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Causal Effect of Self-esteem on Cigarette Smoking Stages in Adolescents: Coarsened Exact Matching in a Longitudinal Study

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Abstract

Objectives: Identification of the causal impact of self-esteem on smoking stages faces seemingly insurmountable problems in observational data, where self-esteem is not manipulable by the researcher and cannot be assigned randomly. The aim of this study was to find out if weaker self-esteem in adolescence is a risk factor of cigarette smoking in a longitudinal study in Iran.
Methods: In this longitudinal study, 4,853 students (14–18 years) completed a self-administered multiple-choice anonym questionnaire. The students were evaluated twice, 12 months apart. Students were matched based on coarsened exact matching on pretreatment variables, including age, gender, smoking stages at the first wave of study, socioeconomic status, general risk-taking behavior, having a smoker in the family, having a smoker friend, attitude toward smoking, and self-injury, to ensure statistically equivalent comparison groups. Self-esteem was measured using the Rosenberg 10-item questionnaire and were classified using a latent class analysis. After matching, the effect of self-esteem was evaluated using a multinomial logistic model.
Results: In the causal fitted model, for adolescents with weaker self-esteem relative to those with stronger self-esteem, the relative risk for experimenters and regular smokers relative to nonsmokers would be expected to increase by a factor of 2.2 (1.9–2.6) and 2.0 (1.5–2.6), respectively.
Conclusion: Using a causal approach, our study indicates that low self-esteem is consistently associated with progression in cigarette smoking stages.

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1. Introduction

Cigarette smoking is one of the most important public health problems [1], and reviewing the studies in Iranian adolescents, an increasing trend in smoking prevalence in Iranian adolescents can easily be observed [2]. Despite differences in smoking prevalence in different countries, a major concern is that the age of initiating smoking is decreasing in both developed and developing countries [3]. Many of the smokers begin smoking before 18 years of age [4].

A variety of factors such as low conscientiousness, high neuroticism [5,6], and low agreeableness [6], as well as depressiveness [7] have been associated with smoking. Low self-esteem in adolescence predicts vulnerability to depression [8−10], and smoking is a predictor of depression [11]. Low self-esteem in adolescence also relates to a variety of health risk behaviors [12]. Self-esteem has been reported to relate to aspects of adolescent smoking behavior [13,14]. The use of substances is a way to cope with negative feelings and escape from stressors in low self-esteem adolescents [15]. Some studies contradicted these findings, and noted an insignificant association between low self-esteem and the specified risk behaviors [16,17] such as smoking and substances use [18,19].

All in all, smokers often have weaker self-esteem and those with weaker self-esteem are expected to smoke. The majority of studies about the relationship of self-esteem and smoking conducted in adolescents have been cross sectional [20,21] and cohort [22,23] studies. Identification of the causal impact of self-esteem on smoking stages faces seemingly insurmountable problems in observational data, where self-esteem is not manipulable by the researcher and cannot be assigned randomly [24]. Matching and reweighting estimators offer an approach to causal inference using observational data [25].

The perspective toward the concept of self-esteem and smoking might be varied in Iranian adolescents. The disparities in different studies may be due to variations in demographic groups, culture, and definitions of self-esteem [26]. The aim of this study was to find out if weaker self-esteem in adolescence is a risk factor of cigarette smoking using coarsened exact matching (CEM) in a longitudinal study in Iran.

2. Materials and methods

2.1. Participants

In this school-based longitudinal study (with 2 waves during 2010−2012) , a representative sample of 10-grade students of Tabriz (north-west of Iran) were randomly selected by considering the type of school and the number of students in each school. Overall, 196 classes (out of about 865 classes, 82 boys' and 114 girls'

classes) were randomly selected. All 5,106 students of these classes were invited to participate in the study. More details about sampling can be found elsewhere [27]. Finally, 4,853 students (14−18 years) completed a self-administered multiple-choice anonym questionnaire for the first phase of study. One year later, the same questionnaire was distributed to the same students in order to study the changes in their smoking behavior. The participants were ensured about the voluntary nature of participation and confidentiality of information. This study and the related questionnaire were approved by the East Azerbaijan Province Education Organization and Ethics Committee of Tabriz University of Medical Sciences.

2.2. Study tools

We used a standard and valid algorithm for the assessment of smoking stages [28]. Students were classified in three stages of cigarette smoking continuum in the first and second phases of study, according to Mohammadpoorasl et al [19] and Kaplan et al [29], as follows: (1) never smokers: adolescents who have never smoked (even a puff); (2) experimenters: adolescents who have tried cigarettes (even a puff), but have smoked less than 100 cigarettes in their lifetime; and (3) regular smokers: adolescents who have smoked 100 cigarettes and more in their lifetime, without considering their present consumption. Self-esteem was measured using the Rosenberg 10-item questionnaire in the first phase of the study [30]. Each of these 10 questions was assigned a score of 1−4. The answer choices of these questions include "completely agree," "agree," "disagree," and "completely disagree," with the scores assigned to them being 1, 2, 3, and 4, respectively. Attitude toward smoking among the students was measured through six questions similar to those of Hill et al [31]. The general risk taking behavior was measured in a way similar to that of Kaplan et al [29] using the question "Do you enjoy doing a little risky action?", with a "yes" and "no" response. Socioeconomic status of the students was built based on information regarding their father's education, mother's education, family assets, and family income. It was calculated using the principal component analysis. Using this variable, the students were classified into one of the three socioeconomic status levels of high, middle, and lower.

2.3. Data analysis

In this study, we used the CEM method for the estimation of causal effect of self-esteem on smoking behavior of adolescents. The CEM method improves the estimation of causal effects in observational studies by reducing imbalance in covariates between treated and control groups [32,33]. To compensate for the observational data problem where the treated and control groups are not necessarily identical before treatment, matching estimators attempt to control for pretreatment covariates. The CEM model improves the multivariate balance

between the self-esteem levels. In detail, the CEM algorithm consists of three steps: (1) desired variables of all participants are coarsened temporarily; (2) all participants of the initial cohort are sorted into strata on the basis of their coarsened variables; and (3) only participants with strata containing at least one weaker and one stronger self-esteem are kept and others are discarded. Additionally, a weighting variable is generated to equalize the number of treated (weaker self-esteem) and control (stronger self-esteem) individuals in one stratum. With a CEM-matched sample, the goal is to estimate the average treatment effect on the treated individuals [34]. Matching is a nonparametric method of controlling for some of or all the confounding influence of pretreatment control variables in observational data [33]. Participants were matched on pretreatment variables, including age, gender, smoking stages at the first wave of study (never smokers, experimenters, and regular smokers), socioeconomic status (low, middle, and high), general risk taking behavior (yes and no), having a smoker in the family (yes and no), having a smoker friend (yes and no), attitude toward smoking (yes and no), and self-injury (yes and no), to ensure statistically equivalent comparison groups to estimate the effect of the self-esteem levels on cigarette smoking behavior 1 year later.

The latent class analysis was applied to construct self-esteem as a treatment variable with two categories of weaker and stronger self-esteem. In this model, the latent variable (self-esteem) is not measured directly. Instead, it is measured indirectly by means of 10 questions as observed variables.

A multinomial logistic model was applied to estimate the effect of self-esteem on cigarette smoking behavior incorporating matched weights. The effects were reported as relative risk ratios and 95% confidence interval. All data analyses were performed using STATA v.12.

3. Results

Of the 4,853 study students, 2,087 (43%) were boys and 2,766 (57%) girls. The mean and standard deviation of the students' age was 15.69 ± 0.73 (age range, 14−19 years). The mean ± standard deviation score of self-esteem in the first phase of study was 17.8 ± 4.87. There were statistically significant differences in self-esteem mean scores in the first phase of study between the groups of never smokers, experimenters, and regular smokers. We used a latent class analysis for dichotomization of self-esteem scores. Participants were classified into those with stronger or weaker self-esteem (53% vs. 47%, respectively). After the matching, a matched subsample ($n = 4,198$) was used for analysis.

After 1-year follow-up in 2011, 3,962 individuals reported their smoking stages (5.6% missing to follow-up). Table 1 shows the transition in cigarette smoking stages for the first and second phases of the study. Those

with weaker self-esteem during adolescence were more likely to be experimenters or regular smokers.

First, we used an unmatched approach for the analysis. In the unmatched cohort analysis of data on the relationship between self-esteem (exposure) and smoking stages 1 year later (outcome), self-esteem was significantly associated with smoking stages in the univariate, but not in the multivariate, analysis adjusting for sex, age, smoking state in the first phase of study, socioeconomic status, general risk taking behavior, having a smoker in the family, having a smoker friend, attitude toward smoking, and self-injury. In the second approach for analysis, CEM was used to make the two groups of weaker and stronger self-esteem statistically equivalent based on age, gender, smoking states in the first phase of study, socioeconomic status, general risk taking behavior, having a smoker in the family, having a smoker friend, attitude toward smoking, and self-injury. Exposure groups were compared regarding the proportion of smoking stages 1 year later using a multinomial logit model incorporating matched weights. In the causal fitted model (Table 2), for adolescents with weaker self-esteem relative to those with stronger self-esteem, the relative risk for experimenters and regular smokers relative to nonsmokers would be expected to increase by a factor of 2.2 (1.9−2.6) and 2.0 (1.5−2.6), respectively. In other words, the expected risk of transition in the experimenter or regular smoking stages is higher for individuals who have weaker self-esteem.

4. Discussion

Estimation of the treatment effect of weaker self-esteem on the progression of smoking stages is the goal of our study. The results of our study revealed that weaker self-esteem was related to adolescent smoking stages. Although self-esteem had an effect in the starting stages of cigarette smoking in our study, it had not played any significant role in the starting stage of cigarette smoking in a cross-sectional analysis of data from the first phase of a study [19]. In another longitudinal study in Iran, 1,785 students were randomly selected and assessed twice, with a 12-month interval; the effect of self-esteem on smoking stages was not significant [22]. In the study of Glendinning and Inglis [35], no evidence was found in support of a relationship between self-esteem and regular smoking. In line with our study, the role of self-esteem at the starting of smoking among adolescents has been shown in previous longitudinal [13] and cross-sectional [36,37] studies. In another study, daily smoking among males was associated with a lower initial level of self-esteem [38].

Using a causal approach, our study indicates that low self-esteem is consistently associated with cigarette smoking. In our model, we used a vector of variables as confounders and matching was done according to these

Table 1.   Transition of smoking stages between two phases of study according to treatment levels.

Self-esteem	Smoking stages in first phase	Smoking stages 1 y later (%)			Total (%)
		Never smoker	Experimenter	Regular smoker	
Stronger (n = 2,129)	Never smoker	1,650 (92.9)	101 (5.7)	26 (1.4)	1,777 (100.0)
	Experimenter	—	245 (84.8)	44 (15.2)	289 (100.0)
	Regular smoker	—	—	63 (100.0)	63 (100.0)
Weaker (n = 1,833)	Never smoker	1,260 (91.0)	108 (7.8)	17 (1.2)	1,385 (100.0)
	Experimenter	—	298 (83.9)	57 (16.1)	355 (100.0)
	Regular smoker	—	—	93 (100.0)	93 (100.0)

Table 2.   Relative risk ratio of smoking behavior by self-esteem (95% confidence interval).

Treatment factor	Cigarette smoking stages		
Self-esteem	Never smoker	Experimenter	Regular smoker
Stronger	1	1	1
Weaker	1	2.2 (1.9–2.6)	2.0 (1.5–2.6)

confounder variables. Matching on these predictors is a strength of this study. The relation between each variable with smoking stages previously well assessed. Study of Cremers et al [39] indicated that a positive attitude toward smoking was related to the intention to smoke among boys of high socioeconomic status. Various studies have shown that there is a positive relationship between the presences of a cigarette smoker member in the family and cigarette smoking [19]. Smoking behavior is more frequent among low people of socioeconomic status than among those with a high status [40]. Findings of some studies showed that having a smoker friend is a predictor of transmission between cigarette smoking stages [29,41,42]. Previous studies have shown that the prevalence of more advanced stages of cigarette smoking is high among adolescents with general risk taking behavior [19]. Andrews and Duncan [43] have shown that the attitude toward cigarettes significantly predicted both frequency of subsequent cigarette smoking and growth in its use.

Given that all the studies mentioned are observational, the reported relation between self-esteem and smoking stages is an association. The cross-sectional nature of some studies can only act as evidence for the relationship between self-esteem and cigarette smoking stages, and does not show the causality. Our study is one of the main study that used a causal model for a causal inference in smoking field. The key strength of this study is its analytical method, pointing to minimize the bias due to different covariates in a longitudinal study. Risk estimation in our matched study is already more robust than that of the unmatched longitudinal study with a multivariate analysis. Despite using a quite satisfactory methodology and sampling method, generalization of the study results is limited as the study was limited to 10th grade students of Tabriz city only. Another limitation of this study is that the covariates were evaluated only at the beginning of the study and could have changed during the period of follow-up.

The results of our study revealed that weaker self-esteem was a risk factor for progression in adolescent smoking. In recent years, health professionals have shifted emphasis from treating adult smokers to preventing smoking among children and adolescents. Our findings could be used in developing intervention programs in schools for promoting self-esteem and control of other specified risk factors in adolescents, and as a reference for related research and policy development in Iran and other countries.

Conflicts of interest

All authors declare that they have no conflicts of interest.

Acknowledgments

References

1. Nelson DE, Mowery P, Asman K, et al. Long-term trends in adolescent and young adult smoking in the United States: meta-patterns and implications. Am J Pub Health 2008 May;98(5): 905–15. http://dx.doi.org/10.2105/ajph.2007.115931.
2. Mohammadpoorasl A. Increasing the trend of smoking in Iranian adolescents. Iran J Pub Health 2013 Oct;42(10):1197–8.
3. Huang M, Hollis J, Polen M, et al. Stages of smoking acquisition versus susceptibility as predictors of smoking initiation in

adolescents in primary care. Addict Behav 2005 Jul;30(6): 1183−94. http://dx.doi.org/10.1016/j.addbeh.2004.12.009.

4. Novotny T. Tobacco use. In: Brownson RC, R P, Davis JR, editors. Chronic disease epidemiology and control. Baltimore (MD): American Public Health Association; 1993. p. 199−220.

5. Terracciano A, Lockenhoff CE, Crum RM, et al. Five-factor model personality profiles of drug users. BMC Psychiatry 2008 Apr;8(1):22. http://dx.doi.org/10.1186/1471-244x-8-22.

6. Malouff JM, Thorsteinsson EB, Schutte NS. The five-factor model of personality and smoking: a meta-analysis. J Drug Educ 2006 Mar;36(1):47−58.

7. Haukkala A, Uutela A, Vartiainen E, et al. Depression and smoking cessation: the role of motivation and self-efficacy. Addict Behav 2000 Mar−Apr;25(2):311−6.

8. Andrews B, Brown GW. Self-esteem and vulnerability to depression: the concurrent validity of interview and questionnaire measures. J Abnorm Psychol 1993 Nov;102(4):565−72.

9. Vaananen JM, Isomaa R, Kaltiala-Heino R, et al. Decrease in self-esteem mediates the association between symptoms of social phobia and depression in middle adolescence in a sex-specific manner: a 2-year follow-up of a prospective population cohort study. BMC Psychiatry 2014 Mar;14(1):79. http://dx.doi.org/10.1186/1471-244x-14-79.

10. Rawana JS, Morgan AS. Trajectories of depressive symptoms from adolescence to young adulthood: the role of self-esteem and body-related predictors. J Youth Adolesc 2014 Apr;43(4):597−611. http://dx.doi.org/10.1007/s10964-013-9995-4.

11. Korhonen T, Broms U, Varjonen J, et al. Smoking behaviour as a predictor of depression among Finnish men and women: a prospective cohort study of adult twins. Psychol Med 2007 May;37(5):705−15. http://dx.doi.org/10.1017/s0033291706009639.

12. Gordon Rouse KA, Ingersoll GM, Orr DP. Longitudinal health endangering behavior risk among resilient and nonresilient early adolescents. J Adolesc Health 1998 Nov;23(5):297−302.

13. Botvin GJ, Baker E, Botvin EM, et al. Factors promoting cigarette smoking among black youth: a causal modeling approach. Addict Behav 1993 Jul−Aug;18(4):397−405.

14. Murphy NT, Price CJ. The influence of self-esteem, parental smoking, and living in a tobacco production region on adolescent smoking behaviors. J School Health 1988 Dec;58(10):401−5.

15. Jessor R, Van Den Bos J, Vanderryn J, et al. Protective factors in adolescent problem behavior: Moderator effects and developmental change. Develop Psychol 1995 Nov;31(6):923−33. http://dx.doi.org/10.1037/0012-1649.31.6.923.

16. Abernathy TJ, Massad L, Romano-Dwyer L. The relationship between smoking and self-esteem. Adolescence 1995 Winter;30(120):899−907.

17. Kavas AB. Self-esteem and health-risk behaviors among Turkish late adolescents. Adolescence 2009 Spring;44(173):187−98.

18. McGee ROB, Williams S. Does low self-esteem predict health compromising behaviours among adolescents? J Adolesc 2000 Oct;23(5):569−82. http://dx.doi.org/10.1006/jado.2000.0344.

19. Mohammadpoorasl A, Nedjat S, Fakhari A, et al. Smoking stages in an Iranian adolescent population. Acta Med Iran 2012 Sep;50(11):746−54.

20. Byrne DG, Mazanov J. Self-esteem, stress and cigarette smoking in adolescents. Stress Health 2001 Feb;17(2):105−10. http://dx.doi.org/10.1002/smi.885.

21. Wu CS, Wong HT, Shek CH, et al. Multi-dimensional self-esteem and substance use among Chinese adolescents. Subst Abuse Treat Prev Policy 2014 Oct;9(1):1−8. http://dx.doi.org/10.1186/1747-597x-9-42.

22. Mohammadpoorasl A, Fakhari A, Rostami F, et al. Predictors of transition in different stages of smoking: a longitudinal study. J Addict Health 2010 Winter−Spring;1:1−8.

23. Saari AJ, Kentala J, Mattila KJ. Weaker self-esteem in adolescence predicts smoking. BioMed Res Int 2015;2015:687541. http://dx.doi.org/10.1155/2015/687541.

24. Austin N. Causal inference with observational data. Stata J 2007;7(4):507−41.

25. Shadish WR, Cook TD, Campbell DT. Experimental and quasiexperimental designs for generalized causal inference. Boston (MA): Houghton Mifflin; 2002.

26. Buhrmester MD, Blanton H, Swann Jr WB. Implicit self-esteem: nature, measurement, and a new way forward. J Pers Soc Psychol 2011 Feb;100(2):365−85. http://dx.doi.org/10.1037/a0021341.

27. Khosravi A, Mansournia M, Mahmoodi M, et al. Estimating the transitional probabilities of smoking stages with cross-sectional data and 10-year projection for smoking behavior in Iranian adolescents. Int J Prev Med 2016 Aug;7(1):101. http://dx.doi.org/10.4103/2008-7802.188602.

28. Mohammadpoorasl A, Nedjat S, Yazdani K, et al. An algorithm of smoking stages assessment in adolescents: a validation study using the latent class analysis model. Int J Prev Med 2013 Nov;4(11):1304−11.

29. Kaplan CP, Napoles-Springer A, Stewart SL, et al. Smoking acquisition among adolescents and young Latinas: the role of socio-environmental and personal factors. Addict Behav 2001 Jul−Aug;26(4):531−50. http://dx.doi.org/10.1016/S0306-4603(00)00143-X.

30. Rosenberg M. Society and the adolescent self-image. Princeton (NJ): Princeton University Press; 1965.

31. Hill AJ, Boudreau F, Amyot E, et al. Predicting the stages of smoking acquisition according to the theory of planned behavior. J Adolesc Health 1997 Aug;21(2):107−15. http://dx.doi.org/10.1016/S1054-139X(97)00039-6.

32. Stuart EA. Matching methods for causal inference: a review and a look forward. Stat Sci 2010 Feb;25(1):1−21. http://dx.doi.org/10.1214/09-sts313.

33. Blackwell M, Iacus S, King G, et al. Coarsened exact matching in Stata. Stata J 2009;9(4):524−46.

34. Iacus SM, King G, Porro G. Causal inference without balance checking: coarsened exact matching. Polit Anal 2012 Jan;20(1):1−24. http://dx.doi.org/10.1093/pan/mpr013.

35. Glendinning A, Inglis D. Smoking behaviour in youth: the problem of low self-esteem? J Adolesc 1999 Oct;22(5):673−82. http://dx.doi.org/10.1006/jado.1999.0262.

36. Carvajal SC, Wiatrek DE, Evans RI, et al. Psychosocial determinants of the onset and escalation of smoking: cross-sectional and prospective findings in multiethnic middle school samples. J Adolesc Health 2000 Oct;27(4):255−65.

37. Pederson LL, Koval JJ, McGrady GA, et al. The degree and type of relationship between psychosocial variables and smoking status for students in grade 8: is there a dose-response relationship? Prev Med 1998 May−Jun;27(3):337−47. http://dx.doi.org/10.1006/pmed.1998.0305.

38. Kiviruusu O, Huurre T, Aro H, et al. Self-esteem growth trajectory from adolescence to mid-adulthood and its predictors in adolescence. Adv Life Course Res 2015 Mar;23:29−43. http://dx.doi.org/10.1016/j.alcr.2014.12.003.

39. Cremers HP, Mercken L, de Vries H, et al. A longitudinal study on determinants of the intention to start smoking among non-smoking boys and girls of high and low socioeconomic status. BMC Public Health 2015 Jul;15(1):648. http://dx.doi.org/10.1186/s12889-015-1917-9.

40. de Vries H. Socio-economic differences in smoking: Dutch adolescents' beliefs and behaviour. Soc Sci Med 1995 Aug;41(3):419−24.

41. Mayhew KP, Flay BR, Mott JA. Stages in the development of adolescent smoking. Drug Alcohol Depend 2000 May;59(Suppl 1):S61−81. http://dx.doi.org/10.1016/S0376-8716(99)00165-9.

42. Wang MQ, Fitzhugh EC, Westerfield RC, et al. Family and peer influences on smoking behavior among American adolescents: an age trend. J Adolesc Health 1995 Mar;16(3):200−3. http://dx.doi.org/10.1016/1054-139x(94)00097-x.

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