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Current lifestyle and risk for asthma: Sedentary lifestyle, obesity, and ETS

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Abstract
Background: The increasing prevalence of asthma necessitates consideration of modifiable asthma risk factors, such as sedentary lifestyle, overweight/obesity, and environmental tobacco smoke (ETS) exposure. The aim of this study was to analyze the relationship between asthma symptoms and the risk factors in young adolescents.
Methods: This cross-sectional study, as part of the Global Asthma Network (GAN) Phase I project, used standardized questionnaires based on ISAAC (International Study of Asthma and Allergies in Childhood) Phase I and Phase III questionnaires. In Gjilan, Kosovo, self-reported data from 1200 school children aged 13–14 years were collected.
Results: Overweight (BMI [body mass index] > 25 kg/m^2) had a statistically significant association with asthma symptoms ($p < 0.05$), particularly with disturbed sleep due to wheezing (OR [odds ratio] = 3.93 [95% CI [confidence interval]: 1.27–12.12]) and the reported wheezing by females during or after exercise. Sedentary lifestyle (≥ 3 hours/day on a computer/television) was found to be associated with wheezing (OR = 1.89 [95% CI: 1.34–2.66]) and the diagnosis of asthma. ETS exposure was significantly associated with wheezing during or after exercise (OR = 1.67 [95% CI: 1.15–2.42]) and coughing at night (OR = 1.67 [95% CI: 1.19–2.33]).
Conclusion: The findings support the importance of sedentary lifestyle, obesity, and ETS exposure as asthma risk factors in young adolescents experiencing asthma symptoms. Future public health interventions should take these modifiable risk factors into account, especially in urban locations, in order to alleviate asthma morbidity.

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Introduction

Asthma is a complex respiratory disease resulting from the interplay of genetics, environment, and lifestyle factors. Asthma prevalence has increased due, in large part, to changes in environmental conditions and lifestyle over the last few decades.[1] Some of the major lifestyle changes that have been implicated in the increasing rate of airway diseases include changes in diet, decreased physical activity, increased time spent indoors, and sedentary occupations that have emerged in the last 50 years. Environmental contributors to airway disease include increased air pollution exposure and also the risk of pollutant exposure combined with allergens.[2]

There are a number of mechanisms suggesting connections between asthma and obesity, including mechanical effects, modified inflammation, and immune responses.[3] Sedentary lifestyle has been suggested as a mediator of risk for asthma and obesity, with some evidence supporting increased episodes of television viewing leading to increased incidence of both.[4–6]

Indoor air pollution represents another critical environmental determinant of respiratory and systemic diseases.[7] According to the World Health Organization (WHO), 4.3 million deaths per year are attributable to exposure to poor indoor air quality; in other words, indoor air pollution.[8] Environmental tobacco smoke (ETS)—the side stream smoke from a lit cigarette and the exhaled smoke from the smoker—is one of the main factors. Epidemiological data are sufficiently consistent in suggesting that exposure to tobacco smoke in early life is associated with increased risk of symptoms of asthma—exposure to parental smoking, especially maternal smoking.[9,10]

Children exposed to secondhand smoke are at increased risk from asthma attacks, bronchitis, and pneumonia.[11] Some studies have demonstrated that exposure to ETS is followed by immunological changes in favor of allergic reactions, with an increased response in allergen-induced specific IgE (immunoglobulin E) levels, increased levels of interleukin (IL)-4, IL-5, and IL-13, and also with increased amounts of post-allergen histamine in nasal secretions.[7,12]

The aim of this paper was to present the data collected on the relationship between and contribution to the prevalence and severity of asthma symptoms with sedentary lifestyle, obesity, and ETS among school children aged 13–14 years from Gjilan, a municipality located in the southeast of Kosovo. The objective is to quantify the associations between these modifiable risk factors and asthma symptoms in this population, providing evidence to inform targeted public health interventions aimed at reducing asthma morbidity in urban regions with similar socio-environmental characteristics.

In Kosovo, a new country and region going through rapid urbanization and lifestyle changes, the incidence of asthma among school-age children is an increasing concern. An important area of study is Gjilan, where the combination of living in urban and rural areas provides an opportunity to examine how risk factors for exposures to the environment and lifestyle choices influence asthma symptoms.

Material and Methods

This cross-sectional study was conducted in Gjilan, south-eastern Kosovo, as a part of the Project of Global Asthma Network (GAN) Phase I, addressing the risk factors for asthma in school children.

A survey was conducted among 1500 children (adolescents) aged 13–14 years from randomly selected schools in Gjilan, with a healthy response rate of 80% from the final sample of 1200 respondents out of 1500 school children. According to GAN, the sample has to be no less than 1000 school children. In addition, we included a sample of 1825 guardians who participated in the survey to provide data of interest on the adolescents.

This study utilized standardized GAN written questionnaires, translated into Albanian and validated without adding extra questions. The translation was evaluated through a pilot study involving 50 randomly selected children, with all feedback incorporated into the final questionnaire version.

In accordance with the study protocol, we elaborated seven symptoms as indicators of asthma: wheezing or whistling in the chest EVER (WHEZEV) in the last 12 months (WHEZ12); disturbed sleep due to wheezing in the last 12 months (AWAKE12); severe enough wheezing to limit speech in the last 12 months (SPEECH12); asthma ever (ASTHMAEV); chest sounded wheezy during or after exercise in the last 12 months (EXWHEZ12); and dry cough at night (not from cold/flu) in the last 12 months (COUGH12).

This study examined the weight, height, and nutrition of the adolescents. Body mass index (BMI), calculated as body weight (kg) divided by the square of body height (m^2), was used to assess nutritional status. International BMI cut-off points for overweight and obesity, specific to sex and aged 2–18 years, were applied, defined to align with a BMI of 25 kg/m^2 for overweight and 30 kg/m^2 for obesity at age 18.[13]

The sedentary lifestyle of adolescents we evaluated through the questions for number of hours/days spent on computer/TV included the use of social networks and phone. A predictive role of computer/TV for symptoms of asthma was analyzed as a time < 3 hours versus ≥ 3 hours daily.

Exposure of adolescent to ETS was analyzed by the guardian smoking status.

Statistical analysis

The data obtained with the research were processed in the Statistical Package for the Social Sciences (SPSS) software package, version 22.0 for Windows, and presented in tables. By determining the coefficient of relations, proportions, and rates, we processed the qualitative series, which were shown as absolute and relative numbers. Quantitative series were analyzed with dispersion measures (standard deviation and standard error) as well as by measures of central tendency (mean, median, minimum values, maximum values, interactive ranks). The Shapiro-Wilk W test was used to determine the normality of frequency distribution of investigated variables. To determine the association

between certain variables in the subjects, we used Pearson chi-square test, Fischer exact test, and Fisher-Freeman-Halton exact test. The risk calculation was determined using odds ratio (OR) and the difference test was used to compare the proportions. Two independent samples were compared, depending on frequency distribution, with the T-test for independent sample or with the Mann-Whitney U test. Univariate and multiple logistic regression analysis were used to determine and quantify the independent significant predictors of asthma. To determine the statistical significance, we used a two-sided analysis with a significance level of $p < 0.05$.

Ethical approval

The implementation of GAN Phase I in Kosovo was approved by Ethics Committee of the Ministry of Health and the Ministry of Education and Science (approval No. 21/550). Permission was asked and authorization issued by the education authorities of the municipality before the beginning of the study. Passive informed consent was used.

Results

We analyzed the relationship of selected indicators for symptoms of asthma with BMI, time spent on TV/computer/telephone/social networks as well as exposure to ETS of adolescents. We applied binary and multiple logistic regression analysis for each of the selected factors. In multiple logistic regression analysis, we made an adjustment with consideration to the potential confounding factors, such as BMI, physical activity, paracetamol, indoor/outdoor pollution, indoor allergens, social status (mother's education), computer/TV, and nutrition/diet.

According to the international cut-off points for BMI, boys and girls were divided into three groups: (a) normal weight; (b) overweight; and (c) obesity (Table 1). The international sex and age between 2 and 18 reference values were defined to pass through a BMI of 25 kg/m2 for overweight and 30 kg/m^2 for obesity (explained in the Material and Methods section). In our study, adolescents numbering 928 (77.3%) were with normal nutrition, 206 (17.2%) were overweight, and 66 (5.5%) were obese (Table 1). Boys and girls with normal nutrition were 471 (76.2%) versus 457 (78.5%), overweight were 105 (17%) versus 101 (17.3%), and obese were 42 (6.8%) versus 24 (4.1%). For $p > 0.05$, we found no statistically significant association between adolescent's sex and nutrition (Pearson chi-square test = 4.1217; df = 2; p = 0.1273). Because there was no significant association between gender and the three BMI groups (normal/overweight/ obese) to which the adolescents belonged, we created two BMI groups: (a) normal: BMI ≤ 25 kg/m^2; and (b) overweight: BMI > 25 kg/m^2.

Related to the assessment of BMI predictive role for symptoms of asthma, we found that disturbed sleep due to wheezing/whistling in the chest in the last 12 months was significantly positively associated with BMI in girls, and remains significant after adjusting for potential confounding factors for, consequently, p = 0.013 (OR = 3146 [1.27–7.77] 95% CI [confidence interval]) versus p = 0.015 (OR = 8407 [1.51–46.68] 95% CI). Significant positive association of this symptom with BMI was also found for the entire sample before and after adjusting for p = 0.032 (OR = 2168 [1.07–4.39] 95% CI) versus p = 0.017 (OR = 3931 [1.27–12.12] 95% CI) (Table 2).

For $p < 0.05$, there was a significant positive association of BMI with the restricted speech on one to two words due to wheezing for the entire sample for p = 0.030 (OR = 0.401 [0.18–0.91] 95% CI) as well as chest sounded wheezy during/after exercise for girls for p = 0.005 (OR = 1950 [1.22–3.12] 95% CI) as well as for the whole sample for p = 0.025 (OR = 1484 [1.05–2.09] 95% CI). After adjusting for $p > 0.05$ because of the influence of confounding factors, there was no significance association of BMI with any of these symptoms (Table 2).

The symptom of dry cough at night (in the absence of cold/flu) was significantly positive associated with BMI in girls before and after the adjustment for p = 0.001 (OR = 2212 [1.39–3.48] 95% CI) versus p = 0.001 (OR = 2509 [1.45–4.35] 95% CI) as well for the whole sample before the adjustment for p = 0.034 (OR = 1416 [1.03–1.95] 95% CI). Symptoms of wheezing/whistling in the chest in the last 12 months was significantly positively associated with BMI in girls, but only after adjusting for p = 0.041 (OR = 2553

Table 1 Sample analysis by gender and BMI groups.

BMI groups		Gender		Total	P
		Male	Female		
Normal	N	471	457	928	Pearson chi-square test = 4.1217; df = 2; p = 0.1273
	%	76.21%	78.52%	77.33%	
Overweight	N	105	101	206	
	%	16.99%	17.35%	17.17%	
Obesity	N	42	24	66	
	%	6.80%	4.12%	5.50%	
Total	N	618	582	1200	
	%	51.50%	48.50%	100%	

*Significant for $p < 0.05$.

Table 2 Binary and multiple logistic regression analysis for predictive role of BMI for symptoms of asthma by gender.

Symptoms of Asthma	Unadjusted OR	95% CI		P	Adjusted OR[1]	95% CI		p
		Lower	Upper			Lower	Upper	
Have you ever had wheezing or whistling in the chest at any time in the past?								
Male	1.16	0.68	1.99	0.579	1.21	0.60	2.41	0.587
Female	1.33	0.76	2.35	0.313	1.39	0.71	2.72	0.327
Total	1.24	0.84	1.83	0.272	1.25	0.78	1.99	0.350
Have you had wheezing or whistling in the chest in the past 12 months?								
Male	1.07	0.52	2.18	0.844	0.99	0.39	2.55	0.996
Female	1.90	0.89	4.04	0.092	2.55	1.04	6.26	**0.041***
Total	1.39	0.83	2.33	0.203	1.44	0.78	2.68	0.239
Has your sleep been disturbed due to wheezing in the past 12 months?								
Male	1.29	0.39	4.17	0.671	1.438	0.213	9.726	0709
Female	3.14	1.27	7.77	**0.013***	3.83	1.36	10.75	**0.011***
Total	2.16	1.07	4.38	**0.032***	2.45	1.06	5.69	**0.036***
Has wheezing ever been severe enough to limit your speech to only one or two words in the past 12 months?								
Male	2.33	0.73	7.46	0.153	2.29	0.44	11.80	0.319
Female	2.67	0.83	8.58	0.097	3.12	0.75	13.03	0.117
Total	2.49	1.09	5.67	**0.030***	2.35	0.86	6.39	0.094
Have you ever had asthma?								
Male	0.59	0.20	1.77	0.355	0.45	0.09	2.23	0.330
Female	0.91	0.29	2.77	0.870	1.06	0.28	4.05	0.927
Total	0.73	0.33	1.58	0.426	0.71	0.26	1.92	0.501
Has your chest sounded wheezy during or after exercise in the past 12 months?								
Male	1.11	0.66	1.87	0.670	1.13	0.58	2.19	0.712
Female	1.95	1.21	3.12	**0.005***	1.77	0.99	3.15	0.052
Total	1.48	1.05	2.09	**0.025***	1.41	0.92	2.15	0.110
Have you had a dry cough at night, apart from a cough associated with a cold or chest infection in the past 12 months?								
Male	0.93	0.59	1.48	0.789	0.79	0.44	1.42	0.446
Female	2.21	1.39	3.49	**0.001***	2.50	1.44	4.35	**0.001***
Total	1.41	1.02	1.95	**0.034***	1.44	0.97	2.12	0.065

[1]Adjusted OR for BMI with physical activity, paracetamol, indoor/outdoor pollution, indoor allergens, mother's education, computer/TV, nutrition/diets, and so on.
*Significant for $p < 0.05$: OR, odds ratio; CI, confidence interval.
***BMI (body mass index): > 25 kg/m^2 versus ≤ 25 kg/m^2; male = 618; female = 582.

[1.04-6.27] 95% CI). For $p > 0.05$, there is no significant association between BMI and symptoms of wheezing/whistling in the chest EVER and asthma EVER in life (Table 2).

We evaluated the sedentary lifestyle of adolescents through the questions for the number of hours/days spent on computer/TV, including the use of social networks and phone (Table 3).

The analysis of watching TV/DVD daily indicated that the majority being adolescents numbering 574 (47.8%)—288 (46.6%) males and 286 (49.1%) females—reported watching between ≥ 1 and < 3 hours/day; (b) 296 (24.7%)—131 (21.2%) males and 165 (28.3%) females—watched < 1 hour/day; (c) 208 (17.3%)—112 (18.1%) males and 96 (16.5%) females—watched between ≥ 3 and< 5 hours/day; and (d) and 122 (10.2%)—87 (14.1%) males and 35 (6%) females—watched ≥ 5 hours/day. Girls watched TV/DVD < 1 hour/day, 1471 times significantly more often compared to boys (OR = 1471 [1.13-1.91] 95% CI). In addition, boys watched TV/DVD ≥ 5 hours/day, 2561 times significantly more often compared to girls (OR = 2561 [1.71-3.86] 95% CI).

Time spent on computer/smartphone/social networks, the majority being adolescents numbering 460 (38.4%)—223 (36.1%) males and 237 (40.7%) females—spent ≥ 1 hour to < 3 hours/day. The smallest proportion of 160 (13.3%)—104 (16.8%) males and 56 (9.6%) females—spent ≥ 5 hours/day. Girls spent on computer < 1 hour/day, 1683 times significantly more often compared to boys (OR = 1683 [1.29-2.18] 95% CI). Boys on computer spent ≥ 3 hours/day, 2014 times significantly more often compared to girls (OR = 2014 [1.59-2.54] 95% CI). Boys spent on computer ≥ 5 hours/day, 1901 times significantly more often compared to girls (OR = 1901 [1.34-2.69] 95% CI). A predictive role of computer/TV for symptoms of asthma was analyzed as a time < 3 hours versus ≥ 3 hours daily (Table 4).

Significant positive association of time spent on computer/TV was found with: (a) wheezing/whistling in the chest EVER: for boys $p = 0.025$, for girls $p = 0.003$ (remain significant after adjustment for $p = 0.008$), and for the whole sample $p = 0.0001$; (b) wheezing/whistling in the chest in the last 12 months: for girls $p = 0.007$ and for

Table 3 Analysis of selected lifestyle parameters by gender.

Questions		Adolescents (N = 1200)			P
		Male	Female	Total	
How many hours a day do you watch television (including DVDs, films, videos) during the week? (N = 1200)					
< 1 hour	N	131	165	296	Pearson chi-square: 26.251;
	%	21.20%	28.35%	24.67%	df = 3; p = 0.000001*
≥ 1 hour to < 3 hours	N	288	286	574	
	%	46.60%	49.14%	47.83%	
≥ 3 hours to < 5 hours	N	112	96	208	
	%	18.12%	16.49%	17.33%	
≥5 hours	N	87	35	122	
	%	14.08%	6.01%	10.17%	
How many hours a day do you spend on computer (including PlayStation, Smartphone, tablet) and on the internet (including Chat, Facebook, Games, Twitter, YouTube)? (N = 1200)					
< 1 hour	N	134	185	319	Pearson chi-square: 32.692;
	%	21.68%	31.79%	26.58%	df = 3; p = 0.000001*
≥ 1 hour to < 3 hours	N	223	237	460	
	%	36.08%	40.72%	38.33%	
≥ 3 hours to < 5 hours	N	157	104	261	
	%	25.40%	17.87%	21.75%	
≥ 5 hours	N	104	56	160	
	%	16.83%	9.62%	13.33%	
How many hours a day do you spend on computer, TV, social network? (N = 1200)					
< 3 hours	N	313	392	705	Pearson chi-square: 34.5207;
	%	50.65%	67.35%	58.75%	df = 1; p = 0.000001*
≥ 3 hours	N	305	190	495	
	%	49.35%	32.65%	41.25%	

*Significant for p < 0.05.

the whole sample p = 0.001 (both remain significant after adjustment for consequently p = 0.011 vs. p = 0.028); (c) asthma symptoms ever: for the whole sample p = 0.028 (remain significant after adjustment for p = 0.046); (d) chest sounded wheezy during or after exercise: for boys p = 0.020 and for the whole sample p = 0.007; (e) dry cough at night for the whole sample p = 0.049 (Table 4).

Guardians smoking status of 362 (30,2%) adolescents had one and 42 (3.5%) had both parents who were smokers. A total of 796 (66,3%) adolescents had parents who were nonsmokers. For p > 0.05, there is no significant association between adolescents' gender and guardians smoking status (Pearson chi-square: 4.2103; df = 2; p = 0.1218) (Table 5).

After adjusting, we found that guardian smoking status was significantly positively associated with: (a) chest sounded wheezy during or after exercise for 12 months (EXWHEZ12) p = 0.007 (OR = 1672; 95% CI = 1.15–2.42]; (b) cough at night apart from cold/flu for 12 months (COUGH12) p = 0.002 (OR = 1673; 95% CI = 1.19–2.33]. Guardian smoking significantly increased the probability of: (a) EXWHEZ12 by 1672 times; and (b) COUGH12 by 1673 times (Table 6).

Discussion

Asthma continues to pose a significant public health issue, and the rapid growth of cities and changes in lifestyle have contributed to a higher prevalence. As a cross-sectional study embedded within the framework of the GAN Phase I study in Gjilan, Kosovo, we explored the association between asthma symptoms and modifiable risk factors that include overweight status, sedentary behavior, and exposure to ETS amongst school children aged 13–14 years. Elucidation of these associations provides timely evidence on risk factors contributing to the frequency of asthma morbidity in a transitional socio-environmental space, which affords a basis for public health efforts.[1,8]

We observed a statistically significant positive association between overweight status (BMI > 25 kg/m^2) and asthma symptoms, including disturbed sleep due to wheezing, wheezing with exercise, and nocturnal dry cough; these associations were more pronounced in girls. These findings are in accordance with prior epidemiological evidence that has indicated a link between obesity and asthma in children.[14,15,17] The gender-specific pattern demonstrated in our sample, especially the strengthened association in girls, adds support to earlier findings indicating that obesity could have differing influences on asthma by sex, potentially due to hormonal influences or differences in fat tissues.[15] In mechanistic terms, it has been suggested that excess weight can worsen asthma through airway compression and systemic inflammation or both processes which leads to increased airway hyperresponsiveness.[3] It is particularly noteworthy that the association we identified continued to hold in the model accounting for potential confounders and the modifying effect of

Table 4 Binary and multiple logistic regression analysis for predictive role of time with computer/TV for symptoms of asthma by gender.

Symptoms of Asthma	Unadjusted OR	95% CI		p	Adjusted OR[1]	95% CI		P
		Lower	Upper			Lower	Upper	
Have you ever had wheezing or whistling in the chest at any time in the past?								
Male	1.74	1.07	2.83	**0.025***	.93	0.50	1.71	0.823
Female	2.10	1.28	3.45	**0.003***	2.20	1.23	3.94	**0.008***
Total	1.89	1.34	2.66	**0.000***	1.45	0.96	2.18	0.073
Have you had wheezing or whistling in the chest in the past 12 months?								
Male	1.86	0.98	3.55	9.058	1.15	0.50	2.61	0.732
Female	2.67	1.30	5.44	**0.007***	3.03	1.29	7.14	**0.011***
Total	2.24	1.39	3.60	**0.001***	1.89	1.07	3.33	**0.028***
Has your sleep been disturbed due to wheezing in the past 12 months?								
Male	3.47	0.96	12.58	0.058	1.62	0.26	9.98	0.599
Female	1.54	0.62	3.77	0.346	1.81	0.63	5.14	0.265
Total	1.87	0.93	3.73	0.077	1.49	0.65	3.41	0.343
Has wheezing ever been severe enough to limit your speech to only one or two words in the past 12 months?								
Male	1.30	0.40	4.14	0.655	1.10	0.21	5.56	0.908
Female	1.87	0.59	5.90	0.280	1.36	0.34	5.46	0.661
Total	1.53	0.68	3.44	0.302	1.30	0.48	3.52	0.606
Have you ever had asthma?								
Male	2.02	0.85	4.75	0.107	2.52	0.75	8.47	0.133
Female	1.89	0.77	4.63	0.160	2.84	0.94	8.51	0.062
Total	1.97	1.07	3.63	**0.028***	2.21	1.01	4.81	**0.046***
Has your chest sounded wheezy during or after exercise in the past 12 months?								
Male	1.72	1.08	2.74	**0.020***	1.48	0.82	2.68	0.190
Female	1.53	0.99	2.35	0.054	1.59	0.93	2.72	0.085
Total	1.52	1.12	2.08	**0.007***	1.40	0.96	2.05	0.077
Have you had a dry cough at night, apart from a cough associated with a cold or chest infection, in the past 12 months?								
Male	1.36	0.92	2.01	0.118	1.20	0.73	1.97	0.453
Female	1.24	0.80	1.90	0.325	1.35	0.80	2.27	0.260
Total	1.32	1.00	1.76	**0.049***	1.27	0.90	1.79	0.171

[1]Adjusted OR for computer/TV with BMI, paracetamol, indoor/outdoor pollution, indoor allergens, mother's education, intensive physical activity, nutrition/diets, and more.
*Significant for $p < 0.05$: OR, odds ratio; CI, confidence interval.
***Computer/TV: ≥ 3 hours versus < 3 hours daily; male = 618; female = 582.

Table 5. Analysis of exposure to ETS by gender.

Question		Gender			P
		Male	Female	Total	
How many parents were smokers? (N = 1200)					
None	N	422	374	796	Pearson chi-square: 4.2103; df = 2; p = 0.1218
	%	68.28%	64.26%	66.33%	
One of the parents	N	180	182	362	
	%	29.13%	31.27%	30.17%	
Both parents	N	16	26	42	
	%	2.59%	4.47%	3.50%	

Table 6 Binary and multiple logistic regression analysis for predictive role of guardian smoking for selective symptoms of asthma

Symptoms		p	Unadjusted OR	95% CI		p	Adjusted OR	95% CI	
				Lower	Upper			Lower	Upper
Guardian smoking	AWAKE12	**0.098***	1.78	0.89	3.53	0.176	1.46	0.84	2.53
	EXWHEZ12	**0.004***	1.59	1.16	2.18	**0.007***	1.67	1.15	2.42
	COUGH12	**0.000***	1.78	1.33	2.37	**0.002***	1.67	1.19	2.33

[1]Adjusted OR for guardian smoking with sex, BMI, physical activity, Paracetamol, indoor/outdoor pollution, adolescent smoke/pipe, cat at home, damp/mold, mother's education, computer/TV, nutrition/diets, and more.
*Significant for $p < 0.05$: OR, odds ratio; CI, confidence interval.
***Guardian smoking: yes versus no; male = 618; female = 582.

sedentary behavior and allergen exposure. Collectively, this suggests that overweight status is an independent risk factor for asthma.

Similar to some of the studies identified in the literature, for example, Mitchell et al.[16] who detected stronger obesity-asthma associations among boys, we found a more robust relationship in girls in our study, suggesting that regional factors, such as dietary habits or sociocultural influences on physical activity in Kosovo, may influence these relationships. For example, girls in our sample reported less screen time than boys, yet their asthma symptoms showed a stronger association with overweight, suggesting involvement of hormonal factors, exposure to indoor allergens, or stress in overweight girls.[7,12] Despite the limitations of categorizing BMI into binary cut points, we found relatively strong relationships between overweight and asthma symptoms, highlighting the importance of overweight status as a modifiable risk factor of asthma morbidity.[18]

Sedentary behavior (≥ 3 hours/day of computer or television usage) was significantly associated with asthma symptoms—lifetime wheezing, wheezing in the past 12 months, and diagnosed asthma—above and beyond other confounding factors, and also more prevalent in girls. This finding is consistent with the existing literature linking excessive media usage and asthma severity.[5,21] Sedentary behavior may negatively influence asthma through reduced physical fitness (affecting lung function) and prolonged exposure to indoor pollutants.[6] Gender differences in our study may be interpreted as differences in activity patterns, with boys self-reporting greater amounts of screen time (≥ 5 hours/day) than girls. Yet, the greater association in girls suggests that sedentary behavior may interact with other risk factors like obesity or ETS that contribute to increased asthma symptoms.[23]

ETS, as assessed by the smoking status of a child's guardian, was positively associated with exercise-induced wheezing and nocturnal dry cough; and above and beyond any confounding variables, we found strong associations. About a third of adolescents self-reported an ETS exposure, which is lower than some global estimates but nonetheless a significant public health issue.[9,12] These findings were consistent with substantial literature identifying that ETS exposure is involved in asthma symptoms via air inflammation, oxidative stress, and immune dysregulation mechanisms.[10,11,24] Because of the strong evidence of maternal smoking, as previous studies have identified, maternal smoking may be more relevant to our population than paternal smoking, although we did not collect data to indicate whether smoking was maternal or paternal.[10] The associations with exercise-induced wheezing highlight a need for targeted tobacco reduction in Kosovo, where smoking rates exceed a number of global averages.

Based on our findings, the implications for public health are large. The relationship between overweight status, sedentary behavior, ETS exposure, and asthma symptoms suggests the need for a multifaceted intervention that focuses on lifestyle and environment. For example, for adolescents, there is quite a bit of evidence that promoting obesity prevention programs encouraging healthy food intake and healthy physical activity levels, especially for girls, could limit asthma morbidity.[6,14] Likewise, time spent with screens and outdoor physical activity for adolescents could lessen the impacts of sedentary behavior, and legislation barring smoking within homes as well as public campaigns surrounding exposing children to ETS are imperative.[9,25] In urbanizing countries such as Kosovo, where change is rapid, these interventions are urgently needed to combat the rising asthma burden.

The study has both strengths and limitations. Notably, the sample size of 1200 adolescents is impressive, and using GAN questionnaires standardized with many past studies allows for comparability with the global data collected during the GAN study.[10,16] Limitations include the reliance on self-reported risk factor status which could have potential recall bias since either, the adolescent or guardian may under- or overreport their symptoms or risk factor status. Additionally, since the study was cross-sectional, we cannot report on causation. This study also lacks objective measures to confirm diagnostic status, such as spirometry and allergen sensitization testing.[1,12] There is need for longitudinal studies to verify outcomes and accurate scientific methodology to assess associations as well as identify factors mediating mechanisms of association such as using inflammatory biomarkers or pollution.[1,12]

Our study provides evidence of associations between overweight status, sedentary behavior, and ETS exposure and asthma symptomology in adolescents in Gjilan, Kosovo. Our findings underscore the need for public health initiatives targeting modifiable behaviors, such as programs reducing tobacco smoke exposures and providing healthy

lifestyle changes emphasizing active living, to improve overall health in urban areas experiencing pervasive and increasing levels of asthma morbidity.[8,19-23]

Conclusion

This cross-sectional investigation, which formed part of the GAN Phase I study in Gjilan, Kosovo, identified significant associations between modifiable lifestyle and environmental risk factors and asthma symptoms among school children aged 13–14 years. Overweight status (BMI > 25 kg/m^2) was significantly associated with asthma symptoms of disturbed sleep due to wheezing, exercise-induced wheezing, and nocturnal dry cough; stronger associations with overweight status were seen in girls. Sedentary behavior (≥ 3 hours/day of computer or television) was positively associated with asthma symptoms of wheezing ever, wheezing in the past 12 months, and diagnosis of asthma; these associations remained after adjustment for confounders. Exposure to ETS, assessed via the guardian smoking status, significantly increased the likelihood of exercise-induced wheezing and nocturnal dry cough, further supporting its role as an important modifiable environmental risk factor. This study identifies an important public health imperative to develop population health strategies to prevent obesity, promote physical activity, and reduce ETS exposure to reduce asthma morbidity in adolescents. Public health outcomes could be improved in areas of rapid urbanization, like Kosovo, where the prevalence of increasing asthma can be attributed to lifestyle change driving risk factors.

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GAN Global Centre

Each center may publish its own data without the approval of the Global Asthma Network Steering Group.

Authors Contribution

All authors contributed equally to this article.

Conflicts of Interest

The authors declare no potential conflicts of interest with respect to research, authorship, and/or publication of this article.

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