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The prevalence of the co-occurrence of risky behaviors and association with socioeconomic status in Iran: a latent class analysis

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Abstract

Background This study aimed to identify distinct population classes with different risk profiles using Latent Class Analysis (LCA) in Iran, as well as, to evaluate the association between various classes of risky behavior and Socio-Economic Status (SES) levels.

Methods This cross-sectional study was conducted on 860 participants in Tabriz, northwestern Iran from September to November 2023. The source population included clients who visited the Asadabadi Family Medicine Clinic. Data were collected using two standard self-report questionnaires. LCA was utilized to categorize the data. Twelve variables were utilized to determine the classes of risky behaviors. After considering the model selection indices, we found that the model with three latent classes was the most suitable. Multi-nominal logistic regression was employed to assess the association between risky behavior and SES.

Results The results of this study showed that the prevalence of the middle-risk class and high-risk class among the study population was 13% and 21%, respectively. Individuals with a very high SES were less likely to engage in multiple risky behavior classes compared to those with a low SES (OR: 0.82, 95% CI: 0.59–0.97 and OR: 0.79, 95% CI: 0.48–1.29). Additionally, divorced participants (OR: 1.7, 95% CI: 1.08–2.71 and 4.31, 95% CI: 1.61–11.56).

Conclusions In the present study, the co-occurrence of risky behaviors was reported as 10 and 3 for the high-risk behavior class and the middle-risk behavior class, respectively. The findings suggest that prevention and treatment interventions aimed at modifying multiple high-risk behaviors should be integrated into the healthcare system, in addition to those focused on altering a single behavior. Furthermore, the results of this study indicate that individuals with lower socioeconomic status are given higher priority in screening programs designed to identify high-risk behaviors.

Keywords Latent class analysis, Socioeconomic factors, Health behaviors, Risk-taking

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Background

Along with epidemiologic and demographic transitions, there has been an increase in Non-Communicable Diseases (NCDs), as well as emerging and re-emerging communicable diseases [1]. The majority of the world's deaths are caused by NCDs, including heart disease, stroke, cancer, diabetes, and chronic lung disease. Low- and middle-income countries accounted for 86% of the 17 million premature deaths occurring before the age of 70 [2, 3].

To decrease NCD-related deaths, it is crucial to manage the risk factors that contribute to their development. Several scientific studies have shown a significant association between NCDs and various modifiable lifestyle behaviors [4–8]. High-risk behaviors are actions that increase the likelihood of injury or disease, possibly resulting in death, disability, or social problems [9–11]. Based on the World Health Organization (WHO), NCDs are exacerbated by modifiable behaviors such as tobacco use, unhealthy diet, physical inactivity, and harmful alcohol use. Given the importance of this issue, the WHO has prioritized reducing deaths from non-communicable diseases by 25% by 2025. Therefore, obtaining data on the risk profiles of populations is crucial for NCD prevention. From various reported statistics, it is evident that multiple risky behaviors commonly co-occur [12–14]. Furthermore, ample studies have shown that while risky behaviors can independently predict disease, they may also have a multiplicative effect [15–19]. This multiplicative effect indicates that a multimodal approach, which is the recognized gold standard for diagnosing and managing many diseases, is essential. A more accurate understanding of which behaviors tend to co-occur would enhance the efficiency and efficacy of deploying resources to promote overall health. Previous evidence investigating the prevalence of high-risk behaviors, often consider these factors as individual predictors of health. There is significantly less understanding of how multiple risky behaviors cluster and how distinct clusters of multiple risky behaviors exist among the general population in Iran. New methods, such as Latent Class Analysis (LCA), offer ways to assess the simultaneous prevalence of risky behaviors by identifying latent subgroups with similar traits [20].

Although various studies assessed risky behavior individually, we could not find a study that assesses multiple risky behaviors simultaneously among the general population in Iran. Therefore, this study aimed to determine population classes with distinct risk profiles using LCA in northwestern Iran, as well as to estimate the prevalence of each class. This study also evaluates the association between various classes of risky behavior and Socioeconomic Status (SES) levels.

Methods

Study design and participants

The present cross-sectional study was conducted on 860 participants in Tabriz, located in northwestern Iran from September to November 2023. The source population consisted of clients who refer to the Asadabadi Family Medicine Clinic, which offers a range of services including preventative, diagnostic, and outpatient treatment, as well as educational and counseling programs. Each rural and urban region of Tabriz was considered as a stratum and a proportional sampling method was used based on the size of each stratum. Some clients were randomly selected from each category. The sample size was calculated for each of the high-risk behaviors. The high-risk behavior with the largest sample size (alcohol consumption) was selected. Ultimately, the sample size was determined to be 896 individuals, with a prevalence (P) of 0.16, 95% confidence level, and a d (margin of error) value of 0.15 P. Out of the 896 clients invited to participate, 36 individuals declined. Finally, 860 individuals enrolled in the study. The inclusion criteria were being 14 years old, residing in Tabriz for a minimum of one year. Due to the self-report nature of the questionnaire, individuals with severe physical and mental disabilities who were unable to answer the questions were excluded from the study ($n=0$).

Procedures

Data was collected using two validated self-reported questionnaires. The risky behavior were assessed using the Persian version of Behavioral risk factor questioner [21]. The questions in this questionnaire were designed to gather information on the following topics: sleep status, physical activity status, cigarette and hookah smoking, alcohol use, cannabis use, stimulant drug use, analgesic drug use, sedative-hypnotics use, suicide attempt, unsafe extramarital sex, nutritional status, colorectal, breast and cervical cancer screening and some demographic characteristics. The content validity index of this questionnaire was 0.95, the overall Cronbach's alpha was 0.85, and the intraclass correlation coefficient (ICC) was 0.86, 0.88 and 0.87 for the main domain, optional domain, and total tool, respectively. In this questionnaire, scores can be computed for each domain as well as for the overall questionnaire. Using the mean clustering method, the participants were categorized into two groups for each risky behavior: those exhibiting risky behavior and those not exhibiting risky behavior.

To assess SES, a short version of the SES questionnaire was utilized [22]. This self-reported questionnaire consists of six items: house cost, health expenditure, car cost, salary, education, and occupation. The items are rated on scale ranging from a maximum 7-point Likert scale to a minimum 5-point Likert scale. A higher score indicates

Table 1 Comparison of LCA models with different latent classes based on model selection statistics

Number of latent Class	Number of parameters estimated	AIC	BIC	G ²	Maximum log-likelihood
1	12	6204.06	6375.27	1186.7	-3066.03
2	25	5560.47	6157.64	419.11	-2682.34
3	38	5527.46	6050.60	362.12	-2653.73
4	51	5558.57	6257.67	319.22	-2632.28
5	64	5634.87	6509.94	321.52	-2633.44
6	77	5688.94	6739.94	301.56	-2623.46
7	90	5711.44	6938.43	250.08	-2597.7
8	103	5748.1	7151.05	212.74	-2579.05
9	116	5800.3	7379.21	190.21	-2568.15

LCA: latent class analysis, AIC: Akaike Information Criterion, BIC: Bayesian Information Criterion

Table 2 Basic characteristic of the study participants

Variable	Number	Percent
Age*	41.5	16.01
Sex	Male	49.53
	Female	50.47
Literacy	Elementary	25.93
	Diploma	33.60
	Undergraduate	28.95
	Post graduate	11.51
Marital status	Single	55.35
	Married	37.67
	Widowed	2.79
	Divorce	4.19
Socio economic status	Low	220.09
	Medium	28.37
	High	25.70
	Very high	23.84

*Mean (standard deviation)

a higher level of SES. The reliability of the SES questionnaire was assessed using Cronbach's alpha coefficient, yielding a satisfactory value ($\alpha > 0.65$). Trained data collectors were employed to prevent misclassification due to information bias. The data collectors clarified the questions to ensure a consistent understanding among participants.

Statistical analysis

Mean and standard deviation (SD) were used to describe quantitative variables, while frequency and percentage were used for categorical variables. LCA was performed by considering models with 1 to 9 classes and calculating associated indices for each model. Twelve variables were utilized to determine the classes of risky behaviors. In this study, lower AIC and BIC values indicate a better goodness of fit. After considering the model selection indices, we found that the model with three latent classes was the most suitable. Latent class 1 was labeled as 'low-risk' due to its low probability for all risky behaviors. Latent class 3 was named "high risk" because of its high probability of risky behaviors. In contrast, latent class 2, named "middle risk," showed individuals at high risk for

malnutrition, smoking cigarettes, and insufficient physical activity (Table 1).

Multi-nominal logistic regression was employed to evaluate the association between latent classes and SES. All covariates, including gender, age, education level, and marital status, were adjusted if their *p*-value was less than or equal to 0.2. R 4.3.1 software was used for all analyses.

Results

A total of 860 participants aged 14 years and above were enrolled, nearly half of them being male. Approximately, 324 (37.67%) of participants were married. The mean age of the participants was 41.5 (16) years. (Table 2)

Figure 1 displays the prevalence of individual risky behaviors among Iranians in 2023. The data shows that inadequate physical activity, hookah smoking, and cigarette smoking were the most prevalent risky behaviors, with approximately 85%, 25%, and 20%, respectively. In contrast, stimulant drugs, suicide attempts, and cannabis use had a lower prevalence, around 2%, 3%, and 3% respectively.

Table 3 shows the prevalence of latent classes and item response probability among various latent classes.

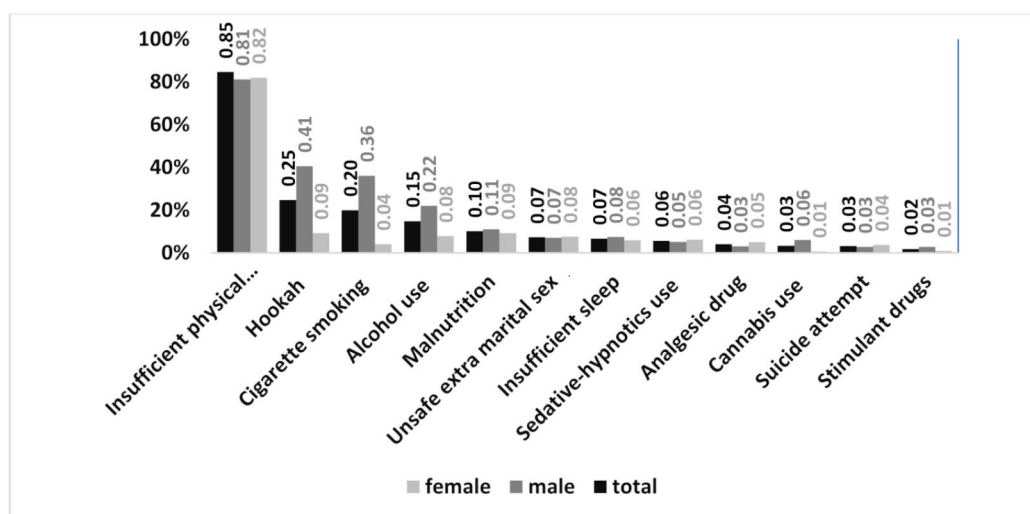


Fig. 1 Prevalence of risky behavior among Iranian, 2023

Table 3 The three latent classes' model of risky behaviors among Iranian, 2023

	Latent class		
	1 (Low risk)	2 (Middle risk)	3 (High risk)
Latent class prevalence	0.66	0.13	0.21
Item-response probabilities	Probability of a "Yes" response		
Malnutrition	0.05	0.61	0.81
Insufficient sleep	0.12	0.15	0.56
Insufficient physical activity	0.08	0.58	0.77
Cigarette smoking	0.07	0.54	1
Hookah	0.06	0.06	1
Alcohol use	0.01	0.08	0.52
Cannabis use	0.03	0.02	0.7
Stimulant drugs	0.01	0	0.05
Analgesic drug	0.04	0.03	0.06
Sedative-hypnotics use	0.04	0.1	0.52
Suicide attempt	0.03	0.05	0.61
Extra marital sex without condom	0.06	0.03	0.58

Note. Probability of a "Yes" response: proportion of participants who reported special behavior

The probability of a "No" response can be calculated by subtracting the item-response probabilities shown above from 1

Item-response probabilities > 0.5 in bold to facilitate interpretation

Approximately, 66% of participants were categorized as low risk class. Additionally, the prevalence of middle-risk and high-risk classes among participants was 13% and 21%, respectively. Although in the low-risk class, the probability of any risky behaviors is not zero, none of the risky behaviors have a prevalence rate greater than or equal to 0.5.

Table 4 demonstrates the results of multinomial logistic regressions on risky behavior classes. The likelihood of the occurrence of risky behavior among people with very high level of SES was lower than among people who were categorized with low level of SES. Divorced participants showed a higher likelihood of risky behavior than married participants. In the middle-risk class, the prevalence of risky behaviors in females was 1.58 times higher than

in males, while in class 3, females had a lower likelihood of risky behaviors than males. Participants with a post graduate level of literacy had a 4% and 40% lower likelihood of engaging in middle-risk and high-risk classes than people with an elementary level of education, respectively.

Discussion

Identifying clusters of risky behaviors and understanding the determinants of these behaviors are necessary for public health. Although various reported statistics indicate that multiple risky behaviors commonly co-occur, there is no significant evidence of the clustering of these behaviors in Iran [23]. This study aimed to determine the clusters of risky behaviors among the source population

Table 4 Results of multinomial logistic regressions regarding the risky behavior class

		Class2 (Middle risk)			Class3 (High risk)		
		OR	95% CI	P-value	OR	95% CI	P-value
Age		1.001	0.99–1.01	0.8	0.99	0.98–2.1	0.7
Sex (Ref: male)	Female	1.58	1.0–2.28	0.01	0.95	0.67–1.35	0.8
Literacy (Ref: Elementary)	Diploma	1.48	0.87–2.5	0.1	1.24	0.48–3.21	0.6
	Undergraduate	1.5	0.75–2.96	0.2	0.73	0.36–1.4	0.4
	Post graduate	0.96	0.37–2.48	2.9	0.6	0.35–1.05	0.07
Marital status (Ref: Married)	Single	1.45	0.94–2.24	0.08	1.58	1.09–2.5	0.04
	Widowed	0.8	0.17–3.75	0.7	2.39	1.47–3.89	0.001
	Divorce	1.7	1.08–2.71	0.02	4.31	1.61–11.56	0.004
Socio economic status (Ref: low)	Medium	0.65	0.39–0.86	0.04	0.38	0.21–0.67	0.001
	High	0.7	0.44–1.16	0.18	0.87	0.57–1.39	0.6
	Very high	0.82	0.59–0.97	0.042	0.79	0.48–1.29	0.4

Reference category for this analysis was the low-risk class

OR: Odds Ratios are adjusted for all variables, CI: confidence interval, R square = **0.68**

and to estimate the prevalence of these classes. As well, the association between various behavior classes and SES levels was examined.

Regarding the result, the prevalence of the middle-risk class and high-risk class among the study population was 13% and 21%, respectively. These findings showed that 13% of the participants in the study exhibited three risky behaviors, such as malnutrition, inadequate physical activity, and cigarette smoking. Also, 21% of participants reported all examined risk behaviors except for stimulant drugs and analgesic drugs.

In the current study, a negative association was found between various risky behavior classes and SES levels. This indicates that individuals with low SES are more likely to engage in middle-risk and high-risk classes. This could be explained by the fact that people with low SES may be vulnerable due to poor living conditions, increased psychological stress, limited understanding of the adverse effects of risky behaviors, restricted entry to exercise facilities, and insufficient access to adequate nutrition. Although the association between risky behavior classes and SES has not been extensively studied, numerous studies have investigated the relationship between single risky behaviors and SES. This result is consistent with previous studies demonstrating the association between low SES and increased prevalence of smoking and alcohol use [24–28]. In contrast to our results, Martin CC et al. and Simon P et al. found a positive correlation between high SES and participation in risky behaviors like alcohol consumption and cigarette smoking in adults [29, 30]. Armstrong-Carter E et al. reported that there was no statistically significant association between SES and risk-taking behavior among adolescents [31].

According to the results obtained in this study, the literacy level is inversely associated with the high-risk class but this association is not statistically significant. In other

words, individuals with a higher level of literacy are less likely to engage in the high-risk class than individuals with a lower level of literacy. This is because university education is required in Iran and many other countries to obtain a good job, income, and well-being. Additionally, individuals with higher levels of education are more informed about risky behaviors and are more conscientious about their actions. This finding is consistent with the result of the study conducted by Svendsen M et al. and Kann L et al. [32, 33].

The result of this study revealed that single and divorced participants are significantly more associated with high-risk behaviors compared to married participants. This could be explained by the higher mental health of married participants compared to those who are single or divorced. Furthermore, previous studies show that married people are more inclined to participate in screening and treatment programs [34, 35].

According to the results of the present study, while females were more likely to engage in middle-risk behavior than males, they are less likely to engage in high-risk behavior than males. This may stem from cultural issues prevalent in society, distinct personality traits among women, and a lower propensity for risk-taking in women compared to men. Given the societal cultural conditions, exhibiting risky behaviors such as consuming alcohol and smoking, along with engaging in risky sexual activities, is more stigmatized and viewed negatively by women. Furthermore, women are less inclined to engage in such risky behaviors due to their maternal responsibilities and strong emotional resilience to uphold their children's honor. Furthermore, numerous studies indicate that women are generally less risk-taking than men, resulting in a reduced likelihood of women engaging in risky behaviors [36]. Also, the results obtained in this study indicated that the frequency of single high-risk behaviors, namely alcohol use and insufficient physical

activity, were 14.88 and 84.63 respectively. In addition, females have a lower rate of alcohol consumption than males. A systematic review was conducted by Maryam Chegeni et al. found that the prevalence rate of lifetime alcohol consumption and last 12-month alcohol consumption among the general population was 13.0% and 15%, respectively [37]. The low prevalence of alcohol consumption among Iranian women may be explained by religious and cultural factors; alcohol consumption is associated with a higher level of stigma in women. On the other hand, legal and religious prohibitions may have led to an underreporting of alcohol use. However, some studies reported that the gender gap may be narrowing in the younger generation of Iranians [38, 39].

We found that more than half of the study population had Insufficient Physical Activity (IPA) levels lower than the minimum physical activity recommended by the WHO [40]. According to Mohebbi et al., the prevalence of IPA in 2016 among the general population in Iran was 54.7% (95%CI: 54.0–55.3) [41]. Kamalian et al. demonstrated that the prevalence of IPA has steadily increased over time [42]. This could be explained by social, economic, and cultural developments in the study area, such as the lack of sidewalks and sports/recreational facilities, poor air quality and air pollution, and the prevalent use of private vehicles.

Regarding the results, it's recommended to individuals with low SES and those who are divorced is a suitable group for screening of risky behaviors in health service systems. Furthermore, considering the clustering of multiple risky behaviors, it is suggested that interventions and screenings should be integrated into health service systems using a multifaceted approach alongside a distinct assessment system.

Strength and limitation

The study's strengths included a high response rate and a sufficient sample size. However, the present study also has several limitations. Firstly, while we adjusted for confounding factors using multi nominal logistic regression, the cross-sectional design prevents us from determining temporality or causal inference. The second limitation of this investigation the reliance on self-evaluation nature of questionnaires. This limitation was reduced using trained interviewers. The training course consists of, justifying individuals and gaining their trust for the filling out of the questionnaires. The third limitation of the present study is related to the assessed influence of family support and access to health services on the occurrence of high-risk behavior. We could not evaluate the effect of family support and access to health services because we did not gather data on these factors.

Conclusions

There is not enough evidence to support the clustering of major risky behaviors in the population. Therefore, examining the co-occurrence of risky behaviors facilitates the identification of important clusters for health promotion interventions. In this study, three classes of behaviors were determined among the participants. Our study suggests that alongside interventions focused on altering a single behavior, interventions targeting the modification of multiple high-risk behaviors should be integrated into the healthcare system.

Additionally, individuals with lower SES and literacy, singles, and widowed marital status tend to engage in multiple risky behavior classes. The findings of this study suggest that greater consideration should be given to these specific population groups when designing interventions to control risky behaviors. Therefore, the population could benefit from interventions targeting multiple related risky behaviors for specific groups, as well as interventions focused on a single risk factor. A longitudinal study with a larger sample size is recommended to evaluate the association between SES and cluster of risky behaviors.

Abbreviations

NCD	Non-communicable diseases
WHO	World health organization
LCA	Latent class analysis
SES	Socioeconomic status
SD	Standard deviation
IPA	Insufficient physical activity

Acknowledgements

The authors are thankful to everyone who participated in this study as well as helped them in conducting this research.

Author contributions

SD and EDE developed the original idea, developed the protocol, interpreted and analyzed data, collected data, and drafted all the manuscript sections. LK, AZ and AGH contributed to the protocol development, data collection, technical comments, and interpretation. All authors read and approved the final version of the manuscript.

Funding

This study was based on data from Elham Davtalab esmaeili's Ph.D. thesis, which was financially supported by the Research Deputy of the Tabriz University of Medical Sciences (Grant No. 69209).

Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

The study protocol was approved by the ethics committee at Tabriz University of Medical Sciences (Ref No. IR.TBZMED.REC. 1400.1169). Written informed consent was obtained. The study was carried out in accordance with the ethical standards of the 1964 Helsinki Declaration. All methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Received: 9 February 2025 / Accepted: 30 April 2025

Published online: 10 May 2025

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