

# STATISTICAL NEWS

Pa. Department of Health ♦ Bureau of Health Statistics and Research ♦ Vol. 36 No. 3 ♦ 3<sup>rd</sup> Quarter 2013

## In this issue...

### Healthy People 2020: Topic Area RD (Respiratory Diseases)

#### Asthma Hospitalization Rates Highest Among Blacks and Hispanics

Asthma is a public health issue that affects roughly 25 million Americans of all ages (children and adults). According to the [U.S. Department of Health and Human Services](#), asthma is a chronic inflammatory disorder of the airways characterized by episodes of reversible breathing problems due to airway narrowing and obstruction. These episodes range widely in severity from mild to life-threatening.

[Continue reading this article >>>](#)

### Automated Consolidation of Collaborative Stage Data Items

#### Pennsylvania Cancer Registry Improves Labor Intensive Process

More than 140,000 cancer abstracts are submitted to the Pennsylvania Cancer Registry (PCR) annually by various reporting sources throughout the state. PCR staff consolidate the information from the 140,000 reports to create approximately 84,000 incidence records per year. Due to volume and staffing issues, there have historically been large backlogs in consolidation...

[Continue reading this article >>>](#)

### Cancer of the Thyroid Reviewed

#### Thyroid Cancers Increasing, but Less Deadly Compared to Other Cancers

September is Thyroid Cancer Awareness Month, a time to promote thyroid cancer awareness for early detection, as well as for risk factors, symptoms, diagnosis, treatment and advocacy. Cancers of the thyroid have become much more prevalent in recent years, with 2,728 invasive cases diagnosed in Pennsylvania in 2010. Thyroid cancer is now the eighth most commonly diagnosed cancer overall in Pennsylvania...

[Continue reading this article >>>](#)

### Wilson Score Confidence Interval for Binomial Proportions Outperforms Traditional Wald Interval

#### A “Tools of the Trade” Article

Recently, statisticians in the Bureau of Health Statistics and Research were verifying and checking some cancer incidence data when they noticed that the Wald method for confidence intervals occasionally failed. In particular, the confidence interval’s lower limit went below zero, or the upper limit went above one. Both outcomes are impossible for binomial proportions (e.g., crude rates or percentages).

[Continue reading this article >>>](#)

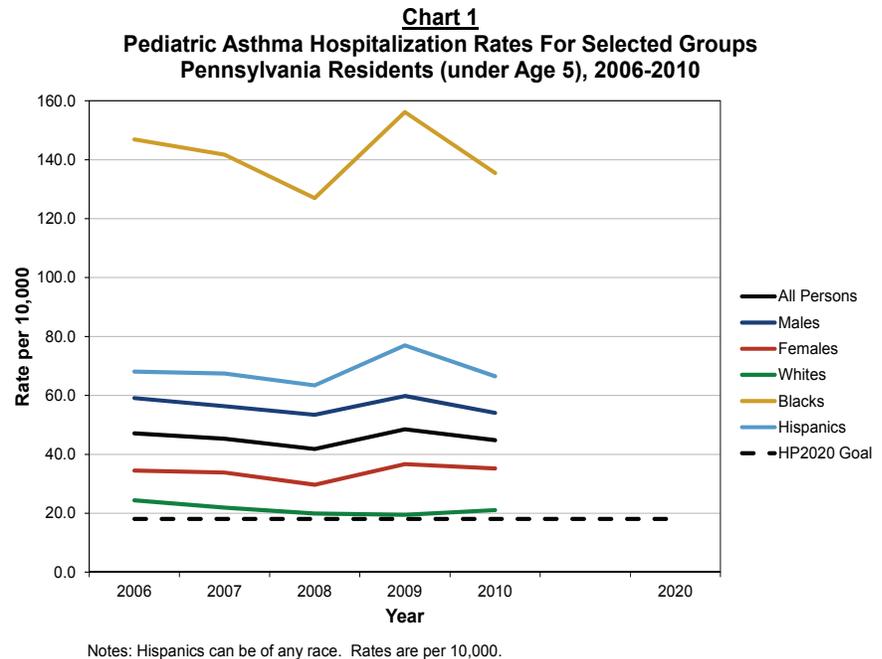
# Healthy People 2020: Topic Area RD (Respiratory Diseases)

## Asthma Hospitalization Rates Highest Among Blacks and Hispanics

Asthma is a public health issue that affects roughly 25 million Americans of all ages (children and adults) annually. According to the [U.S. Department of Health and Human Services](#), asthma is a chronic inflammatory disorder of the airways characterized by episodes of reversible breathing problems due to airway narrowing and obstruction. These episodes range widely in severity from mild to life-threatening. Asthma symptoms include wheezing, coughing, chest tightness and shortness of breath. Preventive treatment on a daily basis can prevent symptoms and attacks and enable asthmatic individuals to lead active lives.

According to the [Pennsylvania Asthma Control Program](#), asthma has no known cause associated with it. However, there are some variables which can trigger asthma attacks. These include outdoor air pollution, tobacco smoke, mold and mildew, extreme weather conditions, and strenuous physical activity. The best way to treat asthma is to take medicine as prescribed, to avoid the triggers which cause asthma attacks and (in the case of children) to use an asthma action plan. An asthma action plan contains individually tailored plans as to which medications to take and which actions to follow whenever an asthma attack takes place. This plan is put together with the help of a healthcare provider and should be given to teachers, nurses, babysitters and other caregivers.

Healthy People 2020 has devoted an entire topic area to respiratory diseases, for which most of the objectives deal with asthma. This article will focus on one of these asthma-related objectives (RD-2, asthma



hospitalizations) from a statistical viewpoint for Pennsylvania. Please note that the Pennsylvania Health Care Cost Containment Council (PHC4) provided the counts for the hospitalization data used in this article, while the rates were calculated by the Pennsylvania Department of Health, Bureau of Health Statistics and Research.

### RD-2.1: Asthma Hospitalization Rate (under 5 years of age) {2020 Target: 18.1 per 10,000}

The asthma hospitalization rate (per 10,000 population) for those under 5 years of age decreased among Pennsylvania residents by almost five percent (see Chart 1) from 2006 (47.1) to 2010 (44.8). The national Healthy People 2020 goal is a rate of 18.1 per 10,000, so while the Pennsylvania rate is headed in the right direction, it is not on target to achieve the goal. The rate for males

under 5 years old also decreased (59.1 in 2006 to 54.1 in 2010) in the past five years while remaining much higher than the 2020 target. The female rate (34.5 in 2006 to 35.2 in 2010) had a slight increase during the same time period but has consistently been much lower than the corresponding rate for males. Looking at the data by race and ethnicity shows large disparities. It is important to note that the rate for blacks (less than 5 years old) has been at least six times greater than the corresponding rate for whites throughout the five-year period. The rate for whites was close to meeting the 2020 goal (it needs to drop by just over 14 percent by the year 2020). The Hispanic rate was consistently much lower than the rate for blacks, but it has been much higher than the rate for whites and remains very far from the 2020 target of 18.1.

Continue reading this article >>>

Continued...

## Healthy People 2020: Topic Area RD (Respiratory Diseases)

### RD-2.2: Asthma Hospitalization Rate (5-64 years of age)

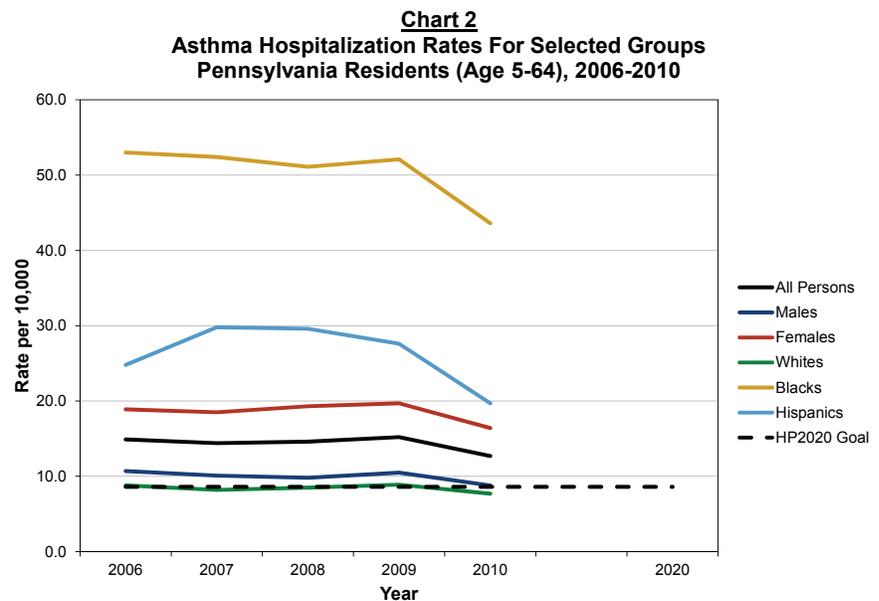
{2020 Target: 8.6 per 10,000 (age-adjusted)}

The hospitalization rate due to asthma for those between the ages of 5-64 decreased by almost 15 percent among Pennsylvania residents (see Chart 2) from 2006 (14.9) to 2010 (12.7). The national Healthy People 2020 goal is an age-adjusted rate of 8.6 per 10,000, so the Pennsylvania rate still needs to decrease by over 32 percent in order to achieve the goal. Looking at the data by gender shows that the rate for females (5-64 years old) has been almost double the rate for males throughout the five-year period. On a positive note, the male rate (8.8) was very close to meeting the HP2020 goal. Examining the data by race and ethnicity once again shows very large disparities. From 2006-2010, the age-adjusted rate for blacks (between 5 and 64 years of age) has been at least five times greater than the corresponding rate for whites. The Hispanic rate was roughly half the rate for blacks, but was still much higher than the rate for whites. One piece of good news is that the white rate (7.7) met the 2020 target in 2010.

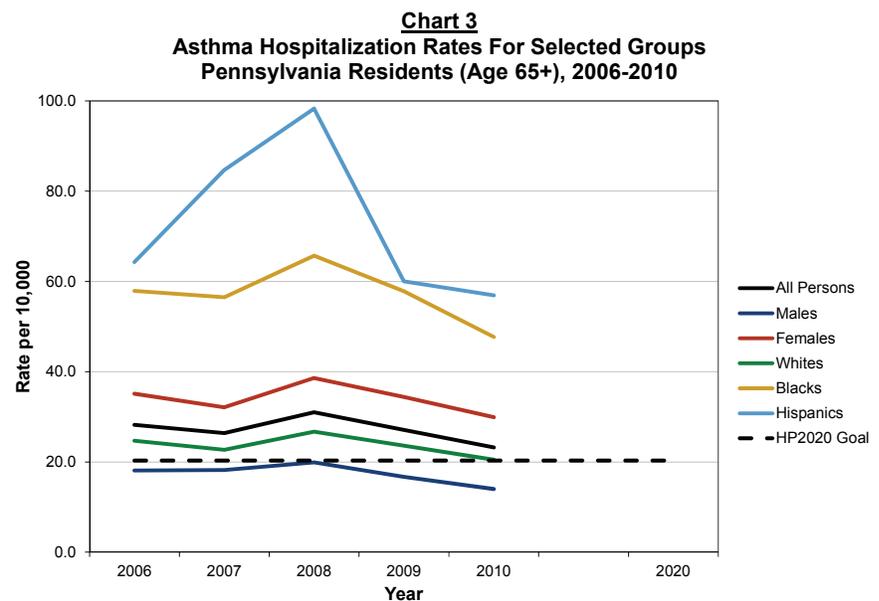
### RD-2.3: Asthma Hospitalization Rate (age 65+)

{2020 Target: 20.3 per 10,000 (age-adjusted)}

The asthma hospitalization rate (age-adjusted per 10,000 population) for those 65 years of age and older decreased among Pennsylvania residents by almost 18 percent (see Chart 3) from 2006 (28.2) to 2010 (23.2). The national Healthy People 2020 goal is an age-adjusted rate of



Notes: Rates are age-adjusted to the 2000 U.S. standard million population. Hispanics can be of any race.



Notes: Rates are age-adjusted to the 2000 U.S. standard million population. Hispanics can be of any race.

20.3 per 10,000. The Pennsylvania rate is headed in the right direction and, at its current pace, should meet the goal by 2020. The male rate (age 65 and older) has already met the 2020 goal of 20.3. However, the rate for females has been approximately twice as high as the rate for males

during the five-year period 2006-2010. Exploring the data by race and ethnicity shows that whites are very close to meeting the goal (rate of 20.5 for 2010, compared to the goal of 20.3 per 10,000). The rate for blacks (age 65 and older) has been

Continue reading this article >>>

---

Continued...

## Healthy People 2020: Topic Area RD (Respiratory Diseases)

more than double the rate for whites during this time but has been declining in recent years. The Hispanic rate has been the highest of the selected race and ethnicity groups from 2006 to 2010 and is very unlikely to meet the 2020 goal.

As the most recent data shows, Pennsylvania residents generally are not meeting the Healthy People 2020 goals for asthma hospitalization. At this point, we are early in the data

reporting for the 2020 goals, and will hopefully close the gap in future years. Most alarming are the rates for minorities. According to the U.S. Department of Health and Human Services, asthma rates are generally higher in minorities. This was found to be consistent for Pennsylvania data, as the highest rates were among blacks and Hispanics for all age groups.

### **HP2020 State and County Level Data on the Web**

To access the Department of Health's Web page of Healthy People 2020 statistics, go to [www.health.state.pa.us/stats](http://www.health.state.pa.us/stats) and select "Healthy People." The latest available statistics as well as trend data are shown. Data sets at the state and county level can be viewed and downloaded. There is also a link to the national HP2020 web site.

Return to list of articles >>>

---

# Automated Consolidation of Collaborative Stage Data Items

## Pennsylvania Cancer Registry Improves Labor Intensive Process

More than 140,000 cancer abstracts are submitted to the Pennsylvania Cancer Registry (PCR) annually by various reporting sources throughout the state. PCR staff consolidate the information from the 140,000 reports to create approximately 84,000 incidence records per year. Due to volume and staffing issues, there have historically been large backlogs in consolidation, the process by which a 'best value' is populated in the incident record from disparate values reported from different sources.

Consolidation of stage data was found to be the most labor-intensive for staff. The Collaborative Staging (CS) System was implemented in 2004 and is a detailed, complex set of data items describing how far a cancer has spread at the time of diagnosis. Based on the input values for the CS data items, summary stage and American Joint Committee on Cancer – Tumor, Node, Metastases (AJCC TNM) stage are derived and retained in the PCR database. Due to complexities of the staging system and annual updates, automated consolidation was not initially implemented, and manual review was often needed for individual data items.

When developing enhancements for consolidation, several key factors were considered: 1) there are no national standards in the cancer registry community for data item consolidation; 2) the coding structure is different for all sites or schema in CS; and, 3) all CS data items needed to be

consolidated. Valuable staging information may be received from more than one reporting source. Retaining the ability to consolidate the individual data items so the derived stage fields could be re-calculated (based on the best information from all reporting sources) was critical.

In addition to selecting known information over unknown, staff created automated CS consolidation logic by site to select specific values over non-specific. They also assigned a combination code when multiple codes from the combination are reported by multiple sources, and they selected codes based on the hierarchy of reporting source. The intent for the first round of enhancements was to limit automated consolidation to decisions that trained PCR staff would make based solely on the codes, without the need for review of text or other information.

In November 2012, site-specific consolidation logic was implemented for high volume sites including breast, colon, rectum, lung and prostate. With this enhancement, the need for manual consolidation decreased significantly.

Increasing automation for CS consolidation has benefitted the PCR in three ways: 1) reducing the overall number of records requiring manual review if CS items were the only data items requiring manual review; 2) reducing the total number of data items requiring manual review per record; and 3) ensuring consistency in consolidation decisions.

### Evaluation

Twenty-five cases were reviewed at random for each of the five high volume sites. Unknown values were excluded from this evaluation. For prostate, there were a total of 97 CS data items to consolidate when values were different in the 25 cases. There were 88 of the 97 CS data items consolidated using the new automated directives. Nine CS data items still required manual review, since more than one specific value was reported.

By enhancing automation, manual review was reduced by 91 percent for CS data items for prostate, 75 percent for breast, 73 percent for rectum, 61 percent for colon and 51 percent for lung. The differences in the results are attributed to the extent of complexities of the disease and the detailed coding structure.

Less than three percent of cases within the five sites require manual review since the consolidation logic was implemented, making consolidation much more manageable and increasing efficiency within the registry.

Additional information on the [Pennsylvania Cancer Registry](#) can be found on the Department's website under the Pennsylvania Cancer Registry section. For questions about this article, please call the PCR staff at 717-783-2548.

[Return to list of articles >>>](#)

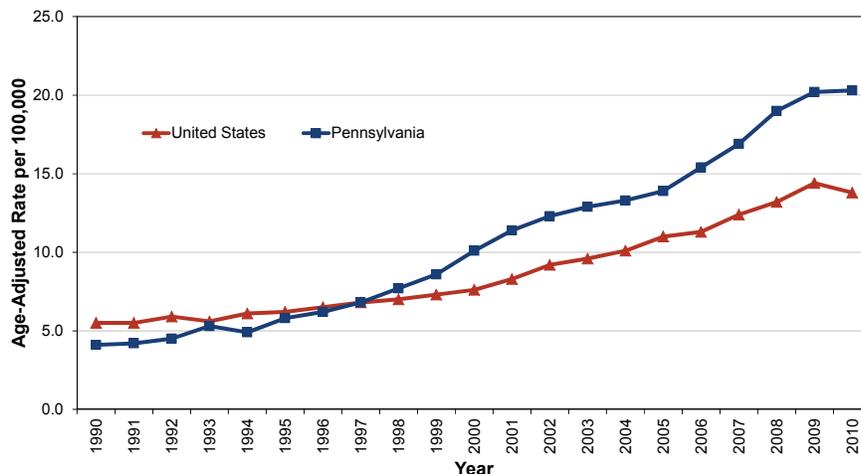
# Cancer of the Thyroid Reviewed

## Thyroid Cancers Increasing, but Less Deadly Compared to Other Cancers

September is Thyroid Cancer Awareness Month, a time to promote thyroid cancer awareness for early detection, as well as for risk factors, symptoms, diagnosis, treatment and advocacy. Cancers of the thyroid have become much more prevalent in recent years, with 2,728 invasive cases diagnosed for Pennsylvania residents in 2010. Thyroid cancer is now the eighth most commonly diagnosed cancer overall in Pennsylvania and represents 3.6 percent of all cancers that were diagnosed. Thyroid cancer is not as deadly as some other cancers though, and in 2010, there were only 89 deaths reported with thyroid cancer listed as the underlying cause of death. Previous analysis has indicated that thyroid cancer as a contributing cause of death was also not very common.

Although there has been a rapid increase in the number of cases of thyroid cancer being diagnosed in Pennsylvania, there has not been a similar increase in the number of thyroid cancer deaths. This also holds true for the United States, as thyroid cancer incidence rates have been steadily increasing, while death rates have not. Although the exact reason for the increase is not yet known, the [National Cancer Institute's Surveillance, Epidemiology and End Results \(SEER\) Program website](#) offers a word of caution when trying to interpret the increase. They explain that "rising incidence rates must be interpreted with caution, since trends can reflect 'real' increases in cases, temporary increase in cases with earlier detection or additional finding of cases that are histologically malignant but biologically indolent."

**Chart 1**  
**Age-Adjusted Incidence Rates\* of Invasive Thyroid Cancer**  
**Pennsylvania and the United States, 1990 to 2010**



\* Age-adjusted rates are per 100,000 and are computed by the direct method using the 2000 U.S. standard million population. U.S. age-adjusted rates were calculated from the National Cancer Institute's SEER program (based on 9 registries).

From 1990 to 2010, the number of invasive thyroid cancer cases in Pennsylvania increased almost 450 percent, from 498 cases to 2,728 cases. In contrast, there were 65 deaths in 1990 for which thyroid cancer was the underlying cause of death, compared with only a small increase to 89 deaths in 2010. The number of thyroid cancer deaths has stayed in a range of 57 (in 1991) to 89 deaths (in 2010). While invasive thyroid cancer cases have shown a dramatic five times increase from 1990 to 2010, the number of deaths due to thyroid cancer has not fluctuated much during this same period.

Thyroid cancer incidence rates in Pennsylvania have also increased at a higher rate than the U.S. over the time period 1990 to 2010. As shown in Chart 1, from 1990 to 1997, the Pennsylvania rate was the same as or lower than the U.S. rate; from 1998 to 2010, the Pennsylvania rate was higher than the U.S. rate. In 2010,

the U.S. experienced its first annual decrease in the thyroid cancer incidence rate since 1993, dropping to 13.8 per 100,000 from its highest historical rate of 14.4 per 100,000 in 2009. The Pennsylvania rate increased slightly from 20.2 in 2009 to 20.3 in 2010, marking the smallest annual increase seen in Pennsylvania since 1994.

Thyroid cancer is much more likely to occur in women. In fact, the [American Cancer Society](#) states that "for unclear reasons thyroid cancers (like almost all diseases of the thyroid) occur about three times more often in women than in men." In 2010, thyroid cancer was the fifth most commonly diagnosed cancer among women in Pennsylvania. In addition, thyroid cancer is more likely to occur at a younger age for females than for males. For 1990-2010, the incidence rate among females increased with age and peaked

Continue reading this article >>>

Continued...

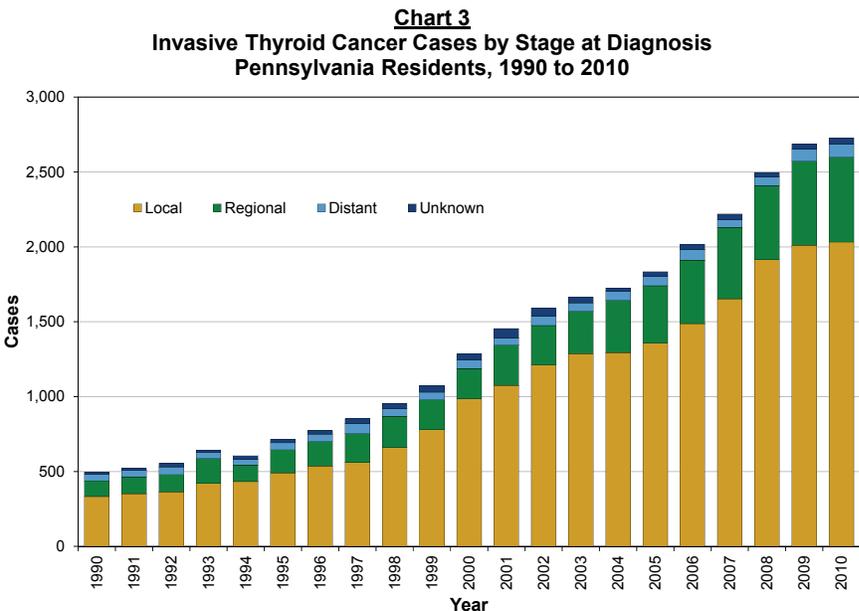
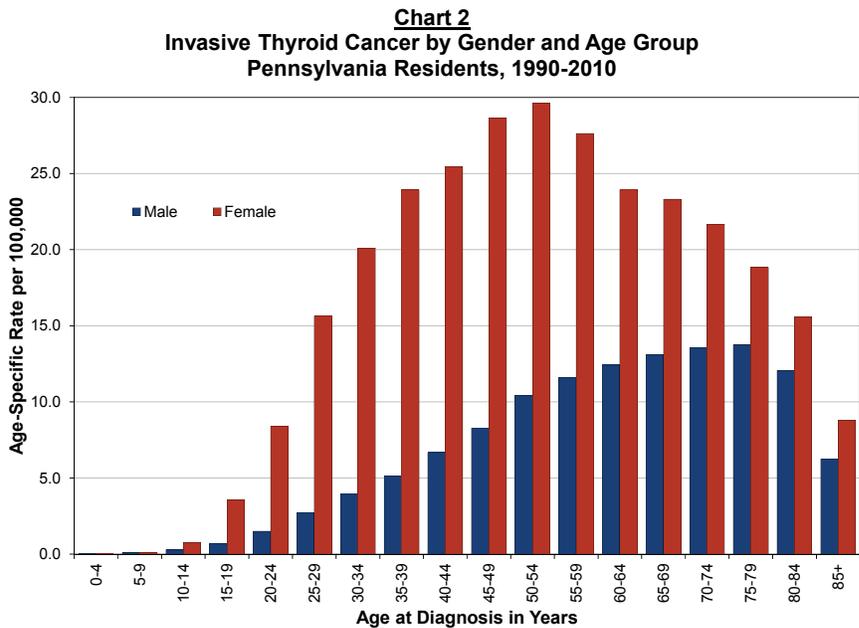
## Cancer of the Thyroid Reviewed

within the 50-54 age group before decreasing for older age groups (see Chart 2). For males, the incidence rate gradually increased with age until reaching a peak within the 75-79 age group, then decreasing in the 80-84 and 85+ age groups.

The excessive risk for thyroid cancer associated with exposure to external ionizing radiation has been well-established. Other risk factors for thyroid cancer include: dietary factors (especially low iodine intake), hormonal and reproductive factors, and hereditary conditions.

Within the thyroid cancer classification there are four main subtypes: papillary, follicular, medullary and anaplastic. Papillary and follicular are usually grouped together and are collectively known as differentiated thyroid cancers. These two subtypes are the most commonly diagnosed thyroid cancers, are highly treatable by performing a thyroidectomy (removal of the thyroid gland), and have an excellent prognosis and survival rate. In 2010 in Pennsylvania, there were 2,548 differentiated thyroid cancer cases representing over 93 percent of all thyroid cancers. The fact that these two subtypes of thyroid cancer represent the majority of cases in Pennsylvania and that they have such a good prognosis helps to explain why we've seen a small increase in the number of deaths from thyroid cancer compared to a large increase in the number of cases.

As with any cancer, the sooner it is diagnosed, the better. For thyroid cancer, it is important to identify it in either the local or regional stages of the disease. The [SEER Program website](#) contains data on the relative survival from cancers by stage of the



disease (how far the cancer has spread at the time of diagnosis). The five-year survival rates for thyroid cancer at the national level by stage are 99.9 percent for localized, 97.4 percent for regional and 55.0 percent for distant. Of the 2,728 thyroid can-

cer cases diagnosed in 2010 in Pennsylvania, 2,032 (74.5 percent) were local, 567 (20.8 percent) were regional, 87 (3.2 percent) were distant and 42 (1.5 percent) were at an unknown stage (see Chart 3). The chart

Continue reading this article >>>



# Wilson Score Confidence Interval for Binomial Proportions Outperforms Traditional Wald Interval

## A “Tools of the Trade” Article

Recently, statisticians in the Bureau of Health Statistics and Research were verifying and checking some cancer incidence data when they noticed that the Wald method for confidence intervals occasionally failed. In particular, the confidence interval’s lower limit went below zero, or the upper limit went above one. Both outcomes are impossible for binomial proportions (e.g., crude rates or percentages). To deal with the problem, our statisticians began researching confidence intervals and discovered that the same issues along with less obvious but more serious problems were published in professional journals. In fact, the Wald method was frequently discredited and many alternative methods were preferred.

For this article, a binomial proportion refers to a crude rate or percentage. Specifically, the data are considered binomial when the population can be grouped into two categories, such as those who died and those who did not die, or those with a disease and those without a disease. There are many formulas available for calculating confidence intervals of binomial proportions.<sup>1</sup> However, we will focus on the Wald interval, point out the main issues with it and recommend an improved method known as the Wilson score confidence interval with continuity correction. While no method is perfect, we will summarize why the Wilson score interval is preferred.

A confidence interval consists of a lower and upper bound that can be thought of as a measurement of error associated with a particular statistic

and is often used to estimate a statistic’s reliability. Most confidence intervals are calculated at a specified confidence level. For example, a 95% confidence level indicates that a statistic will fall within the confidence interval 95 percent of the time if the process of collecting and analyzing the data were to be repeated many times.

A very large or wide confidence interval indicates that a statistic is unreliable, while on the other hand a very small or narrow confidence interval indicates that a statistic is reliable. A rate based on a small population (denominator) will result in a wider confidence interval, compared to a rate based on a larger population.

Confidence intervals are extremely important when estimating the reliability of survey data as well as statistics that are calculated from complete datasets such as deaths. With complete datasets, the confidence intervals are used to account for human error or unknown aspects of the data. On one hand, we can be very confident about the total number of deaths in a year, as collected by death certificates. However, the uncertainty in race, age, residence, etc., as well as the uncertainty in the population denominator, warrants the need for confidence intervals when calculating rates or percentages. The bottom line is that all statistics are subject to chance variation.

The Wald interval, shown in Formulas 1 and 2, is commonly listed in statistical textbooks despite its having many issues and limitations.

**Formula 1:** 95% Confidence Level for Wald Interval

$$95\% \text{ Wald Interval} = \text{Rate} \pm 1.96 * \sqrt{\frac{\text{Rate} * (1 - \text{Rate})}{\text{Population}}}$$

Where *Rate* represents a binomial proportion, such as  $\text{Rate} = d/n$ , with  $d = \text{the number of events}$  and  $n = \text{population}$ .

Sometimes the Wald formula is rearranged algebraically as shown in Formula 2.

**Formula 2:** 95% Confidence Level for Wald Interval (algebraically equivalent to Formula 1)

$$95\% \text{ Wald Interval} = \frac{1}{n} \left\{ d \pm 1.96 * \sqrt{d \left( 1 - \frac{d}{n} \right)} \right\}$$

There are three main issues that arise when using the Wald interval. First, the formula results in a zero-width interval when the proportion is one or zero ( $\text{rate} = 1$  or  $\text{rate} = 0$ ). This is a problem for calculations of 100 percent. We do not calculate proportions based on less than 10 events and, therefore, do not encounter proportions of zero percent. The second issue (often referred to as overshoot) with the Wald interval occurs when the proportion is close to zero or one. When the proportion is close to zero, the lower limit of the Wald interval becomes negative. Likewise, when the proportion is close to one, the upper limit exceeds one. The third and most critical issue with the Wald interval has to do with poor coverage of the nominal confidence level, which is usually set at the 95% con-

Continue reading this article >>>

Continued...

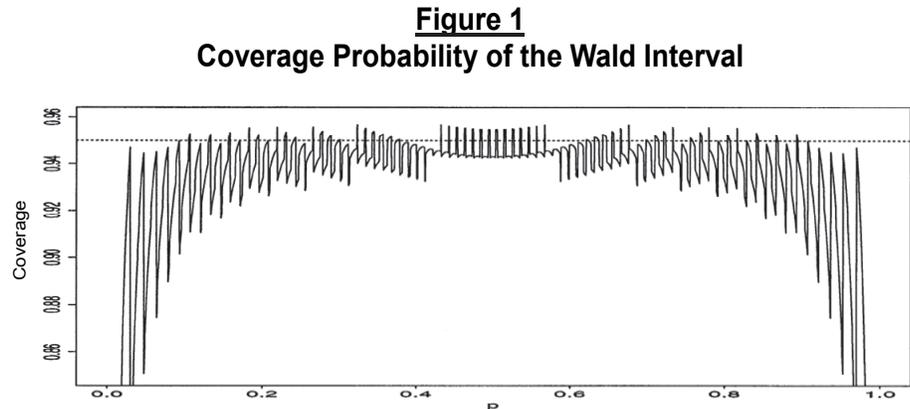
## Wilson Score Confidence Interval for Binomial Proportions Outperforms Traditional Wald Interval

confidence level. According to Newcombe, the coverage of the Wald interval is very anti-conservative on average, as we will explain.<sup>2</sup>

Mathematicians calculate and graph “coverage probabilities” for each type of confidence interval (e.g., Wald interval, Wilson score, etc.) in order to evaluate their performance. The coverage probability shows that the actual confidence level oscillates (see Figure 1). In other words, the actual confidence level varies despite the fact that the nominal confidence level was set at the 95% confidence level. The nominal 95% confidence level is represented as a dotted line in Figure 1. Brown explained that the oscillations are a result of the data’s discreteness which is inherent to binomial data.<sup>3</sup>

The coverage probability is used to determine if the confidence interval is, on average, conservative or anti-conservative. If the interval’s actual confidence level is on average greater than the nominal confidence level (usually set at 95%), then the interval is considered conservative. Likewise, if the interval’s actual confidence level is on average less than the nominal 95% confidence level, then the interval is considered anti-conservative. Newcombe further pointed out that a confidence interval is “strictly conservative” if the minimum coverage probability is greater than or equal to the nominal confidence level.<sup>2</sup>

In their analysis, Newcombe and numerous other mathematicians such as Vollset, Brown and Pires concluded that the Wald interval was anti-conservative, since the mean cover-



Coverage probability was calculated as a function of a binomial proportion,  $p$ , at a 95% confidence level for  $n=100$ . On average the coverage probability oscillated below the 95% nominal confidence level (dotted line), especially for  $p$  near zero or one. Source: Brown<sup>3</sup>

age dropped below the nominal 95% confidence level. In fact, Newcombe showed that the minimum coverage probability for the Wald interval could be severely under the desired 95% confidence level. In Figure 1, the coverage probability was graphed for the Wald interval with a nominal 95% confidence level, and the oscillations frequently drop below the 95% confidence level (dotted line), especially for proportions below 0.1 or above 0.9.<sup>3</sup>

There are many alternatives to the Wald interval, but an in-depth review of the mathematical literature indicates that the Wilson score interval with a continuity correction (see Formula 3) is a more suitable confidence interval for binomial proportions than the Wald confidence interval. In particular, the Wilson score interval with a continuity correction is a very conservative method.<sup>4</sup> Without getting into the mathematical details, the continuity correction is used to improve estimates for a

discrete distribution (e.g., binomial) that are based on a continuous distribution (e.g., normal).

**Formula 3:** Wilson Score Interval with Continuity Correction

$$\text{Lower Bound} = \frac{2np + z^2 - 1 - z \sqrt{\{z^2 - 2 - \frac{1}{n} + 4p(nq + 1)\}}}{2(n + z^2)}$$

$$\text{Upper Bound} = \frac{2np + z^2 + 1 + z \sqrt{\{z^2 + 2 - \frac{1}{n} + 4p(nq - 1)\}}}{2(n + z^2)}$$

In Formula 3,  $z$  is the  $1-\alpha/2$  point or the standard score of the standard normal distribution (e.g.,  $z = 1.96$  standard deviations for a 95% confidence interval),  $n$  is the population or denominator of a proportion or a percentage,  $p$  is the proportion or percentage ( $p = d/n$ , where  $d$  is the number of events in the numerator), and  $q = (1 - p)$ . If  $p = 0$ , then the lower bound is set to zero, and if  $p = 1$ , then the upper bound is set to one.

Continue reading this article >>>

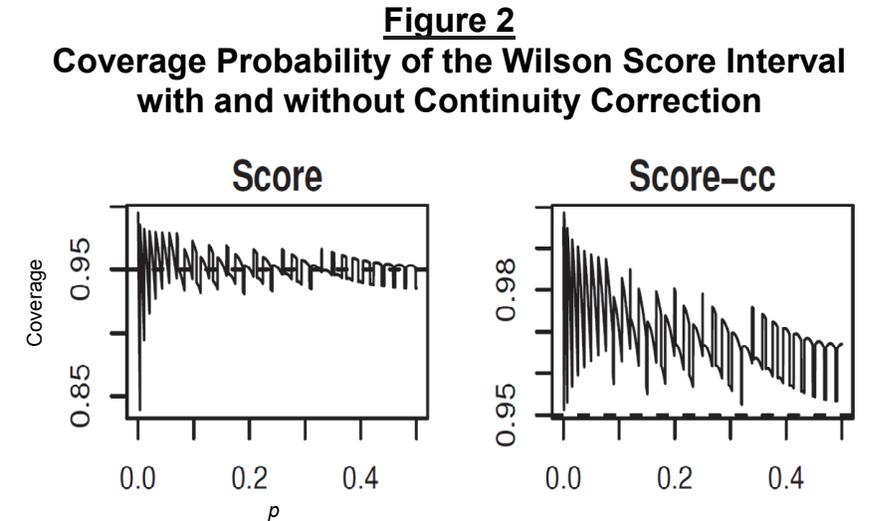
Continued...

## Wilson Score Confidence Interval for Binomial Proportions Outperforms Traditional Wald Interval

In Figure 2, the coverage probability was plotted for the Wilson score interval with and without continuity correction.<sup>1</sup> While both methods outperformed the Wald interval, the Wilson score with continuity correction was even more conservative than a Wilson score without the continuity correction. Figure 2 shows that the continuity correction allowed the confidence level to remain above 95% for all values of the proportion,  $p$ . Still, the continuity correction was not always considered strictly conservative, since the minimum coverage could go below the nominal 95% confidence level under certain conditions.<sup>2</sup> However, the continuity correction performed very well in comparison to many other methods.<sup>5</sup>

In the field of health statistics, a conservative confidence interval is preferred for accuracy, since important decisions are being made for public health issues. In particular, significance testing based on the Wilson score with continuity correction is more reliable, since the interval does a great job at maintaining a 95% confidence level.

Although this review of confidence intervals began when our statisticians noticed that the Wald interval failed to perform well in certain circumstances, we have since learned that many methods have been com-



Coverage probability was calculated as a function of a binomial proportion,  $p$  at a 95% confidence level for  $n=50$ . The graphs are symmetric and are not shown for  $p>0.5$ . Of the two graphs, the continuity correction (Score-cc) resulted in a more conservative coverage. Without the continuity correction (Score), the coverage preformed well but occasionally dropped below the 95% confidence level (dotted line).  
Source: Pires<sup>1</sup>

pared and reported through numerous studies. One positive point for the Wald interval appears to be the ease of calculation compared to other methods, allowing for better comprehension of the calculations by the average health data user. However, the main problem of the Wald interval is its failure to maintain a 95% confidence level.

The Bureau of Health Statistics and Research will be calculating confidence intervals using the Wilson score with continuity correction for late stage percentages in a new

cancer report, which is currently under construction. We will also evaluate switching to this confidence interval calculation for other statistical publications that use crude rates.

If you have any questions about this article, please contact the Bureau of Health Statistics and Research at 717-783-2548. Additional information of statistical methods can be obtained on the [Understanding Health Statistics](#) Web page and by reviewing the references used for this article and cited below.

Return to list of articles >>>

<sup>1</sup> Pires, A.M., Amado, C. (June 2008). Interval estimators for a binomial proportion: comparison of twenty methods. "REVSTAT", Volume 6, Number 2, p165-197.

<sup>2</sup> Newcombe, R.G. (1998). Two-sided confidence intervals for the single proportion: comparison of seven methods, "Statistics in Medicine", 17, p857-872.

<sup>3</sup> Brown, L.D., Cai, T.T. and DasGupta, A. (2001). Interval estimation for a binomial proportion, "Statistical Science", Volume 16, Number 2, p101-133.

<sup>4</sup> Vollset, S.E. (1993). Confidence intervals for a binomial proportion, "Statistics in Medicine", 12, p809-824.

<sup>5</sup> Brown, L.D., Cai, T.T. and DasGupta, A. (2002). Confidence intervals for a binomial proportion and asymptotic expansions, "The Annals of Statistics", Volume 30, Number 1, p160-201.