Allergologia et immunopathologia
Sociedad Española de Inmunología Clínica, Alergología y Asma Pediátrica
www.all-imm.com

RESEARCH ARTICLE

OPEN ACCESS

Are the presence of asthma and the COVID-19 infection associated with behavioral changes in Lebanese adolescents?

Vanessa Azzi[a], Joya Maria Karam[b], Wendy D'Andrea[c,d], Diana Malaeb[e], Sami El Khatib[f,g], Fouad Sakr[h,i], Mariam Dabbous[h], Souheil Hallit[a,j*,#], Michel Soufia[a,#]

[a]*School of Medicine and Medical Sciences, Holy Spirit University of Kaslik, Jounieh, Lebanon*
[b]*Faculty of Medicine, Lebanese University, Beirut, Lebanon*
[c]*The New School for Social Research, New York, NY, USA*
[d]*Trauma Research Foundation, Brooklyn, MA, USA*
[e]*College of Pharmacy, Gulf Medical University, Ajman, United Arab Emirates*
[f]*Department of Biomedical Sciences, School of Arts and Sciences, Lebanese International University, Bekaa, Lebanon*
[g]*Center for Applied Mathematics and Bioinformatics (CAMB), Gulf University for Science and Technology (GUST), Hawally, Kuwait*
[h]*School of Pharmacy, Lebanese International University, Beirut, Lebanon*
[i]*École Doctorale Sciences de la Vie et de la Santé, Université Paris-Est Créteil, Paris, France*
[j]*Applied Science Research Center, Applied Science Private University, Amman, Jordan*

#Souheil Hallit and Michel Soufia are last coauthors.

Received 7 December 2023; Accepted 13 February 2024
Available online 1 March 2024

KEYWORDS
adolescents;
asthma;
behavioral problems;
Lebanon

ABSTRACT
Background: Little evidence is available about psychological stressors in Lebanese asthmatic adolescents, where health-risk behaviors are a serious threat to public health. In addition, the COVID-19 epidemic has had a substantial influence on adolescents' mental health globally, especially in Lebanon, where the ongoing economic and political challenges have largely impacted their psychological well-being. This study aimed to explore the association of asthma and the COVID-19 infection with behaviors among Lebanese adolescents.
Methods: Data were collected in July 2023, using the snowball sampling technique. Inclusion criteria for participation in the study included being of a resident and citizen of Lebanon and aged 12-18 years. Behavioral problems were assessed using the Youth Self-Report (YSR) scale, which yields nine subscales (anxious/depressed, withdrawn/depressed, somatic complaints, social problems, thought problems, attention problems, rule-breaking behavior, aggressive behavior, and other problems) and a total score.
Results: Asthma was significantly associated with somatic complaints (Beta [β] = 2.98), attention problems (β = 0.01), and other behavioral problems (β = 0.68). Having contracted the COVID-19 infection, compared to healthy asymptomatic state (β = 1.55), was significantly associated with more anxious behaviors. In the case of stratifying the analysis in terms of gender, the results showed that the presence of asthma was significantly associated with more social behaviors (β = 3.31), thought problems (β = 2.91), attention problems (β = 0.02), other

***Corresponding author:** Souheil Hallit, School of Medicine and Medical Sciences, Holy Spirit University of Kaslik, P.O. Box 446, Jounieh, Lebanon. *Email address:* souheilhallit@hotmail.com

https://doi.org/10.15586/aei.v52i2.1054

behavioral problems (β = 1.71), and total behavioral problems (β = 5.71) in males. In case stratifying the analysis as to school type, the presence of asthma was significantly associated with more somatic complaints (β = 2.77) in participants from private schools whereas it was significantly associated with more total behavioral problems (total YSR scores) (β = 5.05) in participants from public schools.

Conclusion: It is confirmed that asthma and psychiatric disorders are interconnected, so it would be of great importance to include screening through a psychological intervention in treating asthmatic adolescents by means of (1) recognizing factors affecting patients' mental health, and (2) regulating uncontrolled behaviors that can exacerbate symptoms in order to avoid the future morbidity.

INTRODUCTION

Asthma has emerged as one of the most common causes of respiratory illness worldwide. It is the most frequently diagnosed chronic childhood disease primarily affecting children living in urban areas.[1] Owing to its high frequency, complexity, heterogeneity, and enormous burden on individuals, their families, and the society, asthma has been a source of great challenge for healthcare professionals worldwide. This chronic inflammatory condition, which is characterized by recurring episodes of wheezing, coughing, shortness of breath, and chest tightness, varying in time and intensity, affects approximately 300 million people globally.[2] Prevalence of asthma has roughly doubled in the last few decades, and it is anticipated to affect an additional 100 million people by 2025.[3]

The global prevalence of asthma is estimated at 262.41 million [95% CI 224.05; 309.45].[4] The physician-diagnosis of asthma is estimated at 4.3%.[5] According to an Italian study, the prevalence of asthma is around 4%.[6] Moreover, a Lebanese study conducted in 2017 showed the asthma prevalence of 6.4% in children aged 3–15 years[7] and 8.2% in preschool children.[8]

Although the causes of asthma are not fully understood, the rise in its incidence has recently focused attention on several comorbidities related to its occurrence. Occurrence of asthma and exacerbation are associated with several genetic and environmental factors, including exposure to allergens, cigarette and waterpipe smoking, male gender, urban residence, viral respiratory infections, and lower educational status.[9]

In addition, an association is observed between mental health and illness of the lungs. Compared to children without asthma, both male and female asthmatic children have a higher prevalence of emotional issues.[10,11] Although disparities could be discovered in the literature,[12] a conducted meta-analysis concluded that asthmatic children had behavioral problems that were one-half to two-thirds of a standard deviation greater than the control group, with differences being substantially pronounced among adolescents with withdrawn, anxiety/depression, and somatic complaints.

Experimental evidence suggests that asthma and therapeutics may trigger anxiety among children.[13] Such results have been strengthened by other conducted studies illustrating that children who can better manage their asthma symptoms are less likely to exhibit behavioral issues.[14] This process appears to be influenced by the familial environment. As such, parental psychiatric disorders or marital conflicts are shown to have a negative impact on a child's psychological development as well as her ability to cope with asthma and related medical compliance.[15] These findings imply that difficulties in managing asthma among adolescents may be indirectly related to these behavioral problems.[16] The relationship between behavioral problems and asthma is bidirectional;[14] while the presence of a chronic disease such as asthma might predispose a person to stress, anxiety, and other behavioral issues; behavioral problems might in turn cause uncontrolled asthma through non-adherence to asthma management strategies.

Moreover, the central nervous system (CNS) of a child or an adolescent is still in a vulnerable developing stage, any stressful circumstances during this crucial stage could cause both temporary and permanent physical, intellectual, and behavioral impairments.[17,18] Given that widespread inflammation contributes to compromised neurological processes and psychological and behavioral disorders,[19] it appears reasonable to assume that inflammatory changes in adolescents exposed to the COVID-19 infection could cause long-term physiological and psychological harm and be a major concern.[20] As such, it has been suggested that the COVID-19 pandemic could have altered emotions and behaviors of adolescents, with around half of the infected children having experienced withdrawal, anxiety/depression, and physical symptoms.[20]

A little evidence is available about psychological stressors among Lebanese asthmatic adolescents, where health-risk behaviors are a serious threat to public health. In addition, the COVID-19 epidemic had a substantial influence on the mental health of adolescents globally, and especially in Lebanon, where the ongoing economic and political challenges have largely impacted their psychological well-being.[21]

Moreover, in Lebanon, behavioral and psychosocial challenges could be difficult for families to adhere to treatment recommendations. Therefore, identifying and comprehending behavioral changes that may surge in asthmatics could lead to a better preventive care. On top of that, on August 4, 2020, a massive explosion at the Beirut port resulted in the death of hundreds and disabled thousands of people, leaving them unsheltered. A consequential buildup of all these adverse events has led Lebanon to

socioeconomic decline and institutional collapse, such as universities and more microscopically but most importantly schools.[22]

In Lebanon, schools are divided as private and public schools. It is collectively agreed that public schools are for children with lower socioeconomic class. In fact, because of Lebanon's crisis, the management of schools has been more challenging, leaving children unsatisfied with their education and their emotional and social needs have suppressed.[23] Lebanese public schools suffer from a severe shortage of qualified teachers who can teach mathematics and science in English and French. In addition, a large number of public schools have infrastructure problems, such as broken windows and leaking roofs.[24] Hence, the present study aimed to explore the association of asthma and the COVID-19 infection with behaviors among Lebanese adolescents while considering notable potentially confounding variables in our analysis.

METHODS

Study design

Data were collected in July 2023, using the snowball sampling technique. The questionnaire was developed with Google Forms and distributed to participants via social media platforms and messaging applications. The research team contacted the known adolescents; and those who accepted to participate were asked to forward the link to other adolescents they knew, explaining the snowball sampling technique. Inclusion criteria for participation included being of a resident and citizen of Lebanon, and aged 12–18 years. The introductory paragraph included the objectives of this study as well as a request to adolescents to seek parental permission prior to filling the survey. No credits were perceived for participation.[25]

Minimum sample calculation

Using the multiple regression option (R^2 deviation from zero) in the G-power software, a minimum sample of 439 patients was estimated, based on a squared multiple correlation $R^2 = 0.05$, an alpha error of 5%, power of 80%, and 23 predictors to be entered in the final model.

Questionnaire and variables

The Arabic questionnaire had three sections: The first part was a written consent to confirm the approval of adolescents and their parents to fill the questionnaire. The second part evaluated the participants' socio-demographic characteristics, that were, age, gender, and household crowding index calculated by dividing the number of residents by the number of rooms.[28] Furthermore, other factors known to be associated with asthma were included based on the previous studies conducted in Lebanon[7,26]: school type, humidity at home and molds in the house as seen on walls, exposure to pesticides, cigarette and waterpipe smoking, and living area (urban/rural). Questions about the COVID-19 infection (yes/no) and the intake of the COVID-19 vaccine (yes/no) were also included in the questionnaire.

The second part of the questionnaire included the Youth Self-Report (YSR) scale.[27] The scale was used to evaluate behavioral problems, and was designed specifically for use among adolescents aged 11–18 years. It yielded a behavioral total score and scores for the following nine subscales: anxious–depressed, withdrawn–depressed, somatic complaints, social problems, thought problems, attention problems, rule-breaking behavior, aggressive behavior, and other problems. Higher total score reflected worse behavior in each domain and overall behavior. The Cronbach's α values for subscales were as follows: anxious–depressed, 0.89; withdrawn–depressed, 0.79; somatic complaints, 0.85; social problems, 0.86; thought problems, 0.87; attention problems, 0.84; rule-breaking behavior, 0.89; aggressive behavior, 0.89; other problems, 0.76. Cronbach's α for behavioral total score was 0.97. Permission to use the scale was granted by Achenbach System of Empirically Based Assessment (ASEBA)/Research Center for Children, Youth, and Families, Inc. The Arabic version used here was created by D'Andrea et al.[28]

Statistical Analysis

The SPSS software v.25 was used for the statistical analysis. The behavioral total score, subscale scores, and the Asthma Control Test (ACT) score were considered normally distributed, as the skewness and kurtosis values varied between -2 and +2, except for the attention score with values falling outside this range. The log transformation was applied, which yielded a normally distributed score afterwards. The Student's *t* test was used to compare two mean values, and the Pearson's test was used to correlate two continuous variables. Multiple linear regressions were conducted using the total YSR score and each subscale score as the dependent variable. Only variables with $P < 0.25$ in bivariate analysis were included in the final regression; $P < 0.05$ was deemed statistically significant.

RESULTS

In all, 202 asthmatic adolescents and 402 adolescents without asthma participated in this study. A comparison between the two groups is summarized in Table 1. No significant difference was discovered between asthmatic patients and healthy adolescents, except for a higher mean body mass index (BMI), a higher percentage of persons working with pesticides, and humid residences.

Bivariate analysis

The bivariate analysis of factors associated with each subscale and the total YSR scores are shown in Tables 2 and 3. A higher mean YSR total score was discovered in participants studying in public schools, compared to private schools; in cigarette smokers, compared to nonsmokers; and in asthmatics, compared to healthy ones.

Table 1 Comparison of characteristics between healthy adolescents and asthmatics.

	Healthy	Asthmatics	t/X^2	*df*	P
Age	15.95 ± 1.71	15.96 ± 1.88	-0.07	602	0.949
Body mass index (BMI)	21.68 ± 3.37	22.39 ± 4.27	-2.05	602	**0.041**
Household crowding index	1.23 ± 0.54	1.24 ± 0.55	-0.14	602	0.892
Number of smokers in the house	1.34 ± 1.19	1.44 ± 1.16	-0.96	602	0.339
Gender			2.29	1	0.130
Female	235 (58.5%)	105 (52.0%)			
Male	167 (41.5%)	97 (48.0%)			
Place of living			0.40	1	0.525
Urban	190 (47.3%)	101 (50.0%)			
Rural	212 (52.7%)	101 (50.0%)			
School type			1.21	1	0.271
Public	112 (27.9%)	65 (32.2%)			
Private	290 (72.1%)	137 (67.8%)			
COVID-19 infection			0.56	1	0.455
No	178 (44.3%)	83 (41.1%)			
Yes	224 (55.7%)	119 (58.9%)			
COVID-19 vaccine			1.82	1	0.177
No	160 (39.8%)	69 (34.2%)			
Yes	242 (60.2%)	133 (65.8%)			
Person in the house working with pesticides			0.75	1	0.385
No	220 (54.7%)	103 (51.0%)			
Yes	182 (45.3%)	99 (49.0%)			
Living in a region sprayed with pesticides			7.33	1	**0.007**
No	310 (77.1%)	135 (66.8%)			
Yes	92 (22.9%)	67 (33.2%)			
Humidity at home			4.81	1	**0.028**
No	288 (71.6%)	127 (62.9%)			
Yes	114 (28.4%)	75 (37.1%)			
Cigarette smoking			0.10	1	0.749
No	365 (90.8%)	185 (91.6%)			
Yes	37 (9.2%)	17 (8.4%)			
Waterpipe smoking			0.06	1	0.805
No	323 (80.3%)	164 (81.2%)			
Yes	79 (19.7%)	38 (18.8%)			

Numbers in bold indicate significant *p* values. t = ratio of the difference between the mean of the two sample sets and the variation that exists within the sample sets; X^2= Chi-square value; *df* = degree of freedom.

Multivariable analyses

The results of multivariable analyses are summarized in Table 4. Asthma was significantly associated with somatic complaints (β = 2.98), attention problems (β = 0.01), and other behavioral problems (β = 0.68). Having contracted the COVID-19 infection, compared to healthy asymptomatic state (β = 1.55), was significantly associated with more anxious behaviors. Studying in a private school versus studying in a public was significantly associated with lower anxious behaviors (β = -1.56), withdrawn behaviors (β = -1.89), somatic complaints (β = -2.90), thought problems (β = -2.20), social behavioral problems (β = -2.29), attention problems (β = -0.01), rule-breaking problems (β = -2.76), aggressive problems (β = -2.21), and lower total YSR scores (β = -3.52).

Cigarette smoking was significantly associated with more anxious behaviors (β = 4.41), lower social behavioral problems (β = 4.29), higher attention problems (β = 0.02), more rule-breaking problems (β = 5.21), higher aggressive problems (β = 3.17), and higher total behavioral problems (higher total YSR scores; β = 5.97). Smoking waterpipe was significantly associated with lower anxious behaviors (β = -2.32), lower social behaviors (β = -2.27), and more rule-breaking problems (β = 1.91).

Males, compared to females, were significantly associated with lower withdrawal behaviors (β = -2.32), somatic complaints (β = -4.48), more rule-breaking problems (β = 1.43), and lower total behavioral problems (lower total YSR scores; β = -3.29). Older age (β = -0.003) was significantly associated with lower attention problems.

Stratification analysis

In case stratifying the analysis in terms of gender, the results showed that the presence of asthma in males was significantly associated with more social behaviors (β = 3.31), thought problems (β = 2.91), attention problems (β = 0.02), other behavioral problems (β = 1.71), and total behavioral problems (β = 5.71) (Table S1).

In the case of stratifying the analysis in terms of school type, the presence of asthma was significantly associated with more somatic complaints (β = 2.77) in participants from private schools whereas it was significantly associated with more total behavioral problems (total YSR scores; β = 5.05) in participants from public schools (Table S2).

DISCUSSION

Amid the surge of dynamic studies concerning asthma patients in the last couple of years, our research contributed to the ongoing discourse of behavioral problems in asthmatic adolescents, showing that having asthma is associated with three variables, such as somatic complaints, attention and behavioral problems, and other problems (Table 4).

A considerable body of literature exists on the association between asthma and somatic complaints. A case-control study evaluated 134 participants with differing degrees of asthma control;[29] it was deduced that higher levels of somatization were observed in uncontrolled asthma patients, compared to patients with controlled asthma. In parallel, another review went beyond previous reports by specifying that the most common psychosomatic manifestations in asthmatics were stomachache, backache, arm/leg/joint pain, menstrual pain, headaches, chest pain, insomnia, and conditions.[30] Asthmatics reported low

Table 2 Factors associated with behavioral total score and subscale scores.

	Anxious	Withdrawn	Somatic complaints	Social problems	Thought problems	Attention problems	Rule-breaking behaviors	Aggressive behaviors	Other problems	Total YSR score
Gender										
Female	59.25 ± 10.04	59.11 ± 9.43	60.39 ± 10.7	57.36 ± 9.45	57.46 ± 9.27	1.73 ± 0.05	54.82 ± 8.24	55.53 ± 8.43	4.04 ± 3.35	50.14 ± 14.98
Male	55.34 ± 8.65	57.22 ± 8.92	56.36 ± 8.91	56.57 ± 9.48	56.95 ± 8.76	1.73 ± 0.05	57.15 ± 8.87	55.58 ± 8.29	4.45 ± 3.70	48.16 ± 15.15
t	5.13	2.51	5.07	1.02	0.68	-0.75	-3.31	-0.07	-1.42	1.61
df	602	602	602	602	602	602	602	602	602	602
P	<**0.001**	**0.012**	<**0.001**	0.309	0.497	0.452	**0.001**	0.945	0.155	0.109
Place of living										
Urban	57.21 ± 9.20	57.87 ± 9.15	58.70 ± 10.34	56.94 ± 9.46	57.15 ± 8.81	1.73 ± 0.05	55.78 ± 8.58	55.41 ± 8.25	4.19 ± 3.43	49.03 ± 14.86
Rural	57.85 ± 10.05	58.70 ± 10.34	58.57 ± 9.94	57.09 ± 9.48	57.32 ± 9.27	1.73 ± 0.05	55.89 ± 8.62	55.68 ± 8.48	4.25 ± 3.59	49.50 ± 15.29
t	-0.82	-1.06	0.16	-0.19	-0.22	-0.87	-0.16	-0.40	-0.21	-0.38
df	602	602	602	0.602	602	602	602	602	602	602
P	0.411	0.292	0.873	0.851	0.826	0.385	0.874	0.691	0.833	0.702
School type										
Public	58.41 ± 10.68	59.61 ± 10.38	60.55 ± 10.84	58.58 ± 10.33	58.73 ± 10.13	1.74 ± 0.06	58.23 ± 10.15	57.21 ± 9.65	4.69 ± 3.86	51.84 ± 16.24
Private	57.18 ± 9.17	57.74 ± 8.69	57.83 ± 9.72	56.37 ± 9.01	56.62 ± 8.49	1.73 ± 0.05	54.85 ± 7.66	54.87 ± 7.68	4.02 ± 3.34	48.22 ± 14.45
t	1.34	2.12	2.89	2.48	2.44	2.47	3.98	2.88	2.02	2.57
df	602	602	602	602	602	602	602	602	602	602
P	0.180	**0.035**	**0.004**	**0.014**	**0.015**	**0.014**	<**0.001**	**0.004**	**0.044**	**0.011**
COVID-19 infection										
No	56.72 ± 9.38	57.94 ± 9.25	57.61 ± 9.62	56.39 ± 9.41	57.12 ± 9.45	1.73 ± 0.05	55.48 ± 8.78	55.35 ± 8.56	4.15 ± 3.64	48.08 ± 15.44
Yes	58.17 ± 9.81	58.55 ± 9.25	59.40 ± 10.45	57.50 ± 9.49	57.33 ± 8.74	1.73 ± 0.05	56.11 ± 8.45	55.71 ± 8.22	4.27 ± 3.41	50.19 ± 14.74
t	-1.84	-0.79	-2.16	-1.43	-0.27	0.10	-0.90	-0.51	-0.41	-1.70
df	602	602	602	602	602	602	602	602	602	602
P	0.067	0.428	**0.031**	0.154	0.784	0.922	0.366	0.608	0.683	0.089
COVID-19 vaccine										
No	57.21 ± 10.02	58.39 ± 9.99	58.19 ± 10.03	56.38 ± 9.17	57.12 ± 9.39	1.73 ± 0.06	55.76 ± 8.67	54.97 ± 8.08	4.24 ± 3.71	48.82 ± 15.04
Yes	57.75 ± 9.42	58.22 ± 8.78	58.90 ± 10.19	57.40 ± 9.63	57.31 ± 8.84	1.73 ± 0.05	55.88 ± 8.56	55.91 ± 8.52	4.21 ± 3.39	49.56 ± 15.11
t	-0.67	0.21	-0.83	-1.28	-0.26	0.65	-0.16	-1.36	0.09	-0.58
df	602	602	602	602	602	602	602	602	602	602
P	0.504	0.835	0.408	0.200	0.798	0.518	0.870	0.175	0.932	0.561
Cigarette smoking										
No	57.33 ± 9.37	58.12 ± 9.22	58.51 ± 9.92	56.72 ± 9.16	57.07 ± 8.90	1.73 ± 0.05	55.23 ± 8.30	55.25 ± 8.20	4.14 ± 3.42	48.79 ± 14.90
Yes	59.74 ± 11.95	59.93 ± 9.49	59.87 ± 12.14	60.07 ± 11.81	58.94 ± 10.30	1.75 ± 0.06	62.02 ± 9.21	58.65 ± 9.42	5.04 ± 4.30	54.24 ± 16.06
t	-1.44	-1.37	-0.80	-2.03	-1.29	-2.11	-5.21	-2.56	-1.49	-2.40
df	602	602	602	602	602	602	602	602	602	602
P	0.154	0.172	0.427	0.047	0.202	**0.039**	<**0.001**	**0.013**	0.142	**0.020**
Waterpipe smoking										
No	57.86 ± 989	58.48 ± 9.43	58.51 ± 10.27	57.32 ± 9.79	57.50 ± 9.24	1.73 ± 0.05	55.14 ± 8.60	55.52 ± 8.37	4.24 ± 3.57	49.05 ± 15.39
Yes	56.23 ± 8.47	57.49 ± 8.43	59.12 ± 9.56	55.74 ± 7.86	56.16 ± 8.14	1.73 ± 0.05	58.74 ± 7.98	55.68 ± 8.35	4.15 ± 3.25	50.25 ± 13.67
t	1.80	1.04	-0.58	1.87	1.55	0.060	-4.11	-0.19	0.26	-0.83
df	602	602	602	602	602	602	602	602	602	602
P	0.073	0.299	0.560	0.063	0.123	0.952	<**0.001**	0.851	0.797	0.406
Asthma										
No	57.39 ± 9.72	58.07 ± 9.28	57.69 ± 9.69	56.69 ± 9.34	56.92 ± 8.92	1.73 ± 0.05	55.80 ± 8.43	55.51 ± 8.38	3.98 ± 3.43	48.42 ± 15.40
Yes	57.84 ± 9.51	58.70 ± 9.19	60.51 ± 10.73	57.67 ± 9.69	57.87 ± 9.27	1.74 ± 0.06	55.92 ± 8.94	55.64 ± 8.35	4.69 ± 3.63	50.99 ± 14.29
t	-0.53	-0.79	-3.25	-1.21	-1.22	-2.11	-0.16	-0.18	-2.36	-1.98
df	602	602	602	602	602	602	602	602	602	602
P	0.594	0.431	**0.001**	0.227	0.223	**0.036**	0.874	0.859	**0.019**	**0.048**

Numbers in bold indicate significant P values.
Log transformation of the attention score was used.
Numbers in the table refer to means ± standard deviation.

Table 3 Correlation matrix of continuous variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Anxious	1													
2. Withdrawn	0.79***	1												
3. Somatic complaints	0.76***	0.68***	1											
4. Social problems	0.83***	0.74***	0.67***	1										
5. Thought problems	0.76***	0.71***	0.72***	0.79***	1									
6. Attention problems	0.64***	0.59***	0.61***	0.73***	0.71***	1								
7. Rule-breaking behaviors	0.60***	0.54***	0.56***	0.70***	0.71***	0.58***	1							
8. Aggressive behaviors	0.70***	0.64***	0.62***	0.78***	0.80***	0.65***	0.80***	1						
9. Other problems	0.63***	0.60***	0.63***	0.69***	0.71***	0.61***	0.67***	0.71***	1					
10. Total YSR score	0.84***	0.80***	0.79***	0.85***	0.86***	0.73***	0.75***	0.81***	0.78***	1				
11. Age	-0.02	-0.004	0.04	-0.06	-0.06	-0.08	0.09*	-0.04	-0.04	0.01	1			
12. Body mass index (BMI)	-0.02	-0.02	0.03	-0.01	0.05	0.02	0.07	0.02	0.14**	0.05	0.26***	1		
13. Household crowding index	0.06	0.05	0.07	0.01	0.04	0.01	0.001	-0.02	0.04	0.04	-0.05	-0.07	1	
14. Number of smokers in the house	-0.01	-0.01	0.03	-0.003	-0.02	-0.03	0.09*	0.03	0.03	0.04	0.09*	0.08*	0.05	1

*P < 0.05; **P < 0.01; ***P < 0.001.

scores of internal controllability of symptoms;[31] they were more attentive and more sensitized regarding their bodily functions. Moreover, the association of asthma with attention problems was a topic of interest in many literature reviews. By means of a comparison, a recent investigation in children suggested that incidence of attention deficit hyperactivity disorder (ADHD) was 1.17 times higher in the asthma group than in the non-asthma group.[32] Other studies had similar results and elaborated that symptoms of ADHD could negatively affect the course of asthma treatment,[33] which could lead to an increase in asthma morbidity. In some instances, parents with a low socioeconomic background were also diagnosed with attention deficit problems, which affected the management of their child's asthma and ADHD.[34] In addition, our analysis discovered a clear correlation between asthma and behavioral problems in adolescents. Interestingly, a meta-analysis of approximately 5000 asthmatic children reported more behavioral difficulties in patients than in healthy children.[35] Another study with the same interest recruited 1445 children aged 5–12 years and studied their behavioral problems. Researchers discovered a greater proportion of behavioral problems (25.25%) in asthmatic children, compared to non-asthmatic participants (16.49%).[36] Still another study shed light on the challenges faced by the parents who were constantly dealing with their children's inappropriate behaviors, such as potentially experienced breathing difficulties, and conceded to their children's wants in order to avoid adverse situations.[13] The recurrence of such events aggravated unhealthy cycles of interactions between parents and children, tantrums, and rule- breaking behaviors.

Regarding respiratory infection, our investigation concluded that the COVID-19 infection was associated with psychological distress (e.g., anxiety). The basic information was consistent to a previous meta-analysis that combined the data of 31 studies comprising 5153 patients; the prevalence of depression and anxiety among the COVID-19 patients was 45% and 47%, respectively.[37]

In our investigation, multiple confounding factors were associated with behavioral problems in our sample age group. First, we observed that cigarette smoking was correlated to anxiety (Module 1, Table 4) whereas cigarette and waterpipe smoking was correlated to low problematic social behaviors, higher attention problems (Module 6, Table 4), higher rule-breaking problems, and more aggressive behaviors (Module 8, Table 4), compared to nonsmokers. In line with our findings, a recent study described a causal association between smoking and aggressive behavior by comparing aggressive behaviors of 187,787 adolescents recruited for a dose-dependent tobacco use. Planned comparison demonstrated that at day 0 (lowest amount of tobacco use), aggressive behaviors were discovered in 5.9% of participants and this proportion increased 28.2% after 30 days (highest amount of tobacco use).[38] Moreover, another study emphasized on the fact that adolescence smoking was associated with high risk of attention problems, affecting the adulthood.[39] Our study observed that a cigarette smoker, compared to a waterpipe smoker, was at a risk of suffering more anxiety. In contrast, a previous study conducted among 113,786 waterpipe smoking students revealed that waterpipe smoking was resulted in anxiety, depression, and ADHD by 11%, 10%, and 4%, respectively.

We also discovered that male adolescents were more susceptible to rule-breaking behaviors than females (Module 7, Table 4). Contrarily, males tend to have a lower YSR score than females (Module 10, Table 4). According to an established review, it was illustrated that males were more expressive and aggressive than females for externalizing their problems whereas females tended to internalize their problems, which lead to higher anxiety, depression, and withdrawal behaviors, corresponding to higher YSR scores.[40]

An additional confounding factor regarding behavioral changes in Lebanese adolescents was found to be the type of schooling. Our results demonstrated a novel comparison that showed higher levels of YSR scores (Table 4). In public schools, students experienced higher levels of anxiety and aggressive behavior as well as more rule-breaking problems than students in private schools. For instance, a comparative study with 800 participants revealed that

Table 4 Multivariable analyses.

	Unstandardized β	Standardized β	P	95% confidence interval (95% CI)
Model 1: Anxious score as a dependent variable (R^2 = 0.074)				
Gender (males vs. females*)	-4.34	-0.22	<**0.001**	-5.88; -2.81
School type (private vs. public*)	-1.56	-0.07	0.070	-3.25; 0.13
COVID infection (yes vs. no*)	1.55	0.08	**0.044**	0.04; 3.06
Household crowding index	1.04	0.06	0.149	-0.37; 2.45
Cigarette smoking (yes vs. no*)	4.41	0.13	**0.002**	1.67; 7.15
Waterpipe smoking (yes vs. no*)	-2.32	-0.10	**0.020**	-4.29; -0.36
Model 2: Withdrawal score as a dependent variable (R^2 = 0.027)				
Gender (males vs. females*)	-2.32	-0.12	**0.003**	-3.82; -0.81
School type (private vs. public*)	-1.89	-0.09	**0.024**	-3.54; -0.25
Household crowding index	0.59	0.04	0.400	-0.79; 1.98
Cigarette smoking (yes vs. no*)	2.40	0.07	0.072	-0.22; 5.02
Model 3: Somatic complaints score as a dependent variable (R^2 = 0.080)				
Gender (males vs. females*)	-4.48	-0.22	<**0.001**	-6.06; -2.89
School type (private vs. public*)	-2.90	-0.13	**0.001**	-4.65; -1.14
Household crowding index	0.77	0.04	0.301	-0.70; 2.24
Asthma (yes vs. no*)	2.98	0.14	<**0.001**	1.32; 4.63
Model 4: Social behavioral score as a dependent variable (R^2 = 0.037)				
School type (private vs. public*)	-2.29	-0.11	**0.007**	-3.95; -0.64
Cigarette smoking (yes vs. no*)	4.29	0.13	**0.002**	1.57; 7.01
Waterpipe smoking (yes vs. no*)	-2.27	-0.10	**0.026**	-4.28; -0.27
Asthma (yes vs. no*)	0.91	0.05	0.261	-0.68; 2.49
Age	-0.34	-0.06	0.127	-0.78; 0.10
Model 5: Thought problems score as a dependent variable (R^2 = 0.026)				
School type (private vs. public*)	-2.20	-0.11	**0.007**	-3.79; -0.61
Cigarette smoking (yes vs. no*)	2.57	0.08	0.053	-0.04; 5.18
Waterpipe smoking (yes vs. no*)	-1.78	-0.08	0.070	-3.71; 0.15
Asthma (yes vs. no*)	0.86	0.05	0.265	-0.66; 2.38
Age	-0.28	-0.05	0.197	-0.70; 0.15
Model 6: Attention problems score as a dependent variable (R^2 = 0.040)				
School type (private vs. public*)	-0.01	-0.10	**0.014**	-0.02; -0.002
Cigarette smoking (yes vs. no*)	0.02	0.12	**0.003**	0.01; 0.04
Asthma (yes vs. no*)	0.01	0.09	**0.032**	0.001; 0.02
Age	-0.003	-0.11	**0.007**	-0.01; -0.001
Model 7: Rule-breaking problems score as a dependent variable (R^2 = 0.094)				
Gender (males vs. females*)	1.43	08	**0.044**	0.04; 2.81
School type (private vs. public*)	-2.76	-0.15	<**0.001**	-4.22; -1.29
Cigarette smoking (yes vs. no*)	5.21	0.17	<**0.001**	2.77; 7.65
Waterpipe smoking (yes vs. no*)	1.91	0.09	**0.036**	0.13; 3.69
Age	0.15	0.03	0.471	-0.26; 0.55
Body mass index (BMI)	0.03	01	0.784	-0.16; 0.22
Model 8: Aggressive problems score as a dependent variable (R^2 = 0.094)				
School type (private vs. public*)	-2.21	-0.12	**0.003**	-3.67; -0.76
Cigarette smoking (yes vs. no*)	3.17	0.11	**0.008**	0.85; 5.48
Model 9: Other problems score as a dependent variable (R^2 = 0.022)				
Gender (males vs. females*)	0.24	0.03	0.419	-0.34; 81
School type (private vs. public*)	-0.58	-0.08	0.064	-1.20; 0.03
Cigarette smoking (yes vs. no*)	0.78	0.06	0.125	-0.22; 1.77
Asthma (yes vs. no*)	0.68	0.09	**0.025**	0.08; 1.27
Model 10: Total YSR score as a dependent variable (R^2 = 0.039)				
Gender (males vs. females*)	-3.29	-0.11	**0.009**	-5.77; -0.81
School type (private vs. public*)	-3.52	-0.11	**0.009**	-6.14; -0.89
Cigarette smoking (yes vs. no*)	5.97	0.11	**0.006**	1.74; 10.21
Asthma (yes vs. no*)	2.51	0.08	0.052	-0.02; 5.04
Body mass index (BMI)	0.20	0.05	0.231	-0.13; 0.53

Numbers in bold indicate significant P values.
Log transformation of the attention score was used.

24.7% of students in public schools engaged in aggressive behaviors, compared to 12.9% students in private schools.[41] In fact, it is collectively agreed in Lebanon that children pursuing education in public schools belonged to a poor socioeconomic background. A low socioeconomic background affected child's development, and living in a stressed environment (with social, financial, and interpersonal problems) could result into becoming an aggressive person.[42] However, some researchers established that in India, students studying in private schools were more aggressive than students of public schools, and concluded that the type of school was not an important factor influencing children's behavior.[46] We explained these differences by considering that cultural diversity in Lebanon, compared to other countries, impacted the school education, resulting in different type of emotional development (e.g., aggression, anxiety etc.).

Clinical Implications

Nowadays, treatment of asthmatic patients and patients with respiratory infections is mainly managed by medications that alleviate symptoms only.[43] Physicians and parents overlook the effect of mental health on the child's recovery and well-being.[44] Studies concerning psychological interventions during the course of asthma treatment are limited in explaining different approaches to assist asthmatics having high risks of psychological distress (e.g., anxiety, depression, etc.) and behavioral changes (attention disorders, aggressive behaviors, etc.).[36]

The findings from this research could aid in guiding valuable avenues of inquiry during clinical consultations with adolescent patients suffering from asthma. An understanding of various factors associated with behavioral changes associated with the severity of respiratory diseases could help in building a constructive plan to assist these patients correctly. It is crucial for parents to check behavioral changes manifested in children and look for negative habits that they might develop, such as cigarette or waterpipe smoking. All these factors could result in adverse asthma outcomes. A clear assessment of factors exacerbating such conditions must be made by a psychologist included in the multidisciplinary approach for managing asthma.

Limitations

Possible limitations infiltrated our investigations. In fact, biases related to data collection could have affected our results, especially the underestimation or overestimation of symptoms (adolescents might not know that they either lived in a region sprayed with pesticides or in a house having high humidity). In addition, the overall response rate in our study was low and varied across different schools. Moreover, the characteristic of our cross-sectional study was limited: it did not allow us to confirm the possible causes of emotional and behavioral problems in Lebanon. The YSR scale is not validated in Arabic yet. A selection bias was present because of the snowball sampling technique followed to recruit participants and the unknown response rate.

CONCLUSION

The presence of asthma and the COVID-19 infection is associated with behavioral changes among adolescents in Lebanon. Our analysis suggested that the asthma was correlated to three adverse attitudes: (1) somatic complaints, (2) attention problems, and (3) behavioral problems. We also discovered confounding factors associated with behavioral changes, such as cigarette and waterpipe smoking, leading to higher risks of anxiety, attention deficit and rule-breaking problems, and aggression. In addition, our study demonstrated that studying in a public school in Lebanon could generate a series of adverse emotions and behaviors reflected by higher YSR scores (anxious-depressed, withdrawn–depressed, somatic complaints, social problems, thought problems, attention problems, rule-breaking behaviors, aggressive behavior, and other problems). However, the study established an important protective factor that studying in a private school resulted in lower YSR scores, compared to studying in a public school. It was confirmed that asthma and psychiatric disorders are interconnected. Therefore, it is important to include screening through psychological intervention in the treatment of asthmatic adolescents by (1) recognizing factors affecting patients' mental health and (2) regulating uncontrolled behaviors that could exacerbate symptoms in order to avoid the future morbidity.

Ethics Approval and Consent to Participate

The study protocol was approved by the ethics committee of the School of Pharmacy, Lebanese International University (Reference #2023RC-018-LIUSOP). Participants were asked to get their parents' approval before filling the survey; an electronically informed consent was obtained from all participants and their legal guardians at the time of submitting online forms. All procedures were carried out according to relevant guidelines and regulations.

Availability of data

All data generated or analyzed in this study are not available publicly due the restrictions of ethics committee. Reasonable requests can be addressed to the corresponding author (Souheil Hallit).

Competing interests

The authors have nothing to disclose.

Author contributions

Vanessa Azzi, Michel Soufia, and Souheil Hallit designed the study. Vanessa Azzi drafted the manuscript and collected the data. Souheil Hallit carried out the analysis and interpreted the results. Vanessa Azzi, Fouad Sakr, and Mariam Dabbous collected the data. Diana Malaeb, Joya Maria Karam, Wendy D'Andrea, and Sami El Khatib reviewed the

paper for intellectual content. All authors reviewed the final manuscript and gave their consent for publication.

Acknowledgments

The authors thanked all participants.

REFERENCES

1. Grant TL, Wood RA: The influence of urban exposures and residence on childhood asthma. Pediatr Allergy Immunol 2022, 33(5):e13784. https://doi.org/10.1111/pai.13784
2. Dharmage SC, Perret JL, Custovic A: Epidemiology of Asthma in Children and Adults. Front Pediatr 2019, 7:246. https://doi.org/10.3389/fped.2019.00246
3. Schluger NW, Koppaka R: Lung disease in a global context. A call for public health action. Annals of the American Thoracic Society 2014, 11(3):407–416. https://doi.org/10.1513/AnnalsATS.201312-420PS
4. Wang Z, Li Y, Gao Y, Fu Y, Lin J, Lei X, Zheng J, Jiang M: Global, regional, and national burden of asthma and its attributable risk factors from 1990 to 2019: a systematic analysis for the Global Burden of Disease Study 2019. Respir Res 2023, 24(1):169. https://doi.org/10.1186/s12931-023-02475-6
5. Asher MI, Garcia-Marcos L, Pearce NE, Strachan DP: Trends in worldwide asthma prevalence. Eur Respir J 2020, 56(6). https://doi.org/10.1183/13993003.02094-2020
6. Braido F, Blasi F, Canonica GW, Paggiaro P, Beghe B, Bonini M, Carpagnano GE, Del Giacco S, Lavorini F, Milanese M et al: Mild/Moderate Asthma Network in Italy (MANI): a long-term observational study. J Asthma 2022, 59(9):1908–1913. https://doi.org/10.1080/02770903.2021.1968895
7. Hallit S, Salameh P: Exposure to toxics during pregnancy and childhood and asthma in children: A pilot study. J Epidemiol Glob Health 2017, 7(3):147–154. https://doi.org/10.1016/j.jegh.2017.04.004
8. Hallit S, Sacre H, Kheir N, Hallit R, Waked M, Salameh P: Prevalence of asthma, its correlates, and validation of the Pre-School Asthma Risk Factors Scale (PS-ARFS) among preschool children in Lebanon. Allergol Immunopathol (Madr) 2021, 49(1):40–49. https://doi.org/10.15586/aei.v49i1.25
9. Ramji R, Nilsson M, Arnetz B, Wiklund Y, Arnetz J: Taking a stand: An untapped strategy to reduce waterpipe smoking in adolescents. Substance use & misuse 2019, 54(3):514–524. https://doi.org/10.1080/10826084.2018.1521429
10. Akcakaya N, Aydogğan M, Hassanzadeh A, Camciogğlu Y, Çokugğras H: Psychological problems in Turkish asthmatic children and their families. Allergologia et immunopathologia 2003, 31(5):282–287. https://doi.org/10.1016/S0301-0546(03)79197-6
11. Calam R, Gregg L, Simpson B, Morris J, Woodcock A, Custovic A: Childhood asthma, behavior problems, and family functioning. Journal of Allergy and Clinical Immunology 2003, 112(3):499-504. https://doi.org/10.1016/S0091-6749(03)00008-3
12. Wamboldt MZ, Fritz G, Mansell A, McQuaid EL, Klein RB: Relationship of asthma severity and psychological problems in children. Journal of the American Academy of Child & Adolescent Psychiatry 1998, 37(9):943–950. https://doi.org/10.1097/00004583-199809000-00014
13. Caulfield JI: Anxiety, depression, and asthma: New perspectives and approaches for psychoneuroimmunology research. Brain Behav Immun Health 2021, 18:100360. https://doi.org/10.1016/j.bbih.2021.100360
14. Baiardini I, Sicuro F, Balbi F, Canonica GW, Braido F: Psychological aspects in asthma: do psychological factors affect asthma management? Asthma Res Pract 2015, 1:7. https://doi.org/10.1186/s40733-015-0007-1
15. Christiansen H, Reck C, Zietlow AL, Otto K, Steinmayr R, Wirthwein L, Weigelt S, Stark R, Ebert DD, Buntrock C et al: Children of Mentally Ill Parents at Risk Evaluation (COMPARE): Design and Methods of a Randomized Controlled Multicenter Study-Part I. Front Psychiatry 2019, 10:128. https://doi.org/10.3389/fpsyt.2019.00128
16. Ahmad A, Sorensen K: Enabling and hindering factors influencing adherence to asthma treatment among adolescents: A systematic literature review. J Asthma 2016, 53(8):862–878. https://doi.org/10.3109/02770903.2016.1155217
17. Attia M, Ibrahim FA, Elsady MA, Khorkhash MK, Rizk MA, Shah J, Amer SA: Cognitive, emotional, physical, and behavioral stress-related symptoms and coping strategies among university students during the third wave of COVID-19 pandemic. Front Psychiatry 2022, 13:933981. https://doi.org/10.3389/fpsyt.2022.933981
18. Robinson OJ, Vytal K, Cornwell BR, Grillon C: The impact of anxiety upon cognition: perspectives from human threat of shock studies. Front Hum Neurosci 2013, 7:203. https://doi.org/10.3389/fnhum.2013.00203
19. Devoto C, Arcurio L, Fetta J, Ley M, Rodney T, Kanefsky R, Gill J: Inflammation Relates to Chronic Behavioral and Neurological Symptoms in Military Personnel with Traumatic Brain Injuries. Cell Transplant 2017, 26(7):1169–1177. https://doi.org/10.1177/0963689717714098
20. Ahmed GK, Elbeh K, Gomaa HM, Soliman S: Does COVID-19 infection have an impact on children's psychological problems? Middle East Current Psychiatry 2021, 28(1):1–9. https://doi.org/10.1186/s43045-021-00155-z
21. El Othman R, Touma E, El Othman R, Haddad C, Hallit R, Obeid S, Salameh P, Hallit S: COVID-19 pandemic and mental health in Lebanon: a cross-sectional study. Int J Psychiatry Clin Pract 2021, 25(2):152–163. https://doi.org/10.1080/13651501.2021.1879159
22. Mahfoud D, Fawaz M, Obeid S, Hallit S: The co-moderating effect of social support and religiosity in the association between psychological distress and coping strategies in a sample of lebanese adults. BMC Psychol 2023, 11(1):61. https://doi.org/10.1186/s40359-023-01102-9
23. Difference between public and private schools in Lebanon. Global History Dialogues. Available from: https://globalhistorydialogues.org/projects/difference-between-public-and-private-schools-in-lebanon/ [Access date: November 30, 2023]
24. Lebanon- Education. Available from: https://www.usaid.gov/lebanon/education#:~:text=Lebanese%20public%20schools%20suffer%20from,broken%20windows%20and%20leaking%20roofs [Access date: November 30, 2023]
25. Azzi V, Malaeb D, El Khatib S, Sakr F, Dabbous M, Hallit S, Soufia M: Association of behaviors and asthma control in a sample of Lebanese adolescents with asthma. Allergol Immunopathol (Madr) 2024, 52(2):1–9.
26. Akiki Z, Saadeh D, Farah R, Hallit S, Sacre H, Hosseini H, Salameh P: Asthma prevalence and associated factors among lebanese adults: the first national survey. BMC Pulm Med 2021, 21(1):162. https://doi.org/10.1186/s12890-021-01529-z
27. Achenbach TM: Manual for ASEBA school-age forms & profiles. University of Vermont, Research Center for Children, Youth & Families 2001.
28. D'Andrea W, Aboagye A, Lee KA, Freed S, Joachim B, Khedari-DePierro V, Yates E, Wilmes A, Krohner S, Madhoun S et al: Growing Up on the Edge: A Community-Based Intervention for Children in Gaza. Res Child Adol Psychopath 2023. https://doi.org/10.1007/s10802-023-01124-2

29. Samaha HMS, Elsaid AR, Sabri Y: Depression, anxiety, distress and somatization in asthmatic patients. Egyptian Journal of Chest Diseases and Tuberculosis 2015, 64(2):307–311. https://doi.org/10.1016/j.ejcdt.2015.02.010
30. Moore M, Duncan C, Gonis A: Uncon-trolled Asthma is Associated with Comorbid Stress and Somato-form Symptoms. Ann Pulmonol 2020, 4(1):45–49. https://doi.org/10.36959/918/451
31. Goldbeck L, Bundschuh S: Illness perception in pediatric somatization and asthma: complaints and health locus of control beliefs. Child and adolescent psychiatry and mental health 2007, 1:1–7. https://doi.org/10.1186/1753-2000-1-5
32. Park HJ, Kim YH, Na DY, Jeong SW, Lee MG, Lee J-H, Yang YN, Kang MG, Yeom SW, Kim JS: Long-term bidirectional association between asthma and attention deficit hyperactivity disorder: A big data cohort study. Frontiers in Psychiatry 2023, 13:1044742. https://doi.org/10.3389/fpsyt.2022.1044742
33. McQuaid EL, Weiss-Laxer N, Kopel SJ, Koinis Mitchell D, Nassau JH, Wamboldt MZ, Klein RB, Fritz GK: Pediatric asthma and problems in attention, concentration, and impulsivity: Disruption of the family management system. Families, Systems, & Health 2008, 26(1):16. https://doi.org/10.1037/1091-7527.26.1.16
34. McQuaid EL, Walders N, Kopel SJ, Fritz GK, Klinnert MD: Pediatric asthma management in the family context: The family asthma management system scale. Journal of pediatric psychology 2005, 30(6):492–502. https://doi.org/10.1093/jpepsy/jsi074
35. McQuaid EL, Kopel SJ, Nassau JH: Behavioral adjustment in children with asthma: a meta-analysis. Journal of Developmental & Behavioral Pediatrics 2001, 22(6):430–439. https://doi.org/10.1097/00004703-200112000-00011
36. Feitosa CA, Santos DN, do Carmo MBB, Santos LM, Teles CA, Rodrigues LC, Barreto ML: Behavior problems and prevalence of asthma symptoms among Brazilian children. Journal of psychosomatic research 2011, 71(3):160–165. https://doi.org/10.1016/j.jpsychores.2011.02.004
37. Deng J, Zhou F, Hou W, Silver Z, Wong CY, Chang O, Huang E, Zuo QK: The prevalence of depression, anxiety, and sleep disturbances in COVID-19 patients: a meta-analysis. Annals of the New York Academy of Sciences 2021, 1486(1):90–111. https://doi.org/10.1111/nyas.14506
38. Liu H, Ma X, Shi L, Wang J, Juan JTH, Ma D, Sun J: Associations between tobacco and alcohol use and aggressive behavior among adolescents in 55 Low-and Middle-Income countries. Journal of affective disorders 2023, 329:519–524. https://doi.org/10.1016/j.jad.2023.02.131
39. Treur JL, Willemsen G, Bartels M, Geels LM, van Beek JH, Huppertz C, van Beijsterveldt CE, Boomsma DI, Vink JM: Smoking during adolescence as a risk factor for attention problems. Biological Psychiatry 2015, 78(9):656–663. https://doi.org/10.1016/j.biopsych.2014.06.019
40. Antia K, Račaitė J, Šurkienė G, Winkler V: The gender gap in adolescents' emotional and behavioural problems in Georgia: a cross-sectional study using Achenbach's Youth Self Report. Child and Adolescent Psychiatry and Mental Health 2023, 17(1):1–11. https://doi.org/10.1186/s13034-023-00592-0
41. Omisore A, Omisore B, Adelekan B, Afolabi O, Olajide F, Arije O, Agunbiade O: A comparative study of school based violence and strategies for control in public and private secondary schools in Osun State. Nigerian journal of medicine 2012, 21(1):81–88.
42. Letourneau NL, Duffett-Leger L, Levac L, Watson B, Young-Morris C: Socioeconomic status and child development: A meta-analysis. Journal of Emotional and Behavioral Disorders 2013, 21(3):211–224. https://doi.org/10.1177/1063426611421007
43. Papi A, Blasi F, Canonica GW, Morandi L, Richeldi L, Rossi A: Treatment strategies for asthma: reshaping the concept of asthma management. Allergy, Asthma & Clinical Immunology 2020, 16:1–11. https://doi.org/10.1186/s13223-020-00472-8
44. Baiardini I, Sicuro F, Balbi F, Canonica GW, Braido F: Psychological aspects in asthma: do psychological factors affect asthma management? Asthma research and practice 2015, 1(1):1–6. https://doi.org/10.1186/s40733-015-0007-1

Supplementary

Table S1 Multivariable analyses stratified over gender.

	Females				Males			
	B	β	*p*	95% CI	B	β	*p*	95% CI
Model 1: Anxious score as the dependent variable								
School type (private vs public*)	-.59	-.03	.647	-3.13; 1.95	-2.81	-.16	**.012**	-4.98; -.64
COVID infection (yes vs no*)	2.68	.13	**.016**	.50; 4.87	-.04	-.002	.969	-2.08; 2.00
Household crowding index	.86	.05	.362	-.99; 2.71	1.66	.09	.143	-.57; 3.88
Cigarette smoking (yes vs no*)	1.80	.04	.508	-3.54; 7.14	5.68	.23	**<.001**	2.73; 8.63
Waterpipe smoking (yes vs no*)	-1.57	-.06	.300	-4.55; 1.41	-3.12	-.15	**.014**	-5.61; -.63
Model 2: Withdrawn score as the dependent variable								
School type (private vs public*)	-1.27	-.06	.296	-3.65; 1.11	-2.63	-.14	**.023**	-4.90; -.36
Household crowding index	.57	.04	.521	-1.17; 2.31	.71	.04	.553	-1.63; 3.04
Cigarette smoking (yes vs no*)	-.31	-.01	.903	-5.24; 4.62	3.59	.14	**.020**	.57; 6.60
Model 3: Somatic complaints score as the dependent variable								
School type (private vs public*)	-2.80	-.11	**.039**	-5.47; -.14	-2.93	-.16	**.010**	-5.13; -.72
Household crowding index	.35	.02	.727	-1.61; 2.30	1.67	.09	.147	-.59; 3.93
Asthma (yes vs no*)	1.79	.08	.152	-.66; 4.24	4.37	.24	**<.001**	2.23; 6.52
Model 4: Social behaviors score as the dependent variable								
School type (private vs public*)	-2.18	-.10	.067	-4.51; .16	-2.64	-.13	**.028**	-4.99; -.29
Cigarette smoking (yes vs no*)	3.76	.08	.141	-1.25; 8.77	5.54	.21	**.001**	2.18; 8.90
Waterpipe smoking (yes vs no*)	-1.67	-.07	.251	-4.53; 1.19	-.290	-.13	**.044**	-5.71; -.08
Asthma (yes vs no*)	-.86	-.04	.436	-3.05; 1.32	3.31	.17	**.005**	1.001; 5.63
Age	-.39	-.07	.191	-.98; .20	-.32	-.06	.358	-1.01; .36
Model 5: Thought problems score as the dependent variable								
School type (private vs public*)	-2.07	-.10	.077	-4.37; .23	-2.47	-.13	**.027**	-4.65; -.28
Cigarette smoking (yes vs no*)	1.03	.02	.683	-3.91; 5.97	4.21	.17	**.009**	1.08; 7.33
Waterpipe smoking (yes vs no*)	-1.32	-.05	.358	-4.14; 1.50	-2.21	-.11	.098	-4.83; .41
Asthma (yes vs no*)	-.68	-.03	.535	-2.83; 1.47	2.91	.16	**.008**	.76; 5.06
Age	-.23	-.04	.446	-.81; .36	-.40	-.08	.213	-1.04; .23
Model 6: Attention problems score as the dependent variable								
School type (private vs public*)	-.01	-.06	.260	-.02; .01	-.02	-.15	**.015**	-.03; -.003
Cigarette smoking (yes vs no*)	.002	.01	.903	-.03; .03	.03	.23	**<.001**	.02; .05
Asthma (yes vs no*)	.004	.04	.459	-.01; .02	.02	.15	**.014**	.003; .03
Age	-.003	-.09	.110	-.01; .001	-.004	-.15	**.016**	-.01; -.001
Model 7: Rule breaking problems score as the dependent variable								
School type (private vs public*)	-2.04	-.11	**.047**	-4.04; -.03	-3.47	-.19	.002	-5.64; -1.30
Cigarette smoking (yes vs no*)	4.44	.11	**.043**	.13; 8.74	5.93	.24	<.001	2.82; 9.04
Waterpipe smoking (yes vs no*)	2.21	.10	.078	-.25; 4.67	1.67	.08	.211	-.95; 4.30
Age	.30	.06	.265	-.23; .82	-.07	-.02	.824	-.73; .58
Body Mass Index	.04	.02	.764	-.22; .29	.02	.01	.871	-.26; .31
Model 8: Aggressive problems score as the dependent variable								
School type (private vs public*)	-2.12	-.11	**.042**	-4.16; -.08	-2.35	-.14	**.028**	-4.44; -.25
Cigarette smoking (yes vs no*)	5.95	.15	**.007**	1.63; 10.28	2.19	.09	.126	-.62; 4.99
Model 9: Other problems score as the dependent variable								
School type (private vs public*)	-.38	-.05	.361	-1.21; .44	-.76	-.10	.105	-1.68; .16
Cigarette smoking (yes vs no*)	.47	.03	.595	-1.28; 2.22	1.05	.10	.094	-.18; 2.28
Asthma (yes vs no*)	-.19	-.03	.637	-.96; .59	1.71	.22	**<.001**	.81; 2.62
Model 10: Total YSR score as the dependent variable								
School type (private vs public*)	-2.74	-.08	.145	-6.41; .94	-4.06	-.13	**.031**	-7.76; -.37
Cigarette smoking (yes vs no*)	3.70	.05	.350	-4.07; 11.47	7.76	.18	**.002**	2.80; 12.72
Asthma (yes vs no*)	-1.81	-.06	.307	-5.28; 1.67	7.59	.24	**<.001**	3.94; 11.25
Body Mass Index	.40	.09	.086	-.06; .85	.03	.01	.886	-.43; .50

*Reference group; B= Unstandardized Beta; β = Standardized Beta; numbers in bold indicate significant *p* values.

Table S2 Multivariable analyses stratified over the school type.

	Public				Private			
	B	β	*p*	95% CI	B	β	*p*	95% CI
Model 1: Anxious score as the dependent variable								
Gender (males vs females*)	-2.84	-.13	.072	-5.94; .26	-4.70	-.25	**<.001**	-6.44; -2.96
COVID infection (yes vs no*)	-1.39	-.07	.384	-4.52; 1.75	2.48	.13	**.004**	.79; 4.18
Household crowding index	1.88	.13	.078	-.21; 3.98	.13	.01	.895	-1.87; 2.14
Cigarette smoking (yes vs no*)	9.44	.29	**<.001**	4.42; 14.46	1.76	.05	.289	-1.50; 5.02
Waterpipe smoking (yes vs no*)	-203	-.09	.269	-5.63; 1.58	-2.55	-.10	**.032**	-4.88; -.22
Model 2: Withdrawn score as the dependent variable								
Gender (males vs females*)	-1.61	-.08	.304	-4.69; 1.47	-2.53	-.14	**.004**	-4.24; -.83
Household crowding index	.71	.05	.505	-1.38; 2.79	.66	.03	.511	-1.31; 2.63
Cigarette smoking (yes vs no*)	6.23	.20	**.011**	145; 11.01	.07	.002	.963	-3.06; 3.21
Model 3: Somatic complaints score as the dependent variable								
Gender (males vs females*)	-4.00	-.19	**.013**	-7.14; -.86	-4.60	-.23	**<.001**	-6.42; -2.78
Household crowding index	2.04	.14	.061	-.10; 4.17	-.84	-.04	.443	-2.99; 1.31
Asthma (yes vs no*)	3.18	.14	.056	-.08; 6.43	2.77	.13	**.005**	.85; 4.69
Model 4: Social behaviors score as the dependent variable								
Cigarette smoking (yes vs no*)	7.47	.23	**.003**	2.58; 12.36	2.29	.07	.173	-1.01; 5.59
Waterpipe smoking (yes vs no*)	-1.50	-.07	.414	-5.10; 2.11	-2.90	-.12	**.020**	-5.33; -.46
Asthma (yes vs no*)	.60	.03	.706	-2.54; 3.73	.97	.05	.299	-.86; 2.79
Age	-.34	-.06	.456	-1.23; .55	-.30	-.06	.248	-.80; .21
Model 5: Thought problems score as the dependent variable								
Cigarette smoking (yes vs no*)	6.48	.21	**.009**	1.67; 11.29	.19	.01	.907	-2.93; 3.30
Waterpipe smoking (yes vs no*)	-1.58	-.07	.380	-5.13; 1.96	-2.13	-.09	.070	-4.43; .17
Asthma (yes vs no*)	1.68	.08	.285	-1.41; 4.76	.44	.02	.620	-1.29; 2.16
Age	.06	.01	.894	-.82; .93	-.37	-.08	.135	-.84; .11
Model 6: Attention problems score as the dependent variable								
Cigarette smoking (yes vs no*)	.05	.25	.001	.02; .07	.01	.04	.399	-.01; .03
Asthma (yes vs no*)	.01	.10	.180	-.01; .03	.01	.08	.108	-.002; .02
Age	-.002	-.07	.353	-.01; .003	-.003	-.12	**.012**	-.01; -.001
Model 7: Rule breaking problems score as the dependent variable								
Gender (males vs females*)	2.41	.12	.113	-.58; 5.40	1.07	.07	.169	-.46; 2.61
Cigarette smoking (yes vs no*)	7.55	.24	**.002**	2.78; 12.31	3.96	.14	**.006**	1.12; 6.80
Waterpipe smoking (yes vs no*)	1.77	.08	.316	-1.70; 5.24	1.90	.09	.072	-.17; 3.96
Age	.45	.08	.325	-.45; 1.35	.07	.02	.743	-.37; .52
Body Mass Index	-.12	-.04	.570	-.53; .29	.07	.03	.509	-.14; .28
Model 8: Aggressive problems score as the dependent variable								
Cigarette smoking (yes vs no*)	4.73	.16	**.034**	.35; 9.12	2.21	.08	.112	-.52; 4.94
Model 9: Other problems score as the dependent variable								
Gender (males vs females*)	.36	.05	.528	-.77; 1.49	.22	.03	.511	-.44; .88
Cigarette smoking (yes vs no*)	2.63	.22	**.003**	.89; 4.37	-.37	-.03	.546	-1.59; .84
Asthma (yes vs no*)	1.04	.13	.078	-.12; 2.20	.49	.07	.162	-.20; 1.17
Model 10: Total YSR score as the dependent variable								
Gender (males vs females*)	-2.75	-.09	.254	-7.49; 1.99	-3.42	-.12	.021	-6.33; -.52
Cigarette smoking (yes vs no*)	12.60	.25	**.001**	5.20; 19.99	2.10	.04	.430	-3.13; 7.34
Asthma (yes vs no*)	5.05	.15	**.043**	.16; 9.94	1.36	.04	.364	-1.59; 4.31
Body Mass Index	-.02	-.003	.963	-.65; .62	.24	.06	.213	-.14; .62

*Reference group; B= Unstandardized Beta; β = Standardized Beta; numbers in bold indicate significant *p* values.