

## The Effect of the Steroid Era on Major League Baseball Hitters: Did It Enhance Hitting?

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### Abstract

**Background:** The "steroid era" in Major League Baseball (MLB) was a time when drug testing for performance enhancing drugs (PED) was not routinely performed.

**Purpose:** To determine if there was a correlation between the steroid era and home runs, batting average, and isolated power (ISO) in MLB players.

**Methods:** Home run, batting average, and ISO data from 1973 to 2012 was collected and analyzed. The data from the steroid era 1993-2002 was compared to the pre steroid eras 1973-1982, 1983-1992, and post steroid era 2003-2012.

**Results:** There was no statistically significant increase in the number of home runs (HR) hit by the American League (AL), National League (NL) or overall in MLB. There was no statistically significant increase in the ISO or highest yearly single player HR total during the steroid era. There were significantly more players who hit 40 or more HR per season during 1993-2002 compared to each of the other time periods ( $p < 0.002$ ). Throughout all time periods, there was no significant change in batting average.

**Conclusion:** There was a significant increase in players who hit more than 40 HR in a single season during the steroid era compared to before and after this time period.

**Keywords:** Steroids; Performance enhancing drugs; Major league baseball; Home runs; Mitchell report; Hitting

### Introduction

Anabolic steroids, which fall under the general category of Performance Enhancing Drugs (PED), have been a banned substance for Major League Baseball (MLB) players since 1991. However, despite being illegal, MLB did not implement a league wide testing policy for PED until 2003. In the years leading up to 2003, there were many steroid derivatives and precursors for which players were not tested (Table 1) [1]. This made it relatively easy for players to pass drugs tests while still using PED until 2003 [2]. Furthermore, the penalties for testing positive for PED at that time were not significant (10 game suspension for a player's first offense, one year suspension for a fourth offense, and a lifetime ban from MLB for a fifth offense).

With the release of the Mitchell Report on December 13, 2007 and the surrounding media coverage in years prior to this, PED testing in MLB became stricter (the number of steroid derivatives tested for increased, the number of mandatory tests per season for each player increased from one to two, as well as random tests) and penalties for testing positive became more severe [3,4]. The Mitchell report given to the commissioner of baseball identified 89 former and current MLB players who were suspected of using PED at some point in their career. The report also added that because there was not proper cooperation

with the investigation, there were players who were not likely discovered.

Approximately the same time steroids use was suspected to have increased in MLB, there was an increase in the number of home runs (HR) hit per season, both overall in the league as well as the highest HR totals per player per season [5]. Hitters also seemed to be increasing in size. As such, the purpose of this study was to determine if there was a correlation between the steroid era, defined as 1993-2002 prior to the institution of stricter PED testing policies, and home runs hit, batting average, and isolated power in MLB players. The authors hypothesized that there will be an increase in home runs hit, batting average, and isolated power during the steroid era compared to the time periods before and after.

### Methods

A thorough search of the literature was conducted including online resources such as Google, baseball almanac, MLB.com regarding MLB policies surrounding steroid use and testing. Between 1993 and 2002, prior to the inception of mandatory testing for steroid use, there was an increase in the number of players using PED as shown by the Mitchell report. Given this, the time periods of pre 1973, 1973-1982 (early pre-steroid era), 1983-1992 (pre-steroid era), 1993-2002 (steroid era) and 2003-2012 (post-steroid era) were created. Using these breakdowns, performance data for the entire MLB was collected and analyzed as it related to hitting performance.

Drug	Side effects
Anavar (Oxandrolone, Lipidex, Anatrophill, Lonavar)	Minimal
Andriol (Testosterone Undecanoate, Mexican Beans)	Liver Damage, Acne, Sterility, Hypertension, Enlarged Prostate, Gynocomastia Virilization
Clomid (Clomiphene Citrate, Serophene)	Headaches, Hot flashes
The Clear (THG, Tetrahydrogestrinone, Norbolethone)	Unknown
Clenbuterol (Ventipulmin)	Headaches, Tremors, Anxiety, Insomnia, Sweating, Increased appetite, Nausea, Hypertension
The Cream (Testosterone-Epitesosterone Cream)jects	Unknown
Creatine	Possibel muscle strains
Deca-Durabolin (Deca, Nandrolone Decanoate)	Liver Damage, Acne, Sterility, Baldness, Enlarged Prostate, Gynocomastia, Virilization
Depo-Testosterone (Testosterone Cypionate)	Liver damage, Acne, Sterility, Baldness, Enlarged Prostate, Gynocomastia, Virilization
Ephedra (Ephedrine)	Addiciton, Irritability, Nervousness,Diizziness, Trembling, Headache, Vomiting, Hyperthermia
EPO (Erythropoietin, Epogen, Procrit)	Circulatory strain, Increaeed Risk of Clotting
Equipoise (Boldenone Undecylenate, Boldabol)	Hypertension, Testicular Atrophy, Liver Damage, Acne, Sterility, Baldness, Enlarged Prostate Gynocomastia Virilization
Human Growth Hormone (hGH, Somatropin, Serostim)	Hypothyroidism, Acromegaly, Frontal Bossing, Cardiomegaly
Increlex (Insulin-Like Growth Factor-1, IGF-1)	Hypothyroidism, Acromegaly, Frontal Bossing, Cardiomegaly
Insulin (Humulin, Novolin)	Hypoglycemia
Modafinil (Provigil)	Headache, Nausea, Nervousness, Rhinitis, Diarrhea, Back Pain, Anxiety, Insomnia, Dizziness
Prohormones (Andro, Androstenedione, 4-androstenedione 19-norandrostenedione, 19-norandrostenediol, 1-AD, 19-nor)	Liver damage, Acne, Sterility, Baldness, Enlarged Prostate, Gynocomastia, Virilization
Stanozolol (Winstrol, Winthrop, Stromba)	Liver damage, Acne, Sterility, Baldness, Enlarged Prostate, Gynocomastia, Virilization

**Table 1:** List of steroids, steroid derivatives, and precursors used.

The following performance data was collected using baseballalmanac.com and analyzed: number of home runs (HR) hit by the American League (AL), National League (NL), and total number of HR hit by MLB in each individual year from 1973-2012, number of players who hit more than 40 HR in a single season for each season 1973-2012, highest number of HR hit by a single player in a single season for each individual season from 1973-2012, average isolated power (ISO) for MLB for each season from 1972-2012, batting average, and batting average for players who hit more than 40 home runs in a season. Isolated power is a sabermetric used to measure a batters raw power. It calculated by subtracting batting average from slugging percentage. These variables were felt to give the best measure of a batters power, which PED would effect, and so were chosen. Other variables such as number of singles, doubles, strike outs, etc. were not felt to be directly related to PED and so were not analyzed. There were six teams added to MLB between 1973 and 2012. The Seattle Mariners and Toronto Blue Jays were added in 1977, the Colorado Rockies and Florida Marlins (now Miami Marlins) were added in 1993, and the

Arizona Diamondbacks and Tampa Bay Devil Rays (now Tampa Bay Rays) were added in 1998.

### Statistical Analysis

Statistical analysis was performed using ANOVA with Tukey's post hoc tests to compare each baseball parameter amongst eras. Analysis was performed with Microsoft Excel 2011 (Microsoft Corporation, Redmond WA, United States) and XLSTAT 2011 (Addinsoft S.A.R.L, Paris, France) with significance for all analyses set at p<0.05.

### Results

The average total number of home runs (HR) hit per season during the steroid era (1993-2002) was 4,782 +/- 767 while in the post-steroid era (2003-2012) was 4,549 +/- 296, and pre-steroid era (1983-1992) was 3,443 +/- 425 and in the early pre-steroid era (1973-1982) was 2,896 +/- 582 (Figure 1). There were no significant differences between the number of HR hit per year in the American League (AL) and National League (NL) (Table 2). When comparing the total number of

home runs (HR) hit in Major League Baseball (MLB), there was no statistically significant difference between the steroid era and the other 10-year time frames.

The average number of players who hit more than 40 HR in a single season significantly increased during the steroid era 10.2 +/- 5.2 from the early pre-steroid era 1973-1982: 1.4 +/- 1.6 and pre-steroid era 1983-1992: 1.6 +/- 0.97, and declined in the post-steroid era 6.1 +/- 3.5 (Figure 2) ( $p < 0.002$ ). There was no significant difference in the overall highest number of HR hit in a single season in the steroid era compared to the pre and post eras (Figure 3) ( $p > 0.05$ ).

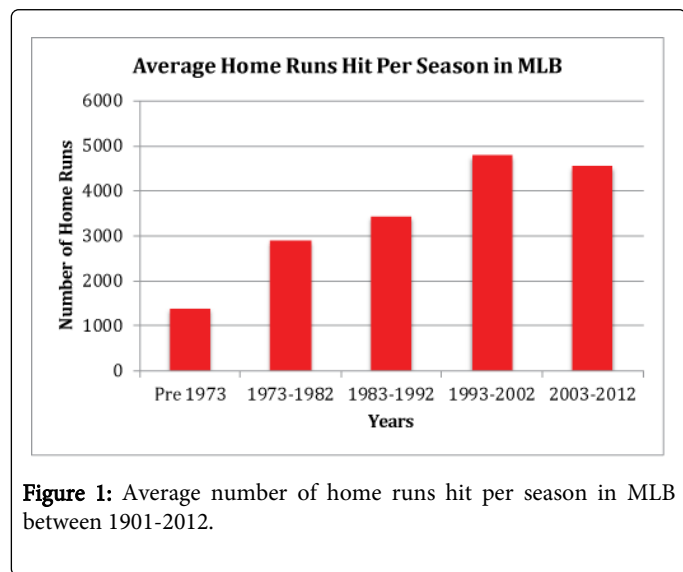


Figure 1: Average number of home runs hit per season in MLB between 1901-2012.

The average isolated power (ISO) was not statistically significantly different for the steroid era (0.159 +/- 0.008) compared to the early pre steroid era of 1973-1982 (0.124 +/- 0.009), pre-steroid era 1983-1992 (0.133 +/- 0.009) or the post steroid era of 2003-2012 (0.157 +/- 0.006) ( $p > 0.05$ ). Also, the mean batting average was not significantly different between the pre steroid era, steroid era, and post steroid era ( $p > 0.05$ ). The mean batting average for players hitting over 40 home runs per season was not statistically significantly different between the various eras (Figure 4) ( $p > 0.05$ ). Finally, during the steroid era, the overall batting average for MLB as a whole did not change significantly compared to before and after the steroid era, despite the number of players who were hitting greater than 40 home runs, and there were no statistically significant differences in batting average between the players who hit greater than 40 home runs and MLB overall (Figure 4).

## Discussion

Despite having a ban on performance enhancing drugs (PED) since 1991, a time known as the steroid era existed in baseball from 1993-2002. This was an era before league wide testing for PED was mandatory, specifically for the starting roster. The purpose of this study was to determine if this steroid era led to an improvement in home runs hit, batting average, and isolated power throughout Major League Baseball (MLB). The authors hypothesized there would be an increase in home runs hit, batting average, and isolated power (ISO) during the steroid era compared to before and after. The author's hypotheses were partly confirmed. Players who hit 40 or more home runs in a single season was significantly greater during the steroid era than both before and after, while batting average and ISO were not significantly different.

Years	1901-1973	1973-1982	1983-1992	1993-2002	2003-2012
Total HR	99,185	28,964	34,433	47,821	50,037
Avg Per Year	1396	2896	3443	4782	4548
Std Dev	856	572	425	767	296
AL	48,992	16,193	20,129	24,020	24,149
AL Avg	690	1619	2012	2402	2195
Std Dev	448	368	280	305	143
NL	49,993	12,771	14,304	23,801	25,888
NL Avg	704	1277	1430	2380	2353
Std Dev	422	250	167	499	221
Std Dev=Standard Deviation; Avg=Average					

Table 2: Total number of home runs hit in MLB, American League (AL) and National League (NL) from 1901-2012. No significant differences were observed.

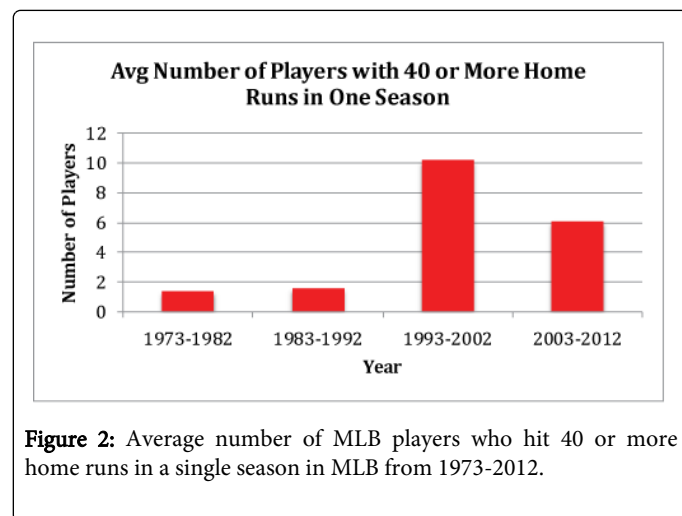


Figure 2: Average number of MLB players who hit 40 or more home runs in a single season in MLB from 1973-2012.

There have been no studies to date that have directly analyzed the performance of MLB players during the era when steroids were widely used and compared these to the eras before and after. It is well known that several athletes used PED during this era [3,6]. Most performance studies looking at MLB players have focused on their return to sport and performance after various injuries and operations including medial ulnar collateral ligament reconstruction [7-9], shoulder surgery [10,11], and cervical and lumbar disc herniations [12]. These studies were mostly conducted in MLB pitchers and did not evaluate batting performance or comment on timing as it related to the steroid era.

There have been several studies which have demonstrated the effects of steroid and steroid derivatives on the body (Table 1) [1,13,14]. Bhasin et al. performed a prospective, placebo controlled study evaluating the effects of supraphysiologic levels testosterone enanthate (TE) on muscle mass over a 10-week period [15]. The

authors concluded that patients with supraphysiologic levels of TE had a significantly greater increase in their lean muscle mass as well as a more significant increase in size of their legs and triceps, and a more significant increase in the weight they could bench press and squat compared to the control group. However, despite the benefits steroids provide in muscle mass and strength, multiple studies have demonstrated that there are innumerable side effects associated with these drugs including cardiovascular disease, testicular atrophy, sudden cardiac death, liver disease and mood alterations [16-19].

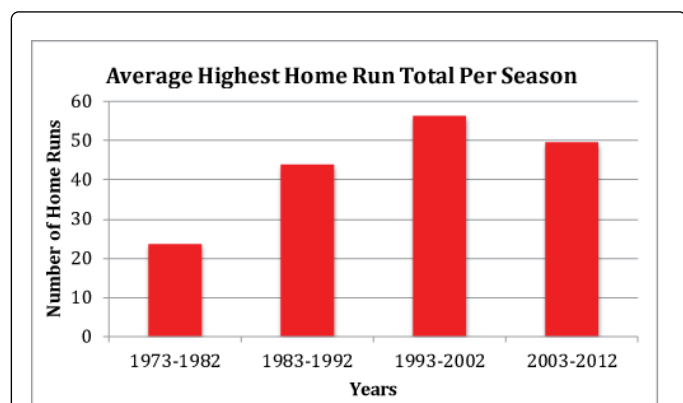


Figure 3: Average highest total number of home runs hit by a single player per season in MLB from 1973-2012.

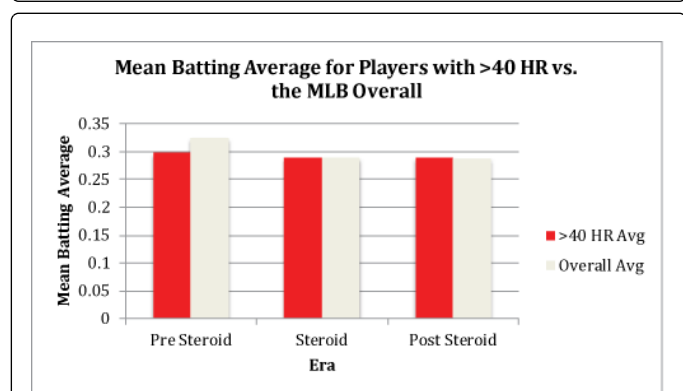


Figure 4: Mean batting average distribution of players who hit greater than 40 Home Runs per season compared to the overall mean batting average for MLB by era 1983-2012 HR=Home Runs. Avg=Average.

Despite the compelling data on the side effects of steroids, a survey completed by 198 Olympic level power athletes asking whether they would be willing to take an illegal supplement, under the premise that they would not get caught, that would eventually kill them within five years of taking it, to be guaranteed to win in their competition, over 50% said they would use the substance [20]. An even more disturbing survey of 873 Indiana high school football players published by Stilger and Yesalis found that 6.3% either currently or previously used steroids, and that 15% of these kids began taking them before the age of 10 [21]. This survey brought to light the pervasive nature of steroids. However, an intervention study by Goldberg et al. attempted to educate high school football players about steroids, the side effects,

and the healthy alternatives [22]. They found that eight weekly, one-hour sessions about steroids caused the intervention population to be much less likely to want to try steroids, even if their friends were using them compared to controls.

One of the measured variables, isolated power (ISO), is a sabermetric measurement that attempts to describe a hitter's raw power. A value of zero would mean the player only hits singles as they never have an extra base hit, while a value of three, the highest value, would mean the player hits a home run at every single at bat. As this sabermetric is used to determine a batter's power, it was used as a proxy in this study to determine if PED enhanced a hitter's performance. However, the study did not show a statistically significant increase in the ISO during the steroid era compared to before and after these years. This could have been due to the fact that pitchers were using PEDs as well, and so because of this, were more difficult to hit.

In addition, this study did show significant increase in the number of players who hit more than 40 home runs in a single season during the steroid era, but it did not show a significant increase in the batting average across the league (Figure 4). There was no significant difference in the batting average across MLB in the years of the steroid era compared to before or after, nor was the batting average different between the players who were hitting more than 40 HR in a single season and those who hit less than this (Figure 4). This means that players were not hitting at an overall higher percentage, but were simply hitting a higher percentage of home runs than in previous years. The number of expansion teams which were added would have no effect on this variable. The conclusion that can be drawn from this is that the steroid era helped with raw power, but did not increase a hitter's ability to make contact with a ball and obtain a base hit, and in fact may have hurt this if one looks at the slight decline in overall batting average in the steroid era compared to the pre steroid era.

## Limitations

The strengths of this study include the breadth of data utilized and the novelty of the study. The limitations include the use of publicly available data, although this has been the source of data in numerous high level studies [7,11,23-26], as well as lack of control for confounding factors. The study also did not evaluate all hitting parameter including singles, doubles, triples, strikeouts, etc. There are some external factors that could potentially alter the hitting data other than PED. For example, cork in baseball bats and shorter baseball fields could falsely elevate the home run numbers. Finally, the total number of players using PED before and after 1993 could not be determined with absolute certainty as there are likely players who used PED but were never caught and never admitted to it. Given the health detriments associated with PED as well as the use of PED by high school athletes, high schools should institute a learning program about steroids to educate their athletes on the detriments of taking steroids in the hopes of decreasing the number of athletes who use PED.

## Conclusion

There was a significant increase in players who hit more than 40 HR in a single season during the steroid era compared to before and after this time period.

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