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# Effect of Asthma and Cystic Fibrosis on Health Utilization and Education Progress in Children and Adolescents.

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# Abstract

**Aims.** To determining the effect of asthma, cystic fibrosis (CF), and both on healthcare utilization, absences from school, and rate of progress in school.

**Background.** Previous studies on academic progression and health care utilization in children with the respiratory diseases of asthma and CF have been limited or conflicting.

**Design.** Non experimental, cross-sectional, secondary data analysis using a multilevel probability sample.

**Methods.** The response of all persons under 18 years of age in the U.S. 1997-2012 National Health Interview Survey to interviewer questions on demographic, educational, and health care utilization items were analyzed. The mean and 95% confidence intervals for these variables were compared for children with asthma, CF, and controls.

**Results/Findings.** Children with asthma, CF, or both had a higher utilization of all major types of healthcare services than children with neither of these conditions. Children with asthma or CF were more likely to have not only poor health, but more rapid declines in recent health with the greatest decline in those with both conditions. The number of missed school days was also higher, and highest in children with both CF and asthma. Despite the many missed school days, children with asthma paradoxically had a greater rate of progression in school than those without asthma. Those with CF or CF with asthma had a slower rate.

**Conclusion.** Asthma in CF has a negative impact on attendance and progress in school largely opposite that of asthma alone.

# Key Words

Cystic Fibrosis, Asthma, Education, Hospitalization, Children, Adolescents, School, Absenteeism, Emergency Room, Emergency Department, Minors, Academic Progress, Primary Health Care, Length of Stay, Nursing

# Summary Statement

**Why is this research or review needed?**

- Previous findings on the effect of asthma on school absenteeism and progress in school have been conflicting.
- Few studies have been conducted on the effects of cystic fibrosis on health care utilization, and none on school absenteeism and rate of progress in school.
- The size and nature of the compounding effects of asthma on cystic fibrosis have not been studied despite their importance in life fulfillment.

**What are the key findings?**

- Children with asthma, CF, or both had a higher utilization of all major types of healthcare services than children with neither of these conditions.
- Children with asthma or CF were more likely to have not only poor health, but more rapid declines in recent health with the greatest decline in those with both conditions.
- The number of missed school days was also higher, and highest in children with both CF and asthma.
- Despite the many missed school days, children with asthma paradoxically had a greater rate of progression in school than those without asthma. Those with CF or CF with asthma had a slower rate.

**How should the findings be used to influence policy/practice/research/education?**

- Asthma does not appear to have a harmful effect on progression in school, so there is not need to provide academic intervention programs that target all children with asthma.
- Cystic fibrosis does have a harmful effect on school absences and progression, particularly if there is a dual diagnosis of asthma, so early intervention and aggressive treatments for asthma, as well as targeted academic programs, are recommended.

# Introduction

## Background

Many studies have been conducted on the effect of asthma on healthcare utilization and absentee school days; however, few have focused on the effects of cystic fibrosis (CF). Moreover, the previous findings in asthma are conflicted so a clear picture of its effects on healthcare visits and school absenteeism is difficult to form. Cystic fibrosis is a condition that affects many organs and leads to a failure to thrive (Mogayzel *et al.* 2013). Asthma and CF both can severely impair respiration, leading to partial or complete suffocation, but the pathophysiological mechanisms are distinct. For asthma, the active constriction of the airways in response to aeroallergens causes the airway obstruction. Asthma is generally treated with medications that reverse the airway constriction (bronchodilators). The cause of airway obstruction in CF is a buildup of abnormally thick mucus, which is treated with medications that dissolve the mucus (mucolytic) and chest percussion therapy. The etiology of asthma is not known (Subbarao *et al* 2009). On the other hand, CF is known to have a genetic origin: a gene that disables chloride ion channels thereby thickening mucus along the epithelial linings of the airways (Watson *et al.* 2004, Jenkins & Glenn 2013, Hull *et al.* 2013). The question of whether or not asthma is more common in children with CF than usual has not been resolved (Subbarao *et al* 2009), although a recent study suggested that CF predisposes a child to asthma (Jenkins and Glenn 2013).

In regards to asthma survivor's educational progress, most studies at the school district or national level have found that adolescent children with asthma have an increased risk of absenteeism, which could impact a child's educational progress (Lipstein *et al*. 2009, Millard *et*

*al*. 2009, Moonie *et al*. 2010). The few studies conducted on the rate of progress through school have been inconclusive. Two studies concluded that absenteeism leads to a slower rate of progress (Basch *et al*. 2011, Moonie *et al*. 2010), while another two concluded that the greater absenteeism in asthma does not lead to a slower rate of progress.

Studies in a large number of countries have shown that children with asthma use health care services such as hospitals and emergency departments far more than usual, but use office visits to healthcare providers less than expected (Chua *et al*. 2013, Kim *et al*. 2008, Akinbami *et al*., 2011, Guilbert *et al*. 2011). A recent national study showed that 9.7% of young adults with asthma visit the Emergency Departments in any given year (Chua *et al*. 2013). Guilbert *et al*. (2011) reported that asthma survivors who have limited control of their asthma have a lower quality of life and henceforth require an increased amount of healthcare utilization due to a need for education on the importance of using inhalers and other medicines regularly. Minority and socioeconomically underprivileged asthma children use emergency department and urgent care facilities over primary preventive care even more than other categories of children (Kim *et al*. 2008). The specific role of increased hospital stays in academic progress has not been systematically studied, nor has previous research addressed whether the educational and health care utilization effects of CF are the same or different than those diagnosed with asthma or with the combination of CF and asthma.

With regard to CF, few studies have directly and systematically focused on the effects of CF on health care utilization, school absenteeism, and academic progress in school. A classic study (Goldberg *et al*. 1979) touched on this issue, reporting that adolescents with CF group scored lower on vocational educational planning but scored higher on commitment to work values and vocational choice (O'Sullivan *et al*. 2011). Another study also touched on this issue

in CF patients of all ages who have acquired pulmonary infections, where it was determined that there was an increased use of hospital services on average (O'Sullivan *et al*. 2011). This partially refuted and older study which found that significantly increased use of major healthcare resources was only observed in patients with a more severe disease based on the Epidemiological Study of Cystic Fibrosis (ESCF) (Konstan *et al*. 1999). Although the above studies provide fragmentary evidence related to hospital stays, school absenteeism, and academic progress, a study that directly addresses this question in children with either CF or CF with asthma has not been conducted, and is likely overdue.

# The Study

### Aim

The aims of the present study therefore was to (1) confirm or refute previous findings that asthma is associated with more missed school and more visits for heath care without reducing educational progress can be confirmed, and (2) determine for the first time whether the same holds for CF and for the dual diagnosis of CF with asthma.

### Design

Non experimental, cross-sectional, secondary data analysis.

### Sample/Participants

The sample type was a multilevel probabilistic sample using stratified, cluster, and random sampling methods within the levels. The sample was extracted from the Integrated Health Interview Series (a compilation of the National Health Interview Survey (NHIS) by the Minnesota Population Center (2012). The sample criteria were minors (under 18 years of age) living within the U.S. This was a multi-level probability sample containing hundreds of thousands of children and adolescents that are interviewed each year but because of the low prevalence of CF, only between two to four cases are interviewed yearly. The core survey questionnaire for this sample has been constant since 1997, so the data used in this study contained the survey data from 1997 through 2012, in order to obtain a sufficient sample size of children and adolescents with the rare condition of CF. The strength of this study is that the data came from a probability sample method, so all findings from this study are generalizable nationwide if statistical methods are used that take the complex sample design into account.

**Data Collection**

Survey items were extracted on demographic variables, diagnosis of CF, diagnosis of asthma, the number of missed school days per year, self-reported health status, number of nights in a hospital per year, number of times admitted into the emergency department (ED) per year, and the total amount of office visits per year. The key question of whether or not a child had CF or asthma was determined in a face-to-face interview. Questions were directed to the guardian of the child, asking whether or not the child was ever diagnosed as having CF or asthma by a healthcare professional.

## Data Analysis

The data were imported into SAS 9.2. Non-response codes such as 0, 97, 998, and 9997 were coded as missing values. The variable for number of emergency department visits per year was not an ordinal variable; it was transformed to be ordinal as shown in the appendix. No other transformations or recodes were made. The statistical analysis used group mean calculations when the dependent variable was a continuous variable and crosstabulation when it was a nominal variable. The independent variable (the independent variable presence of asthma and CF) in every analysis was nominal. The dependent variables were the academic progress, health status, and healthcare utilization variables that were extracted. The cases in the NHIS sample do not have equal weights as they would if only random or convenience sampling were used, so they cannot be analyzed accurately with the usual methods found in statistical software but require special methods such as methods based on Taylor series linearization. The domain analysis capabilities in the *surveymeans* or *surveyfreq* procedures in SAS 9.2 were used because they allowed subpopulation analysis while compensating for the three different embedded case weights in the NHIS sample design (cluster, random, and stratified sample case weights) by Taylor linearization. The statistical analysis consisted of descriptive statistics and a one way analysis variance (ANOVA) for each of the 10 dependent variables across the independent variable. The 10 $p$ values from the 10 ANOVA calculations were corrected for the number of tests conducted by dividing each $p$ value by 10 to produce $p_{\text{corrected}}$ (Bonferroni correction), with $p_{\text{corrected}}$ used to determine the statistical significance of the findings.

## Validity and Reliability/Rigour

Pierannunzi *et al*. (2013) reviewed a large number of studies on the validity and reliability of the NHIS survey items and concluded that the validity and reliability were both medium to high.

# Results

### *Demographic and academic variables*

#### *Demographics*

Age was similar across all asthma and CF groups with the exception that the children with asthma were approximately a year-and-a-half older than those without asthma or CF in that the confidence limits did not overlap (Table 1). The likely reason for this is that asthma usually appears in childhood long after birth, so asthma victims would be expected to be older on average. The mean level of educational attainment was similar across all groups except that, in accordance with the age differences described above, those with asthma were in a slightly higher average school grade level (6.17, which is early sixth grade) than those without asthma or CF (5.89, which is late fifth grade). There was a trend for those with both CF and asthma to be over a full grade lower than the other groups. The average of the ordinal codes for family income range was similar across all groups, from a minimum of 17.0 to a maximum of 17.8 (Table 1). Note that all means are between 17 and 18, but this does not indicate 17 thousand per annual income; it indicates that the mean family income is closest to the code of 20 for the income range of $35,000 – $74,999 (see Appendix for a list of codes). Although exact mean income cannot be determined from the mean code, the codes are ordered transformations of income and can be

used for the purpose of determining if there are income differences in families with asthma or CF, and the differences were minor.

*Progress In School*

A more useful indicator of academic progress is the school grade level reached for the child's age, calculated as educational attainment divided by age and herein referred to as the rate of progress in school. This indicator would be expected to compensate for the older age and education level of children with asthma in order to determine whether asthma had a negative effect on academic progress. The findings in Table 1 show that those with asthma paradoxically had a greater rate of progress in school than those without asthma or CF. The explanation for this is unclear although it could be conjectured that the central nervous system stimulating effects of many types of bronchodilators (Cazzola et al., 2012) are partially or completely responsible for this paradoxical finding. Children with both CF and asthma, but not those with CF alone, had a lower rate of progress in school. As compared to children without CF or asthma, those with both CF and asthma progressed at an 18% lower rate (Table 1).

The last academic measure studied was the number of school days missed in the previous 12 months. Children without CF or asthma missed an average of 3.20 school days per year, but those with CF or asthma missed almost twice as many days (5 to 6 days) and those with both CF and asthma missed over six times as many days (21.5 days). The lower rate of progress of children with both CF and asthma, may conceivably be explained, either partially or fully, by the larger number of schools days missed.

*Health Status and Health Care Utilization*

Health status ranged from 1 (excellent) to 5 (poor). The parents of children with asthma or CF rated their child's overall health to be poorer than those without CF or asthma (Table 1). Whereas those without CF or asthma had an average health rating between very good and excellent, those with asthma were rated at very good and those with CF were rated at just good. Oddly, the health status ratings for children with CF only and children with both asthma and CF were nearly identical in the distribution of reported health status.

The health status ratings are completely subjective, of course. A more objective method of rating health is by the rate at which health care services were utilized. Health care utilization was assessed for three types of service: emergency department visits, hospital stays, and office visits to health care providers (Table 2). Note that the values for emergency department visits in Table 2 are not the actual number of emergency department visits but a transformation of this number using ordinal coding shown in the Appendix. Children with asthma had a higher frequency of visits for all three types of service than children without CF or asthma: 33% more office visits, 25% more emergency department visits, and 25% more overnight hospital stays. This can be compared to children with CF who had 108% more office visits, 21% more emergency department visits, and 19% more hospital visits. There was also a trend for children with both asthma and CF to have greater utilization of the emergency department and hospital than those with CF only.

*Health Decline*

The NHIS interviewers asked whether the health of the child is better, the same, or worse than twelve months ago. Fig. 1 shows a higher incidence of worsening health for each of the

conditions studied. The odds of worsening health doubled for asthma and tripled for CF and CF with asthma, with a trend for worsening health in CF with asthma to be more likely than in CF alone.

# Discussion

The main findings in the present study were that children with asthma, CF, or both had a greater utilization of all major types of healthcare services associated with reduced health status than children with neither of these conditions. Children with asthma or CF were more likely to have declining health with the combination of CF and asthma being associated with greatest likelihood of decline. Accordingly, children afflicted with both CF and asthma missed more school days than any other group. Despite the large number of missed school days, children with asthma paradoxically had a greater rate of progression in school than those without asthma. However, those with CF or CF with asthma had a slower rate of progression, showing the negative effects of CF on this important aspect of child development. The next question addressed is how these findings compare to or extend previous findings.

### Asthma and Utilization of Health Care Services

Before discussing health care utilization, it is important to bear in mind that the health care utilization in children with asthma or cystic fibrosis may not always be associated with these conditions, however any increases in health care use is herein assumed to be related to these conditions, even though the reasons for the utilization may not be respiratory in nature (for

example, some children with CF have feeding tubes). The present study confirms previous studies in a variety of countries that there was a markedly increased utilization of emergency and hospital health care services by children who have asthma, and a only slightly increased utilization of office visits (Akinbami *et al*., 2011). Minority and socioeconomically disadvantaged children used more emergency and urgent care services and fewer preventive care services (Kim *et al*. 2009, Chang *et al*. 2013). Although we did not address this in our study, it does point out that healthcare utilization rates cannot be assumed to be uniformed across all segments of our sample. Only a fifth of those that visited an emergency department for help with asthma did so because they believed that the emergency department managed them faster than a clinic and because they believed their symptoms were so severe that they could not wait for a clinic visit (Al-Jahdali *et al*. 2012). Instead, the main reason was lack of education about the importance of inhalers and lack of education about the consequences of uncontrolled asthma, still pointing to a need for community outreach services as found over a decade ago (Grant *et al*., 1999). Chua *et al*. (2013) performed a national study based on the 1999 to 2009 Medical Expenditure Panel Survey. They found that young adults were more likely to visit the ED within the past year at a 9.7% greater likelihood. Although our study was directed at children and adolescents, our study found an 18% increase probability to be admitted into the ED (Table 2). One possible explanation is that adults have knowledge about prevention of an asthma attack and can better control exacerbations versus children who may not.

With regard to health status, Guilbert *et al*. (2013) found that children who do not have a well-controlled asthma not only have more health care utilization, but also have a significantly lower quality of life. The findings of Guilbert *et al*. (2013) are supported by the present findings (Table 2), which show a 23.9% decrease in self-reported health status.

**CF and Utilization of Health Care Services**

Estimates of the degree of increased utilization of health care services have been provided in a number of studies. Dewitt *et al*. (2012) reported that over a 48-week period, 22% of children and adults with CF were hospitalized and 7.4 days of school or work were missed. After extrapolating from 48 weeks to a full year, the findings corresponded well to the present findings, with clarification that 5.58 school days were missed in non-asthmatic CF and 21.5 days in asthmatic CF, who comprise about one-third of the CF population. The original estimates of Konstan *et al*. (1999) and the newer estimates of Briesacher *et al*. (2011), who reported that 34.6% and 38.9% of CF patients, respectively, are hospitalized at least once per year. Bradley *et al*. (2013) reported that the average number of pulmonary exacerbations per year in British CF patients was 3.6, with a mean hospital stay of 9 days. This is over twice that found in the present study but it could reflect differences in the health care systems or policies between mostly fee: for service system in the U.S. and universal system in Britain, rather than CF severity differences between the two countries. O'Sullivan *et al*. (2011) reported that CF patients have a substantial higher level of health care utilization and costs, particularly if they acquire pulmonary infections. Thirty-four percent had a CF-related hospital stay in a one-year period and 80% had at least one CF-related office visit. The present results are in good agreement with their findings and show the magnitude of the health care burden and life interference of CF.

**Asthma and Rate of Progress in School**

A large number of studies of have been conducted on the effects of asthma on school attendance

and progress, most of which report that asthma leads to more school absenteeism (Shendell *et al*. 2010). Moonie (2008) found that children with asthma are 60% more likely to miss more than ten days of school per year. Lipstein *et al*. (2009) reported in a 2003 nationwide study that children with asthma missed 6.6 days of school per year, or 4.9 days per year if they had a parent with chronic disease. This is in good agreement with our findings that children with asthma overall missed a mean of 5.35 days of school (Table 1). They are not in agreement with the findings of Mizan *et al*. (2011) who reported only 2.73 days missed for children with asthma and only 1.89 days missed for children without asthma in a school district in Georgia. A school district in Dallas, Texas had an absentee rate of 2.59% for children with asthma (Millard *et al*. 2009). Assuming there are 180 days per school year, this calculates to 5.13 missed school days per year, in good agreement with our findings. However, our findings were not in agreement with the Millard *et al*. (2009) findings regarding the absentee rate for children without asthma, nor their conclusion that students with asthma miss no more school than those without asthma. In fact, their study showed a higher absentee rate for students without asthma, which is inconsistent with our findings in a larger and more heterogeneous population, both in terms of demographics and geographic location. Overall, our findings are most consistent with studies conducted with a national sample and less consistent with those conducted in a particular school district, which might be expected due to district-by-district demographic, health system, and education system differences.

In a study within the Clark County School District of Las Vegas, NV during 2006-2007, Moonie *et al.* (2010) found that children with asthma have a greater risk of missed school days, which is associated with grade retention. In our study, asthma survivors had a tendency to move forward in grade level despite the fact that their study suggests otherwise. We calculated the grade level

per age and found that there was a slight increase in educational attainment when compared to non-asthma survivors.

Basch (2011) and Moonie *et al*. (2010) reasoned that since absenteeism is associated with poor progression through school, the high absentee rates of asthmatic children likely leads to difficulties in academic progression. In contrast, Mooney *et al*. (2008) studied a school district in Missouri and found that children with asthma performed the same academically as those without asthma, despite having greater absentee rates, a conclusion shared by Taras & Potts-Datema (2005). In the present study with a larger and wider sample than any previous studies, asthmatics were found to progress through school faster (about 5% faster), not slower, despite also having a greater absentee rate. Thus, it appears that that the greater number of missed school days in asthmatics defies the main trend in the wider population in that it is not associated with reduced performance in school.

**CF and Rate of Progress in School**

As noted in the Introduction section, few studies have been conducted on the school and academic effects of CF, either with or without concurrent asthma. Some studies touch tangentially on this topic, however. The classic study by Goldberg *et al*. (1979) focused on adolescents with cystic fibrosis with normal adolescents of the same age and educational grade level (12-16 years old and were reported to be in grades 7, 8, and 9) on several measures of vocational development and adjustment. Findings revealed that the CF group scored lower on vocational and educational planning, and also on realism in setting financial limits. However, the CF group scored higher among the normal group in commitment to vocational choice, work

values and occupational awareness. Years ago, Walters *et al*. (1993) also reported mixed effects of CF on employment and productivity measures in adults in Britain. Most adults with CF had levels of employment and productivity that was in a normal range, in contrary to the image of chronic illness and disability, however fewer achieved the higher levels of standardized British employment qualifications, a possible effect of the CF. Grieve *et al*. (2011) asked forty adolescents with CF to complete a battery of psychometric tests. The cognitive and academic scores, including grade point average and standardized test scores, were in the normal range. Our results contrast with that of Grieve *et al*. (2011) in that children and adolescents with CF had a lower rate of educational attainment, as compared to either asthmatics (0.479 grade for age) or to children and adolescents without CF or asthma (0.480 grade for age). The two most likely explanations for the difference are the smaller sample size in the Grieve *et al*. (2011) study, which made it slightly more difficult to detect small effects that were statistically significant, or due to the fact that the Grieve *et al.* (2011) study was in adolescents whereas the present study is based on a mixture of children and adolescents.

**Pathophysiology**

At least three different mechanisms have been suggested for interaction between asthma and CF. The first comes from stereological analysis of bronchial biopsies on children that found three-fold smooth muscle cell increases by three-fold in the CF population and an extreme seven-fold in asthma survivors. What these results suggest is that preclinical asthma is more likely to develop into clinical asthma in CF survivors, suggesting that the CF condition can exacerbate preexisting, undiagnosed asthma.

A wide variety of pulmonary viruses and bacteria are detected in both CF and asthma populations due in part to the impaired immune system. One that is prevalent in CF, and leads to allergic reactions in topic patients is Aspergillus fumigatus (Knutsen and Slavin 2011). Viruses that have been found in both asthma and CF include respiratory syncytial virus and influenza. In fact, the viscous mucus secretions in CF facilitate viral infections have been implicated in secondarily evoking asthma (Singanayagam *et al*. 2012, Holtzman *et al*. 2011) went deeper by proposing that one of the manifestations of CF may be a hypersusceptibility to respiratory viruses that could initiate asthma.

Luciani *et al*. (2010) proposed that the most essential aspect of the CF disorder is disabled autophagocystosis. The impaired chloride channel appears to disrupt the autophagocytosis process by sequestering molecules required for the intracellular trafficking of molecules that need to be catabolized (Villella *et al*. 2013).

Although some of the above pathophysiological studies have suggested mechanisms by which CF and asthma interact, a major obstacle on progress has been the lack of consistent evidence that CF does in fact cause asthma exacerbation (Subbarao *et al*. 2009). Without consistent epidemiological evidence available for such interaction, the motivation for further work might be diminished.

# Limitations

Four limitations of the present study are: (1) The dependence of all findings in the present study on the parent's recall of whether or not a child had ever been clinical diagnosed with asthma or

CF; (2) One of the groups (CF with asthma) was relatively small at N =18, due to the extremely low incidence of CF; (3) The reason for hospitalization in CF is not necessarily for treatment of respiratory conditions, and as such, hospitalizations between asthma and CF may not be similar in nature; and (4) The findings of the present study can be reliably extrapolated to the U.S. population due to the use of probabilistic samples but cannot be generalized to any other countries. Nevertheless, tangential studies in a large number of countries reflect more similarities to the U.S. than differences when it comes to the impact of CF and asthma on academic and health care services.

# Conclusion

The present study confirms previous findings that asthma is associated with more visits for health care and more missed school days but refutes previous studies by finding that children with asthma have a higher rate of progression through school than children without asthma. The present study is also the first to reflect the magnitude of the negative impact CF has on the large number of missed school days and on educational attainment. Asthma contrasts with CF in that children with asthma paradoxically have a greater rate of progression through school than children without either CF or asthma. Importantly, the development of children with asthma has a multiplicative effect on school absenteeism, but with regard to other aspects of educational attainment and health care utilization, children with CF were roughly similar to those with both CF and asthma.

When taken in conjunction with other studies, the findings point to the importance of early detection and thorough patient education on caring for asthma, especially in children with

CF. This is where aggressive patient education by nurses can make a difference in the quality of life of the afflicted individual, as well as help health care systems function more efficiently by minimizing unnecessary hospital and emergency department visits.

# Appendix

List of codes for education attainment and family income in 1997 dollars.

*Family Income*

| Code | Income Range |
|---|---|
| 10 | $0 - $34,999 |
| 20 | $35,000-$74,999 |
| 30 | $75,000 and over |
| 31 | $75,000-$99,999 |
| 32 | $100,000 and over |

*Education Attainment*

| Code | Education Status |
|---|---|
| 01 | Never attended/kindergarten only |
| 02 | Grade 1 |
| 03 | Grade 2 |
| 04 | Grade 3 |
| 05 | Grade 4 |
| 06 | Grade 5 |
| 07 | Grade 6 |
| 08 | Grade 7 |
| 09 | Grade 8 |

| | |
|---|---|
| 10 | Grade 9 |
| 11 | Grade 10 |
| 12 | Grade 11 |
| 13 | 12th grade, no diploma |
| 14 | High school graduate |
| 15 | GED or equivalent |

*Health*

| **Code** | **Health Status** |
|---|---|
| 1 | Excellent |
| 2 | Very Good |
| 3 | Good |
| 4 | Fair |
| 5 | Poor |

*Emergency Department Visits*

| **Code** | **Number of Visits** |
|---|---|
| 10 | No visits |
| 20 | 1 visit |
| 30 | 2 to 3 visits |
| 40 | 4 to 9 visits |
| 50 | 10 to 12 visits |
| 60 | 13 or more visits |

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# Figure Legends

**Fig. 1.** Percentage of children and adolescents whose parents reported a decline in health of the child or adolescent in the past twelve months. (Pearson $\chi^2 = 3932$, $p<0.0005$)

# Figures

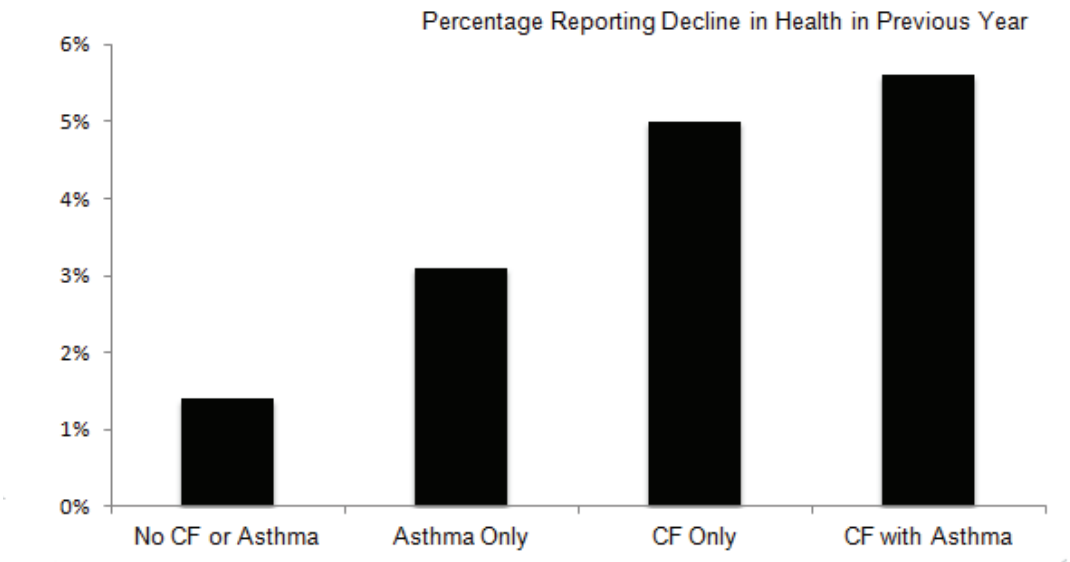


**Fig. 1.**

**Table 1**. *Demographic and academic progression for children and adolescents in the USA. Mean, 95% confidence limit (in square brackets), and sample group size (in parentheses) shown. Corrected p is the statistical significance after adjusting for the number of comparisons (10) using the Bonferroni correction method. See Appendix for list of codes for educational attainment and family income.*

| | Age | Educational Attainment | Family Income | Education Attainment For Age | School Loss Days in Past 12 Months |
|---|---|---|---|---|---|
| **No CF or Asthma** | 8.34 [8.31, 8.366] (168,892) | 5.89 [5.87, 5.91] (118,300) | 1.78 [17.7, 17.8] (124,392) | 0.480 [0.477, 0.482] (118,300) | 3.20 [3.16, 3.26] (116,400) |
| **Asthma** | 9.85 [9.79, 9.91] (24,791) | 6.17 [6.12, 6.22] (20,539) | 17.0 [16.8, 17.1] (19,233) | 0.492 [0.490, 0.490] (20539) | 5.35 [5.22, 5.47] (20,237) |
| **CF** | 8.77 [7.27, 10.272] (39) | 5.67 [4.44, 6.89] (29) | 17.1 [13.5, 20.6] (24) | 0.479 [0.410, 0.540] (29) | 5.58 [3.40, 7.76] (29) |
| **CF + Asthma** | 8.82 [6.74, 10.9] (17) | 4.50 [2.66, 6.34] (15) | 17.7 [13.7, 21.7] (15) | 0.395 [0.290, 0.450] (15) | 21.5 [4.60, 38.4] (15) |
| **$P_{corrected}$** | < 0.005 | < 0.005 | < 0.005 | < 0.005 | < 0.005 |

**Table 2.** *General health status and health utilization for children and adolescents in USA. Mean, 95% confidence limit (in square brackets), and sample group size (in parentheses) shown. Corrected p is the statistical significance after adjusting for the number of comparisons (10) using the Bonferroni correction method.*

| | **Self-Reported Health Status** | **Total Office Visits Past 12 Months** | **Number of Times in ER/ED Past 12 Months** | **Number of Nights in Hospital Past 12 Months** |
|---|---|---|---|---|
| **No CF or Asthma** | 1.59 [1.58, 1.59] (168,827) | 3.50 [3.47, 3.52] (166,829) | 13.0 [12.96, 13.04] (168,046) | .270 [.256, .284] (168,158) |
| **Asthma** | 1.97 [1.95, 1.98] (24,783) | 4.76 [4.67, 4.84] (24,546) | 15.5 [15.4, 15.6] (24,648) | .340 [.296, .384 ] (24,686) |
| **CF** | 2.92 [2.49, 3.35] (39) | 7.28 [4.19, 10.4] (39) | 14.7 [12.0, 17.4] (39) | 3.22 [-2.04, 8.48 ] (39) |
| **CF + Asthma** | 2.89 [2.44, 3.36] (17) | 6.20 [4.88, 7.51] (17) | 19.1 [13.2, 25.3] (17) | 3.42 [-4.26, 11.1] (17) |
| **P corrected** | < 0.005 | < 0.005 | < 0.005 | < 0.005 |