Asthma diagnosis and learning disabilities among children in the United States

IRENE RETHEMIOTAKI

School of Production Engineering and Management, Technical University of Crete, Chania, Greece

Summary

Background. This study intends to investigate the impact of socio-economic factors on children with asthma, as well as the impact of these factors on their academic performance.

Objectives. This work aims at studying asthma and learning disabilities in the United States during the years 2009–2018 and to find not only statistically significant indicators for asthma but also a possible link between asthma and learning disabilities.

Material and methods. The statistical methods used to extract the results of this work are the chi-square test and One-way Analysis of Variance (ANOVA) in order to check the statistical significance of asthma with regard to the socio-economic factors of patients. Additionally, a multiple logistic regression analysis was used with the odds ratio (OR) to find statistically significant prognostic factors for both asthma and learning disabilities.

Results. As specified by multiple logistic regression analysis, males who have neither a mother nor father have a higher risk of developing both asthma and learning disabilities, while Black or African Americans are three times more at risk for the occurrence of these types of diseases. In addition, parents’ education and family income proved to also be prognostic risks for both asthma and learning disabilities.

Conclusions. The results of this work explain the significance of deprivation (of family and financial support) as the main prognostic risk factor for asthma. Moreover, the same factor proved to be the main prognostic risk factor for learning disabilities as for asthma, which implies a possible association between asthma and learning disabilities.

Key words: prognosis, asthma, learning disabilities, socio-economic factors.

Background

Asthma is a chronic inflammatory disease of the respiratory system that can cause an intermittent reduction of airflow to/from the lungs, resulting in dyspnea, chest tightness and cough [1]. Asthma ranks not only as the sixteenth most leading cause of Years Lived with Disability (YLD) but also the twenty-third leading cause of premature mortality, with an estimated 10.5 million Years of Life Lost (YLL) due to premature death in 2016 worldwide [2]. An increased trend of asthma was reported during the decade 2001–2010 [3]. This was due to both asthma related quality of life and pediatric management practices, as well as changes in the prevalence of the main risk factors for asthma, several of which are associated with socio-economic development [4–6].

Regarding asthma etiology, it is thought to be caused by interactions between genetic susceptibility and environmental exposure [7, 8], while important risk factors are age, race, family income and diet [3]. More specifically, the age of 5 years is considered the age of the most common occurrence of this disease, while black males have the most frequent incidence of asthma [3, 9]. Socio-economic Status (SES) plays a key role in the incidence rate and mortality from asthma [10]. Children coming from a low socio-economic status have a higher incidence rate of asthma compared to their peers coming from a high SES [11–17]. This is most likely due to different behavior in medical care, as well as higher levels of asthma-related stressors leading to uncontrolled asthma [14, 17].

Prior studies have reported an increased risk of learning disabilities in children with asthma [18, 19]. More specifically, it has been found that asthma is associated with poor executive function of children, i.e. the management of cognitive processing [20, 21], which in turn affects their learning performance [22, 23].

This work studies asthma and learning disabilities in US during the years 2009–2018 with a view to find statistically significant indicators for asthma and a possible association between asthma and learning disabilities.

Material and methods

The data used in this work originates from the National Health Interview Survey (NHIS) dataset [24] and covers the period 2009–2018. The number of children with asthma studied was 64,427. The statistical methods used to derive the results of this work were the chi-square test and One-way Analysis of Variance (ANOVA) for categorical continuous variables, respectively, in order to check the statistical significance of asthma in relation to the socio-economic characteristics of patients, such as gender, age, race, family structure, parents’ education, family income, poverty status, health insurance coverage, place of residence and origin. Factors that ascertain the incidence of asthma were evaluated by using multiple logistic regression analysis. To better estimate the predictors of asthma, data concerning children with a new diagnosis of asthma compared to a matched cohort group of children without asthma was used. More specifically, the control group of children was made up of the target population without asthma with the same socio-economic characteristics as the group of asthmatic children. The data was weighted before analyzed. Predictors were presented using the...
OR and 95% confidence intervals, and \( p < 0.05 \) was regarded as statistically significant. The study was conducted using the IBM SPSS 25 software package for Windows. An opinion from the bioethics committee was not necessary for this work.

**Results**

To test the zero hypotheses that the mean of the children in the United States with asthma did not differ in accordance with their socio-economic characteristics, the chi-square test and One-way Analysis of Variance (ANOVA) were used. As shown in Table 1, there is a statistically significant difference in the number of asthmatic children in relation to gender and age, and this occurs mainly in males (57.4%) in the age group of 5–11 (43.9%), while the most common origin and race was white (69.6%) compared to Hispanic or Latino (42.9%). The parents’ education found to be statistically significant was “More than a high school diploma” (66.3%). The poverty status found to be statistically significant was “not poor” (48.4%), with a family income of $35,000 or more (37.6%). Health insurance coverage considered statistically significant was private (45.7%). In addition, the current health status that most asthmatic children had was “Excellent or very good” (67.7%). Moreover, most asthmatic children had both a mother and father as the family structure (57.3%). Finally, the region with the most frequent occurrence of asthma was the South (39.1%), with a population size of one million or more (54.4%).

Table 2 represents the multiple logistic regression analysis and Odds Ratios with the aim of finding the predictors for the incidence rate of asthma.

| Characteristics of children with asthma: United States 2009–2018 | Number of patients | Percentages | \( p \) |
|---------------------------------------------------------------|--------------------|-------------|------|
| **Gender**                                                    |                    |             |      |
| Male                                                          | 36,999             | 57.4%       | 0.000|
| Female                                                        | 27,428             | 42.6%       |      |
| **Age**                                                       |                    |             |      |
| 3–4                                                          | 10,139             | 15.7%       | 0.000|
| 5–11                                                         | 28,291             | 43.9%       |      |
| 12–17                                                        | 25,996             | 40.4%       |      |
| **Race**                                                      |                    |             |      |
| White                                                         | 41,273             | 69.6%       | 0.000|
| Black or African American                                     | 15,944             | 26.9%       |      |
| Asian                                                         | 2,076              | 3.5%        |      |
| **Origin**                                                    |                    |             |      |
| Hispanic or Latino                                            | 14,295             | 29.3%       | 0.000|
| Mexican or Mexican American                                   | 8,182              | 16.6%       |      |
| Not Hispanic or Latino                                        | 50,132             | 38.7%       |      |
| White. Single race                                            | 29,378             | 32.2%       |      |
| Asian. Single race                                            | 14,902             | 21.2%       |      |
| **Parent’s education**                                        |                    |             |      |
| Less than a high school diploma                               | 7,386              | 12.0%       | 0.000|
| High school diploma                                          | 13,269             | 21.6%       |      |
| More than a high school diploma                               | 40,674             | 66.3%       |      |
| **Family income**                                             |                    |             |      |
| Less than $35,000                                             | 24,083             | 24.9%       | 0.000|
| $35,000 or more                                               | 36,351             | 37.6%       |      |
| $35,000–$49,999                                               | 7,698              | 8.0%        |      |
| $50,000–$74,999                                               | 8,890              | 9.2%        |      |
| $75,000–$99,999                                               | 6,434              | 6.6%        |      |
| $100,000 or more                                              | 13,328             | 13.8%       |      |
| **Poverty status**                                            |                    |             |      |
| Poor                                                          | 16,753             | 27.4%       | 0.000|
| Near poor                                                     | 14,814             | 24.2%       |      |
| Not poor                                                      | 29,600             | 48.4%       |      |
| **Health insurance coverage**                                 |                    |             |      |
| Private                                                       | 30,444             | 47.4%       | 0.000|
| Medicaid                                                     | 29,354             | 45.7%       |      |
| Other coverage                                                | 1,379              | 2.1%        |      |
| Uninsured                                                     | 2,998              | 4.7%        |      |
| **Current health status**                                     |                    |             |      |
| Excellent or very good                                        | 43,619             | 67.7%       | 0.000|
| Good                                                          | 16,177             | 25.1%       |      |
| Fair or poor                                                  | 4,624              | 7.2%        |      |
| **Family structure**                                          |                    |             |      |
| Mother and father                                             | 36,900             | 57.3%       | 0.000|
| Mother, no father                                             | 22,459             | 34.9%       |      |
| Father, no mother                                             | 2,081              | 3.2%        |      |
| Neither mother nor father                                      | 2,988              | 4.6%        |      |
| **Place of residence**                                        |                    |             |      |
| (MSA: Metropolitan Statistical Area)                          |                    |             |      |
| Large MSA (population size 1 million or more)                 | 35,080             | 54.4%       | 0.000|
| Small MSA (less than 1 million)                               | 19,989             | 31.0%       |      |
| Not in MSA                                                    | 9,359              | 14.5%       |      |
| **Region**                                                    |                    |             |      |
| Northeast                                                    | 11,806             | 18.3%       | 0.000|
| Midwest                                                      | 14,304             | 22.2%       |      |
| South                                                        | 25,165             | 39.1%       |      |
| West                                                         | 13,151             | 20.4%       |      |
Table 2. Statistically significant predictors of asthma in children using multivariate logistic regression

| Socio-economic characteristics of children: United States 2009–2018 | Patients | Controls | OR (95%CI)     | p     |
|---------------------------------------------------------------|----------|----------|----------------|-------|
| **Gender**                                                   |          |          |                |       |
| Male                                                         | 36,999   | 339,740  | 1.32 (1.29–1.34) | 0.000 |
| Female                                                       | 27,428   | 332,440  | 1.0 (ref)       |       |
| **Age**                                                      |          |          |                |       |
| 3–4                                                          | 10,139   | 192,620  | 0.44 (0.43–0.46) | 0.000 |
| 5–11                                                         | 28,291   | 258,945  | 0.93 (0.91–0.94) | 1.0 (ref) |
| 12–17                                                        | 25,596   | 221,701  | 1.0 (ref)       |       |
| **Race**                                                     |          |          |                |       |
| White                                                        | 41,273   | 505,986  | 1.36 (1.30–1.42) | 0.000 |
| Black or African American                                    | 15,944   | 92,617   | 2.87 (2.74–3.01) | 1.0 (ref) |
| Asian                                                        | 2,076    | 34,665   | 1.0 (ref)       |       |
| **Origin**                                                   |          |          |                |       |
| Hispanic or Latino                                           | 14,295   | 163,857  | 0.50 (0.49–0.51) | 0.000 |
| Mexican or Mexican American                                  | 8,182    | 111,476  | 0.42 (0.41–0.43) | 1.06 |
| Not Hispanic or Latino                                       | 50,132   | 509,413  | 0.56 (0.55–0.57) | 1.0 (ref) |
| White. Single race                                            | 29,378   | 360,128  | 0.46 (0.46–0.47) |       |
| Black or African American. Single race                       | 14,902   | 85,791   | 1.0 (ref)       |       |
| **Parent’s education**                                       |          |          |                |       |
| Less than a high school diploma                              | 7,386    | 77,344   | 1.06 (1.03–1.09) | 0.000 |
| High school diploma                                          | 13,269   | 121,150  | 1.22 (1.19–1.24) | 1.0 (ref) |
| More than a high school diploma                              | 40,674   | 452,985  | 1.0 (ref)       |       |
| **Family income**                                            |          |          |                |       |
| Less than $35,000                                            | 24,083   | 187,145  | 1.68 (1.64–1.72) | 0.000 |
| $35,000–$49,999                                              | 36,351   | 435,351  | 1.09 (1.07–1.11) | 1.0 (ref) |
| $50,000–$74,999                                              | 7,698    | 76,584   | 1.31 (1.27–1.35) | 1.06 |
| $75,000–$99,999                                              | 8,890    | 105,637  | 1.10 (1.07–1.13) | 1.0 (ref) |
| $100,000 or more                                             | 6,434    | 78,476   | 1.07 (1.04–1.10) |       |
| **Poverty status**                                           |          |          |                |       |
| Poor                                                         | 16,753   | 127,161  | 1.62 (1.59–1.65) | 0.000 |
| Near poor                                                    | 14,814   | 143,080  | 1.27 (1.24–1.30) | 1.0 (ref) |
| Not poor                                                     | 29,600   | 364,562  | 1.0 (ref)       |       |
| **Health insurance coverage**                                |          |          |                |       |
| Private                                                      | 30,444   | 368,283  | 1.15 (1.11–1.19) | 0.000 |
| Medicaid                                                     | 29,354   | 241,965  | 1.69 (1.62–1.76) | 1.0 (ref) |
| Other coverage                                               | 1,379    | 18,626   | 1.03 (0.96–1.10) |       |
| Uninsured                                                    | 2,998    | 41,836   | 1.0 (ref)       |       |
| **Current health status**                                    |          |          |                |       |
| Excellent or very good                                       | 43,619   | 576,170  | 0.15 (0.14–0.15) | 0.000 |
| Good                                                         | 16,177   | 87,678   | 0.37 (0.35–0.38) | 1.0 (ref) |
| Fair or poor                                                 | 4,624    | 9,311    | 1.0 (ref)       |       |
| **Family structure**                                         |          |          |                |       |
| Neither mother nor father                                     | 2,988    | 19,793   | 1.95 (1.87–2.02) | 0.000 |
| Mother, no father                                            | 22,459   | 152,297  | 1.90 (1.87–1.93) | 1.0 (ref) |
| Father, no mother                                            | 2,081    | 24,641   | 1.90 (1.94–2.00) |       |
| Mother and father                                            | 36,900   | 476,338  | 1.0 (ref)       |       |
| **Place of residence (MSA: Metropolitan Statistical Area)**   |          |          |                |       |
| Large MSA (population size 1 million or more)                | 35,080   | 367,925  | 0.97 (0.95–0.99) | 0.000 |
| Small MSA (less than 1 million)                              | 19,989   | 209,851  | 0.97 (0.94–0.99) | 1.0 (ref) |
| Not in MSA                                                   | 9,359    | 95,491   | 1.0 (ref)       |       |
| **Region**                                                   |          |          |                |       |
| Northeast                                                    | 11,806   | 107,676  | 1.37 (1.34–1.41) | 0.000 |
| Midwest                                                      | 14,304   | 152,408  | 1.17 (1.14–1.20) | 1.0 (ref) |
| South                                                        | 25,165   | 248,270  | 1.27 (1.24–1.29) |       |
| West                                                         | 13,151   | 164,918  | 1.0 (ref)       |       |

As can be seen in Table 2, all prognostic factors are statistically significant (p < 0.05). Based on multiple logistic regression, the risk of asthma is significantly higher in males (OR 1.32), as well as in the age group of 12–17 (OR 1.0). Black or African American (OR 2.87) and “High school diploma” as parents’ educational status (OR 1.22). Moreover, those with a family income “less than $35,000” are almost two times more at risk of developing asthma (OR 1.67). In addition, the risk of asthma is significantly higher with a poverty status of “poor” (OR 1.62) and with health insurance coverage indicated as “Medicaid” (OR 1.69). Children with neither mother nor father are two times more at risk of developing asthma (OR 1.95), while those with a current health status of “Fair or poor” are also at a higher risk. Finally, the risk of asthma is significantly higher in the “Northeast” region (OR 1.37) and place of residence listed as “not in a Metropolitan Statistical Area” (OR 1.0).

Figure 1 represents the trends in asthma and learning disabilities during the years 2009–2018 in the US. The occurrence of asthma decreased, while learning disabilities continued to increase from 2009 to 2018.
sis was used for children with learning disabilities. As shown in Table 3, family structure and race play an essential role in the occurrence of learning disabilities. Black or African American children who have neither mother nor father have the highest risk for the occurrence of learning disabilities (OR 3.0 and 1.5, respectively). Family income, gender and parents’ education are also prognostic risks for learning disabilities. More specifically, those with family income “less than $35,000” (OR 2.3), males (OR 1.71) and “less than a high school diploma” indicated as parents’ education status (OR 1.5) are at a higher risk for learning disabilities. Moreover, the risk of learning disabilities is significantly higher with age 12–17 (OR 1.0), as well as in those of Black or African American origin (OR 1.0). The risk of learning disabilities is significantly higher with a poverty status of “poor” (OR 2.0) and in those with health insurance coverage indicated as “Medicaid” (OR 1.8). Finally, the risk of learning disabilities is higher in those with a current health status of “Fair or poor” (OR 1.0).

### Discussion

Greater focus should be given to the prognostic factors that had the highest Odds Ratio. It should be pointed out that the socio-economic characteristic of asthmatic children with the highest risk is family structure, and more specifically, it was found that children with neither mother nor father have the highest risk of developing asthma (OR 1.95). Additionally, family income and parents’ education play a key role in developing this type of disease. Children with family income “Less than $35,000” and “High school diploma” indicated as parents’ education are twice as likely to be at risk of having asthma (OR 1.68 and 1.22, respectively). Finally, race is a prognostic risk for this type of disease, as it was found that Black or African American males are at a higher risk of developing asthma (OR 2.67 and 1.32, respectively).

#### Table 3. Multivariate logistic regression

| Learning disabilities in children | Children with LD | Controls | Odds ratio (95% CI) | p |
|----------------------------------|------------------|----------|---------------------|---|
| **Gender**                       |                  |          |                     |   |
| Male                             | 30,061           | 285,295  | 1.71 (1.67–1.74)    | 1.0 (ref) | 0.000 |
| Female                           | 17,487           | 284,169  |                     |   |
| **Age**                          |                  |          |                     |   |
| 1–4                              | 2,420            | 80,834   | 0.28 (0.26–0.30)    | 0.74 (0.72–0.76) | 1.0 (ref) | 0.000 |
| 5–11                             | 21,177           | 266,059  |                     |   |
| 12–17                            | 23,952           | 223,745  |                     |   |
| **Race**                         |                  |          |                     |   |
| White                            | 35,111           | 424,057  | 2.5 (2.3–2.7)       | 3.0 (2.9–3.2) | 1.0 (ref) | 0.000 |
| Black or African American         | 8,267            | 242,913  |                     |   |
| Asian                            | 983              | 30,201   |                     |   |
| **Origin**                       |                  |          |                     |   |
| Hispanic or Latino               | 10,570           | 136,434  | 0.78 (0.75–0.8)     | 0.71 (0.69–0.74) | 1.0 (ref) | 0.000 |
| Mexican or Mexican American      | 6,607            | 92,513   |                     |   |
| Not Hispanic or Latino           | 36,980           | 434,196  | 0.85 (0.83–0.88)    | 0.86 (0.84–0.88) | 1.0 (ref) | 0.000 |
| White. Single race                | 25,984           | 302,728  |                     |   |
| Black or African American. Single race | 7,676 | 77,259   |                     |   |
| **Parent’s education**           |                  |          |                     |   |
| Less than a high school diploma  | 6,940            | 63,908   | 1.5 (1.4–1.5)       | 1.4 (1.3–1.4) | 1.0 (ref) | 0.000 |
| High school diploma              | 10,157           | 101,156  |                     |   |
| More than a high school diploma  | 27,965           | 385,959  |                     |   |
| **Family income**                |                  |          |                     |   |
| Less than $35,000                 | 19,318           | 153,275  | 2.3 (2.2–2.3)       | 1.23 (1.2–1.26) | 1.6 (1.5–1.6) | 1.3 (1.4–1.5) | 1.2 (1.14–1.23) | 1.0 (ref) | 0.000 |
| $35,000–$49,999                   | 25,353           | 373,386  |                     |   |
| $50,000–$74,999                   | 5,531            | 64,804   | 1.6 (1.5–1.7)       | 1.5 (1.4–1.6) | 1.3 (1.4–1.5) | 1.2 (1.14–1.23) | 1.0 (ref) | 0.000 |
| $75,000–$99,999                   | 6,975            | 88,497   |                     |   |
| $100,000 or more                  | 4,388            | 66,734   |                     |   |
| **Poverty status**               |                  |          |                     |   |
| Poor                             | 13,435           | 103,107  | 2.0 (2.0–2.1)       | 1.6 (1.6–1.7) | 1.0 (ref) | 0.000 |
| Near poor                        | 12,209           | 120,563  |                     |   |
| Not poor                         | 19,864           | 313,776  |                     |   |
| **Health insurance coverage**    |                  |          |                     |   |
| Private                          | 19,597           | 320,083  | 0.90 (0.8–0.9)      | 1.8 (1.7–1.9) | 1.1 (1.0–1.2) | 1.0 (ref) | 0.000 |
| Medicaid                         | 23,999           | 195,893  |                     |   |
| Other coverage                   | 1,154            | 15,287   |                     |   |
| Uninsured                        | 2,526            | 37,192   |                     |   |
| **Current health status**        |                  |          |                     |   |
| Excellent or very good           | 29,937           | 485,316  | 0.11 (0.10–0.12)    | 0.30 (0.29–0.31) | 1.0 (ref) | 0.000 |
| Good                             | 13,196           | 77,331   |                     |   |
| Fair or poor                     | 4,401            | 7,899    |                     |   |
| **Family structure**             |                  |          |                     |   |
| Neither mother nor father        | 26,828           | 396,020  | 1.5 (1.4–1.6)       | 0.76 (0.72–0.8) | 1.3 (1.3–1.4) | 1.0 (ref) | 0.000 |
| Mother, no father                | 16,317           | 134,129  |                     |   |
| Father, no mother                | 2,006            | 22,620   |                     |   |
| Mother and father                | 2,396            | 17,866   |                     |   |
| **Place of residence**           |                  |          |                     |   |
| Large MSA (population size 1 million or more) | 24,738 | 313,870 | 0.75 (0.73–0.77) | 0.9 (0.8–0.9) | 1.0 (ref) | 0.000 |
| Small MSA (less than 1 million)  | 15,130           | 159,785  |                     |   |
| Not in MSA                       | 7,681            | 73,310   |                     |   |
| **Region**                       |                  |          |                     |   |
| Northeast                        | 8,895            | 92,041   | 1.3 (1.3–1.4)       | 1.1 (1.1–1.2) | 1.1 (1.1–1.2) | 1.0 (ref) | 0.000 |
| Midwest                          | 10,835           | 128,938  |                     |   |
| South                            | 17,719           | 211,029  |                     |   |
| West                             | 10,102           | 138,623  |                     |   |
It is also worth noting that the socio-economic characteristics of children with learning disabilities with the highest Odds Ratio were the same as those of asthmatic children. Deprivation of family and financial comfort were found to be the principal prognostic risk factor for both asthma and learning disabilities, which indicates a possible link between asthma and learning disabilities. It has also been found that not only deprivation but also the death of both mother and father plays a key role in the increased risk of developing these two diseases.

The importance of this study lies in the interaction of multiple socio-economic variables with asthma and learning disabilities, which reflects the complexity and multidimensional nature of deprivation, as well as the various roles of these dimensions during the course of one’s life, which in turn reflects the longest gestation period for both asthma and learning disabilities. Deprivation has been linked to stress, which in turn influences human behavior and health. More specifically, stressors in early life are responsible for the production of cortisol, a hormone that peaks in response to stressful experiences, and has not only immunological effects (hormonal disorders), but also social and behavioral problems (poor social skills and disruptive behaviors) [25–27].

Conclusions

This paper has outlined that different socio-economic variables are associated with different asthma risks, while deprivation (of family and financial comfort) proved to be the primary prognostic risk factor for asthma. Moreover, the same factor proved to be the primary prognostic risk factor for learning disabilities, which implies a possible link between asthma and learning disabilities.

Source of funding: This work was funded from the authors’ own resources.

Conflicts of interest: The authors declare no conflicts of interest.

References

1. National Institutes of Health, National Heart, Lung, and Blood Institute. Expert panel report 3. Guidelines for the diagnosis and management of asthma. Bethesda (MD): US Department of Health and Human Services, National Institutes of Health, National Heart, Lung, and Blood Institute; 2007.

2. The Global Asthma Report 2018. Available from URL: http://www.globalasthmareport.org/.

3. Moorman JE, Akinbami LJ, Bailey CM, et al. National surveillance of asthma: United States, 2001–2010. Vital Health Stat 3 2012; 3: 1–58.

4. Akinbami LJ, Simon AE, Rossen LM. Changing trends in asthma prevalence among children. Pediatrics 2016; 137: e20152354.

5. Dietert RR. Maternal and childhood asthma: risk factors, interactions, and ramifications. Reprod Toxicol 2011; 32: 198–204.

6. Bloomberg GR, Banister C, Sterkel R, et al. Socioeconomic, family, and pediatric practice factors that affect level of asthma control. Pediatrics 2009; 123: 829–835.

7. Martínez FD. Genes, environments, developmental model and asthma: a reappraisal. Eur Respir J 2007; 29: 179–184.

8. Dietert RR. Maternal and childhood asthma risk factors, interactions, and ramifications. Reprod Toxicol 2011; 32: 198–204.

9. Akinbami LJ, Schoendorf KC. Trends in childhood asthma: prevalence, health care utilization, and mortality. Pediatrics 2002; 110: 315–322.

10. Ashley MJ, Montefort S, Bjorksten B, et al. Worldwide time trends in the prevalence of symptoms of asthma, allergic rhinoconjunctivitis, and eczema in childhood: ISAAC Phases One and Three repeat multicountry cross-sectional surveys. Lancet 2006; 368: 733–743.

11. Strachan DP. The role of environmental factors in asthma. Br Med Bull 2000; 56: 865–882.

12. Goodwin RD. Environmental tobacco smoke and the epidemic of asthma in children: the role of cigarette use. Ann Allergy Asthma Immunol 2007; 98: 447–454.

13. Bülöw A von, Kriegbaum M, Backer V, et al. Poor asthma control is associated with low socio-economic status: results from a nationwide cross-sectional study of Danish patients with asthma. Eur Respir J 2015; 46: PA2042.

14. Fanta K, Daba F. Uncontrolled asthma and associated factors among adult asthmatic patients on follow-up at chest clinic of Jimma university specialized hospital, South-West Ethiopia. Indo American Journal of Pharmaceutical Research 2016; 6: 7089–7097.

15. Uphoff E, Cabieses B, Pinart M, et al. A systematic review of socioeconomic position in relation to asthma and allergic diseases. Eur Respir J 2015; 46: 364–374.

16. Carroll, K. Socioeconomic status, race/ethnicity, and asthma in youth. Am J Respir Crit Care Med 2013; 188: 1180–1181.

17. Rodríguez EM, Gulbas LE, Horner SD, et al. Stress and coping in pediatric asthma: the experiences of low-SES Latinx families. Clin Pract Pediatr Psychol 2019; 8(2): 126–138.

18. Fowler MG, Davenport MG, Garg R. School functioning of US children with asthma. Pediatrics 1992; 90: 939–944.

19. Blackman JA, Gurka MJ. Developmental and behavioral comorbidities of asthma in children. J Dev Behav Pediatr 2007; 28: 92–99.

20. Lezak MD, ed. Neuropsychological assessment. New York: Oxford University Press; 2004.

21. Fryt J, Pilecka W, Smoleń T. Importance of symptom control: self-regulation in children with diabetes type 1 and asthma. Stud Psychol 2013; 51: 5–18.

22. Kehagia AA, Murray GK, Robbins TW. Learning and cognitive flexibility: frontostriatal function and monoaminergic modulation. Curr Opin Neurol 2010; 20: 199–204.

23. Best JR, Miller PH, Naglieri JA. Relations between executive function and academic achievement from ages 5 to 17 in a large, representative national sample. Learn Individ Diff 2011; 21: 327–336.

24. National Center for Health Statistics. Data file documentation. National Health Interview Survey, 2016 [cited 25.02.2020]. Available from URL: https://www.cdc.gov/nchs/nhis.htm.

25. Gustafsson PE, Janslert U, Theorell T, et al. Life-course socioeconomic trajectories and diurnal cortisol regulation in adulthood. Psychoneuroendocrinology 2010; 35(4):613–623.

26. Hajić M, Diez-Roux A, Franklin TG, et al. Socioeconomic and race/ethnic differences in daily salivary cortisol profiles: the multi-ethnic study of atherosclerosis. Psychoneuroendocrinology 2010; 35(6): 932–943.

27. Lupis SJ, King S, Meaney MJ, et al. Can poverty get under your skin? basal cortisol levels and cognitive function in children from low and high socioeconomic status. Dev Psychopathol 2001; 13(3): 653–676.

Tables: 3
Figures: 1
References: 27
Received: 25.03.2020
Reviewed: 2.04.2020
Accepted: 3.04.2020

Address for correspondence:
Irene Rethemiotaki, MSc
Technical University of Crete
Campus Kounoupidiana
GR-73100 Chania
Greece
Tel.: 6948588518
E-mail: eirinireth@yahoo.gr