TRADITIONAL vs. INDUSTRIAL FARM CHILDREN HEALTH STUDIES: LOSS OF THE HYGIENE HYPOTHESIS

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July 7, 2012

Introduction

Within the large framework of argumentation, assertion, and proof, scientific research studies serve as a major bulwark of credibility. This gold standard for credibility occurs for several reasons, among which are the following:

- researchers are highly trained in the research standards and critical procedures of their field.
- researchers possess an extensive knowledge base developed through years of study which is evidenced by advanced degrees in their field.
- the research conducted must meet:
    - the research standards of their field as evidenced by publication in a peer-reviewed journal.
    - the critical review standards of additional researchers once the research is published.

This paper will focus upon three critical research studies which undergirded the "Unintended Consequences" PowerPoint discussion by Bob Watson of CAFOs' negative impact upon children's health at the North Winneshiek Community School District.

The discussion of the three studies conducted by researchers at The University of Iowa will illustrate several characteristics of scientific research studies. These characteristics include:

- how assertions are made and buttressed by reference to previous studies.
- how a research-based argument is constructed.
- how research studies build on previous research findings, questions, and suggestions for further research.

Even more specifically, the three studies examined in this paper will present:

- the previous research focused on the intersection of agriculture and health.
- the existing body of scientific research focused on childhood asthma.
- the larger body of scientific research exploring the impact of CAFOs upon human health and the environment.

The three scientific research studies examined follow and are captioned according to their title given by other researchers in citing them.

The Rural Childhood Asthma Study

Chrischilles E, Ahrens R, Kuhl A, Kelly K, Thorne P, Burmeister L, & Merchant J (2004 January). Asthma prevalence and morbidity among rural Iowa schoolchildren. *The Journal of Allergy and Immunology, 113*(1): 66-71.

The Merchant Study

Merchant JA, Naleway AL, Swendsen ER, Kelly KM, Burmeister LF, Stromquist AM, Taylor CD, Thorne PS, Reynolds SJ, Sanderson WT, & Chrischilles EA (2005 March). Asthma and farm exposures in a cohort of rural Iowa children. *Environmental Health Perspectives, 113*(3): 350-356.

The Kline Study

Sigurdarson ST & Kline JN (2006 June). School proximity to concentrated animal feeding operations and prevalence of asthma in children. *Chest, 129*(6): 1486-1491.

Methodology

The Rural Childhood Asthma Study, headed by Dr. Chrischilles, will be presented within the discussion centered on the Merchant Study. The Merchant Study will be analyzed first followed by a review of the Kline Study.

Unless specifically noted, all quotations are taken from the respective three studies without specific page numbers being referenced. This is done for several reasons. First, some quotations are interrupted to present in greater detail the studies cited within the quotation which only contained a reference to the lead researcher and the year published. Second, page numbers were omitted in order to facilitate a smoother, uninterrupted reading which is common to writing done for general audiences. Third, the research studies themselves are not extremely lengthy. It is quite easy for those interested in identifying locations of specific quotations to do so with a brief reading of the research study as published. A final note – quotes within bulleted items and within the discussions utilizing regular margins use quotation marks while quotes that are separately blocked in narrower margins generally do not.

Lastly, the quotations from the Chrischilles' Rural Childhood Asthma Study were taken from the abstract of that study which can be accessed from the *PubMed* web site by conducting an author search using "Chrischilles" as the keyword at: http://www.ncbi.nlm.nih.gov.

The Merchant Study

Most of the initial research work on childhood asthma focused on "inner-city" and "urban populations." Later work then began to focus attention on rural childhood asthma. The majority of rural childhood asthma studies prior to the Twenty-first (21st) Century found an overall health benefit for farm children. The technical term for this health benefit is the "Hygiene Hypothesis." To reiterate, the vast majority of rural childhood asthma studies confirmed various parts of the "Hygiene Hypothesis," which, when applied to farm families, states that children raised on farms:

- **"are less often atopic"** [having an allergic hypersensitivity that typically triggers an overproduction of usually type IgE antibody]:

Braun-Fahrlander C, et al. (1999). Prevalence of hay fever and allergic sensitization in farmer's children and their peers living in the same rural community. SCARPOL team. **Swiss** Study on Childhood Allergy and Respiratory Symptoms with Respect to Air Pollution. *Clinical and Experimental Allergy, 29*(1): 28-34.

Downs SH, et al. (2001). Having lived on a farm and protection against allergic diseases in **Australia**. *Clinical and Experimental Allergy, 31*(4): 570-575.

Riedler J, et al. (2000). **Austrian** children living on a farm have less hay fever, asthma and allergic sensitization. *Clinical and Experimental Allergy, 30*(2): 194-200.

Riedler J, et al. (2001). Exposure to farming in early life and development of asthma and allergy: A cross-sectional survey. *Lancet, 358*(9288): 1129-1133.

- **"have lower rates of allergic diseases:"**

Braun-Fahrlander C, et al. (1999). Prevalence of hay fever and allergic sensitization in farmer's children and their peers living in the same rural community. SCARPOL team. **Swiss** Study on Childhood Allergy and Respiratory Symptoms with Respect to Air Pollution. *Clinical and Experimental Allergy, 29*(1): 28-34.

Kilpelainen M, et al. (2000). Farm environment in childhood prevents the development of allergies. *Clinical and Experimental Allergy, 30*(2): 201-208.

Riedler J, et al. (2000). **Austrian** children living on a farm have less hay fever, asthma and allergic sensitization. *Clinical and Experimental Allergy, 30*(2): 194-200.

Riedler J, et al. (2001). Exposure to farming in early life and development of asthma and allergy: A cross-sectional survey. *Lancet, 358*(9288): 1129-1133.

Von Ehrenstein OS, et al. (2000). Reduced risk of hay fever and asthma among children of farmers. *Clinical and Experimental Allergy, 30*(2): 187-193.

Wickens K, et al. (2002). Farm residence and exposures and the risk of allergic diseases in New Zealand children. *Allergy, 57*(12): 1171-1179.

- **"and, in several reports, also have lower rates of asthma:"**

Ernest P & Cormier Y (2000). Relative scarcity of asthma and atopy among rural adolescents raised on a farm. *American Journal of Respiratory and Critical Care Medicine, 161*(5): 1563-1566.

Kilpelainen M, et al. (2000). Farm environment in childhood prevents the development of allergies. *Clinical and Experimental Allergy, 30*(2): 201-208.

Riedler J, et al. (2000). **Austrian** children living on a farm have less hay fever, asthma and allergic sensitization. *Clinical and Experimental Allergy, 30*(2): 194-200.

Riedler J, et al. (2001). Exposure to farming in early life and development of asthma and allergy: A cross-sectional survey. *Lancet, 358*(9288): 1129-1133.

Von Ehrenstein OS, et al. (2000). Reduced risk of hay fever and asthma among children of farmers. *Clinical and Experimental Allergy, 30*(2): 187-193.

"However," the Merchant Study continued, "several studies have not found positive associations between asthma and asthma symptoms among children and farm exposures" which raised "questions regarding the influence of unmeasured risk factors and/or selection in these cross-sectional studies."

Chrischilles E, et al. (2004). Asthma prevalence and morbidity among rural Iowa schoolchildren. *The Journal of Allergy and Clinical Immunology, 113*(1): 66-71.

Downs SH, et al. (2001). Having lived on a farm and protection against allergic diseases in Australia. *Clinical and Experimental Allergy, 31*(4): 570-575.

Salam MT, et al; Children's Health Study (2004). Early-life environmental risk factors for asthma: Findings from the Children's Health Study. *Environmental Health Perspectives, 112*(6): 760-765.

Wickens K, et al. (2002). Farm residence and exposures and the risk of allergic diseases in New Zealand children. *Allergy, 57*(12): 1171-1179.

In other words, unidentified risk factors that weren't measured could refer to toxic emissions from CAFOs, while selection of subjects could refer to the absence in the study of children who were exposed to the model of Industrial Agriculture practiced so prevalently in Iowa. What does research have to say about these two possibilities?

You'll recall that the vast majority of childhood asthma studies completed in the Twentieth (20th) Century were divided into two main groupings based on a bi-polar classification scheme based upon geographic residence:

- Urban, inner-city childhood asthma studies; and
- Rural childhood asthma studies.

You'll also recall that almost all of the rural childhood asthma studies found a health benefit to rural living. The exceptions, as noted by the Merchant Study, were rural childhood studies conducted in the early 21st Century. These cited scientific research studies did not find a health benefit to rural life.

The **Rural Childhood Asthma Study** (Chrischilles et al., 2004), cited by the Merchant Study as one of the exceptions to the Health Benefits of Rural Living Hypothesis, provides more insight into the contradictory findings of rural childhood asthma studies. That study, based on a rural cohort in Keokuk County, began by noting:

> There are conflicting findings about the prevalence of asthma among farm and nonfarm children.

Because of the conflicting findings, the Chrischilles Study "sought to estimate asthma prevalence and morbidity and determine differences between farm and nonfarm children" in a rural area. The Rural Childhood Asthma Study found that:

> [I]n this large, rural, population-based study, asthma prevalence rivaled that in several large Midwestern cities.

The researchers surmised that "unmeasured risk factors" might be at work in Keokuk County. The Chrischilles Study concluded:

> These findings cast doubt on a protective effect of rural life for the development of childhood asthma.

New Ground Broken By the Merchant Study

The researchers involved in the Merchant Study posed a solution to the problem whereby one set of studies of rural childhood asthma found a positive health benefit for rural life while a different, more recent set of rural childhood asthma studies did not find a health benefit for rural life. The Merchant Study pointed to the differences in types of agriculture as a basis for differentiating the two groups of rural childhood asthma studies.

First, they noted the changes in the agricultural model from a more traditional scheme of many smaller family farms with diverse crop and livestock operations to the current scheme prevailing in Iowa today:

> Over the last three decades, the development of a vertically integrated livestock industry has significantly reduced the number of U.S. family farms raising hogs, poultry, and cattle but has rapidly increased the number of large animal-feeding operations (AFOs).

The researchers conducting the Merchant Study noted the vast body of research studies documenting the health problems suffered by CAFO workers. They did this by referencing a single study whereby research scientists conducted a review of the scientific literature – a review that consisted of 972 research studies:

> Schenker MB, Christiani D, Cormier Y, Dimich-Ward H, Doekes G, Dosman J, et al. (1998 November). Respiratory health hazards in agriculture. *American Journal of Respiratory and Critical Care Medicine, 158*(5 pt 2): S1-S76.

The Merchant Study researchers then itemized the negative effects of CAFOs on worker health centering on "inflammatory airway diseases." This itemized list included:

- "asthma;"
- "chronic bronchitis;"
- "organic dust toxic syndrome;" and
- "progressive airway obstruction."

The medical and scientific research team also pointed out that at the time of the Merchant Study, only a handful of research studies had been conducted which examined the impact of CAFOs upon the health of children and adults living in the neighborhood of such operations. These studies included:

> Reynolds SJ, Donham KJ, Stookesberry J, Thorne PS, Subramanian P, Thu K, & Whitten P (1997). Air quality assessments in the vicinity of swine production facilities. *Journal of Agromedicine, 4*(1-2): 37-45.
>
> Salam MT, et al; Children's Health Study (2004). Early-life environmental risk factors for asthma: Findings from the Children's Health Study. *Environmental Health Perspectives, 112*(6): 760-765.
>
> Thu K, Donham K, Ziegenhorn R, Reynolds S, Thorne PS, Subramanian P, Whitten P, & Stookesberry J (1997). A control study of the physical and mental health of residents living near a large-scale swine operation. *Journal of Agricultural Safety and Health, 3*(1): 13-26.
>
> Wing S & Wolf S (2000 March). Intensive livestock operations, health, and quality of life among eastern North Carolina residents. *Environmental Health Perspectives, 108*(3): 233-238.

The researchers then contrasted the model of Industrial Agriculture with the more traditional model of agriculture:

> Farms in Northern Europe tend to be smaller than Iowa farms and to have livestock that are often housed in immediate proximity to living quarters, and these farm families have been described as more traditional in their way of life. Farms in Canada, Australia, and New Zealand are described as larger but typically not as livestock intensive as Iowa farms (Downs et al. 2001; Ernst and Cormier 2000; Wickens et al. 2002).

By solving the riddle posed by contradictory results from studies of rural childhood asthma, the Merchant Study broke new ground. As a result, childhood asthma studies can no longer be divided into the previous customary bi-polar groupings based solely on residential locale, e.g.:

1. Urban, inner city childhood asthma studies; and
2. Rural childhood asthma studies.

Instead, childhood asthma studies need to be divided into three groups based not only on residential locale, but also upon the types of agricultural activities to which the children were exposed.

1. Urban, Inner City childhood asthma studies;
2. Traditional Agriculture childhood asthma studies; and
3. Industrial Agriculture childhood asthma studies.

Purpose of the Merchant Study

Having reviewed the literature of previous scientific research studies, having solved the riddle posed by contradictory results of rural childhood asthma studies, and having, in effect, posed a new tri-partite division of childhood asthma studies, the Merchant Study researchers identified the purpose of their study.

> "We studied a cohort of rural Iowa children to determine the associations between farm and other environmental risk factors with four asthma outcomes:
>
> - doctor-diagnosed asthma,
> - doctor-diagnosed asthma/medication for wheeze,
> - current wheeze, and
> - cough with exercise.
>
> The aim of the present study was to estimate asthma prevalence and assess whether farm exposures result in less atopy, less allergic disease, and less asthma … among this cohort of farm children."

In other words, what the Merchant Study research team was really doing was checking to see whether or not the Hygiene Hypothesis for rural life held true for children exposed to the effects of Industrial Agriculture.

Who was studied

Children from "birth through 17 years of age collected in round 1 of the KCRHS [Keokuk County Rural Health Study], which began in 1994 and ended in 1998." Keokuk County had been chosen "because it is intensely agricultural and entirely rural."

In other words, Keokuk County provided a typical and representative setting that featured the major components of Industrial Agriculture – CAFOs and row-crop agriculture focused on corn and beans.

Out of the original KCRHS, 1,004 households agreed to participate in the Merchant Study. They formed three basic groups:

- farm – 224 families,
- rural nonfarm – 155 families, and
- town households – 462 families.

The farms in the cohort primarily produced "corn, soybeans, and hogs" with "very few other livestock."

Who were the scientific researchers involved in the Merchant Study and what were their current affiliations at the time the Merchant Study was reported in the peer-reviewed scientific journal, *Environmental Health Perspectives*?

- James A. Merchant (MD, DrPH), Department of Occupational and Environmental Health, **University of Iowa College of Public Health**, Iowa City, Iowa.
- Allison L. Naleway (PhD), Center for Health Research, **Kaiser Permanente Northwest**, Portland, Oregon.
- Erik R. Svendsen (PhD), National Health and Environmental Effects Research Laboratory, Human Studies Division, Epidemiology and Biomarkers Branch, **U.S. Environmental Protection Agency**, Research Triangle Park, North Carolina.
- Leon F. Burmeister (PhD), Department of Biostatistics, **University of Iowa College of Public Health**, Iowa City, Iowa.
- Ann M. Stromquist (PhD), Department of Occupational and Environmental Health, **University of Iowa College of Public Health**, Iowa City, Iowa.
- Craig D. Taylor (PhD), Department of Occupational and Environmental Health, **University of Iowa College of Public Health**, Iowa City, Iowa.
- Peter S. Thorne (PhD), Department of Occupational and Environmental Health, **University of Iowa College of Public Health**, Iowa City, Iowa.
- Stephen J. Reynolds (PhD), Department of Environmental and Radiological Health Sciences, **Colorado State University College of Veterinary Medicine and Biomedical Sciences**, Fort Collins, Colorado.
- Wayne T. Sanderson (PhD), Department of Occupational and Environmental Health, **University of Iowa College of Public Health**, Iowa City, Iowa.
- Elizabeth A. Chrischilles (PhD), Department of Epidemiology, **University of Iowa College of Public Health**, Iowa City, Iowa.

What were the findings of the Merchant Study

According to the researchers:

- 33.6% of all children in the study's three groups exhibited "at least one of the four asthma outcomes," which is "consistent with asthma prevalence observed in studies of U.S. **urban populations**."
- "Asthma and asthmalike symptoms were found to be high and to not differ between children
    - who lived on a farm, and
    - those who did not live on a farm,"

  which differed from previous research studies of non-Industrial agriculture.
- 44.1% of children living on farms which raised swine exhibited asthma health outcomes.
- 55.8% of children living on farms which
    - raised swine and
    - added antibiotics to feed

  "exhibited asthma health outcomes."

What were the conclusions of the Merchant Study

Based on their analysis of the data, the researchers drew the following conclusions:

- The high asthma results found in the study "make clear that on-farm exposure to swine production is associated with asthma among children living on those farms."
- "Swine production contributes to the higher outcomes in this livestock-intensive rural community" for all children living in the area regardless of farm or nonfarm residence.
- The discrepancy between "doctor-diagnosed asthma" (12%) and the presence of "asthmalike symptoms" (33.6%) "underscore[s] the need:
    - for asthma screening programs,
    - for improved rural health care provider asthma diagnostic and management skills, and
    - for health policies that would improve access and insurance coverage for rural children."

The Kline Study

Introduction

The Kline Study built on the preceding Chrischilles and Merchant studies. While the Chrischilles Study called the Hygiene Hypothesis for rural life (being raised on a farm provides protection against atopy & asthma) into question, the Merchant Study found further evidence that rural life provided no protection against asthma as would be expected by the Hygiene Hypothesis. The Merchant Study also provided an explanation for the contradictory findings regarding research studies of rural childhood asthma, i.e., many of the previous studies involved exposures to traditional agriculture whereas current studies involved exposures to Industrial Agriculture.

A Tale of Two Agricultures

The Kline Study re-emphasized the importance of the different types of agriculture to which children were exposed.

> There are a number of characteristics of farms in the United States, and in Iowa in particular, that distinguish them from those in Europe and elsewhere. Iowa is one of the largest hog producers in the world, and most hogs are reared in large-scale "factory farms" or concentrated animal feeding operations (CAFOs) that house large numbers of animals (>3,500) in density.

The researchers continued:

> Operations of this type release multiple irritant and inflammatory substances that can adversely affect the health of workers as well as the air quality in surrounding communities.

Studies cited by the medical researchers in support of this last statement included the following research:

> Iowa Concentrated Animal Feeding Operations Air Quality Study: Iowa State University and The University of Iowa Study Group (2002). Available at www.public-health.uiowa.edu/ehsre/CAFOstudy.html. Accessed March 29, 2006.
>
> Schwartz DA, Donham KJ, Olenchock SA, et al. (1995). Determinants of longitudinal changes in spirometric function among swine confinement operators and farmers. *Am J Respir Crit Care Med, 151*: 47-53.
>
> Quinn TJ, Donham KJ, Merchant JA et al. (1995). Peak flow as a measure of airway dysfunction in wine confinement operators. *Chest, 107*: 1303-1308.

Later in the reported study, the scientific research team of Dr. Kline and Dr. Sigurdarson elaborated on the "multiple irritant and inflammatory substances" being emitted by CAFOs.

> Environmental pollution from CAFOs consists of a mixture of organic dust and chemicals including NH_3 [ammonia] and H_2S [hydrogen sulfide]. Swine dust, endotoxin, and endotoxin-laden dust with and without ammonia have been shown to be a respiratory irritant in numerous exposure studies. Furthermore epidemiologic studies have shown that exposure to swine dust caused decline in pulmonary function over time. [Endotoxin = a toxin that is released from certain bacteria as they disintegrate in the body, causing fever, toxic shock, etc.]

Research studies cited in support of the preceding statements include the following peer-reviewed articles:

> Sigurdarson ST, O'Shaughnessy PT, Watt JA, et al. (2004). Experimental human exposure to inhaled grain dust and ammonia: Towards a model of concentrated animal feeding operations. *Am J Ind Med, 46*: 345-348.
>
> Kline J, Cowden D, Hunninghake G, et al. (1999). Variable airway responsiveness to inhale lipopolysaccharides. *Am J Respir Crit Care Med, 160*: 297-303.
>
> Michel O, Ginanni R, Le Bon B, et al. (1992). Inflammatory response to acute inhalation of endotoxin in asthmatic patients. *Am Rev Respir Dis, 146*: 352-357.
>
> Thorne PS (2000). Inhalation toxicology models of endotoxin- and bioaerosol-induced inflammation. *Toxicology, 152*: 13-23.
>
> Schwartz D, Landas S, Lassise D, et al. (1992). Airway injury in swine confinement workers. *Ann Intern Med, 116*: 630-635.

Purpose of the Study

The Kline Study built specifically upon two of the conclusions drawn by the research team engaged in the Merchant Study regarding swine production exposures and higher rates of asthma. Summarizing previous childhood asthma research in the United States, the two medical researchers for the Kline Study observed, "In rural United States, however, an increased rate of asthma has been found among schoolchildren." The Kline Study would focus attention directly on CAFOs. Dr. Kline and Dr. Sigurdarson articulated the purpose of their study as follows:

> We hypothesized that the rural US environment may not be protective against airway inflammation, perhaps due to environmental effluents from a relatively high number of concentrated animal feeding operations (CAFOs). We compared the prevalence of asthma in two Iowa elementary schools, one adjacent to a CAFO, and the other distant from any large-scale farming operations.

In other words, the Kline Study specifically set out to determine whether asthma rates were higher for children exposed to the toxic emissions of neighboring CAFOs were higher than the asthma rates for children not exposed to toxic emissions from neighboring CAFOs.

Who Was Studied

Students of two elementary schools enrolled in kindergarten through fifth grade were surveyed to determine "their prevalence of asthma and airway symptoms." The study school was located in Northeast Iowa and was situated within a half-mile of a CAFO housing about 3,800 hogs. The control school was situated in East Central Iowa with no CAFOs being situated within a 10-mile radius of the school.

At the time the study was released, the schools were not identified. However, some five years after the study was published, Dr. Kline and Bob Watson (a waste-water specialist who initiated the return of water & waste water operators curriculum to the community colleges of Iowa, beginning with DMACC) were serving as two members of a three-person panel at the annual conference of the Iowa Academy of Science in the spring of 2011. At this conference, which was held at Wartburg College, Dr. Kline revealed to Mr. Watson that the study school for the Kline Study was the **North Winneshiek Elementary School**. This occurred after Watson's discussion of:

1) CAFOs as constituting sewage operations that, in comparison with the rules and regulations governing municipal waste water systems, are unregulated; and
2) the negative impacts of CAFOs on human health as revealed generally by multiple studies, but most particularly by the Kline and Merchant Studies.

Who were the scientific researchers involved in the Kline Study and what were their current affiliations at the time the Kline Study was published in the peer-reviewed medical research publication, *Chest*, the official journal of the American College of Chest Physicians?

- Joel N. Kline (MD, MSc, FCCP), Division of Pulmonary, Critical Care, and Occupational Medicine, Department of Internal Medicine, Roy J. & Lucille Carver College of Medicine, **The University of Iowa**, Iowa City, IA.

- Sigurdur T. Sigurdarson (MD, MPH), Research Center for Occupational Health and Working Life, Administration of Occupational Safety and Health, **University of Iceland**, Surdanes Regional Hospital, Keflavik, Iceland.

What Were the Findings of the Kline Study

According to the researchers:

- "A significant difference was found in the prevalence of physician-diagnosed asthma among the two schools studied."

    - "In the study school [North Winneshiek], located near a CAFO, the asthma prevalence was quite high, 19.7%, approaching the prevalence of asthma reported among inner-city socioeconomically disadvantaged children."
    - The study cited for the reference comparison of asthma rates for rural North Winneshiek children and inner-city disadvantaged children was:

      Cloutier MM, Wakefield DB, Hall CB, et al. (2002). Childhood asthma in an urban community: prevalence, care system, and treatment. *Chest, 122*: 1571-1579.

    - "The prevalence in the control school [no CAFOs within 10 miles of the school] was 7.3%, which is quite close to the overall rate reported for Iowa of 6.7%."
    - The reference cited for the comparison with the Iowa rate of asthma was:

      Rhodes L (2003). Self-reported asthma prevalence and control among adults – United States, 2001. *MMWR Morb Mortal Wkly Rep, 52*: 381-384.

Having discussed the different rates for "physician-diagnosed" asthma, the researchers next addressed the research results which employed a broader definition of asthma, i.e., "physician diagnosis, asthma-like symptoms, or asthma medication use." Using this broader definition for asthma, the researchers noted that:

- "the prevalence of asthma in the study school [North Winneshiek] remained significantly greater than that in the control school." The asthma rates reported for the two schools were:
    - 24.6% Study School [North Winneshiek] Asthma Rate
    - 11,7% Control School Asthma Rates

Turning next to the medical issue of "wheezing," the researchers said the difference in wheezing rates between the two school populations "nearly reached statistical significance." The researchers reported:

> Eighteen percent [18%] of children from the study school [North Winneshiek] but only 9.7% of children from the control school reported wheezing in the past year.

What Were the Conclusions of the Kline Study

The researchers observed at the beginning of the study that "[a]sthma results from complex interactions between genetic predisposition and environmental influences." Near the end of the study, they noted possible environmental influences, e.g., "socioeconomics, different medical practices, and household smoking patterns." The researchers also noted the possibility that medical practitioners in the two communities might use different approaches to the diagnosis of asthma. They continued:

> Addressing the diagnostic criteria for asthma among the physicians in these communities was outside the scope of this study, but would be an important aspect of future studies; we have previously shown that understanding of the National Heart, Lung, and Blood Institute guidelines and diagnostic criteria can vary widely, even among asthma specialists.

However, the researchers noted,

> [I]t is impossible to exclude a role for environmental factors, such as the proximity of the school to CAFOs and exposures generated by family farms, on the **profound difference in asthma rates**. (Emphasis added)

The researchers continued by noting the similarity between their findings and the findings reached previously by the Rural Childhood Asthma Study headed by Dr. Chrischilles:

> Our findings are similar to those of Chrischilles et al, who found a significantly increased asthma prevalence in a rural population of Iowa children.

Illustrative of the cautious and restrained approach taken by scientific researchers, the Kline Study researchers proposed the following:

> The hypothesis that CAFOs contribute to environmental pollution adversely affecting respiratory health in young children needs to be further explored.

The medical researchers advised the following for subsequent research:

> A prospective study in which concentrations of environmental pollutants are correlated with airway symptoms and physiologic measures in exposed children will be important to follow up these findings.

The Kline Study researchers cautiously described the import of their findings:

> This study supports a role for exposure to rural environmental toxicants in the etiology of asthma, and suggests a need for further study of this relationship.

In plain English, the Kline Study researchers indicated that toxic emissions from CAFOs need to be further studied for their role in causing asthma as a result of exposure to such toxins.

References

NOTE: The scientific research studies bearing on the issues discussed in this paper have been divided into the following five groupings:

- Research Studies Cited by the Merchant Study.
- Research Studies Cited by the Kline Study.
- Research Studies Cited by Both the Merchant & Kline Studies.
- Research Studies Pre-Dating the Merchant & Kline Studies.
- Research Studies Ante-Dating the Merchant & Kline Studies.

Studies are placed in only one list to avoid duplication. Therefore, while all of the studies cited in the Merchant Study and in the Kline Study pre-date those studies, they were cited only in the category of study in which they were cited. In other words, each study is only listed once.

Research Studies Cited by the Merchant Study

Campagna D, Kathman SJ, Pierson R, Inserra SG, Phifer BL, Middleton DC, Zarus GM, & White MC (2004 March). Ambient hydrogen sulfide, total reduced sulfur, and hospital visits for respiratory diseases in northeast Nebraska, 1998-2000. *Journal of Exposure Analysis and Environmental Epidemiology, 14*(2): 180-187.

Contreras JP, Ly NP, Gold DR, He H, Wand M, Weiss ST, Perkins DL, Platts-Mills TA, & Finn PW (2003 December). Allergen-induced cytokine production, atopic disease, lgE, and wheeze in children. *The Journal of Allergy and Clinical Immunology, 112*(6): 1072-1077.

Douwes J, McLean D, Slater T, & Pearce N (2001). Asthma and other respiratory symptoms in New Zealand pine processing sawmill workers. *American Journal of Industrial Medicine, 39*(6): 608-615.

Hamscher G, Pawelzick HT, Sczesny S, Nau H, & Hartung J (2003 October). Antibiotics in dust originating from a pig-fattening farm: A new source of health hazard for farmers? *Environmental Health Perspectives, 111*(13): 1590-1594.

Merchant JA, Stromquist AM, Kelly KM, Zwerling C, Reynolds SJ, & Burmeister LF (2002). Chronic disease and injury in an agricultural county: The Keokuk County rural health cohort study. *The Journal of Rural Health, 18*(4): 521-535.

National Academy of Sciences (2003). Air emissions from animal feeding operations: Current knowledge, future needs. Washington, DC: National Academies Press.

Reynolds SJ, Donham KJ, Whitten P, Merchant JA, Burmeister LF, & Popendorf WJ (1996 January). Longitudinal evaluation of dose-response relationships for environmental

exposures and pulmonary function in swine production workers. *American Journal of Industrial Medicine, 29*(1): 33-40.

Reynolds SJ, Donham KJ, Stookesberry J, Thorne PS, Subramanian P, Thu K, et al. (1997). Air quality assessments in the vicinity of swine production facilities. *Journal of Agromedicine, 4*(1-2): 37-45.

Reynolds SJ, Merchant JA, Zwerling C, Stromquist AM, & Burmeister LF (1997). The Keokuk County rural health study: Preliminary results of environmental exposure assessments. *Journal of Agromedicine, 4*(1-2): 55-62.

Salam MT, Li YF, Lanholz B, & Gilliland FD (2004 May). Early-life environmental risk factors for asthma: Findings from the Children's Health Study. *Environmental Health Perspectives, 112*(6): 760-765.

Schenker MB, Christiani D, Comier Y, Dimich-Ward H, Doekes G, Dosman J, et al. (1998 November). Respiratory health hazards in agriculture. *American Journal of Respiratory and Critical Care Medicine, 158*(5 pt 2): S1-S76.

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