

Batters may achieve dramatic increases in home runs through steroids

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Steroid use by a Major League Baseball slugger may produce only modest increases in muscle mass and bat and ball speed but still boost home run production by 50 percent or more, according to a new study by Tufts University physicist Roger Tobin.

Tobin, a specialist in condensed matter physics with a long-time interest in the physics of baseball, will publish his paper "On the potential of a chemical Bonds: Possible effects of steroids on home run production in baseball" in an upcoming issue of the *American Journal of Physics*.

As Tobin's paper notes, Babe Ruth's record of 60 home runs in a single season stood for 34 years until Roger Maris hit 61 homers in 1961. For the next 35 years, no player hit more than 52 home runs in one season. But between 1998 and 2006, players hit more than 60 home runs in a season six times. Barry Bonds hit 73 home runs in 2001—topping Maris' mark by an astonishing 20 percent.

According to Tobin, the explosion in home runs coincides with the dawn of the "steroid era" in sports in the mid-1990s, and that surge quickly dropped to historic levels in 2003, when Major League Baseball instituted steroid testing.

While the increase in home runs has been clouded by suspected use of performance-enhancing steroids, many have wondered why home-running hitting would be particularly vulnerable to performance enhancement. They have also asked if it is even physically and

physiologically plausible that steroids could produce effects of the magnitude observed. The answer to both questions, says Tobin, is "yes."

Home Runs Disproportionately Affected

"A change of only a few percent in the average speed of the batted ball, which can reasonably be expected from steroid use, is enough to increase home run production by at least 50 percent," he says. This disproportionate effect arises because home runs are relatively rare events that occur on the "tail of the range distribution" of batted balls.

"In most any statistical distribution -- of people's heights, SAT scores, or how far baseballs are hit -- there's a large bump where most of the values fall, with the graph falling rapidly as you move away from that region in either direction toward the rarer values," explains Tobin. "It's a well-known statistical property of such distributions that a relatively small shift in the center point of the distribution can produce a much larger proportional change in the number of values well above or below the center. Because the distribution's 'tail' is particularly sensitive to small changes in the peak and/or width, home run records can be more strongly affected by steroid use than other athletic accomplishments."

Muscle Mass Boosts Bat and Ball Speed

Tobin reviewed previous studies of the effect of steroid use and concluded that muscle mass, the force exerted by those muscles and the kinetic energy of the bat could each be increased by about 10 percent through the use of steroids. According to his calculations, the speed of the bat as it strikes the pitched ball will be about 5 percent higher than without the use of steroids and the speed of the ball as it leaves the bat will be about 4 percent higher.

To determine the ultimate impact on home run production, Tobin then analyzed a variety of models for trajectory of the baseball, accounting for gravity, air resistance and lift force due to the ball's spin. While there was considerable variation among the models, "the salient point," he says, "is that a 4 percent increase in ball speed, which can reasonably be expected from steroid use, can increase home run production by anywhere from 50 percent to 100 percent."

What About the Pitchers?

Tobin applied a similar, though less extensive, mechanical analysis to pitching and found that smaller impacts were possible. He calculated that a 10 percent increase in muscle mass should increase the speed of a thrown ball by about 5 percent, or four to five miles per hours for a pitcher with a 90 mile per hour fastball. That translates to a reduction in earned run average of about 0.5 runs per game.

"That is enough to have a meaningful effect on the success of a pitcher, but it is not nearly as dramatic as the effects on home run production," says Tobin. "The unusual sensitivity of home run production to bat speed results in much more dramatic effects, and focuses attention disproportionately on the hitters."

A Reasonable Suspicion

Tobin is quick to acknowledge that athletes in many sports today achieve at a higher level than athletes of the past, and that this trend is not evidence of cheating. He also points out that many other changes, including adjustments in ballpark dimensions, league expansions, entry of African-American athletes, and lowering of the pitcher's mound, could affect major league batting—although he says that none of those

changes coincide with the sudden burst of home run production in the mid-1990s.

"Physics cannot tell us whether a particular home run was steroid-assisted, or even whether an extraordinary individual performance indicates the use of illicit means," says Tobin.

Source: Tufts University

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