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What can be achieved as a natural bodybuilder?

By Eric Helms, MPhil, MS, CSCS

Unintended consequences

A negative outcome to the normally harmless debate that occurs online as to who is natural and who is not, is that it makes it difficult for those new to lifting to determine what is possible to accomplish without drugs. Those who have been dedicated to their training and nutrition for years may have the ability to reason what is possible naturally and what is not, but those just beginning can be left confused at best, and disillusioned at worst.

This debate creates important questions. What options are left for a young lifter who is convinced nothing worthy of note can be accomplished naturally? For those involved in competitive natural bodybuilding, what will it mean for the sport if competitors are convinced that those choosing to compete in even the most strictly tested federations are actually cheating? Does this create a self-fulfilling prophecy, convincing up and comers they must use drugs to achieve their goals and that in order to compete in “natural” bodybuilding, drugs are mandatory?

The burden of proof

This debate never ends due to the inability in most cases to irrefutably show that someone is natural or not. Among extreme optimists, some IFBB pros that carry muscle mass far beyond what seems humanely possible are given the benefit of the doubt. Likewise among the most skeptical, even those of modest size who assert they are drug free, choose to compete in drug-tested organizations and pass dozens of 5 to 7-year drug-free polygraph tests, in-competition urinalysis tests, and occasional out-of-competition urinalysis tests are accused. Skeptics assert it is possible to get around tests and believe it to be a frequent occurrence for competitors to enter natural competitions while using drugs, despite the availability of non-tested events where drug use is accepted. Given the frequent reporting of doping scandals in the media, and the fact that people do in fact cheat and fail drug tests in natural bodybuilding,¹ the position of the skeptics is understandable.

Weighing the evidence: Kouri et al., 1995

While it is more or less impossible to prove drug use on a case by case basis, some have tried to answer this question broadly to determine what is possible without steroids in a global sense. An article by Kouri and colleagues titled “Fat free mass index of users and non-users of anabolic steroids”² was published in 1995, in which two groups of athletes were studied. This study included 83 self-reported users of anabolic steroids and 74 non-users of anabolic steroids. Both groups had their height, weight and body fat measured. Like body mass index (BMI) fat free mass index (FFMI) is a relationship of mass to height, in this

case lean mass, expressed numerically. Increases in lean mass are the most consistently observed effect of anabolic steroids, which is true even in research where participants use one fifth to one twentieth of what is reported by steroid using athletes and bodybuilders.³ Thus, it was reasoned by the authors that there should be differences in the amount of lean mass carried by current and recent steroid users and non-users that could be quantified by FFMI. They found that there were in fact differences, as the average FFMI of the users was ~25, while the average for the non-users was ~22. To put these numbers in perspective, both groups averaged ~1.8m in height and ~13% body fat, yet the users on average weighed ~92kg while the non-users on average weighed ~82kg. On the extreme ends, a handful of non-users reached a FFMI of ~25, while some users reached ~32.

While the participants in this study were classified as “athletes, recruited at gymnasiums”, among the non-users were a handful of competitive “natural” bodybuilders, accomplished weight lifters, and some record holding strength athletes.² Thus, the high end range of what is achievable without drugs may have been at least partially represented by the non-users in this study. However, the researchers reasoned that 74 athletes recruited from gymnasiums couldn't reflect what is maximally possible to achieve by genetically-gifted experienced-bodybuilders without drugs. Thus, to present FFMI's representative of the upper achievable limits of drug-free human potential, they listed the FFMI's of the Mr. America winners from the “pre steroid era” of 1939-1959. In this analysis the average FFMI was 25.4 and the highest reported FFMI was 28, indicating that among the most talented and experienced, a higher limit than 25 existed. According to the researchers' sources, 1939-1959 was a time period before anabolic steroids were available in gymnasiums.²

Skepticism for Kouri et al., 1995

In this study non-users were determined by interview. Those stating they never used steroids took a urine test to confirm they were non-users. One could argue dishonest users currently not “on cycle” may have been included as non-users. While plausible that some may have lied about their status and passed the urine test, it seems unlikely. Research participants do not gain recognition. They are de-identified and represented as part of a group. Also, there were no consequences to reporting steroid use. If the individual reported use, they participated in the study as part of the “user” group. Finally, participants would be told what the study would entail before inclusion, and those uncomfortable with interviews would not have likely volunteered. Nonetheless, perhaps due to the generally negative perception of steroid use, some may have lied and went on to pass the urine test.

However, statistically this wouldn't have affected the outcome according to the authors: “even if an occasional self-described nonuser had in fact used steroids, this phenomenon would not affect our estimate of a maximum FFMI in the region of 25 because many nonusers clustered just below 25, and it is impossible that all of the individuals in this cluster were lying. By contrast, if we had found one or two isolated nonusers with an FFMI far above 25, the possibility of deception would have to be entertained carefully, but this was not the case.”

Thus, while it doesn't seem reasonable to doubt the non-user data, there has been additional skepticism as to the steroid-free status of the Mr. America winners from 1939-1959. Steroid research began in the 1930's, with the first human trial occurring in 1937.⁴ Thus, some have claimed that steroids were used by some or all of the 1939-1959 Mr. America winners. In order to evaluate whether these Mr. America FFMI's represent what can be attained without drugs, we must review the history of the introduction of anabolic steroids to the weight lifting community.

The history of anabolic steroid use by bodybuilders

There are various claims in the literature as to when anabolic steroid use began in the bodybuilding community. What is known with certainty is that the search for isolating and synthetically reproducing testosterone was undertaken by three groups in Switzerland, Germany and the Netherlands in the early 1930's.^{4,9} In late 1935 this research culminated in the production of injectable testosterone propionate and oral methyl-testosterone.^{5,10}

Human research began on hypogonadal men, men with dwarfism, and the elderly.^{5,11} Small cohort case studies began in the late 1930's and early 1940's with low dosages due to the high cost of producing testosterone in appreciable amounts.^{7,8,11} The first record of a suggestion that sex hormones might enhance performance in medical literature occurred in 1939.¹² Yet it was not until 1942 that this was tested on healthy males (as opposed to castrated and hypogonadal men),¹³ and again in 1944 in elderly men.¹⁴ As early as 1941 researchers remarked on the improved muscularity of hypogonadal men treated with testosterone.¹¹

Before one assumes the use of exogenous testosterone began by lifters in the late 30's and early 40's, we must put the era in context. This was before the internet, globalization and any widespread notion that steroids were a muscle building or performance enhancing drug (PED). You could not look up studies online. You could not translate them from foreign languages with the push of a button. To simply be aware that a topic was being studied in any timely fashion you would need to be in contact with someone in the scientific community where the research occurred. Without a contact, you would wait years until the discovery garnered public attention.

Public awareness of the health and performance enhancing capacities of testosterone in the US came in the form of Paul de Kruif's "The Male Hormone" in 1945.^{4,5,8,9,12} In his book, de Kruif detailed the research that occurred in the prior decade, and prophetically wrote: "We know how both the St. Louis Cardinals and the St. Louis Browns have won championships supercharged by vitamins. It would be interesting to watch the productive power of [a] . . . professional group [of athletes] that would try a systematic supercharge with testosterone . . ." ⁸ This book is credited as giving birth to the concept of testosterone use for health and potentially as a PED.^{4,5,8,9,12}

Before de Kruif's publication, even if there had been an awareness of a potential for testosterone to build muscle, it was inaccessible due to cost. To manufacture 1g of testosterone in 1940 it cost \$50,⁷ the equivalent of ~\$850 today in 2014.¹⁵ Even

entertaining the scenario that someone had a personal contact at an experimental drug lab willing to sell testosterone for personal use, after mark-up from manufacturing cost, the price would have been astronomical.

However, the cost of testosterone fell dramatically after the American chemist Russel Marker partnered with a Mexican lab to found the company Syntex SA in 1944.^{7,16} Combining his "Marker degradation" technique of developing progesterone from plants with Mexican-native yams that grew large in size, Marker and his colleagues began the Mexican steroid industry. However, Marker left Syntex SA in 1945 after a dispute, forcing Syntex SA to find a chemist to carry on his work. Later that year they found Dr. George Rosenkranz,^{7,16} who extended the Marker degradation process to testosterone in late 1945.¹⁶

Thus, it is possible after the popularization of testosterone by de Kruif, and after manufacturing costs came down, for bodybuilders on the West Coast from 1945 onward to have potentially obtained testosterone.^{4,9} However, it has not been corroborated that this occurred. The first corroborated reports of testosterone use in the lifting community were in 1952. John Ziegler, a US doctor working for CIBA pharmaceutical began experimenting with top weightlifters and bodybuilders in the early 1950's.^{8,17} In 1954, he began by injecting the 1952 Mr. America winner Jim Park, previous Mr. America Winner and former Olympian weightlifter John Grimek, and featherweight champion weightlifter Yas Kuzahara with testosterone. In 1954, it was confirmed by the soviet team doctor that their weightlifting team had been using testosterone at the 1952 Olympics.¹⁸

In the US, this experimentation with testosterone by Ziegler and top lifters was likely an isolated occurrence.¹⁷ Ziegler and the lifters he experimented on were not impressed with the results, nor happy with the side effects.^{8,17-19} Thus, Ziegler and pharmaceutical companies strove to develop less androgenic, more anabolic synthetic steroids. They succeeded by producing and gaining FDA approval for Nilevar in 1956²⁰ and Dianabol in 1958.⁵ The first known report of a high school football player taking steroids occurred in 1959²¹ and in the literature it is agreed that from 1960 onward, steroids were commonly used in the lifting community.^{2,8,18}

Eras of skepticism

With certainty we know the majority of anabolic steroid use in the US lifting community began in the late 50's once superior synthetic steroids were produced. However, we also know top American lifters and bodybuilders experimented with testosterone as of 1954. Finally, we know testosterone use likely began as early as the late 1940's among soviet lifters, considering the institutionalized use by their weightlifting team at the 1952 Olympics.

These are the confirmed records of when steroid use began. However, just because something was not recorded or corroborated does not mean it couldn't have occurred. The Mexican hormone industry began producing more affordable testosterone in 1945, coinciding with increased public awareness of testosterone's potential with the publication of "The Male

Hormone.” Thus, depending on the level of skepticism applied, one can view the 1939-1959 Mr. America FFMI’s from two perspectives. The highly skeptical can view only the 1939-1944 winners as being almost certainly drug-free, while the moderately skeptical can view the 1939-1953 winners as being almost certainly drug free.

Using Table 2 from Kouri et al (right),² high skepticism is indicated by the winners in the green box, while moderate skepticism is indicated by the winners in the orange box. If we accept the 1939-1944 winners as natural, the average FFMI is 24.9, with the highest reported at 27.3. Applying moderate skepticism and accepting the 1939-1953 winners as natural, the average FFMI is 25.6, with the highest reported at 28.0. These means are not much different from the 1939-1959 group mean. In fact, the authors analyzed the FFMI’s to determine if they were increasing over time. They noted: “there was no significant trend towards increased FFMI among the Mr. America winners over a 20-year span from 1939 to 1959 (slope = 0.044 FFMI units/yr; p = 0.44 by regression analysis).” Thus if drug use was occurring, perhaps it wasn’t frequent or effective enough to significantly affect the aggregate FFMI. Finally, to give a visual, below are pictures of top bodybuilders from these “eras of skepticism” with the added level of “extreme skepticism,” an era before steroids could have possibly been used:

TABLE 2. Estimated normalized FFMI's of Mr. America Winners, 1939-1959

Year	Name	Normal FFMI
1939	Goodrich	24.3
1939	Essmaker	22.6
1940	Grimek	24.0
1941	Grimek	26.9
1942	Leeight	25.5
1943	Bacon	23.9
1944	Stanko	27.3
1945	Ross	26.1
1946	Stephan	25.9
1947	Reeves	23.0
1948	Eiferman	27.7
1949	Delinger	28.0
1950	Farbotnik	26.5
1951	Hilligenn	26.0
1952	Park	NA
1953	Pearl	25.8
1954	Dubois	25.4
1955	Klisanin	23.5
1956	Schaeffer	NA
1957	Lacy	25.2
1958	Sansone	26.8
1959	Johnson	24.6
Mean ± SD		25.4 ± 1.5

E. M. KOURI ET AL.
 Fat-Free Mass Index in Users and Nonusers of Anabolic-Androgenic Steroids
Clin J Sport Med, Vol. 5, No. 4, 1995

Moderate skepticism, 1953 and earlier:

Reg Park, 1951

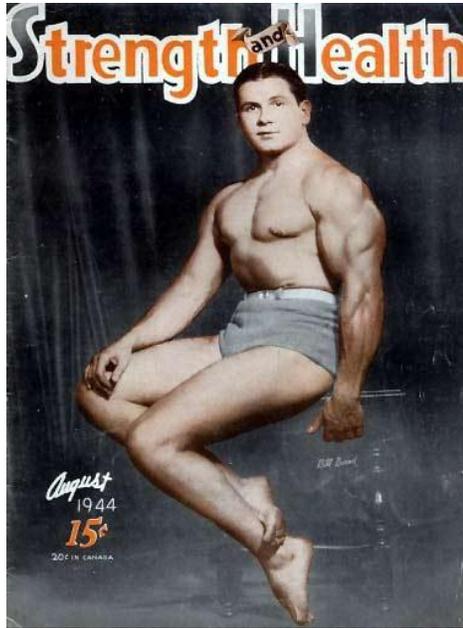
George Eiferman, 1948

Steve Reeves, 1947

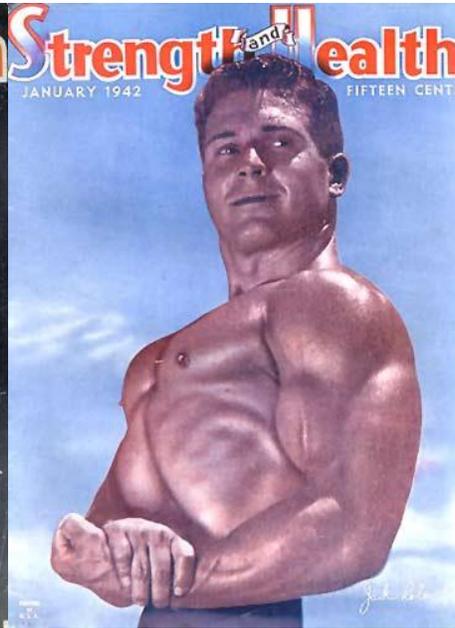


High skepticism, 1944 and earlier:

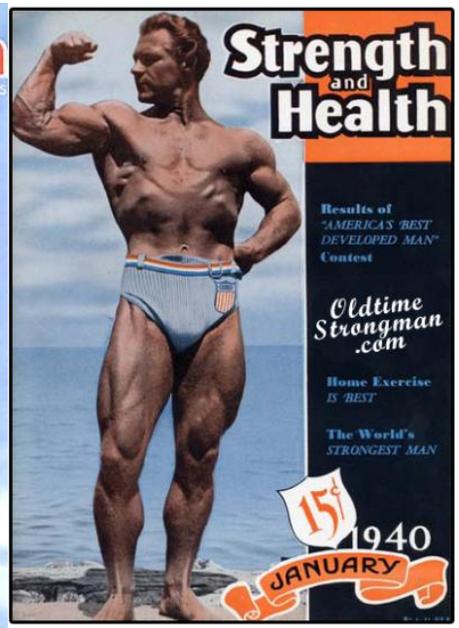
Bill Barad, 1944



Jack Lalane, 1942



John Grimek, 1940



Extreme skepticism, 1936 and earlier:

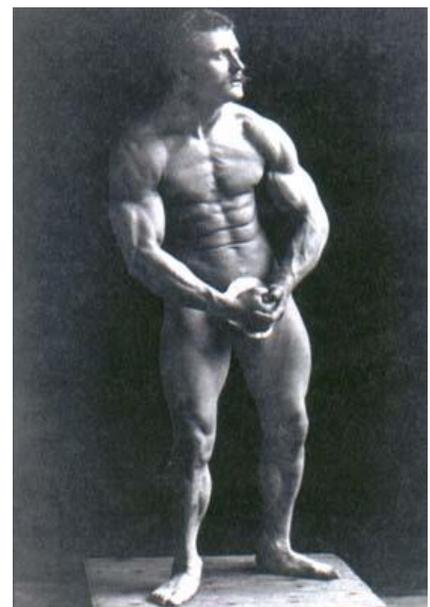
Ernest Cadine, 1920's



Bobby Pandur, 1900's



Eugen Sandow, 1890's



The modern era

Some sceptics assert that the fact that many modern “natural” bodybuilders maintain similar levels of muscularity to those of the pre steroid era while achieving very lean stage conditioning is proof that drug use occurs. Others state that it is impossible to achieve extreme-leanness, or vascularity, or to simultaneously

achieve extreme-leanness while maintaining muscle fullness without steroids. The logic of some of these arguments breaks down upon initial consideration; such as the concept that high degrees of vascularity are only achieved with steroid use. If this were true, there would not be large differences between IFBB

Olympia competitors, whose large PED use is almost undeniable given that even 10 years ago they had FFMI's approaching 40.² As an example, Jay Cutler lacks pronounced vascularity, while Branch Warren is known for extreme vascularity. If steroids do in fact produce vascularity, they seem to do so much less than individual genetic traits.

However, other arguments do contain logical assertions. It is true that the leaner one gets, the harder it is to prevent lean mass losses.^{22,23} It is also true that the standard of leanness in bodybuilding has increased over time. Since the 1980's bodybuilders have strived to achieve striated glute muscles on stage to be competitive. While anabolic steroids provide little to no benefit for fat loss,³ other banned drugs like growth hormone might.²⁴ Additionally, while steroids might not reduce fat mass,³ they likely help to maintain lean mass during a diet. We know that simply achieving extreme leanness doesn't require drugs. In proof, one only needs to view Bobby Pandur above or consider

that IFBB Olympia competitors don't always compete with extreme-leanness. But, are steroids needed during a diet to maintain muscularity and fullness while achieving extreme conditioning?

Only a few years ago this question could not have been answered. However, the results of a 2013 case study titled "Natural bodybuilding competition preparation and recovery: a 12-month case study"²⁵ may help. This case study followed the 6 month contest preparation in 2011 of a professional bodybuilder with the International Federation of Physique Athletes (IFPA). This bodybuilder, pictured below, won his professional status two years prior winning an amateur natural bodybuilding event that was a pro qualifier for the IFPA. The IFPA and its amateur affiliates require all competitors to be polygraphed to determine a minimum of 7 years drug-free prior to stepping on stage, and require urinalysis testing of prize-winners at the pro level and pro-status-winners at the amateur level.²⁶



During this case study a blood and hormonal panel was performed at the 6, 3, and 0 (day of contest) month marks to determine changes in blood and hormone values throughout contest preparation. Hematocrit fell while HDL increased as the diet progressed.²⁵ However, the opposite is seen in bodybuilders using anabolic steroids.²⁷ Total body water remained stable throughout the case study.²⁵ However, body water increases when supraphysiological levels of growth hormone are used.^{24,28} Considering this data and that hormone panels were performed

at the start, mid-point and on competition day along with a polygraph administered by the IFPA, there is near certainty that steroids or growth hormone were not used during this case study. Testosterone levels fell to one fourth their baseline levels as a consequence of dieting. Body mass decreased by 16kg, lean mass decreased by only 3.9%. At the time of competition body fat estimated by DXA was 4.5%, and the subject's FFMI was 24.9.²⁵ In terms of appearance, these are pictures of the competitor on stage. The subject competed with striated glute

muscles, attaining the highest conditioning standard. In terms of fullness and maintenance of muscularity, subjective opinions will vary, however with a FFMI of 24.9 this competitor was on par with many of the Mr. America winners from 1939-1959² while achieving extreme leanness.

In closing

The witch hunt and warlike debate over who is natural and who is not will continue. The most disastrous casualties might not be the bodybuilders whose reputations are tarnished. But rather, competitive natural bodybuilding as a whole and beginners who are convinced the choice to remain drug-free no longer exists. However, to see through this fog of war we have history, logic, and science to hopefully make some sense out of the chaos.

Editor's note: Per Eric's request, here are selected links to the work of our friend and colleague Dr. Casey Butt, who has done perhaps the most diligent quantitative analysis of drug-free muscle-building potential. His investigation is a must-read for those wanting to dig further into the topic of natural limits:

<http://www.weightrainer.net>

<http://www.weightrainer.net/potential.html>

http://www.weightrainer.net/potential_e-book.html



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References

1. INBA. http://www.naturalbodybuilding.com/pages/pages/hall_of_s_hame.php. 2014.
2. Kouri, E.M., et al., *Fat-free mass index in users and nonusers of anabolic-androgenic steroids*. *Clinical Journal of Sport Medicine*, 1995. 5(4): p. 223-8. [[PubMed](#)]
3. Hartgens, F. and H. Kuipers, *Effects of androgenic-anabolic steroids in athletes*. *Sports Medicine*, 2004. 34(8): p. 513-54. [[PubMed](#)]
4. Hoberman, J.M. and C.E. Yesalis, *The history of synthetic testosterone*. *Scientific American*, 1995. 272(2): p. 76-81. [[PubMed](#)]
5. Dotson, J.L. and R.T. Brown, *The history of the development of anabolic-androgenic steroids*. *Pediatric Clinics of North America*, 2007. 54(4): p. 761-9, xi. [[PubMed](#)]
6. Ruzicka, L., A. Wettstein, and H. Kägi, *Sexualhormone VIII. Darstellung von Testosteron unter Anwendung gemischter Ester*. *Helvetica Chimica Acta*, 1935. 18(1): p. 1478-1482. [[Wiley Online](#)]
7. Raviña, E., *The evolution of drug discovery: from traditional medicines to modern drugs*. 2011: John Wiley & Sons. [[Full PDF](#)]
8. Todd, T., *Anabolic steroids: the gremlins of sport*. *J Sport Hist*, 1987. 14(1): p. 87-107. [[PubMed](#)]
9. Freeman, E.R., D.A. Bloom, and E.J. McGuire, *A brief history of testosterone*. *Journal of Urology*, 2001. 165(2): p. 371-3. [[PubMed](#)]
10. Ruzicka, L., M.W. Goldberg, and H.R. Rosenberg, *Sexualhormone X. Herstellung des 17-Methyl-testosterons und anderer Androsten- und Androsterivate. Zusammenhänge zwischen chemischer Konstitution und männlicher Hormonwirkung*. *Helvetica Chimica Acta*, 1935. 18(1): p. 1487-1498. [[Wiley Online](#)]
11. Howard, J.E., *Chemical, Physiological and Clinical Aspects of the Androgens*. *Bulletin of the New York Academy of Medicine*, 1941. 17(7): p. 519-31. [[PubMed Central](#)]
12. Yesalis, C.E. and M.S. Bahrke, *History of doping in sport*. *Performance enhancing substances in sport and exercise*. Champaign: Human Kinetics, 2002: p. 1-20. [[JSH – Full PDF](#)]
13. Samuels, L.T., A.F. Henschel, and A.B. Keys, *Influence of Methyl Testosterone on Muscular Work and Creatine Metabolism in Normal Young Men*. *The Journal of Clinical Endocrinology & Metabolism*, 1942. 2(11): p. 649-654. [[JCEM](#)]
14. Simonson, E., W. Kearns, and N. Enzer, *Effect of Methyl Testosterone Treatment on Muscular Performance and the Central Nervous System of Older Men*. *The Journal of Clinical Endocrinology & Metabolism*, 1944. 4(11): p. 528-534. [[JCEM](#)]
15. *CPI Inflation Calculator*. Available from: <http://data.bls.gov/cgi-bin/cpicalc.pl>.
16. ACS. *The "Marker Degradation" and Creation of the Mexican Steroid Hormone Industry 1938-1945*. 1999 [cited 2014 September, 5]; Available from: <http://www.acs.org/content/acs/en/education/whatischemistry/landmarks/progesteronesynthesis.html>.
17. Fair, J.D., *Isometrics or steroids? Exploring new frontiers of strength in the early 1960s*. *Journal of Sport History*, 1993. 20(1): p. 1-24. [[JSH – Full PDF](#)]
18. Kremenik, M., et al., *A Historical Timeline of Doping in the Olympics (Part 1 1896-1968)*. *Kawasaki Journal of medical welfare*, 2006. 12(1): p. 19-28. [[KJMW – Full PDF](#)]
19. Todd, T. and J. Hoberman, *Yearning for Muscular Power*. *Iron Game History*, 2007. 9: p. 20-32. [[IGH – Full PDF](#)]
20. Colton, F.B., *Steroids and "the Pill": early steroid research at Searle*. *Steroids*, 1992. 57(12): p. 624-630. [[PubMed](#)]
21. Calfee, R. and P. Fadale, *Popular Ergogenic Drugs and Supplements in Young Athletes*. *Pediatrics*, 2006. 117(3): p. e577-e589. [[PubMed](#)]
22. Forbes, G.B., *Body fat content influences the body composition response to nutrition and exercise*. *Annals of the New York Academy of Sciences*, 2000. 904(1): p. 359-65. [[PubMed](#)]
23. Hall, K.D., *Body fat and fat-free mass inter-relationships: Forbes's theory revisited*. *British Journal of Nutrition*, 2007. 97(06): p. 1059-63. [[PubMed](#)]
24. Ehrnborg, C., et al., *Supraphysiological growth hormone: less fat, more extracellular fluid but uncertain effects on muscles in healthy, active young adults*. *Clinical Endocrinology*, 2005. 62(4): p. 449-57. [[PubMed](#)]
25. Rossow, L.M., et al., *Natural bodybuilding competition preparation and recovery: a 12-month case study*. *International Journal of Sports Physiology and Performance*, 2013. 8(5): p. 582-92. [[PubMed](#)]
26. <http://www.naturalmusclenetwork.com/DrugTestingGuidelines.pdf>.
27. Lane, H.A., et al., *Impaired vasoreactivity in bodybuilders using androgenic anabolic steroids*. *European Journal of Clinical Investigation*, 2006. 36(7): p. 483-8. [[PubMed](#)]
28. Berggren, A., et al., *Short-term administration of supraphysiological recombinant human growth hormone (GH) does not increase maximum endurance exercise capacity in healthy, active young men and women with normal GH-insulin-like growth factor I axes*. *Journal of Clinical Endocrinology and Metabolism*, 2005. 90(6): p. 3268-73. [[PubMed](#)]