Trend of passive smoking and associated factors in Iranian children and adolescents: the CASPIAN studies

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Abstract

Background: It is well documented that, similar to active smokers, passive smokers are also at an increased risk of developing non-communicable diseases, and it could impose high financial costs on the healthcare system. This study aimed to evaluate the trend of passive smoking and related determinants during the three phases of a school-based surveillance program.

Methods: This is a secondary study using the national data obtained from three phases of the surveillance program entitled The Childhood and Adolescence Surveillance and Prevention of Adult Noncommunicable Disease (CASPIAN) study, conducted from 2008 to 2014 on Iranian children and adolescents living in urban and rural areas of 30 provinces in Iran. Participants were selected by cluster multistage sampling method.

Results: Overall, the study participants consisted of 33,288 students (50.5% boys) with a mean (± SD) age of 12.8 ± 3.2 years. The passive smoking rate was significantly increased from 35.6% in 2008 to 43.2% in 2015 among children and adolescents. According to the multivariate logistic regression, father’s university education, mother’s employment, life satisfaction, and socioeconomic status had a protective role regarding second-hand smoke exposure. In contrast, the father’s self-employment had a positive role in increasing the rate of passive smoking.

Conclusion: Considering the increasing trend of passive smoking and its considerable adverse health effects, it is necessary to implement large-scale public interventions to reduce the rate and hazards of exposure to tobacco smoke.

Keywords: Passive smoking, Trend, Adolescents, Children

Background

Passive smoking refers to the state in which an individual is involuntarily exposed to the smoke from other peoples’ cigarettes, hookah, and other tobacco substances. Studies show that similar to active smokers, passive smokers are also at an increased risk of developing cardiovascular diseases [1], upper and lower respiratory tract infections [2], pulmonary diseases [3], and lung cancer [4]. Moreover, exposure to second-hand smoke (SHS) increases the mortality rate in chronic obstructive pulmonary disease (COPD).
patients [5]. In 2004, 603,000 deaths were attributable to SHS, which consisted of about 1% of worldwide mortality in the same year. Notably, disability-adjusted life years (DALY) due to smoking was 10.9 million years in the same year. Exposure to SHS increases the risk of lower respiratory tract infection in children<5 years, asthma in adults and children, ischemic heart diseases, and lung cancer in adults, which had the most significant burden of diseases [6]. Women bear nearly 80% of the total passive smoking burden [7]. Furthermore, evidence also shows a cause-and-effect relationship between passive smoking and sudden infant death syndrome (SIDS) [8, 9]. For every 1% increase in smoking-free houses in the US, a 0.4% decrease in the SIDS rate was observed from 1995 to 2006 [10].

Cigarette smoking has an immunosuppressive effect [11]; as a result, leukocyte dysfunction is found in children with smoker parents. Therefore, children exposed to cigarette smoke are at a higher risk of common cold, asthma, Otitis Media (OM), and respiratory complications like bronchitis and pneumonia, and thus they endure longer absentes at school [9, 12, 13]. Furthermore, smoke exposure during pregnancy is associated with the increasing prevalence of “physician-diagnosed asthma” in the child [14].

Children growing up with smoking parents or friends have a higher chance of turning into active smokers in the future [15–17]. Moreover, neurological and neuro-behavioural developmental defects are higher in passive smoking children as there is a 50% higher chance of developing at least two neuro-behavioural disorders, including autistic disorders, Attention deficit hyperactivity disorder (ADHD), and disruptive behaviour disorder in passive smoking children compared to others [18–20].

Children experiencing long-term exposure to SHS have impaired pulmonary evolution and will never reach their maximum pulmonary capacity [21, 22], and the incidence rate of lung and upper respiratory tract cancers is higher in these children [23, 24]. Furthermore, long-term exposure to SHS in children increases their future risk of developing cardiovascular diseases. Cardiovascular risk factors, including obesity, overweight, low high-density lipoprotein cholesterol (HDL-C), and high low-density lipoprotein cholesterol (LDL-C), are more prevalent in children exposed to SHS [25, 26]. In adolescents, passive smoking is also independently associated with metabolic syndrome [27]. In China, 69% of young women reported that they are exposed to SHS, and 49.9% are exposed to SHS on a daily basis [28]. Moreover, studies have shown SHS exposures as high as 32% in Iranian infants [29]. In other studies in Iran, the reported SHS exposure in 13 to 15-year-olds adolescents was considerable [30]. A recent meta-analysis showed that exposure to SHS in Iran was increased and mostly happened in the houses (as high as 49.7% in women and 54.8 in men) [31].

However, despite all evaluations, there is no evidence regarding the trends of passive smoking in Iranian children and adolescents throughout recent years. Moreover, these studies have been conducted in different geographical regions with different design. Considering that exposure to SHS has significant and even long-term consequences on children and adolescents’ health and imposes considerable costs on healthcare system, the present study aimed to evaluate the trend of passive smoking during phases 3, 4, and 5 of Childhood and Adolescence Surveillance and Prevention of Adult Non-communicable Disease (CASPIAN) study (2008–2014) in Iranian children and adolescents and find the determining factors. Furthermore, performing trend studies is essential to evaluate risk factors changes during time, and it could be useful for health policymakers.

**Methods**

This study is a second-hand data analysis aligned with Iranian national studies entitled “Childhood and Adolescence Surveillance and Prevention of Adult Non-communicable Disease (CASPIAN)”, which gathered and analyzed the data obtained from CASPIAN-III, IV, and V phases. The methodology of these surveys was published previously in detail [32–34].

The sample size in each survey was calculated based on the cluster sampling method to achieve an acceptable estimate of the main risk factors of interest. Briefly, CASPIAN-III [32] was conducted among 5570 students (10–18 years) in 2009–2010. CASPIAN-IV [33] was carried out among 14,880 students aged 7–18 years in 2011–2012, and CASPIAN-V [34] was performed among 14,400 students aged 7–18 years in 2014–2015. Five thousand five hundred twenty-eight students in CASPIAN-III, 13,486 subjects in CASPIAN-IV, and 14,274 participants in CASPIAN-V had complete data, so the total number of 33,288 participants with complete data entered the study.

The sampling method in all three phases was multistage cluster sampling conducted in urban and rural areas across the country. Sampling was performed in proportion with the number of students in each residential area and school level with an equal sex ratio; i.e., the number of male and female students was equal in each province, and the ratio of urban/rural students of every province was proportionate to the total urban/rural student population. Cluster sampling with equal clusters was used to reach the necessary sample size in each province. Clusters were determined at the level of schools, including 10 sample units (students and their parents) in each cluster. The study’s protocol was approved by the ethical
committee of Alborz University of Medical Sciences, and all methods were carried out in accordance with relevant guidelines and regulations. Informed written and verbal consents from the parents and students were obtained following an explanation of the aims and procedure of the study.

**Questionnaires**

Two specific questionnaires were considered for students and their parents. The students’ questionnaire was obtained from the World Health Organization-Global School Student Health Survey (WHO-GSHS) translated into Persian. The validity and reliability of questionnaires have been assessed previously [35].

The questionnaire comprised different sections, including friends’ relationships, students’ schools, life satisfaction, health behaviours, physical activity, and leisure time activities. Parents of students were also invited to complete the parent’s questionnaire regarding the family’s socioeconomic status, educational level, job, and health-related behaviours.

According to the GHSH questionnaire, students were asked to report whether their family members (father, mother, siblings, other) used tobacco products (cigarette and hookah smoking, etc.) in their presents. If positive, the student was considered as an SHS.

In order to evaluate screen time (ST) behaviours, the number of hours spent on watching television (TV), video, computer, or playing video games were asked, and the total hours were calculated as ST. Using a reliable questionnaire, weekly leisure-time physical activity data were collected. At least 30 min of daily exercise led to sweating, and a significant increase in heartbeat or breathing was considered as sufficient physical activity. Based on previously defined criteria, in addition to the familial level of SES, we considered the regional level of SES as well. Iran was classified into four sub-national regions using principal component analysis. The regions include Central, Western, North-Northeast, and the Southeast regions ordered from high to low SES, respectively [36].

**Statistical analysis**

STATA package ver. 11.0 (Stata Statistical Software: Release 11. College Station, TX: Stata Corp LP. Package) was used for statistical analysis. Quantitative data were reported as mean ± SD, and qualitative data were expressed as numbers (percentage). The Chi-square test was used to compare qualitative variables among groups. Considering the dual purpose of this study, i.e., evaluating the trend and determinants of passive smoking, the trend analysis was performed on the total data; then, the trend was studied according to each independent variable. The trend of SHS according to independent variables was assessed using the Chi-Square test for trend. Moreover, evaluating the determinants of passive smoking was done on the total data. In order to evaluate passive smoking determinants, each independent variable was initially entered into the univariate logistic regression model. Then, variables with a $P$-Value < 0.20 were entered in the multivariate logistic regression model. The logistic regression model results were presented as odds ratio (OR) and 95% confidence interval (CI). A $P$-Value < 0.05 was considered statistically significant.

**Results**

The mean (SD) of the age of the participants was 12.8 ± 3.2 years. 27.5, 38.5, and 33.9% of the students were in 7–10, 11–14, and 15–18 years age groups, respectively. 50.5% of participants were boys, and 49.5% were girls. The percentage of urban and rural students was 72.8 and 27.2%, respectively. In CASPIAN-III, students aged 10 to 18 years were studied; therefore, there is no data regarding 7–10 years old students. The demographic characteristics of the participants are demonstrated in Table 1. The total passive smoking rate in the present study was 42.2%. Table 2 shows the prevalence of passive smoking according to demographic characteristics and surveys can be seen. The distribution of second-hand smoke exposure was significantly different according to age groups, fathers’ and mothers’ education and occupation, life satisfaction, socioeconomic status, screen time, and physical activity.

The **passive smoking trend during different phases of the CASPIAN study**

The passive smoking rate significantly increased from 35.6% in 2008 (phase III) to 43.2% in 2015 (phase V) ($P$-Value < 0.001). The passive smoking trend is demonstrated in Table 2 according to each independent variable and their significance. Passive smoking increased among ages 11–14 and 15–18 years and both sexes. Also, an increasing trend in urban and rural areas, in people satisfied with their lives and in all family socioeconomic status sub-categories was seen. Moreover, the “North and North-east” and “West” regions of Iran had an increasing trend of passive smoking.

An increasing trend of passive smoking was observed in worker/employee and self-employed sub-categories of father’s occupation and housewife mothers. Considering parents’ education level, the passive smoking trend is increasing at all levels except illiteracy of father and all sub-categories of mother’s education.
Table 1  Characteristics of participants according to the different phases of CASPIAN studies

| Demographic information          | CASPIAN-III (2009–2010) | CASPIAN-IV (2011–2012) | CASPIAN-V (2014–2015) | P-value |
|---------------------------------|--------------------------|------------------------|-----------------------|---------|
| **Age**                         |                          |                        |                       |         |
| 7–10 years                      | (–)                      | 4549 (32.2)            | 4843 (33.9)           | < 0.001*|
| 11–14 years                     | 2593 (46.1)              | 4678 (34.7)            | 5591 (39.2)           |         |
| 15–18 years                     | 3032 (51.9)              | 4459 (33.1)            | 3840 (26.9)           |         |
| **Gender**                      |                          |                        |                       |         |
| Boy                             | 2801 (49.8)              | 6846 (50.8)            | 7228 (50.6)           | 0.45    |
| Girl                            | 2824 (50.2)              | 6640 (49.2)            | 7046 (49.4)           |         |
| **Place of residence**          |                          |                        |                       |         |
| Urban                           | 3785 (69.3)              | 10,191 (75.6)          | 10,194 (71.4)         | < 0.001 |
| Rural                           | 1677 (30.7)              | 3295 (24.4)            | 4080 (28.6)           |         |
| **Father's occupation**         |                          |                        |                       |         |
| Unemployed                      | 342 (6.4)                | 657 (9.0)              | 860 (6.2)             | < 0.001 |
| Worker/Employee                 | 3077 (57.2)              | 7309 (56.1)            | 8110 (58.8)           |         |
| Self-employed                   | 1961 (36.4)              | 5062 (38.9)            | 4833 (35.0)           |         |
| **Mother's occupation**         |                          |                        |                       |         |
| Housewife                       | 5002 (91.0)              | 11,883 (89.0)          | 12,354 (87.2)         | < 0.001 |
| Worker/Employee                 | 386 (7.0)                | 1060 (7.9)             | 1300 (9.2)            |         |
| Other                           | 110 (2.0)                | 409 (3.1)              | 514 (3.6)             |         |
| **Father's education**          |                          |                        |                       |         |
| Illiterate                      | 807 (14.8)               | 1471 (11.2)            | 1734 (12.6)           | < 0.001 |
| High school diploma or lower    | 4125 (75.7)              | 9788 (74.8)            | 10,163 (73.7)         |         |
| Bachelor degree or higher       | 520 (9.5)                | 1831 (14.0)            | 1893 (13.7)           |         |
| **Mother's education**          |                          |                        |                       |         |
| Illiterate                      | 1263 (22.9)              | 2270 (17.0)            | 2500 (17.6)           | < 0.001 |
| High school diploma or lower    | 3973 (72.2)              | 9925 (74.3)            | 10,148 (71.6)         |         |
| Bachelor degree or higher       | 269 (4.9)                | 1167 (8.7)             | 1524 (10.8)           |         |
| **Family members**              |                          |                        |                       |         |
| 4 or less                       | 1953 (39.4)              | 6491 (48.9)            | 6742 (47.9)           | < 0.001 |
| 5 and more                      | 3008 (60.6)              | 6778 (51.1)            | 7336 (52.1)           |         |
| **Life satisfaction**           |                          |                        |                       |         |
| Satisfied                       | 3135 (56.9)              | 10,698 (79.9)          | 11,216 (78.9)         | < 0.001 |
| Dissatisfied                    | 2379 (43.1)              | 2689 (20.1)            | 2996 (21.1)           |         |
| **Socio-economic status of family** |                        |                        |                       |         |
| Weak                            | 1052 (19.8)              | 4147 (33.5)            | 4562 (33.5)           | < 0.001 |
| Moderate                       | 2085 (39.2)              | 4100 (33.1)            | 4521 (33.2)           |         |
| Good                            | 2178 (41.0)              | 4143 (33.4)            | 4555 (33.4)           |         |
| **Socio-economic status of place of residence** | | | | |
| South east                      | 557 (9.9)                | 1181 (8.8)             | 1919 (13.4)           | < 0.001 |
| North & north east              | 1073 (19.1)              | 2359 (17.5)            | 2398 (16.8)           |         |
| West                            | 2340 (41.6)              | 6119 (45.4)            | 6597 (46.2)           |         |
| Central                         | 1654 (29.4)              | 3827 (28.4)            | 3360 (23.5)           |         |
| **Physical activity**           |                          |                        |                       |         |
| Light                           | 2293 (41.5)              | 4553 (34.1)            | 4454 (33.4)           | < 0.001 |
| Moderate                       | 1818 (32.9)              | 4910 (36.8)            | 4424 (33.2)           |         |
| Intense                        | 1417 (25.6)              | 3886 (29.1)            | 4440 (33.3)           |         |
| **ST**                          |                          |                        |                       |         |
| 2h or less                      | 3475 (68.0)              | 10,899 (81.4)          | 12,135 (87.4)         | < 0.001 |
| More than 2h                    | 1634 (32.0)              | 2494 (18.6)            | 1752 (12.6)           |         |
| **Passive smoking**            |                          |                        |                       |         |
| Yes                             | 2002 (35.6)              | 5802 (43.9)            | 5772 (43.2)           | < 0.001 |
| No                              | 3623 (64.4)              | 7424 (56.1)            | 7575 (56.8)           |         |

Values are reported as N (%).

CASPIAN The Childhood and Adolescence Surveillance and Prevention of Adult Noncommunicable Disease study, ST screen time.

*This p-value is for ages 11–14 and 15–18 among the CASPIAN studies.*
Findings of univariate and multivariate analyses on the total data (CASPIANs III, IV and V) are presented in Table 3. Age, gender, and place of residence were not associated with SHS exposure rates in any of the models. The passive smoking rate increased when the

### Table 2

The trend of passive smoking according to demographic characteristics and survey

| Independent variables | All surveys n (%) | CASPIAN-III 2009–2010 | CASPIAN-IV (2011–2012) | CASPIAN-V (2014–2015) | P-trend |
|-----------------------|------------------|------------------------|------------------------|-----------------------|---------|
| Participants          | 13,576 (42.2)    |                        |                        |                       |         |
| Age                   |                  |                        |                        |                       |         |
| 7–10 yrs.             | 3694 (22.2)      | 41.4%                  | 42.9%                  | < 0.001               |         |
| 11–14 yrs.            | 5153 (41.3)      | 42.8%                  | 42.7%                  | < 0.001               |         |
| 15–18 yrs.            | 4727 (34.1)      | 47.3%                  | 44.4%                  | < 0.001               |         |
| AM                    |                  |                        |                        |                       |         |
| Boy                   | 6805 (41.8)      | 32.70%                 | 44.10%                 | 43.40%                | < 0.001 |
| Girl                  | 6771 (42.5)      | 38.40%                 | 43.70%                 | 43.10%                | 0.001   |
| Place of residence    |                  |                        |                        |                       |         |
| Urban                 | 9797 (42.1)      | 34.4%                  | 43.9%                  | 43.3%                 | < 0.001 |
| Rural                 | 3714 (42.4)      | 37.9%                  | 43.9%                  | 43.2%                 | 0.003   |
| Father’s occupation   |                  |                        |                        |                       |         |
| Unemployed            | 778 (34.1)       | 41.5%                  | 51.3%                  | 39.8%                 | 0.914   |
| Worker/Employee       | 7294 (40.9)      | 34.4%                  | 41.1%                  | 43.3%                 | < 0.001 |
| Self-employed         | 5066 (44.3)      | 48.0%                  | 49.5%                  | 44.0%                 | 0.001   |
| Mother’s occupation   |                  |                        |                        |                       |         |
| Housewife             | 12075 (43.4)     | 35.7%                  | 44.4%                  | 44%                   | < 0.001 |
| Worker/Employee       | 876 (33.7)       | 32.4%                  | 34.2%                  | 33.7%                 | 0.754   |
| Other                 | 487 (49.4)       | 39.1%                  | 52.4%                  | 49.4%                 | 0.298   |
| Father’s education    |                  |                        |                        |                       |         |
| Iliterate             | 1600 (46.8)      | 37.4%                  | 46.1%                  | 42.4%                 | 0.108   |
| High school diploma or lower | 10237 (44.0) | 36.5%                  | 46.3%                  | 45.1%                 | < 0.001 |
| Bachelor degree or higher | 1293 (31.8) | 26%                    | 30.2%                  | 35.1%                 | < 0.001 |
| Mother’s education    |                  |                        |                        |                       |         |
| Iliterate             | 2529 (43.4)      | 37.9%                  | 45.2%                  | 44.6%                 | 0.001   |
| High school diploma or lower | 9933 (42.7) | 35.3%                  | 44.8%                  | 43.6%                 | < 0.001 |
| Bachelor degree or higher | 988 (35.5) | 29%                    | 33.2%                  | 38.8%                 | < 0.001 |
| Family members        |                  |                        |                        |                       |         |
| ≤ 4 or less           | 6204 (42.4)      | 34.8%                  | 44.0%                  | 43.3%                 | < 0.001 |
| ≥ 5 or more           | 6949 (42.4)      | 35.7%                  | 43.9%                  | 43.1%                 | < 0.001 |
| Life satisfaction     |                  |                        |                        |                       |         |
| Satisfied             | 9701 (40.0)      | 27.4%                  | 41.5%                  | 42.3%                 | < 0.001 |
| Dissatisfied          | 3781 (48.6)      | 45.4%                  | 53.1%                  | 47.2%                 | 0.313   |
| Socio-economic status of family |        |                        |                        |                       |         |
| Weak                  | 4195 (44.6)      | 42.9%                  | 47.5%                  | 42.3%                 | 0.013   |
| Moderate              | 4540 (44.0)      | 34.3%                  | 46%                    | 46.8%                 | < 0.001 |
| Good                  | 4057 (38.6)      | 33.2%                  | 39.3%                  | 40.7%                 | < 0.001 |
| Socio-economic status of place of residence |        |                        |                        |                       |         |
| South east            | 1371 (39.6)      | 36.6%                  | 39.2%                  | 40.9%                 | 0.068   |
| North & north east    | 2176 (38.5)      | 27.2%                  | 39%                    | 43.3%                 | < 0.001 |
| West                  | 6253 (34.1)      | 38.5%                  | 43.4%                  | 44.6%                 | < 0.001 |
| Central               | 3776 (44.0)      | 36.6%                  | 49%                    | 41.9%                 | 0.101   |
| Physical activity     |                  |                        |                        |                       |         |
| Light                 | 4605 (42.9)      | 45.1%                  | 45%                    | 39.1%                 | < 0.001 |
| Moderate              | 4456 (41.1)      | 25.9%                  | 43.8%                  | 44.4%                 | < 0.001 |
| Intense               | 3992 (41.7)      | 32.3%                  | 42.3%                  | 44.1%                 | < 0.001 |
| ST                    |                  |                        |                        |                       |         |
| 2h or less            | 10,622 (41.6)    | 33%                    | 43.2%                  | 42.7%                 | < 0.001 |
| More than 2h          | 2499 (43.1)      | 38.9%                  | 46.6%                  | 42.2%                 | 0.058   |

CASPIAN: The Childhood and Adolescence Surveillance and Prevention of Adult Noncommunicable Disease study, ST screen time, SHS second-hand smoke
Table 3  Determinants of passive smoking using the univariate and multivariate logistic regression models on three phases of CASPIANs (III, IV and V)

| Variables                     | Crude OR (%95 CI) | P-Value | Adjusted OR (%95 CI) | P-Value |
|-------------------------------|-------------------|---------|----------------------|---------|
| Age                           |                   |         |                      |         |
| 7–10 yrs.                     | (Reference)       | (−)     | (−)                  | (−)     |
| 11–14 yrs.                    | 0.97 (0.91–1.02)  | 0.208   | (−)                  | (−)     |
| 15–18 yrs.                    | 1.04 (0.98–1.10)  | 0.228   | (−)                  | (−)     |
| Gender                        |                   |         |                      |         |
| Boy                           | (Reference)       | (−)     | (−)                  | (−)     |
| Girl                          | 1.03 (0.98–1.07)  | 0.247   | (−)                  | (−)     |
| Place of residence            |                   |         |                      |         |
| Urban                         | (Reference)       | (−)     | (−)                  | (−)     |
| Rural                         | 1.01 (0.97–1.07)  | 0.578   | (−)                  | (−)     |
| Father’s occupation           |                   |         |                      |         |
| Unemployed                    | (Reference)       | (−)     | (Reference)          | (−)     |
| Worker/Employee               | 0.91 (0.83–1.01)  | 0.066   | 1.04 (0.93–1.16)     | 0.475   |
| Self-employed                 | 1.05 (0.95–1.16)  | 0.342   | 1.14 (1.02–1.28)     | 0.019   |
| Mother’s occupation           |                   |         |                      |         |
| Housewife                     | (Reference)       | (−)     | (Reference)          | (−)     |
| Worker/Employee               | 0.68 (0.63–0.74)  | <0.001  | 0.84 (0.75–0.94)     | 0.003   |
| Other                         | 1.31 (1.15–1.49)  | <0.001  | 1.63 (1.41–1.88)     | <0.001  |
| Father’s education            |                   |         |                      |         |
| Illiterate                    | (Reference)       | (−)     | (Reference)          | (−)     |
| High school diploma or lower  | 1.05 (0.98–1.13)  | 0.139   | 1.07 (0.98–1.17)     | 0.135   |
| Bachelor degree or higher     | 0.62 (0.57–0.68)  | <0.001  | 0.73 (0.65–0.83)     | <0.001  |
| Mother’s education            |                   |         |                      |         |
| Illiterate                    | (Reference)       | (−)     | (Reference)          | (−)     |
| High school diploma or lower  | 0.97 (0.92–1.03)  | 0.344   | 1.05 (0.97–1.16)     | 0.221   |
| Bachelor degree or higher     | 0.72 (0.65–0.79)  | <0.001  | 1.10 (0.96–1.26)     | 0.173   |
| Family members                |                   |         |                      |         |
| ≤ 4 or less                   | (Reference)       | (−)     | (−)                  | (−)     |
| ≥ 5 or more                   | 0.98 (0.94–1.03)  | 0.478   | (−)                  | (−)     |
| Life satisfaction             |                   |         |                      |         |
| Dissatisfied                  | (Reference)       | (−)     | (Reference)          | (−)     |
| Satisfied                     | 0.70 (0.67–0.74)  | <0.001  | 0.71 (0.67–0.75)     | <0.001  |
| Socioeconomic status of family|                   |         |                      |         |
| Weak                          | (Reference)       | (−)     | (Reference)          | (−)     |
| Moderate                      | 0.98 (0.92–1.03)  | 0.382   | 0.92 (0.86–0.98)     | 0.015   |
| Good                          | 0.78 (0.74–0.83)  | <0.001  | 0.83 (0.77–0.89)     | <0.001  |
| Socioeconomic status of place of residence | | | | |
| Southeast                     | (Reference)       | (−)     | (Reference)          | (−)     |
| North & north east            | 0.95 (0.87–1.04)  | 0.264   | 1.02 (0.93–1.12)     | 0.714   |
| West                          | 1.15 (1.07–1.24)  | <0.001  | 1.22 (1.12–1.32)     | <0.001  |
| Central                       | 1.20 (1.11–1.30)  | <0.001  | 1.31 (1.20–1.44)     | <0.001  |
| Physical activity             |                   |         |                      |         |
| Light                         | (Reference)       | (−)     | (Reference)          | (−)     |
| Moderate                      | 0.93 (0.88–0.98)  | 0.008   | 0.95 (0.90–1.01)     | 0.110   |
| Intense                       | 0.95 (0.90–1.01)  | 0.085   | 1.02 (0.96–1.09)     | 0.461   |
| ST                            |                   |         |                      |         |
| 2 h or less                   | (Reference)       | (−)     | (Reference)          | (−)     |
| More than 2 h                 | 1.06 (1.00–1.13)  | 0.037   | 1.00 (0.94–1.06)     | 0.913   |

OR: odds ratio, CI: confidence interval, ST: screen time
father was self-employed (OR = 1.14, \( P \)-value = 0.019). Among mother’s occupation sub-categories, the worker/employee group had a protective role against SHS exposure (OR = 0.84, \( P \)-value = 0.03) while mother’s occupation in the “other” sub-category was a risk factor for SHS exposure (OR = 1.63, \( P \)-value = 0.001).

Fathers with university education had a protective role against SHS exposure (OR = 0.73, \( P \)-value < 0.001). However, the mother’s education did not play a role in SHS exposure in the multivariate regression model.

Satisfaction with life had a protective role against SHS exposure compared to dissatisfaction (OR = 0.71, \( P \)-value < 0.001). Moreover, a moderate or good socioeconomic status of family decreased passive smoking rates (OR = 0.72, \( P \)-value = 0.015 and OR = 0.83, \( P \)-value < 0.001; respectively). Residing in Iran’s west and central socio-economic regions increased the passive smoking rates (OR = 1.22, \( P \)-value < 0.001; and OR = 1.31, \( P \)-value < 0.001; respectively). Unlike the univariate logistic regression model, physical activity or ST was not associated with SHS exposure in the multivariate regression model.

Discussion

In Iran, passive smoking has had an increasing trend among Iranian children and adolescents in different study phases and has increased significantly from 35.6% of students in 2008 (phase III) to 43.2% of participants in 2015 (phase V). There was no association between passive smoking, age groups and gender in this study. According to our multivariate logistic regression model results, the fathers’ academic education was associated with decreased passive smoking. However, the mothers’ education was not associated with passive smoking exposure in their children. Moreover, being a self-employed father was a risk factor that increased passive smoking exposure rates in children and adolescents. Nonetheless, the mother’s employee/worker occupation had a protective role while the “other” category of the mother’s occupation was a risk factor for passive smoking exposure in their children.

Regarding the trend of passive smoking, contrary to Iran, studies report a decreasing trend in both sexes in many countries. Passive smoking had a decreasing trend in Germany in different age groups in girls and boys [37]. In Vietnam, passive smoking rates in 13–15-year-old students decreased from 58.5% in 2007 to 47.1% in 2014 [38]. In UK, cotinine levels in 11–15-year-old children decreased from 0.96 ng/ml in 1988 to 0.52 ng/ml in 1998 [39]. Furthermore, serum cotinine levels of 4–15-years-old children decreased from 0.52 ng/ml in 1998 to 0.11 ng/ml in 2012, indicating a significant decrease in

SHS exposure during these years [40]. In Finland, SHS exposure in adolescents decreased from 17% in 1991 to 6% in 2009 [41]. Local and regional studies indicate a high and increasing exposure to SHS in Iran [31]. The increasing trend of passive smoking in Iran may be due to the lack of parents’ education regarding the adverse health complications of SHS in children/adolescents and the weaknesses in enforcing the Law in smoke-free environments, and the ease of acquiring tobacco even in those who are under the legal age (18 years). One other important factor is the popularity of hookah among the Iranian population, as many restaurants and cafes serve hookah, exposing all the customers to SHS [31].

Our results were in line with some studies regarding the association of passive smoking and age groups. In a study conducted in the Global Youth Tobacco Survey (GYTS) framework in South Africa in 2008, no association was found between age and exposure to smoking [42]. In another study conducted on secondary and high school students in the US, there was no association between age groups and SHS exposure [43]. On the contrary, some other studies reported a positive association between passive smoking and age. Studies conducted in India, Gambia, and Malaysia showed a positive association between exposure to smoking both inside and outside of the home and older age [44–46]. On the other hand, the findings of some studies indicated that younger children were at greater risk for passive smoking [47, 48]. Our results can be due to the use of tobacco substances in public places, restaurants, cafes, and parks in which most adolescents hangout, as well as, due to the popularity of hookahs, especially among adolescents, and its ease of use in the public and gatherings without restrictions [31, 43].

Contradictory to our study’s findings, other studies evaluating the relationship between gender and passive smoking showed higher exposure rates to passive smoking in girls [43, 44, 47], while in some other studies, boys were exposed to higher rates of passive smoking [46]. Nonetheless, similar to our findings, Some other studies did not report any relationship between gender and passive smoking [42, 48]. Our findings could be the results of cultural differences among different countries, as in Iran, many households possess hookah and use it regularly, condemning all households, regardless of age and gender, to SHS [31].

Our finding of the multivariate logistic regression model was in line with some other studies. A study performed in Granada, Spain (1999) showed that lower parent’s awareness of smoking at home and low fathers’ education level are associated with higher urinary cotinine levels [49]. Moreover, in a study in Malaysia (2009), salivary cotinine levels were lower in students with
university-educated fathers than fathers with a high school diploma or lower levels of education [50]. Furthermore, in a study conducted in Korea (2012), lower education levels of fathers were associated with higher passive smoking rates [51]. This finding may be due to the fact that fathers with university education are probably more aware of the health complications of smoking exposure in their children and avoid smoking in their presence. However, the mother's education had an inverse association with passive smoking [38, 52, 53]. It should be noted that some studies did not demonstrate any relationship between a mother's education level and passive smoking exposure in children [49, 51, 54]. Regarding parental occupation, our results were similar to other studies. For example, in a study performed in Malaysia (2009), salivary cotinine levels in students with fathers having military jobs were higher than those whose fathers had management/professional occupations [50]. The explanation could be that fathers with higher education levels were not usually self-employed. Moreover, most families with professional and management occupations fall within higher SES groups, and exposure to SHS is lower within this group.

The present study determined that students satisfied with their lives are less exposed to passive smoking; this observation was also reported in other studies. Results of the CASPIAN IV showed passive smoking exposure was associated with lower psychological health, higher violence, anxiety, stress and depression, and inappropriate living conditions of children and adolescents [55], which could lead to a reduction in life satisfaction [56]. As it seems that bad SES can be related to lower life satisfaction. This finding can be the result of the association of SES and SHS [56, 57]. As those with lower life satisfaction and mental distress are at an increased risk of active smoking and being exposed to SHS as well [56].

In this study, students with good socioeconomic levels experienced lower passive smoking exposure than those with moderate/low SES levels. This finding aligns with other studies demonstrating the association between low socioeconomic levels and passive smoking exposure in children. In a study conducted on 4–15 years-old children in the UK (1996–2006), the low socioeconomic level was associated with much more passive smoking exposure [58]. Furthermore, in a study on children and adolescents older than 12 years in Australia (2010), high socioeconomic level was negatively correlated with passive smoking exposure, similar in urban and rural areas [59]. On the contrary, the multivariate logistic regression model findings showed that students residing in the west and central socioeconomic regions (higher socioeconomic regions of Iran) had higher rates of passive smoking exposure. This association was also confirmed in the Korean society [51]. This finding can be the result of the usage of hookahs in cafes and restaurants, and higher frequency of these places within high SES regions and their popularity among the residing population [31].

**Limitations and strengths**

The large sample size of the present study, which was taken from different urban and rural areas of Iran, could be representative of the Iranian children and adolescents population. Therefore, it is possible to generalize the findings to society. This study has some limitations too. First, the effect of unknown confounders on the results should be addressed. Moreover, due to the CASPIAN study’s cross-sectional nature, the cause and effect relationship could not distinguish.

**Conclusion**

Considering the increasing trend of passive smoking and its considerable adverse health effects, it is necessary to implement large-scale public interventions to reduce the rate and hazards of exposure to tobacco smoke. Extra taxes on tobacco and fines for public smoking can be beneficial. It should be kept in mind that educating the parents through school meetings, social media, and television programs could significantly affect passive smoking trends. Further studies are needed to investigate the social and cultural factors that contributed to this rising trend and the consequences of this increase, on the prevalence of non-communicable diseases.

**Abbreviations**

ADHD: Attention Deficit Hyperactivity Disorder; BMI: Body Mass Index; CASPIAN: Childhood and Adolescence Surveillance and Prevention of Adult Non-communicable Disease; CDC: Centers for Disease Control; COPD: Chronic Obstructive Pulmonary Disease; CRP: C-Reactive Protein; DALY: Disability Adjusted Life Year; FEF 2575: Forced Expiratory Flow in 25%-75%; FEV1: Forced Expiratory Volume in One score; FEVI/FVC: Forced Expiratory Volume in One score/Forced Vital Capacity; GATS: Global Adult Tobacco Survey; GYTS: Global Youth Tobacco Survey; HDLC: High-Density Lipoprotein Cholesterol; IHD: Ischemic Heart Disease; IL6: Interleukin 6; KiGGS: German Health Interview and Examination Survey for Children and Adolescents; LDLC: Low Density Lipoprotein Cholesterol; LRI: Lower Respiratory Infection; NHANES: National Health and Nutrition Examination Survey; OM: Otitis Media; RCT: Randomized Controlled Trials; SHS: Second-Hand Smoke; SHSe: Second-Hand Smoke exposure; SDS: Sudden Infant Death Syndrome; WHO-GSHS: World Health Organization-Global school-based Student Health Survey.
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Availability of data and materials
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The study’s protocol was approved by the ethical committee of Alborz University of Medical Sciences, and all methods were carried out in accordance with relevant guidelines and regulations. Informed written and verbal consents were obtained from all the parents and students, for illiterate parents informed consent obtained from a legal guardian/next of kin for their children.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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