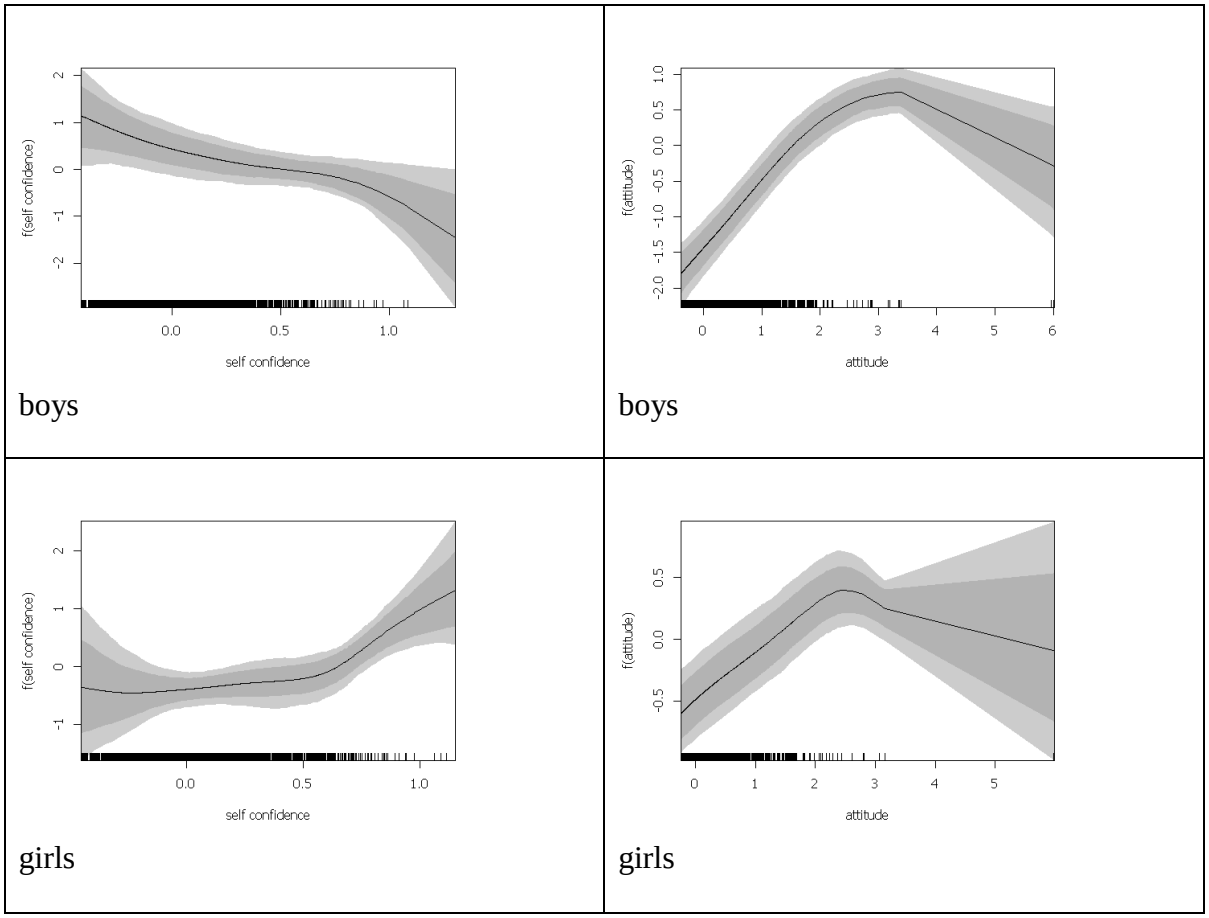

Fig.2: Gender-based Estimates of unknown smooth functions relationships between self-esteem and attitude toward smoking and smoking behavior. The solid curves show the pointwise posterior mean curves, while the bold part represent the 2.5% and 97.5% pointwise quintiles. The lither part represents max and min pointwise when using second order random walk as a prior in Bayesian MCMC methods.

4- DISCUSSION

In this study, we conducted a secondary analysis on a set of data obtained from 4,902 high-school students in Tabriz, Iran to investigate the main nonlinear effects of attitude toward smoking and self-esteem on smoking behavior. We also investigated gender-based patterns of the relationships. This study is unique in providing detailed nonlinear relationships between these risk factors and smoking behavior. A majority of previous studies (26, 28) investigated the significance of relationships between different risk factors and smoking behavior and so, there is not enough evidence about the nature of such relationships. In the present study, we found no association between self-esteem and the behavior in the total sample. However, gender-based investigation of this relationship provided us with different findings between male and female students.

The level of self-esteem and its effect on smoking behavior among male students were higher than those were the female students. In addition, the correlation between self-esteem and smoking behavior especially at high levels was negative among male students and positive among female students. High self-esteem among girls may has made them brave and encouraged to participate in smoking behavior. Willi et al., (2015) studied the effects of low self-esteem and positive beliefs about smoking among college students (47). They concluded that the male students with lower self-esteem exhibited positive beliefs toward smoking more and performed smoking behavior more in proportion to the female students. These findings were similar to those found in our study. However, they did not find any gender-based difference in the associations between self-esteem and smoking behavior. This dissimilarity may be due to the differences in the social contexts of Iran and the United States (47). Khosravi et al. (2016) also investigated the causal effect of self-esteem on cigarette smoking among adolescents using multinomial logistic model, and found that the relative risk for smoking among the experimenters and regular adolescent smokers with low self-esteem was more than 2 times, compared to those with high self-esteem (48). In another study, Kawabata et al. (1999) studied the relationship between self-esteem and smoking behavior among 2090 Japanese high school students and found the never smokers with higher levels of cognitive, family, and global self-esteem, and with lower level of physical self-esteem, compared to ever smokers. They also found the boys with a higher level of self-esteem compared to the girls (49), which was similar to the relationship patterns found in the present study. It is necessary to consider gender differences while designing self-esteem raising strategies within smoking prevention programs among adolescents. It seems that girls perform some risky behaviors, like smoking, for showing off themselves with false self-esteem. We recommend further research on this relationship among girls with qualitative approaches.

Andrews and Duncan (1998), applying latent growth modeling, investigated the effect of attitude toward smoking on adolescent cigarette use and indicated that attitude toward cigarette smoking significantly predicted both the frequency of subsequent cigarette use and the trend of use (50). They finally suggested the need for preventive efforts on attitude change at an early age, prior to experiencing cigarette use by adolescents (50). In another study, Rasmussen et al. (2005) studied gender differences in school connectedness and daily smoking and found an independent inverse association between school connectedness and smoking among both boys and girls. Parents' attitude toward their children's smoking significantly modified this

association among boys. Among girls, however, this modifying effect was less marked. Neither among boys nor among girls had the parental smoking behavior significantly modified the association between school connectedness and smoking, although there was a modifying tendency among girls (51). Piko, in 2001, studied smoking among adolescents focusing attitude toward the behavior (52); she concluded a clear pattern of the relationship between attitude toward smoking and smoking behavior. The shape of correlation between attitude and smoking showed the necessity of our proposed method, namely Bayesian nonparametric functional latent variable model. Increasing smoking until the half point of attitude score and the next increasing dropping down of the trend indicated the complexity of the relationship. It seems preventive plans are needed in the early stages of the attitude trend. The method applied in the present study may be applicable in most clinical, social, psychological and health sciences' studies where the variables were treated as latent, had an abnormal distribution and the relationships between variables were complex and may not be explained as linear. In addition, we interested in clarifying the need for more detail of the relationship scenarios and showing the opposite trends. In our study, we found changes in smoking behavior with varying levels of attitude and trend direction after half of the attitude score.

Our results in this study showed that the proposed method is applicable to make clear the details of nonlinear relationships between the latent variables. Traditional parametric Structural Equation Modeling with linear and/or quadratic terms of latent variables may not correctly reflect the true functional relationships between latent and observed variables, and may provide us with misleading conclusions if the data were analyzed applying a parametric approach. The different shapes of curves showed the necessity for the new method and, the functional curves between the latent factors showed all scenarios of the relationships. We also found no significant change in smoking at low levels of self-esteem. In contrary, at high levels of self-esteem there were different patterns of smoking between male and female students. In other words, being at high levels of self-esteem among boys may lead to the reduced levels of smoking, and among girls may result in the increased level of the behavior. In terms of the relationships between attitude and smoking, ignoring the fluctuations, middle levels of attitude may put adolescents at the highest level of smoking especially among boys. It seems that the excessive attitude of adolescents causes boredom of smoking in both genders.

5- CONCLUSION

Similar to those found in previous studies, we found significant relationships between self-esteem and attitude with smoking. These relationships, however, is not necessarily linear. Bayesian nonparametric functional latent variable model was helpful in finding the nonlinear relationships between these variables, which clarify more details on the associations between these psychological variables and smoking behavior among adolescents. Our findings also showed different relationship patterns by gender. The effect of self-esteem on smoking behavior among male adolescents was higher than that among female adolescents.

6- CONFLICT OF INTEREST: None.

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8- REFERENCES

1. Chang H-Y, Wu W-C, Wu C-C, Cheng JY, Hurng B-S, Yen L-L. The incidence of experimental smoking in school children: an 8-year follow-up of the child and adolescent behaviors in long-term evolution (CABLE) study. BMC Public Health. 2011;11(1):844.

2. Paul CL, Ross S, Bryant J, Hill W, Bonevski B, Keevy N. The social context of smoking: a qualitative study comparing smokers of high versus low socioeconomic position. BMC Public Health. 2010;10(1):211.

3. Kuipers MA, Robert P-O, Richter M, Rathmann K, Rimpelä AH, Perelman J, et al. Individual and contextual determinants of perceived peer smoking prevalence among adolescents in six European cities. Prev Med. 2016; 88:168-75.

4. al'Absi M, Carr SB, Bongard S. Anger and psychobiological changes during smoking abstinence and in response to acute stress: prediction of smoking relapse. Int J Psychophysiol. 2007;66(2):109-15.

5. Hoffman BR, Sussman S, Unger JB, Valente TW. Peer influences on adolescent cigarette smoking: a theoretical review of the literature. Subst Use Misuse. 2006;41(1):103-55.

6. Health UDo, Services H. Preventing tobacco use among youth and young adults: A report of the Surgeon General. Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health. 2012;3.

7. Warren CW, Jones NR, Eriksen MP, Asma S, group GTSSc. Patterns of global tobacco use in young people and implications for future chronic disease burden in adults. The lancet. 2006;367(9512):749-53.

8. Ansari-Moghaddam A, Rakhshani F, Shahraki-Sanavi F, Mohammadi M, Miri-Bonjar M, Bakhshani N-M. Prevalence and patterns of tobacco, alcohol, and drug use among Iranian adolescents: A meta-analysis of 58 studies. Children and Youth Services Review. 2016;60:68-79.

9. Guindon GE, Boisclair D. Past, current and future trends in tobacco use. 2003.

10. Hermalin AI, Lowry D. The Age Prevalence of Smoking among Chinese Women: A Case of Arrested Diffusion?: Population Studies Center, University of Michigan Ann Arbor; 2010.

11. Xu X, Liu L, Sharma M, Zhao Y. Smoking-related knowledge, attitudes, behaviors, smoking cessation idea and education level among young adult male smokers in Chongqing, China. International journal of environmental research and public health. 2015;12(2):2135-49.

12. Evans WD, Powers A, Hersey J, Renaud J. The influence of social environment and social image on adolescent smoking. Health Psychol. 2006;25(1):26.

13. Holm K, Kremers SP, De Vries H . Why do Danish adolescents take up smoking? The European Journal of Public Health. 2003;13(1):67-74.

14. Sherman S, Chassin L, Sherman J, Presson C, Macy J. Social psychological factors in adolescent and adult smoking: Findings and conclusions from a 30-year longitudinal study. 2016.

15. Elmore K, Delva J, Andrade F. Gender differences in psychological factors shaping smoking decisions of Chilean adolescents. J Health Psychol. 2016:1359105316634451.

16. Kim C-B, Choi B-R, Kim J-I. Smoking-Related Knowledge, Attitude, Self-Esteem and Social Support among Children and Adolescents in Gyeonggi-do, Korea. Indian Journal of Science and Technology. 2016;9(S1).

17. Gwon SH, Yan G, Kulbok PA. South Korean Adolescents' Intention to Smoke. 2017.

18. Topa G, Moriano JA. Theory of planned behavior and smoking: Meta-analysis and SEM model. Substance Abuse and Rehabilitation. 2010;1:23.

19. Snyder CR, Lopez SJ. Oxford handbook of positive psychology: Oxford University Press, USA; 2009.

20. Xu X, Leung DYP, Li B, Wang P , Zhao Y. Smoking-related knowledge, attitude, social pressure, and environmental constraints

among new undergraduates in Chongqing, China. International journal of environmental research and public health. 2015;12(1):895-909.

21. Wang Y, Krishnakumar A, Narine L. Parenting practices and adolescent smoking in mainland China: The mediating effect of smoking-related cognitions. J Adolesc. 2014;37(6):915-25.

22. Saari AJ, Kentala J, Mattila KJ. Weaker self-esteem in adolescence predicts smoking. BioMed research international. 2015 Jul 26. Article ID 687541, 5 pages

23. Yang Z, Schaninger CM, editors. The impact of parenting strategies on child smoking behavior: The role of child self-esteem trajectory 2013: American Marketing Association. Available at: www.journals.ama.org.

24. Chun S, Park JW, Heflick N, Lee SM, Kim D, Kwon K. The Moderating Effects of Self-Esteem and Self-Efficacy on Responses to Graphic Health Warnings on Cigarette Packages: A Comparison of Smokers and Nonsmokers. Health Commun. 2017:1-7. doi: 10.1080/10410236.2017.1331186.

25. Mohammadpoorasl A, Nedjat S, Yazdani K, Fakhari A, Foroushani AR, Fotouhi A. An algorithm of smoking stages assessment in adolescents: A validation study using the latent class analysis model. Int J Prev Med. 2013;4(11):1304.

26. Mohammadpoorasl A, Nedjat S, Yazdani K, Fakhari A, Foroushani AR, Fotouhi A. Intention to start smoking and its related factors in never smoked adolescents in tabriz, 2010. Int J Prev Med. 2012;3(12):880.

27. Mohammadpoorasl A, Nedjat S, Fakhari A, Yazdani K, Foroushani AR, Fotouhi A. Smoking stages in an Iranian adolescent population .Acta Med Iran. 2012;50(11):746.

28. Sahib AJ, Al-Badri HJA. Assessment of the knowledge and attitudes of preliminary school students toward smoking in Baghdad. Epidemiology, Biostatistics and Public Health. 2016;13(1): 1-5.

29. Kasim K, Al-Zalabani A, El-Moneim EA, Amer S. Beliefs and attitudes of male and female adolescents and the risk of smoking behavior. J Postgrad Med. 2016;62(2):80.

30. Mbongwe B, Tapera R, Phaladze N, Lord A, Zetola NM. Predictors of smoking among primary and secondary school students in Botswana. PLoS One. 2017;12(4):e0175640.

31. Ziaei R, Mohammadi R, Dastgiri S, Viitasara E, Rahimi VA, Jeddi A, et al. The prevalence, attitudes, and correlates of waterpipe smoking among high school students in Iran: a cross-sectional study. Int J Behav Med. 2016; 23(6):686-96.

32. Li Z, Yao Y, Han W, Yu Y, Liu Y, Tao Y, et al. Smoking prevalence and associated factors as well as attitudes and perceptions towards tobacco control in Northeast China. International journal of environmental research and public health. 2015;12(7):8606-18.

33. Passey ME, D'Este CA, Sanson-Fisher RW. Knowledge, attitudes and other factors associated with assessment of tobacco smoking among pregnant Aboriginal women by health care providers: a cross-sectional survey. BMC Public Health. 2012;12(1):165.

34. Walsh RA, Cholowski K, Tzelepis F, Stojanovski E. Smoking prevalence, attitudes, and confidence about tobacco roles among Australian nursing students. J Addict Nurs. 2012;23(3):181-90.

35. Xiao L, Jiang Y, Li Q, Feng G-Z, Nan Y. Study on the status of cigarette smoking in youths from three cities of China. Zhonghua liu xing bing xue za zhi= Zhonghua liuxingbingxue zazhi. 2012;33(7):676-80.

36. Mejia R, Kaplan CP, Alderete E, Gregorich SE, Pérez-Stable EJ. Influence of gender role attitudes on smoking and drinking among girls from Jujuy, Argentina. Prev Med. 2013;57(3):194-7.

37. Atoyebi O, Ibirongbe D, Babatunde O, Atoyebi O. To start and quit smoking cigarettes: an evaluation of students in a Nigerian city. J Prev Med Hyg2013;54(2):104.

38. Dania MG, Ozoh OB, Bandele EO. Smoking habits, awareness of risks, and attitude towards tobacco control policies

among medical students in Lagos, Nigeria. Annals of African medicine. 2015;14(1):1.

39. French SA, Perry CL. Smoking among adolescent girls: prevalence and etiologyJournal of the American Medical Women's Association (1972). 1996;51(1-2):25-8.

40. Johnson CA, Palmer PH, Chou C-P, Pang Z, Zhou D, Dong L, et al. Tobacco use among youth and adults in Mainland China: the China Seven Cities Study. Public Health. 2006;120(12):1156-69.

41. Hill AJ BF, Amyot E, Dery D, Godin G. Predicting the stages of smoking acquisition according to the theory of planned behavior. Journal of adolescent health. 1997;21(2):107-15.

42. M. R. Society and the Adolescent Self Image . .Princeton, NJ: Princeton University Press; 1965.

43. Baglin J. Improving your exploratory factor analysis for ordinal data: a demonstration using FACTOR. Practical Assessment, Research and Evaluation. 2014;19(5):2.

44. Song X-Y, Lee S-Y. Nonparametric SEMs with Bayesian P-splines. Basic and Advanced Bayesian Structural Equation Modeling With Applications in the Medical and Behavioral Sciences. United Kingdom: John Wiley and Sons, Ltd; 2012.pp. 307-20.

45. Umlauf N, Kneib T, Heinzl F, Lang S, Zeileis A. R2BayesX: Estimate structured additive regression models with BayesX. R package version 01-2. 2013. Available at: https://cran.r-project.org/.

46. Rosseel Y. lavaan: an R package for structural equation modeling and more Version 0.4-9 (BETA). Ghent University; 2011.

47. Hale WJ, Perrotte JK, Baumann MR, Garza RT. Low self-esteem and positive beliefs about smoking: A destructive combination for male college students. Addict Behav. 2015;46:94-9.

48. Khosravi A, Mohammadpoorasl A, Holakouie-Naieni K, Mahmoodi M, Pouyan AA, Mansournia MA. Causal Effect of Self-esteem on Cigarette Smoking Stages in Adolescents: Coarsened Exact Matching in a Longitudinal Study. Osong public health and research perspectives. 2016;7(6):341-5.

49. Kawabata T, Cross D, Nishioka N, Shimai S. Relationship Between Self-Esteem and Smoking Behavior Among Japanese Early Adolescents: Initial Results from a Three-Year Study. J Sch Health. 1999;69(7):280-4.

50. Andrews JA, Duncan SC. The effect of attitude on the development of adolescent cigarette use. J Subst Abuse. 1998;10(1):1-7.

51. Rasmussen M, Damsgaard MT, Holstein BE, Poulsen LH, Due P. School connectedness and daily smoking among boys and girls: the influence of parental smoking norms. The European Journal of Public Health. 2005;15(6):607-12.

52. Piko B. Smoking in adolescence: Do attitudes matter? Addict Behav. 2001;26(2):201-17.