

'Infectobesity'

Can Waterborne Viruses Cause Excessive Weight Gain?

By Kelly A. Reynolds, MSPH, Ph.D.

Human disease-causing viruses transmitted by water are generally associated with acute gastrointestinal symptoms, such as diarrhea and vomiting, which often lead to temporary weight loss. Sometimes viral infections continue to elicit chronic human health effects such as arthritis, diabetes or other syndromes (see *On Tap*, August, 2003 for more information on the chronic *sequelae* of waterborne pathogens). Over the last decade, scientists have discovered evidence linking viruses to a much more common chronic human health concern: obesity. At least one of the suspected human obesity viruses may be spread via the waterborne route.

The 2007-2008 prevalence rate of obesity in the US was over 30 percent for all age groups. Grouping categories of overweight and obese, the prevalence is closer to 68 percent.¹ Obesity is a known risk factor for chronic conditions such as stroke, heart attack, hypertension, diabetes, cancer and other illnesses that are the primary causes of death in the US. The battle against the bulge is most commonly waged with a formula of fewer calories in than out, but there may be more complicated factors at work, including viral infections.

Where did the obesity virus come from?

Adenoviruses are not new. They were first isolated from adenoids surgically removed from children in 1953 as a potential tissue for the growth of polioviruses. Soon, the adenoid viruses were determined to be a cause of respiratory disease.² Between 50 to 80 percent of tonsils removed are positive for culturable adenoviruses.

There are over 50 known adenovirus strains capable of infecting humans. We are frequently exposed to various types of adenoviruses and they are well-known causes of respiratory and eye infections (viral conjunctivitis, or pink eye). Certain strains, transmitted by the fecal-oral route, cause typical enteric symptomology. After acute illness, adenoviruses may remain latent and persistent in the tonsils, adenoids and other human lymphoid tissue. Infectious adenoviruses have been shown to persist in the tonsils, and shed in stools for years following infection. They can also be excreted in urine.

Scientific evidence linking adenovirus and obesity

Adenovirus-36 (Ad-36) was first isolated in 1978 in Germany from the feces of a child with diabetes and diarrhea.³ This particular strain was also associated with respiratory and eye infections, but during laboratory studies with infected animals, a new side effect emerged. Mice and chickens infected with Ad-36 had an increase in adipose tissue (aka, fat).⁴

This is big news and reminiscent of a similar story with *Helicobacter pylori*, a pathogenic bacteria causing more than 80 percent of stomach (duodenal and gastric) ulcers previously linked to stress or spicy food consumption (see *On Tap*, September, 2003 for more information). While overeating, under-exercising and genetics are the primary factors in obesity, the role of microbial infections is intriguing and gaining momentum.

Studies of Ad-36 infections in humans are not alone conclusive. A 2005 study involving over 500 volunteers found a highly significant ($p < 0.001$) association between Ad-36 serum antibodies as evidence of infection in humans and obesity.⁵ Ad-36 infection was evident in 30 percent of obese volunteers versus 11 percent in the control group who were not obese. Another study with 89 twins found that twins with Ad-36 antibodies were more likely to have higher body fat than their twin sibling.⁶ From an epidemiological perspective, these types of studies, with relatively small sample sizes, are subject to other confounding factors that may mislead researchers into false conclusions. Therefore, a large, prospective study of Ad-36, or other human pathogens, and obesity is needed to support the preliminary evidence.

A new disease: 'infectobesity'

The mechanism of Ad-36 leading to obesity appears to be associated with the virus' ability to genetically direct human host cells to produce more fat by turning on lipogenic (fat-producing) enzymes, leading to the production of new fat cells and turning existing cells into fat tissue.⁷ Two other strains of adenovirus (Ad-37 and Ad-5) are also implicated in obesity, but so far only in animals and not humans.

In 2001, the scientist who largely pioneered the Ad-36/obesity connection coined the term, 'infectobesity' or obesity of an infectious origin.⁸ With obesity being a condition of epidemic proportions, it is attractive to place blame on a microbe and away from the sometimes unhealthy habits of our culture.

Currently there is no treatment to eliminate Ad-36 infections, although vaccines for other enteric viruses (including other strains of adenovirus) exist. Adenovirus vaccines were historically given to military personnel to prevent respiratory infections. While a vaccine is feasible for preventing Ad-36, it is not likely to be developed soon, given the role of adenovirus in obesity and related health effects is far from certain. A 2009 review article on the topic, however, clearly states that the link cannot be ruled out.⁹

Exposure prevention through water treatment

Shed in feces and well suited for survival in the environment, adenoviruses are readily found in wastewater, drinking water

and recreational water sources. Clinical isolates of the obesity-associated Ad-36 from stool indicates a fecal-oral route of transmission and thus, like other adenoviruses, Ad-36 is likely spread in drinking water.

Many studies with enteric adenovirus strains show that the virus is susceptible to conventional water treatment methods, such as chlorination, but highly resistant to low-pressure ultraviolet light.¹⁰ Adenoviruses have double-stranded DNA, capable of repairing itself under certain conditions following damage by UV light. Treatment using polychromatic UV lamps greatly enhances adenovirus inactivation in water.¹¹ Low levels of ozone are also effective for disinfection of adenoviruses.¹² Thus, many POU technologies are effective against adenovirus. While various virus strains can have different inactivation kinetics, no studies have been published in the literature related to Ad-36 inactivation.

Conclusion

More research is needed to quantitate the impact and definitively characterize the role of adenovirus infections and obesity. In addition, the various transmission routes of Ad-36 are also not known; however, a waterborne route is likely based on clinical stool isolates and characteristics of related fecal-oral pathogens. Although not directly studied, certain POU water treatment technologies are expected to remove Ad-36 and other enteric pathogens from drinking water. In addition to reducing symptoms of gastroenteritis from waterborne enteric pathogens, POU devices may someday prove to keep consumers thin. Now there's a helpful marketing tool!

Endnotes

1. Flegal, K.M., *et al.* (2010) 1999-2008 Prevalence and Trends in Obesity Among US Adults, *Journal of the American Medical Association*. 303:235-241.

2. Adenoviruses. *Virology Online*. <http://virology-online.com/viruses/Adenoviruses.htm>.

3. Wigand R., *et al.* (1980) New human adenovirus (candidate adenovirus 36), a novel member of subgroup D. *Archives in Virology*. 64:225-233

4. Dhurandhar N.V., *et al.*, (2000) Increased adiposity in animals due to a human virus. *International Journal of Obesity and Related Metabolic Disorders*. 24:989-996.

5. Atkinson R.L., *et al.* (2005) Human adenovirus-36 is associated with increased body weight and paradoxical reduction of serum lipids. *International Journal of Obesity*. 29:281-286.

6. Atkinson R.L. (2007) Viruses as an etiology of obesity. *Mayo Clinic Proceedings*. 82:1192-1198.

7. Atkinson R.L. (2008) Could viruses contribute to the worldwide epidemic of obesity? *International Journal of Pediatric Obesity*. 3 Suppl 1:37-43

8. Dhurandhar, N.V. (2001) Infectobesity: obesity of infectious origin. *Journal of Nutrition*. 131:2794S-2797S.

9. Mitra A.K. and Clarke, K. (2009) *Viral obesity: fact or fiction?* 11: 289-296.

10. Mena, K.D. and Gerba, C.P. (2009) Waterborne adenovirus. *Reviews in Environmental Contamination and Toxicology*. 198:133-167.

11. Linden, *et al.* (2007) Enhanced UV inactivation of adenoviruses under polychromatic UV lamps. *Applied and Environmental Microbiology*. 73: 7571-7574.

12. Thurston-Enriquez, *et al.* (2005) Inactivation of enteric adenovirus and feline caliciviruses by ozone. *Water Research*. 39:3650-3656.

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