

Doping in Sport:
**An interdisciplinary study of its
management and prevention**

A Thesis Submitted by

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Table of Contents

| | |
|---|----|
| Abstract: | 5 |
| Introduction: | 6 |
| Overview and interconnectivity of papers | 9 |
| Declaration | 16 |
| Acknowledgements | 17 |
| Author Contributions: | 19 |
| <i>Manuscripts included in this thesis:</i> | 19 |
| Author Contributions for Paper 1 - The Doping Myth: 100m sprint results are not improved by “doping” | 20 |
| Author Contributions for Paper 2 - Title: Long term effects of doping in sporting records: 1886-2012 | 21 |
| Author Contributions for Paper 3 - Title: Anti-doping systems in sports are doomed to fail: a probability and cost analysis | 22 |
| Author Contributions for Paper 4 - Classical positions on doping and their usefulness to modern sports policy | 23 |
| Author Contributions for Paper 5 - ‘Pool of Responsibility’: A new approach to doping prevention | 24 |
| Paper 1 - Title: The Doping Myth: 100m sprint results are not improved by “doping” | 25 |
| Abstract | 26 |
| 1. Introduction | 28 |
| 2. Materials and Methods | 29 |
| 3. Results | 31 |
| 4. Discussion | 35 |
| 5. Conclusion | 40 |
| 6. Perspective | 40 |
| Acknowledgments | 40 |
| References | 41 |
| Paper 2 - Title: Long term effects of doping in sporting records: 1886-2012 | 44 |
| Abstract | 45 |
| 1. Introduction | 46 |
| 2. Materials and Methods | 48 |
| 3. Results | 51 |
| 4. Discussion | 60 |
| 5. Conclusion | 66 |
| 6. Perspective | 67 |
| Acknowledgments | 67 |
| References | 68 |
| Paper 3 - Title: Anti-doping systems in sports are doomed to fail: a probability and cost analysis | 72 |
| Abstract | 73 |
| 1. Introduction | 74 |
| 1.1 Anti-doping policies and realities | 77 |

| | |
|---|-----|
| 1.1.1 Human Health..... | 77 |
| 1.2 Effectiveness according to some experts..... | 80 |
| 1.3 Window of Detection..... | 81 |
| 1.4 Test Sensitivity..... | 83 |
| 1.5 Doping Regime | 84 |
| 1.6 Predictability of Testing..... | 85 |
| 2. Methods | 86 |
| 3. Results and Discussion..... | 91 |
| 3.1 Odds of Doping Detection | 91 |
| 3.2 Rates of Doping..... | 101 |
| 3.3 Testing Requirements | 104 |
| 3.4 The Cost of Effective Anti-Doping | 106 |
| 3.5 Biological Passport and Forensic Testing..... | 108 |
| 4. Limitations and Future Research | 111 |
| 5. Conclusions..... | 111 |
| Acknowledgments..... | 112 |
| References | 113 |
| Paper 4 - Title: Classical positions on doping and their usefulness to modern sports policy | 122 |
| Abstract..... | 123 |
| 1. Introduction..... | 124 |
| 1.1 Why?..... | 126 |
| 2. Similarities between classical sports and modern sports..... | 129 |
| 2.1 Athletes Health and Anti-doping | 137 |
| 3. Classical practices and their link to ‘doping’..... | 139 |
| 3.1 Societal and Cultural Linkage | 140 |
| 4. Policy implications and recommendations | 144 |
| 5. Conclusion | 146 |
| Bibliography | 148 |
| Paper 5 - Title: ‘Pool of Responsibility’: A new approach to doping prevention | 155 |
| Abstract..... | 156 |
| 1. Anti-doping Arguments: A Critique | 158 |
| 1.1. Fairness and Equality..... | 158 |
| 1.2. Athlete’s Health..... | 162 |
| 1.3. Appearances, Perceptions and Revenue | 163 |
| 2. ‘Pool of Responsibility’: A Novel Approach | 164 |
| 2.1. The Concept | 165 |
| 2.2. The Organisational Arena | 167 |
| 2.3. The Case Studies | 170 |

| | |
|---|-----|
| 2.4. The Legal Arena | 173 |
| 3. 'Pool of Responsibility': The Application..... | 178 |
| Conclusions..... | 180 |
| References | 181 |
| Impacts of this research..... | 190 |
| 1. Citations..... | 190 |
| 2. Media Coverage | 191 |
| 3. Other Impacts..... | 192 |
| Findings of the Research..... | 193 |
| Conclusions | 195 |
| Additional References | 201 |
| Appendix A – Published version of: The Doping 'Myth' - Anti-Doping Systems in Sports are not improved by 'doping', International Journal of Drug Policy, 24: 110–114 | 202 |
| Appendix B – Published version of: Anti-Doping Systems in Sports are Doomed to Fail: A Probability and Cost Analysis. Journal of Sports Medicine and Doping Studies, 4: 148. doi:10.4172/2161-0673.1000148..... | 207 |
| Appendix C – Overview of media coverage arising from thesis research..... | 219 |

Abstract:

This thesis addresses aspects of two key fields of research. One component addresses the areas of medicine and science, whilst the second addresses the areas of law and policy. This research contributes new results regarding effects of doping on sport achievements, the widespread nature of doping and offers new ideas to the area of anti-doping, anti-doping policy and law, and to the greater sporting arena. It firstly demonstrates that doping is far more widespread than official results would have one think. Doping is not confined to a limited few individuals, rather it is a widespread major problem in a number of sports throughout the world. It furthermore demonstrates that summer sports appear to have a greater problem with doping than winter sports. Next, it shows that current anti-doping testing and detection systems are inefficient and ineffective. The current system is structured such that a single test will, in most cases, not detect a doped athlete. Moreover, in order for the current system to be effective, testing and funding would need to be increased to such a level as to make anti-doping, and sports in general, economically unfeasible. This thesis also shows that in order to combat doping (given the realities of the sporting arena and the findings of the papers) there are a few different approaches which could be taken to change the laws and policies; firstly, a restructuring of how sports are promoted and more specifically how they are seen by spectators. This view focuses on sports being an entertainment medium. This may benefit in reducing or removing doping issues. The role sport plays in modern society is such that it often conflicts with many of the ideals in modern society. Finally, as has been demonstrated by many doping scandals of late and the realities of doping cases, that multiple individuals are often involved in such cases not just the doped athlete. As such, this thesis proposes a series of policy changes to expand the responsibility and liability for doping infringements.

Introduction:

Doping in sport has been an issue for more than 100 years. Since the earliest competitions of the modern era, doping has been used as a means of gaining advantage over one's competitor. Before the isolation of steroids in the 1930's, doping was very much a 'hit or miss' practice. Some individuals attempted it, but with unexpected and sometimes fatal result. Before this time doping lacked its systematic option. The isolation of steroids created the first opportunity to systematically and effectively dope. Since the 30's numerous high profile doping scandals have tainted not only promising skilled athletes, but also the wider sporting arena.

Perhaps worse still are the consequences some doping practices can have on the human body. These consequences have, on more than a few occasions, resulted in the untimely death of an athlete. Despite these potentially fatal consequences athletes still are willing to risk the chance of getting caught and potential death to gain the upper hand in hope of winning. Research by Goldman & Klatz (1992) showed that approximately half of the respondents in their survey stated they were willing to die after 5 years if they could be guaranteed success. This shows the state of doping in modern times. The very practice of doping is in direct conflict with some of the primary aims of sport in the modern era, that of fairness and spirit of equality, morality and ethics. All in all doping has come to be seen as one of the greatest evils in the modern sporting arena.

Anti-doping practices have been, in one form or another, in existence since the 1920's with the IAAF's acknowledgement of doping. However, it was only in 1967 that the first grand scale attempts to combat doping were introduced. The International Olympic Committee's

introduction of anti-doping rules and testing saw the beginning of an uphill battle to combat doping. Despite these valiant attempts, the early anti-doping systems, particularly the methods of testing, lacked effectiveness and efficiency; one could say it was introduced more as a method of prevention through fear as opposed to any reliable method of detection.

The last 60 years have seen major changes in anti-doping systems as well as the techniques to combat doping. These changes range from the introduction of the World Anti-Doping Agency, Out-of-competition testing, advancements in detection methods, through to education programs, widespread funding for doping research and national anti-doping associations etc. They have also changed both the way doping has been combatted and also the ways in which doping is undertaken by athletes.

Whilst there have been many positives originating from these changes, an unfortunate reality still exists. The nature of anti-doping policies in modern times is such that doping practices have become so clandestine and more difficult to discover, as to be even more difficult to combat than 60 years ago. Advancements in pharmaceuticals, drug development, science and techniques to introduce drugs into the human body all mean that doping today is more difficult to discover and combat than ever before. Despite policy makers', scientists', lawyers', managers' and educators' best efforts, doping still exists to this day and it appears to always have the upper hand over the anti-doping system.

The perpetual existence of these problems has wider reaching consequences, especially given the role sports play in modern times and modern society. The modern role of sports in society

means that doping has wider societal consequences than ever before. The vast quantities of money, the importance of sports in some people's everyday life and the level to which it is intertwined in, not only lives of adults, but also in the development of children and in some cases a nation's identity, demonstrates this wider reaching impact. The latter of these, a nation's identity, is such that today these impacts spread to encompass the realm of international relations between nations. Moreover, in some cases, these issues can cause serious social problems, including violence and potentially war. This impacts not only individuals, but also companies and the peaceful coexistence between nations as a whole.

As such, given these realities, the continuance of doping and the wider societal and global consequences, a new approach must be constructed in order to help combat doping. This thesis aims to ascertain the current state of doping in sports and to make recommendations to solve the problems faced by the modern and future sporting arenas. This is done in three ways. Firstly, this thesis begins with a determination of the current state of affairs in the sporting arena; what is the situation with doping in the modern times. Secondly, based upon the findings of the initial investigations it analyses the current anti-doping system, its effectiveness and efficiency in reaching its goals through means of an assessment of testing, detection and policy. Finally, again based upon the finding of the previous research it makes recommendations for policy makers, lawyers and sporting officials as to changes to the current systems to help prevent doping, not only combat it.

Overview and interconnectivity of papers

The first paper, contributing to this thesis, pertains to an assessment of the current state in the sporting area with regards to doping. This was performed in order to determine to what extent doping is impacting sports today and to what extent it is inherent in the modern sporting arena. This assessment was performed in order to obtain a better overall indication of the problem. It was felt that this was an important starting point, in order to provide a more effective and efficient solution to the doping problem. It was first necessary to assess exactly what is the current state of doping and to what extent this is a widespread issue or just an overhyped problem.

The first paper sets out to consider the situation with doping. A specific sport (100m sprints) was selected to ascertain the extent to which doping is impacting sports today and the extent to which it is present in the given sport. 100m sprints were selected for two reasons, 1) it is considered the prestige event of the summer Olympics, and 2) the performance results are such that they can be compared directly and the impact of doping can be determined. This analysis contained data relating to top 100m sprint results over the last 30 years of records. The study involved the comparison between times of known 'dopers' vs. those times of athletes without known doping histories. This was performed in order to ascertain any differences in the average achievements. The best performances of 63 males and 69 female athletes were analysed. Results showed that performance times of doped and 'non-doped' athletes did not differ significantly (males 9.89s identical with 'non-dopers' 9.89s, females 10.84s and 10.88s). This indicated that either doping is widespread in 100m sprints and dopers are simply not being caught, or doping does not help performance.

In order to assess which of these conclusions are more likely and in order to get a more complete picture of the current state of doping in the wider sporting arena, the second study expanded the statistical analysis. Additional research was required because using only a single sport would result in an incomplete and skewed impression. That is to say the findings of the first paper may be confined to just 100m sprints; perhaps abnormalities exist within 100m sprints which resulted in the findings of the research. As such it was necessary to expand this research to look at additional sports which could be classified into other sporting and biological categories.

The second study incorporated sports which could be classified as endurance sports (such as marathon), strength sports (such as shot-put) and winter sports (such as speed skating) so to also assess the extent to which the findings of the first paper are representative of the entire sporting arena. As such, paper 2 expanded the study. Moreover, it expanded the period of time of the analysis to include over 125 years of sporting records (1886-2012). The analysis consisted of over 1560 results across 26 different summer and winter sports. Findings of the second paper reinforced that of the first and showed similar trends. Performance times of those athletes considered 'doped' and 'non-doped' were not significantly different across a range of sports. Furthermore, this study assessed long term effects of doping, using non-linear regression techniques. Findings indicated that sporting results did not improve as predicted by results from earlier years. The only differences were found in winter sports. Winter sports were shown to have a very different trend to those of summer sports, the performance results in winter sports coincided with the expected extrapolations. These findings are reinforced when coupled with those of the first study. They indicate two key facts. Firstly, doping if not undertaken with full knowledge and education of the effects, which substances to use and how much to use etc. does not have the desired effects on results. Secondly, it also indicates that doping is more widespread than official anti-doping records indicate. The fact that some

sports show no differences in the performance of those athletes without known histories of doping and those with known usage may indicate that at least some are in fact doping and are simply not being caught.

These findings indicate that there are clearly issues with the current anti-doping systems. Both of the key findings point to the same conclusion. If doping is not working as expected and people are still participating, then there are issues with prevention techniques; and if doping is occurring and athletes are not being caught, then there is a clear and serious problem with the anti-doping systems, especially with testing and detection. These issues arise for a number of reasons. Not only because of the evolving nature of doping substances, i.e. that new substances are always being discovered, but also because of the nature of the testing systems. If doping is occurring and not being caught, then it shows that testing lacks the precision needed, there are problems with the techniques used, or there are realities about human biology and medical realities that have not been fully addressed with the current systems.

Given the evidence that doping is far more widespread and that dopers are not being caught, it was next necessary to assess why this is the case. Why is it that potentially large numbers of doped athletes are ‘slipping through the cracks’? As such, attention was turned to the current anti-doping system, specifically that of testing and detection. There have been claims made by a number of officials in the sporting world as well as athletes both past and present, that the biggest issue with doping and the lack of offenders being caught is because of issues in the testing. In one extreme case Christopher Froome (2014) a professional cyclist, claimed that during a training camp involving a number of high profile and successful cyclists no anti-doping tests were conducted at all. If this is the case, then the findings of the first two papers

need to be addressed by assessing the situation with the current anti-doping systems. Further justification to assess the current systems is that testing and detection plays the single largest role in combatting doping. If testing and detection is faulty, then athletes will not be deterred to undertake the practice. It plays a role not only in catching the offenders but in turn punishment and as such acts as a deterrent against future doping. If doping is widespread, then perhaps this deterrent is lacking.

Paper 3 therefore analyses the current testing and detection systems to determine the extent to which they are effective and efficient in meeting their desired goals of preventing, deterring and/or catching doping. It was shown, through use of mathematical modelling, that with the current systems of detection and testing, the likelihood of being detected in a single test can, on average, be as low as 2.9%. The results showed that the current system is unlikely to catch offenders. As such, it is unlikely to be an effective deterrent, for athletes do not fear being caught. This reality is said to be contributed to because of a number of scientific and human biology facts which may not have been full accounted for in the current anti-doping systems. Realities about how long agents are detectable, which agents are used, how often doping is performed and needed to be performed by athletes to reach their goals, and athletes access to information about testing all contribute to the success rate of doping testing. Moreover, it was found that if the current system of anti-doping detection and testing were to remain, then dramatic increases in the number of tests performed and money invested in the system would need to be introduced in order to make it truly effective. The numbers involved were such as to make anti-doping, and sports in general, economically unfeasible. These findings reinforce the findings of the first two papers. The current systems of testing and detection lack the necessary effectiveness, precision and efficiency, and as such it is completely possible that a number of athletes who dope are not being detected and as such this is impacting the results

obtained in a number of sports. This paper also discovered that one of the key barriers to successful anti-doping detection is athlete's access to information. Other third parties may be contributing to their doping actions, that others may be either influencing them or providing them with assistance. This paper demonstrates that changes are needed in the current system in order to prevent and/or detect doping when it occurs as opposed to years after the event (such as was the case with Lance Armstrong and United States Postal Cycling Team). The question remains, what form do these changes need to be? Changes will be needed to not only address not only the biological realities of the sporting world but also the financial realities and also the specifics of factors impacting on the decision to dope.

In order to better address the problems facing the current anti-doping systems, it was first necessary to consider the current systems, how they have changed and what differs now to the past. As such, given the results of the first, second and third paper, the realities of the anti-doping system's inefficiencies and the apparent widespread nature of doping, it was subsequently necessary to assess the current approach to anti-doping policies and how they have changed over time. After careful research and an investigation of factors influencing an athlete's decision to dope it was determined that one of the key issues with the current system is how sports are viewed today by athletes and spectators; basically the role sports play in society. Therefore, it was next necessary to investigate how these views have changed with time and how they are being considered today. This was done in order to better know what changes are needed and also to make appropriate recommendations that will result in more effective and efficient policies. As such, paper 4 investigated the history of doping, more specifically doping, anti-doping and sports role in life in classical times and modern times.

It was discovered that despite the fact that doping (in some form or another) has been conducted since ancient times, it has only become a major problem within the last 100 years. Given the ineffectiveness of the current system and given that it was not a problem historically, paper 4 investigated the history of doping and anti-doping in ancient times in order to see if some similar policies could be used today to help combat doping. It was discovered that social views of sport and the role sports played in ancient cultures had the largest impact on doping not being a problem in ancient times. More specifically, it was found that sports then, were very much an entertainment medium. Spectators saw it in this manner and as such, a change in spectators' views of sports in the modern era to that of entertainment may help combat doping or at least to reduce its impact. One additional finding to come out of this study reiterates a key finding of the third study, the role others have in an athlete's decision to dope. Ample evidence exists that shows that an individual's decision to dope is rarely made on their own. Influence from coaches, managers, scientists, medical practitioners, or other athletes all contribute to this decision. Doping scandals reveal that numerous other people play a role. Scandals such as with Lance Armstrong and the United States Postal Cycling Team, East Germany or Chinese Swimmers scandal all reveal that doping is rarely confined to one individual. In many cases this is not just influence but rather encouragement or assistance to dope. These factors contribute to the ineffectiveness of the current systems as also demonstrate that they need to be taken into greater consideration with regards to anti-doping policies.

Therefore, this discovery means that research relating to the extent to which current anti-doping systems only address the role of the individual vs. the role of external influences was needed. As such, further analysis was conducted regarding the factors surrounding the problems with anti-doping policies. Moreover, research into the factors in existence with relation to the major doping scandals being revealed in recent times was conducted. This was

done in order to make more practical recommendations to the current policies to combat doping.

Paper 5 addresses the problems faced with the current systems and the lack of responsibility borne by others involved in the athletes doping action. It proposes new policies incorporating these other responsible parties and makes recommendations on a concept termed 'pool of responsibility'. That is to say that the liability (and subsequent punishment) for doping is extended beyond just the individual to include all those involved in the doping case. The results of this paper not only address the realities of the sporting world, and the findings of the previous 4 papers but it also creates a new concept of anti-doping policy so as to better deter doping and deal with it when and if doping does occur.

Declaration

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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Aaron Hermann was the sole author of all aspects of the paper.

Author Contributions for Paper 5 - 'Pool of Responsibility': A new approach to doping prevention

Aaron Hermann was the sole author of all aspects of the paper.

Paper 1 - Title: The Doping Myth: 100m sprint results are not improved by “doping”

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Abstract

Background: Doping is a very serious issue bedevilling the sporting arena. It has consequences for athletes’ careers, perception of sports in the society and funding of sports events and sporting organisations. There is a widespread perception that doping unfairly improves results of athletes.

Methods: A statistical study of information on best lifetime results of top 100m sprinters (males better than 9.98s, females 11.00s), over the period of 1980 to 2011 was conducted. Athletes were divided into categories of “doped” (N=17 males and 14 females), based on self admission, the confirmed detection of known doping agents in their bodies or doping conviction, and “non-doped” (N=46 males and 55 females).

Results: No significant differences (unpaired t-test) between dopers and non-dopers were found in their average results: male “dopers” 9.89s identical with “non-dopers” 9.89s, females 10.84s and 10.88s respectively. Slopes of regressions of best results on dates for both “dopers” and “non dopers” were not significantly different from zero. This indicates that no general improvement as a group in 100m sprint results over a quarter of a century occurred irrespective of doping being or not being used.

Conclusion: Since there are no statistical differences between athletes found “doping” and the others, one of the following must be true: 1. “Doping” as used by athletes so detected does not improve results, or 2. “doping” is widespread and only sometimes detected. Since there

was no improvement in overall results during the last quarter of the century, the first conclusion is more likely. Objectively, various "doping" agents have obvious physiological or anatomical effects. These may not translate into better results due to the clandestine use of doping that prevents its scientific structuring. Perception of the effectiveness of doping should be reconsidered. Policy changes may be required to ensure the continued fairness and equity in testing, legislation and sports in general.

1. Introduction

The issue of doping in sports has for more than half a century been of concern to athletes, sporting organisations, lawyers and greater society alike. It would seem that not a year goes by now that one does not observe a high profile athlete having doped to obtain the advantage over their fellow athlete (Sturbios, 2010). As suggested by Lippi, Banfi, Franchini & Guidi (2008:441), doping now appears to be “an everyday problem”. In a number of cases the athlete seems to justify such actions as per the perceived demands of the sport (Cycling News, 2008; Cycling News, 2010), as if doping was necessary to perform at the required level. Yet is this perception of the performance enhancing effects of doping agents just that, a perception; does the act of doping really enhance the performance of an athlete? There is a plethora of extant research, as to the potential performance enhancing capabilities of various doping agents for athletes (Kohler, Thevis, Schänzer, et. al., 2008; Sjöqvist, Garle, & Rane, 2008; Reichel & Gmeiner, 2010) yet despite this there is also considerable research which demonstrates the very same doping agents as having no performance enhancing effects at all; Beta-2 Adrenergic Agonists are one such example (Norris, Petersen, & Jones, 1996; Goubault, Perault, Leleu, et al., 2001). As such there still remains debate as to whether the use of some doping agents by athletes truly results in the postulated effects, as many agents have unproven (Backhouse, Whitaker, & Petróczy, 2011) or unknown (Lentillon-Kaestner & Carstairs, 2010) effects.

The question remains, why does an athlete choose to dope? In terms of this paper doping should be ideally defined as artificial alteration of an athlete’s body with intent to gain advantage, a win, podium or record, prestige or economic gain (Hardie, Shilbury, Ware et. al., 2010), something that promises benefit to the athlete deciding to engage in the practice. It is

difficult to find exact data fitting this idealised definition and therefore here we use in practical terms doping as a breach of WADA's rules. We realise that this approach may occasionally include unintentional use of some formally banned substances (e.g. use of a cough syrup containing some banned substances not listed on the label). Therefore the aim of this paper is to demonstrate through means of statistical analysis, in the case of the 100m sprint, whether the practice of doping as it is performed today did in fact result in the desired outcomes and enhance the results of those athletes engaging in the act. Over the last quarter of a century a number of sprinters were detected to have used doping agents. Methods of testing are not always reliable and therefore some athletes who used banned substances may not have been detected. Common understanding is that "doping" unfairly improves results. Thus it can be expected that (1) athletes detected "doping" would have achieved on average better results over their lifetime than those non-doping, (2) as a group athletes, some of whom practiced doping whether detected or not, would have improved their lifetime records over the last quarter of a century. The 100m was chosen for this paper as it generally considered as being perhaps the most prestigious event of the summer Olympics, which unfortunately is often marred with numerous doping scandals.

2. Materials and Methods

Data for this research were collected relating to the personal best times, and years these times were set for top 63 male sprinters and 69 female sprinters (males under 9.98s females under 11.00s). This information was obtained from the IAAF website (2011). The very same website provided additional information regarding any discovered use of a banned substance. This information was then crosschecked with various additional sources such as the United States Anti Doping Agency (2011). The information obtained from 63 males included 17

“doped” and 46 not and from 69 females, 14 “doped” and 55 not. Athletes were categorised as “doped” if they fulfilled at least one of two criteria: Firstly the self admission of doping agent usage, or secondly the doping related conviction or the confirmed detection of known doping agents in their bodies irrespective of whether doping convictions were later received, therefore no reinstated athlete was included in the “non-doped” group. Amongst our group of “dopers” 84% were linked to the use of substances considered by WADA to be performance enhancing (e.g. testosterone, Human growth hormone, nandrolone) while 3 males were detected using cannabis, one woman using caffeine and one without the name of the substance detected given. All were included for consistency. All information used in this research is publicly available and therefore there was no need for any ethical clearances.

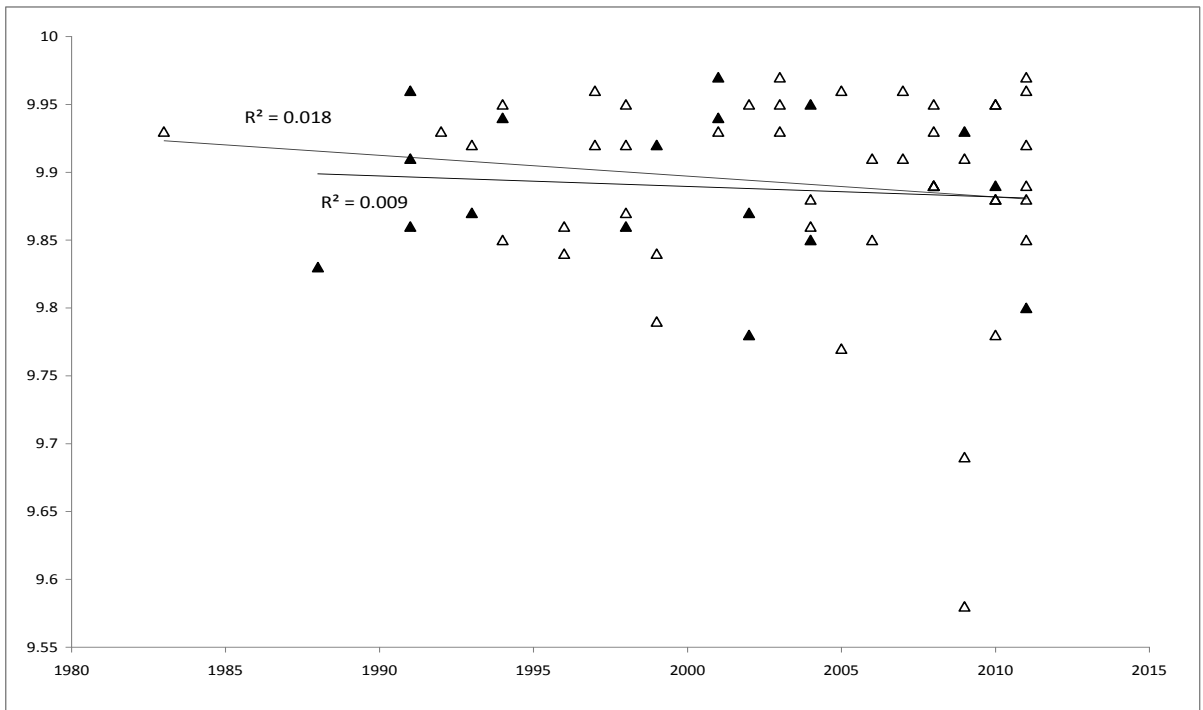
We plotted the best times separately for those athletes with no doping involvement and those with known doping involvement (Figures 1a - males and figure 1b - females). Regression analysis was used to discover changes through time while t-tests were applied to find significance of differences between means of doping and non-doping athletes. The sample sizes are adequate for detection as significant of a difference 0.07 sec. The top result on the IAAF site differs from the next best by 0.11 sec for males and 0.15 sec for females. Power analysis indicates total N=52 (one-tailed test) and N=68 (two-tailed test). Since we are testing a hypothesis that doping improves results, use of one tailed test is justified. Specific *post hoc* power analyses of each test and each regression were run.

There may arise the question, however, that with athletes so closely matched on performance, is it at all possible to obtain any resolution or significant differences from the results? As such further analysis was performed on a series of, available in our sources, variables theoretically likely to influence performance but unrelated to doping. We have compared mean times of

athletes grouped by nationality, venue where the result was obtained and top half and bottom half of the best individual results. Due to limited available information, nationalities were put into two groups: Anglo (US, and the British Commonwealth) and the rest, venues were divided into: Americas (both North and South) and the rest of the world. These groupings may be considered artificial, but that was intentional simply to show whether any significant differences could be obtained.

3. Results

A



B

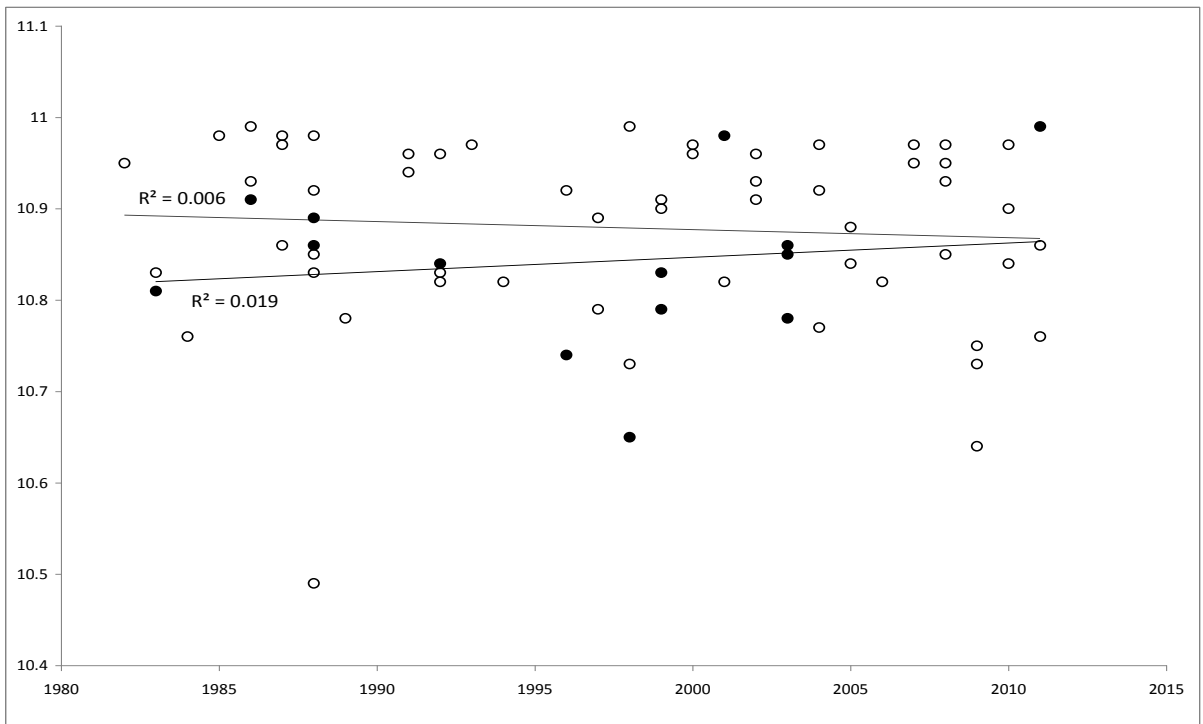


Fig.1 – The personal best times of male (A) and female (B) top 100m sprint athletes by year achieved. Closed figures and solid lines – ‘doped’ athletes, open figures and dashed lines – non-doped athletes.

As can be seen in Figure 1a and 1b, an analysis and comparison of the trend lines demonstrates in terms of performance there is no discernable difference relating to results obtained by the fastest sprinters of the last three decades, that is to say there was no significant regression of results on dates found for either male or female athletes. Moreover slopes of regression lines do not differ significantly. Similarly when the average times for both “doped” athletes and the “non-doped” athletes are compared one again sees no discernable difference (table 1),

| | Males | | | t^0 | Females | | | t^0 |
|------------|-------|-----------|------|----------|---------|-----------|------|-------------|
| | N | \bar{x} | S | | N | \bar{x} | S | |
| Doping | 17 | 9.89 | 0.06 | 0.00ns | 14 | 10.84 | 0.09 | 1.38ns |
| Non-Doping | 46 | 9.89 | 0.08 | Power=0* | 55 | 10.88 | 0.10 | Power=0.07* |

Table 1: Comparison on mean results between ‘doped’ and non ‘doped’ top 100m sprint athletes

* - The sample size required for detection as significant of a difference 0.07 sec is N=52 (one-tailed test) and N=68 (two-tailed test). Since we are testing a hypothesis that doping improves results, use of one-tailed test is justified.

| Males | | | | |
|-----------------------|----|-----------|------|--------------|
| Variable | N | \bar{x} | S | t^0 |
| Nationality - Anglo | 52 | 9.89 | 0.07 | 1.68 |
| - Non-Anglo | 11 | 9.91 | 0.04 | $p < 0.05$ |
| | | | | Power = 0.40 |
| Venue - Americas | 23 | 9.91 | 0.05 | 2.00 |
| - Non-Americas | 40 | 9.88 | 0.08 | $p < 0.03$ |
| | | | | Power = 0.62 |
| Times - Top (fastest) | 32 | 9.84 | 0.07 | 8.15 |
| - Bottom (slowest) | 31 | 9.94 | 0.02 | $p < 0.001$ |
| | | | | Power = 1.00 |
| Females | | | | |
| | N | \bar{x} | S | t^0 |
| Times - Top (fastest) | 34 | 10.79 | 0.08 | 10.79 |
| - Bottom (slowest) | 35 | 10.95 | 0.03 | $p < 0.001$ |
| | | | | Power = |

Table 2: Comparison on mean results between additional variables of top 100m sprinters, t-tests 1 tailed

As can be seen in Table 2 it is possible to obtain significant differences with the same set of data for such variables as nationality and venue times set. Additionally, the record times are not so close to each other as to prevent detecting a significant difference between the average for the top half and the bottom half of the results analysed. As such the results obtained in this article are not as a consequence of insufficient resolution of the results. We have failed to falsify a null hypothesis that dopers and non dopers differ in their results using samples adequate to detect significant differences were they present. Thus the null hypothesis must be accepted, not its alternative. Our results show that doping as defined by WADA does not produce difference in 100m dash results.

4. Discussion

The differences between „doped“ and non „doped“ athletes would seem to indicate that the so called “performance enhancing” agents and “doping cocktails” utilised (the term utilised was specifically selected as it denotes a use other than the original intended use of the agents, which in the case of many of the doping substances was for medicinal purposes) by said athletes do not seem to be having the desired effect. Evidence for this may be seen in the results of athletes returning following doping bans, some of which return with performance improved over that which they achieved when doped. There are a few explanations for this conclusion. To begin a vast majority of the doping agents utilised in the 100m sprint seem to be various forms of anabolic steroids; agents such as Nandrolone, Tetrahydrogestrinone,

Norandrosterone and Stanozolol. One major physical effect of anabolic steroids is the increase of muscle mass particularly focused in the upper torso and shoulders region (Mędraś & Józków, 2009). However this increase of muscle mass also increases the bulk of the athlete which in turn increases the difficulty of rapid propulsion of the athlete's body. Uth (2005) made the observation that those athletes with larger body mass indices and which thus had greater body mass generally had slower 100m sprint times. This would seem to support the supposition that the performance enhancing effects of the doping agents are then offset by the various physical mass changes effected by said agents. Similarly these body mass changes may affect balance which may explain why some athletes have a problem with remaining in their designated sprint lanes, that can in some cases, result in disqualification for lane changes. What this would seem to indicate is that there is a general lack of understanding of all effects of the doping agents. As such, in this case, a lack of knowledge seems to have led to what in management is referred to as the "garbage can" or "rubbish bin" model of decision making (March, Cohen & Olsen 1972). That is to say decisions made in this fashion are somewhat random and irrational being based on a limited number of criteria with partially unknown relation to the outcome expected. The results of such decisions are obtained more-or-less by chance. To put this in a sporting context, there are a number of reasons such decisions may be taking place for potential dopers; 1) new anti-doping tests and organisations impact on an athletes' choices and opportunities, 2) new doping agents or strategies being introduced 3) limited time (window of doping opportunities have been limited by new anti-doping tests), 4) new consequences to being caught, 5) limited information (as suggested by Piffaretti (2011) that at least some athletes get their doping knowledge from the internet and as such may be less than precise). All these components would seem to indicate that decision making regarding doping whilst it may seem in some cases to be quite orderly, may produce suboptimal results.

The final explanation for these results may simply be the differences in human physiology. As one would expect not all doping agents will have the exact same effect on all athletes, human physiology differs from person to person and as such so too will the effects and side effects of any such chemical agent utilised by any particular athlete. To elaborate it has been suggested by Friedl (2000) that because effects of steroids differ in different tissues so too might the overall effects. For example “5 α -reductase, aromatases and the types of receptors” differ from person to person (Friedl, 2000:141) as such the effects of certain anabolic steroids which bind to these receptors etc. will differ by amount, binding infinity etc.

What this therefore brings into the fore is the necessity of a comprehensive scientific understanding of the varied and vast effects and consequences of doping. Moreover, these results perhaps bring into question some of the justifications for current heterogeneous pieces of anti-doping legislation, and indicate that perhaps improvements may be required to ensure the continued fairness and equity of the legislation and sports in general.

There is a possible alternative interpretation of these results. If we assume that athletes whom we considered non doping were actually doping but were not detected then we would expect improvement of results over 20+ years if doping were helping to achieve better times. Since however there is no significant regression of test results on dates they were achieved over the last quarter of a century the top athletes have not significantly improved their results as a group. If they all doped, their effort in this regard was in vain.

It would logically be expected that the performance in any sports would be continually improving to reach an asymptote in the near future (Berthelot, Thibault, Tafflet, et. al., 2008). That is to say even without doping it is reasonable to expect some improvement of results due to improvements in recruiting techniques, training methods, sports technology, nutrition etc. It must then be asked why in the last 30 years have no significant improvements been observed

in either “doped” or “non-doped” athletes. Could it be simply that current records have already reached the limit of human ability or is there some unknown quantity holding them back, that is to say artificial alteration of physiology and/or anatomy. On the other hand perhaps it can be said that given the time frame investigated any potential reductions in the use of doping agents that may worsen the results, are counterbalanced by advancements in the sporting industry.

It is also necessary to mention that this paper in no ways questions the scientifically justified potential performance enhancing effects of specific doping agents. Too many prior historical events indicate that doping, if carefully planned by sport scientists and executed officially by sporting organisations can aid the athlete to achieve better results, such as was the case with the German Democratic Republic (Franke & Berendonk, 1997). The problem is that since the banning of doping and the subsequent scandals, the practice has become clandestine. Thus scientifically organised doping is probably less common. To assume the opposite here would be to assume that sport scientists and medical practitioners are acting in an unethical and immoral manner, that despite these scandals and the subsequent medical consequences on athletes engaging in doping practices, such organised doping is still occurring. Rather we chose to believe that sports scientists and medical practitioners were in fact acting in a moral and ethical way and as such scientifically supported doping is now less common.

This in turn has resulted in, it seems, athletes engaging in forms of doping that will not always produce the desired outcomes. This may explain why our results for 100m sprinters as a group do not show differences between athletes known to engage in doping and the rest. It may indicate to athletes that engaging in doping would be, on the balance or probabilities, acting against their personal interests.

Finally it should be pointed out that the results obtained in this research may well be sports specific. That is to say it is feasible that in certain other sports, particularly endurance or strength orientated sports, the various doping agents utilised may indeed result in the athletes desired effects, either due to the potential ease of understanding which characteristics to target for doping or the nature of the sport. As such more research is required to full understand the doping landscape.

Furthermore it has been suggested by some authors that anti-doping techniques may alter doping practices and yet may not completely eliminate them (Perneger, 2010; Sottas, Robinson, Fischetto, et. al., 2011). As such perhaps it can be said that given potentially limited options the effects of doping practices may also be limited, thus resulting in less effects than could be scientifically expected. Perhaps it can be argued that the optimal way to test just such a hypothesis is to obtain every test result from every sample athlete for every race they have participated in. It should, however, be pointed out that these data are simply not available. What is available is an indication that an athlete engaged in doping, or not. These indications are taken as increasing or decreasing a probability that a specific result of a specific athlete could or could not be affected by doping.

Finally it is possible that the „non-doped“ category of athletes does in fact contain some athletes that were doped but never caught, simply due to the fact that it is not possible (even currently) for antidoping testing to be effective in each and every case. Were this true, however, our results would show that despite nearly everybody using doping, no improvement in the results occurred.

5. Conclusion

Available information indicates that doping as currently practiced does not result in improvement of results in the 100m sprint. Thus the perception of doping within professional sports may in fact be just a perception. This may provide a new perspective for sports policy makers and anti-doping legislators.

6. Perspective

- These findings may result in the understanding that doping as practiced today does not produce better results
- It may alter the athletes perception as to the value of doping
- The current method by which doping is regulated is ineffective, and as such may need reforming
- Sports policy makers may wish to consider this new perspective in future policy decisions

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Paper 2 - Title: Long term effects of doping in sporting records: 1886-2012

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Abstract

Best life times of top athletes, Olympic records, world records, and any doping information were collected from the IOC, IAAF, WADA and national anti-doping associations. About 1560 records of male and female athletes in 22 disciplines of summer and 4 winter sports were collected. Data were analysed for long-term effects of doping using non-linear regression techniques. Comparisons were made of pre-1932 records (when steroids became available) and post. Analyses were repeated using 1967, when widespread use of doping was formally acknowledged. After these dates records in a number of disciplines did not improve as predicted by extrapolation of pre-doping years results. Averaged best life records for 'doped' top athletes did not differ significantly from those considered 'non-doped'. Even assuming that not all cases of doping were discovered, the practice did not alter sporting records as commonly believed, Doping may be damaging image of sports without benefitting results.

Keywords

Drugs; performance enhancing substances; Top athletes; track and field; Winter sports

1. Introduction

Doping is one of the big three scourges of modern day sports. With the advent of professional sports the issue of doping has perhaps become even more prevalent than ever before. The consequences of such actions are no longer confined to the sporting arena. The effects of doping in modern sports are far and widespread, encompassing not only the athletes and sporting teams involved but also sponsors, fans and one may say, greater society as a whole. Yet, despite this, or perhaps because of this, doping is still a major concern. It has been suggested by some, such as David Howman, director general of the World Anti Doping Agency (WADA), that current doping statistics do not fully represent the true extent of doping (Cycling News, 2011). That the suggested approximately 2% of positive tests (WADA, 2010) do not by far represent the actual prevalence of doping agent usage. As suggested by Lentillon-Kaestner and Carstairs (2010:342) and other authors, the true extent of doping is difficult to know due to what they term 'the law of silence' (Noakes, 2004; Simon, Striegel, Aust, Dietz, & Ulrich, 2006). Whilst it is generally accepted that the use of chemical substances in sports is by no means a new issue (Noakes, 2004), it does appear to be the case that structured systematic doping may not have begun until the 1940's. This in turn led to the eventual decision by the International Olympic Committee (IOC) to introduce anti-doping legislation in 1964 (WADA, 2012). Yet despite this, there have since been some of the largest cases and suspected cases of systematic state-sponsored doping; East Germany (Franke and Berendonk, 1997), China (Jeffery, 2008), US Postal Cycling Team (USADA, 2012) and suspicion is now emerging centred on the United States. It can still, however, be said that it was the 1930's that saw the beginning of doping with the potential to truly alter results, the isolation and creation of steroids saw to this. As such if one therefore takes this approximate date as the threshold separating 'clean' sport from doping supplemented sport, an interesting trend arises.

Numerous sources indicate that current doping detection rates seriously underestimate the actual extent of doping (Cycling News, 2011). Literature on success rates of tests and their sensitivity suggests the actual detection may in fact be below 5% in some cases, while typically it is below 50% (Erotokritou-Mulligan, et. al. 2007; Graham, et. al., 2008). These figures indicate that the current lists of records contain at least some achieved with the use of undetected doping. Therefore statistical analysis of official records should reveal at least part of the influence doping has on sport achievements.

Moreover, an early paper by Fowler et. al. (1965), went as far as to suggest that the actual act of doping will not improve an athlete's results; that any such improvement may be caused by increased motivation and training brought on by doping not the doping substance itself. In a similar vein a recent paper by Hermann and Henneberg (2012) demonstrated, through analysis of 100m sprint results, that doping as practiced today, may not be resulting in the desired outcomes for athletes choosing to partake in the practice of doping. There are a number of authors debating the performance enhancing effects of several doping agents (Saugy, Robinson, Saudan, Baume, Avois, & Mangin, 2006; Liu, Bravata, Olkin, Friedlander, Liu, et.al., 2008).

This would seem to counter the research by a number of individual authors which seems to indicate that individual cases of doping improve an athlete's results (Bhasin, Storer, Berman, Callegari, Clevenger, Phillips, et al. 1996; Noakes, 2004), therefore the idea developed in the paper by Hermann and Henneberg (2012) is here further explored to determine the extent in different sports.

Due to the illegality of the practice there are no official statistics showing how many people actually engaged in doping and how this doping influenced top results (Noakes, 2004). We know from work of sports scientists that the injection of some doping substances certainly

improves performances in individual instances (Bhasin, Storer, Berman, Callegari, Clevenger, Phillips, et al. 1996). And therefore we now wanted to detect effect of doping on top results by regressing these results against time during periods in which doping became available and possibly widespread as indicated by numerous discoveries of late. So, an analysis of pre and post doping era was performed to see what effects doping practices have on top results.

The aim of this paper is therefore to attempt to determine if the effects of doping can be seen in historical results and to determine the extent of the conclusions of the paper by Hermann and Henneberg (2012). The purpose being 1) to establish the potential impact widespread doping has on results in an individual sport and 2) to determine if any sports are for the most part doping free. The benefits of such research are that it will aid in an improved understanding regarding how widespread doping is. Furthermore perhaps this research will aid policy makers in formulating fair and appropriate anti-doping legislation, specifically adjustable for specific sports.

2. Materials and Methods

Data for this research were collected relating to a number of Olympic sports in both the Winter and Summer games for both female and male athletes. Information gathered related to gold medals, Olympic records and world records. For each discipline record times or distances as appropriate and years the achievements were made, were noted. The years being independent variable, and results being the dependent variables. Furthermore, information pertaining to the personal best times/distances and year's results were set of top athletes in a number of disciplines were collected. All these data were obtained from websites including the International Association of Athletic Federations (IAAF) (2011), International Olympic Committee (IOC) (2011) and each sports respective governing bodies' sites. This was then

cross referenced through numerous additional sources such as various national anti-doping agencies and the World Anti-Doping Agency. The disciplines studied in this paper are listed in table 1.

| Sporting Events | |
|--------------------|----------------------|
| 100m sprints | Decathlon |
| 4x100m relay | High jump |
| 1500m | Pole vault |
| 3000m | Long Jump |
| 10000m | Triple jump |
| 100km | Shot put |
| 3000m steeplechase | Javelin |
| Marathon | Hammer throw |
| 110m hurdles | Discuss |
| 100m hurdles | 500m Speed skating |
| 400m hurdles | 5000m speed skating |
| 20km race walk | 10000m Speed skating |
| Heptathlon | Ski jump |

Table 1: Sporting events considered in the paper

A wide range of disciplines were selected in order to provide a means to eliminate biases pertaining to any particular singular discipline. Such biases may originate from scoring systems and time measures specific for a discipline. All information used in this research is publicly available, and therefore, there was no need for any ethical clearances.

Data for each discipline, separately for males and females, were analysed using Microsoft Excel™. Scattergrams of records against dates achieved were produced and a number different regression models fitted. Significance of results was tested at $p=0.05$. Regression lines fitted to data for the pre doping era were extrapolated until 2012 in order to provide a prediction of how records should change over time were doping not available. Actual records for post doping era were then compared to those predictions by means of fitting to them separate regression models. Values of slopes and intercepts for the two separate regression

lines were compared for statistical significance using 95% confidence intervals. Pre and post doping points were either 1932 or 1967 as explained in the introduction, which depended on quality of information available. Moreover, as outlined above, before 1932 athletes were all but unable to engage in systematic doping as no substances were available; however this is no longer the case. Now it is known that some athletes do indeed dope as they are being caught. Therefore the more recent results analysed certainly included the results of dopers. The relationships between the results and the years were observed in an attempt to see if the years after the introduction of doping had better results.

In relation to top athletes in each sport, best times were plotted separately for those athletes with no doping involvement and those with known doping agent involvement (figures 5A to 5D). Athletes were categorised as ‘doped’ if they fulfilled at least one of three criteria: Firstly the self-admission of doping agent usage, secondly, a doping related conviction, thirdly the confirmed detection of known doping agents in their bodies irrespective of whether doping convictions were later received. Regression analysis was used to discover changes through time while t-tests were applied to find the significance of differences between means of doping and non-doping athletes.

Furthermore, analysis was performed with regards to the time since the current world record was set versus the date of the analysis, that is 2011, and subsequently to the date the previous world record was set (figure 7A and 7B). This was performed in order to understand how quick the progress of achievements in a given discipline may be. Therefore, in the era of doping we sought to find if there is any important improvement of results, we realise there is a multitude of confounding factors involved, but if the result did not improve then this demonstrates the minimal impact of doping.

3. Results

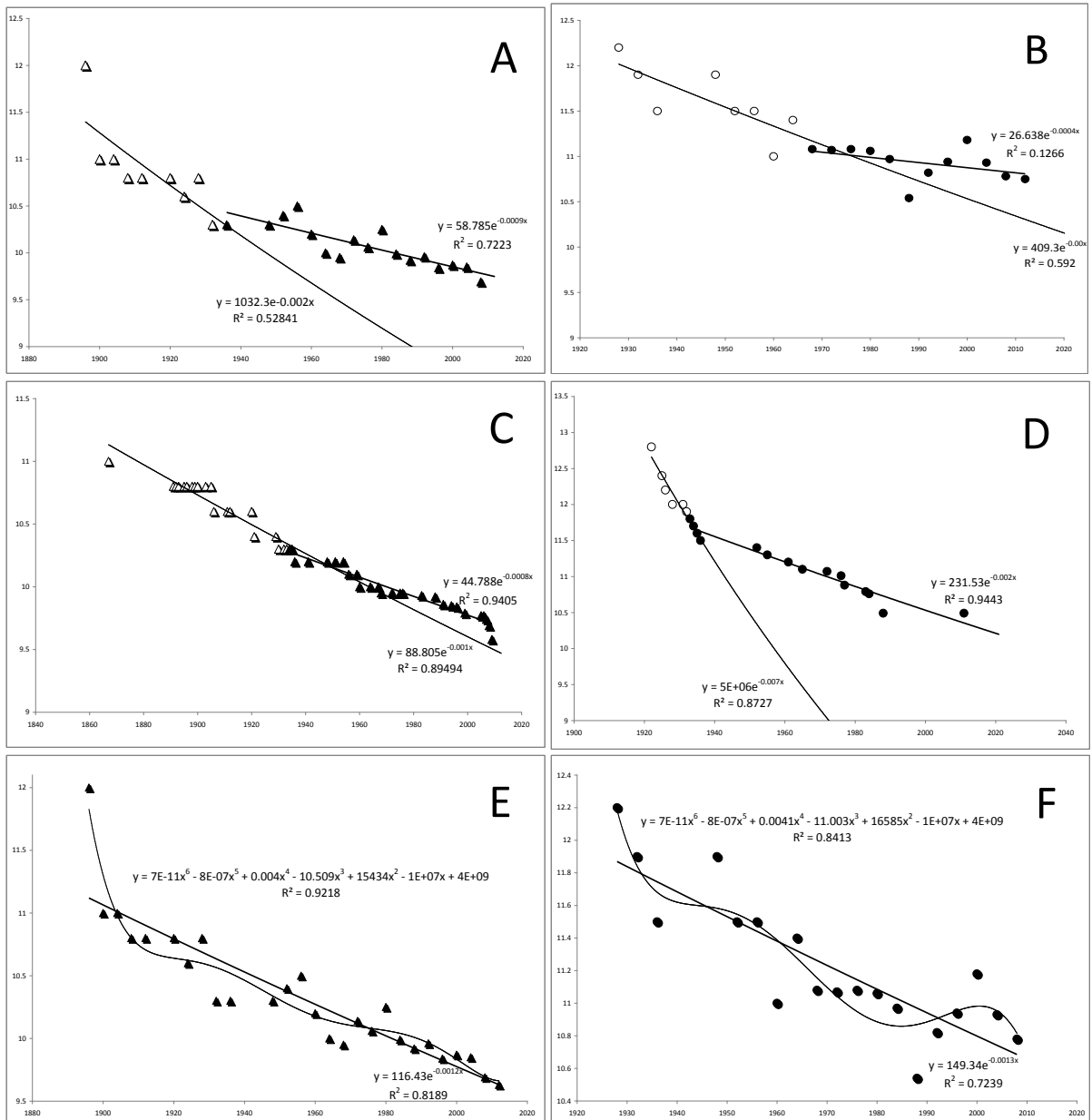


Figure 1: 100m Sprint, Olympic gold medal times pre and post 1932 vs years times set compared for males (A) and pre and post 1967 for females (B); world record times pre and post 1932 vs years times set compared for males (C) and females (D); Olympic gold medal Polynomial trend for males (E) and females (F)

As can be seen in figure 1A, by using 1932 as a date for the commencement of systematic or at least widely practiced doping usage, one observes an exponential trend line extrapolation of pre-1932 100m sprint Olympic medal times well above that of the current fastest Olympic

gold medal time or even world record times. It was not reasonable to plot Women's 100m sprint Gold Medal Times as the women's 100m sprint event only began in 1928, as such reliable conclusions could not be drawn from such a graph. However as can be seen in 1B, when utilising 1967 as the year of comparison results obtained, whilst much less pronounced, do indicate a similar trend.

Figures 1C and 1D demonstrate similar results, an exponential trend line extrapolation of pre-1932 world record times in the 100m sprint provides similar results (particularly post 1960's). When one then collates all the data irrespective of year and attempts a trend line analysis the results as seen in figures 1E and 1F are obtained. As can be seen in Figures 1E and 1F rather complex polynomial trend lines (6th order) are required to fit the gold medal results as obtained in both the men's and women's 100m sprint. When compared with a more simplistic exponential trend line the results differ markedly. Similar if not more pronounced results are obtained in other sporting disciplines.

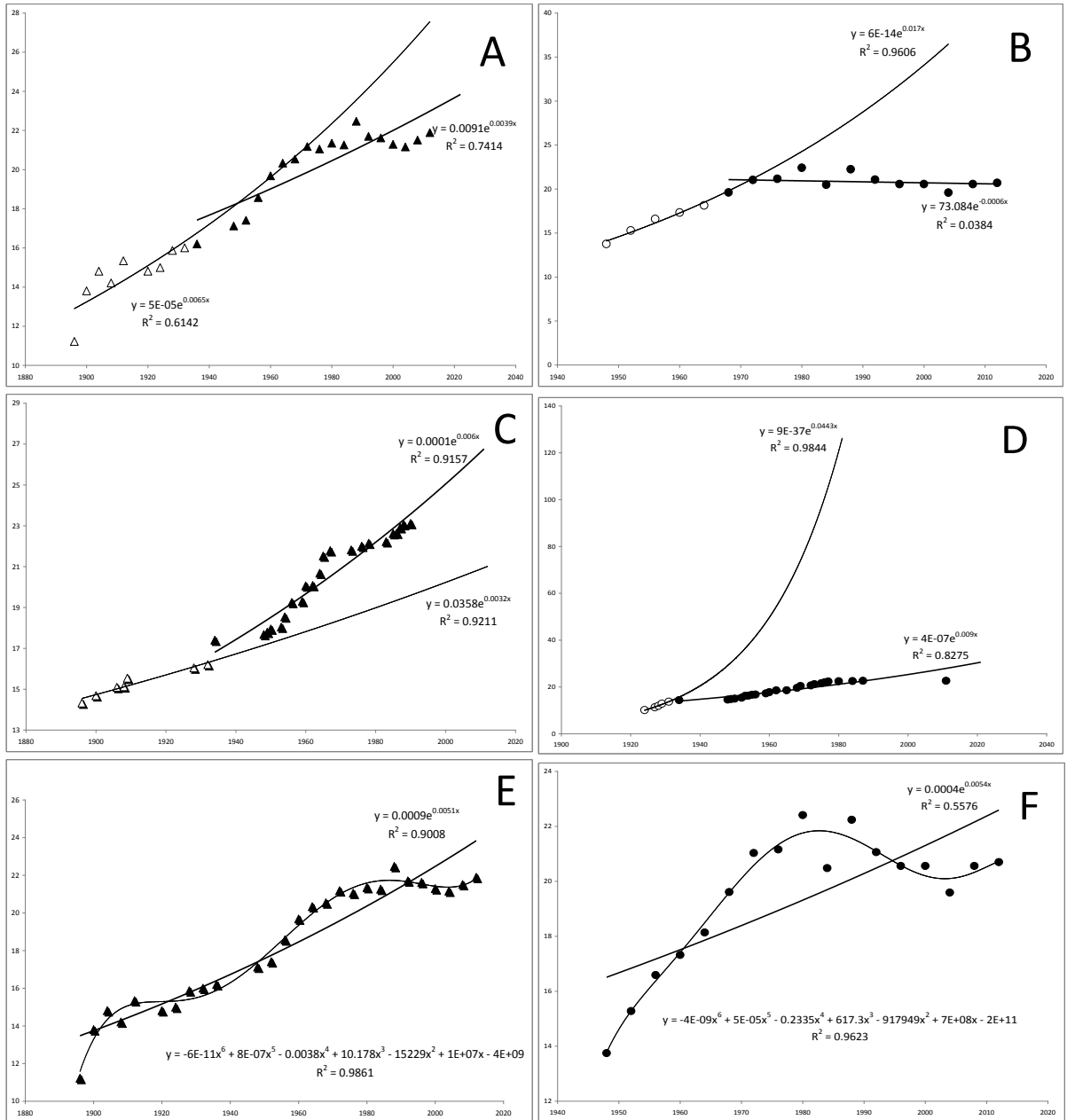


Figure 2: Shotput Olympic gold medal distances pre and post 1932 vs year distances set compared for males (A) and pre and post 1967 for females (B); world record distances pre and post 1932 vs. year distances set compared for males (C) and females (D); Olympic gold medal Polynomial trend for males (E) and females (F)

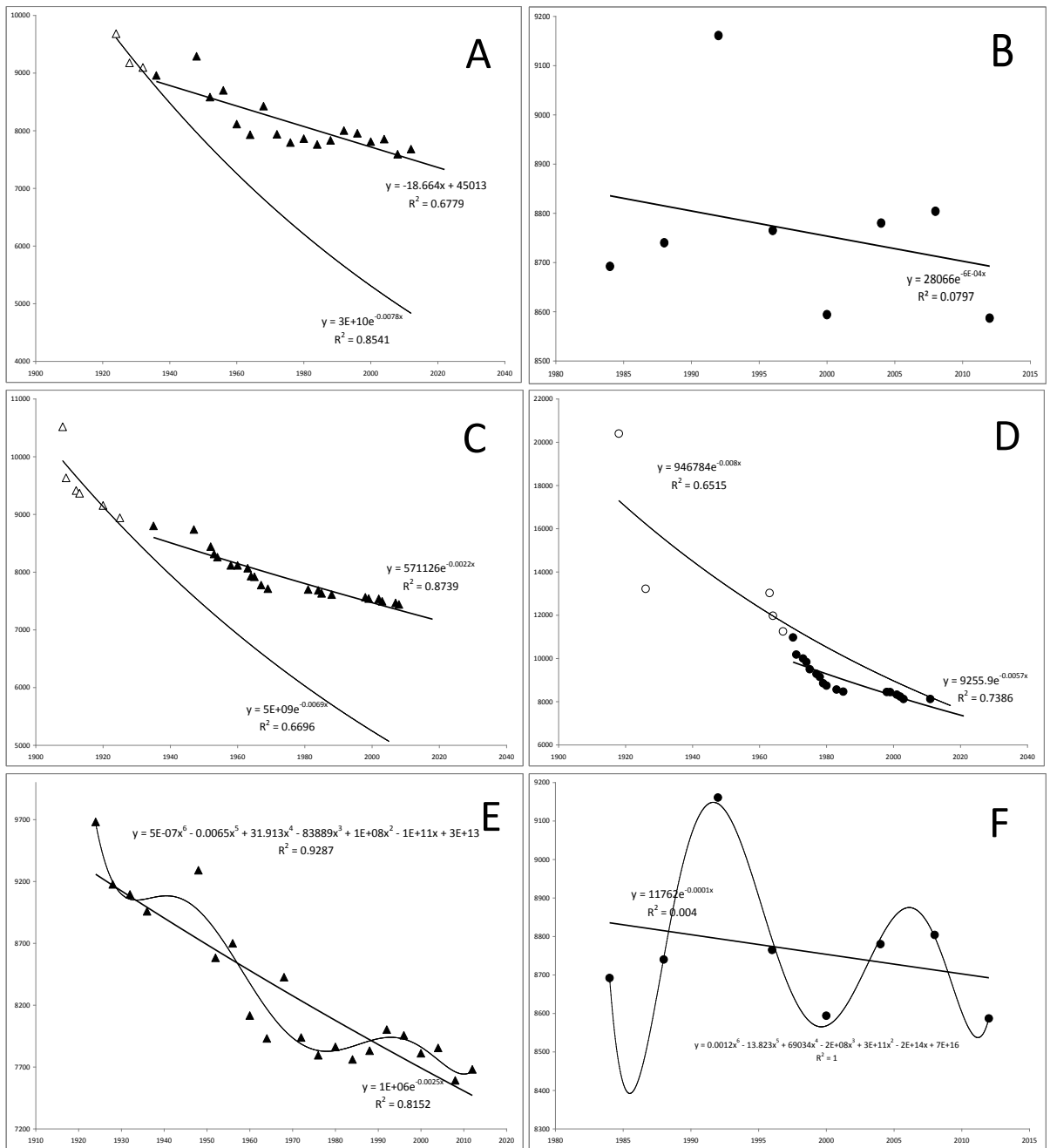


Figure 3: Marathon Olympic gold medal pre and post 1932 times vs year times set compared for males (A) and gold medal times vs year times set compared for females (B); world record times pre and post 1932 vs year times set compared for males (C) and pre and post 1967 for females (D); Olympic gold medal Polynomial trend for males (E) and females (F)

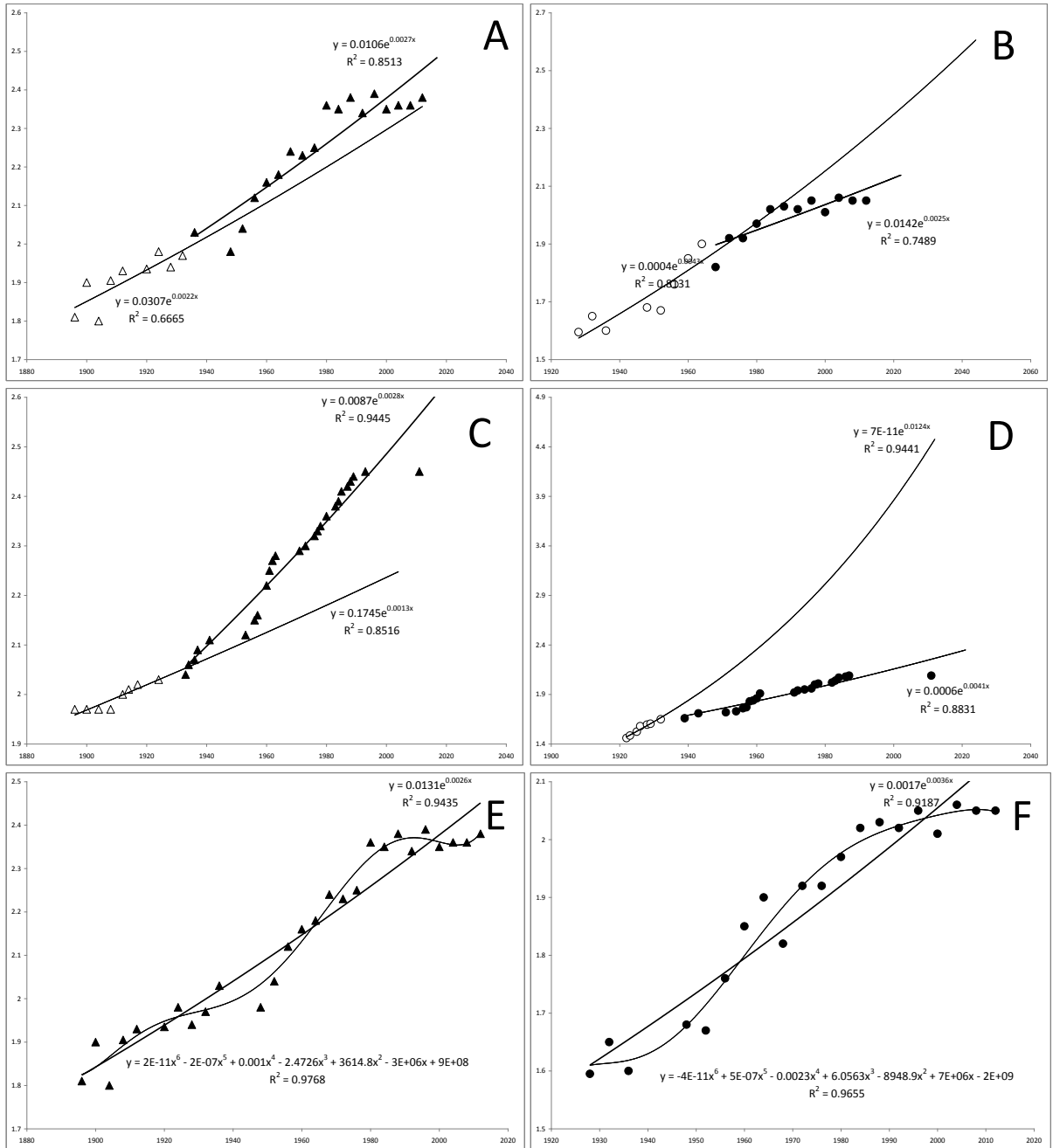


Figure 4: High jump Olympic gold medal pre and post 1932 distances vs year distances set compared for males (A) and pre and post 1967 for females (B); world record distances pre and post 1932 vs. year distance set compared for males (C) and females (D); Olympic gold medal Polynomial trend for males (E) and females (F)

As can be seen from figures 2 to 4 with all but the exception figures 2C and 4C both of which are world record figures, similar results seem to have been obtained in a number of very different sports. That is the pre-1932 results when extrapolated would seem to indicate a level

of performance above that which is currently being realised in the various sports. Furthermore, the research performed on the top athletes (figure 5) in an assortment of sports, provided similar results.

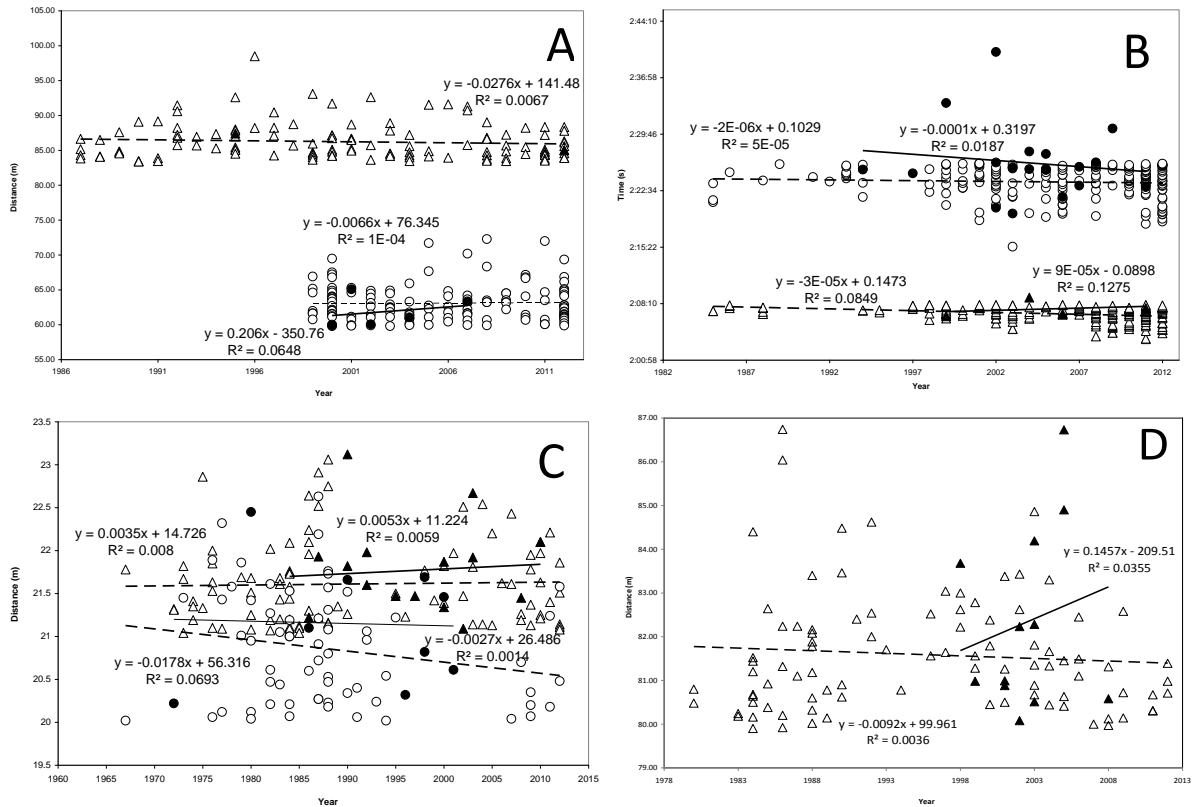


Figure 5: The personal best results of male and female athletes in summer athletics disciplines; Javelin (A), Marathon (B), Shotput (C), Hammer Throw (D) – closed figures solid lines ‘doped’ athletes, open figures and dashed lines ‘non-doped’ athletes

In figure 5D above, it should be pointed out that the ‘doped’ trend line is not significant and as such does not differ from that of the ‘non-doped’ athletes. If one however now turns their attention to the winter sports different results are obtained.

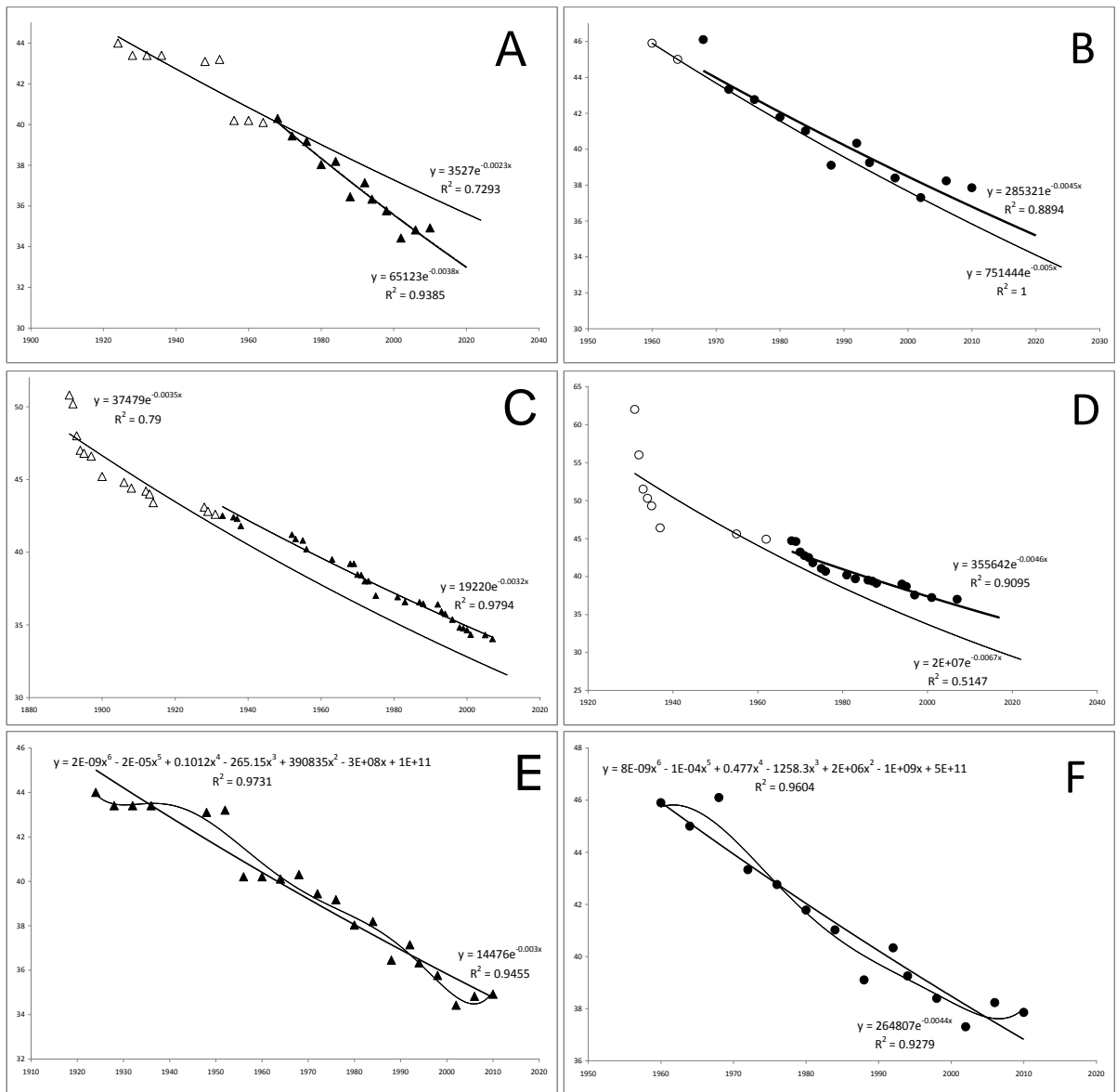


Figure 6: 500m speed skating Olympic gold medal pre and post 1967 times vs year times set compared for males (A) and females (B); world record times pre and post 1932 vs year times set compared for males (C) and pre and post 1967 for females (D); Olympic gold medal Polynomial trend for males (E) and females (F)

As can be observed from figures 6A to 6D the results obtained in the 500m speed skating discipline since 1932/1967 are considerably closer to those obtained pre-1932/1967. In some cases the results are better than those obtained pre-1932. Similarly figures 6E and 6F show that there is far less difference between the complex and simple trend line analyses. These

results can also be observed when one analyses the 10,000m speed skating event, current results are close to the extrapolated results as are trend line analyses.

These results would seem to be verified when compared to figures 7A and 7B. These figures both show that in men's and women's disciplines the winter sports tend to appear further down the list whereas the 'strength' sports appear higher on the lists.

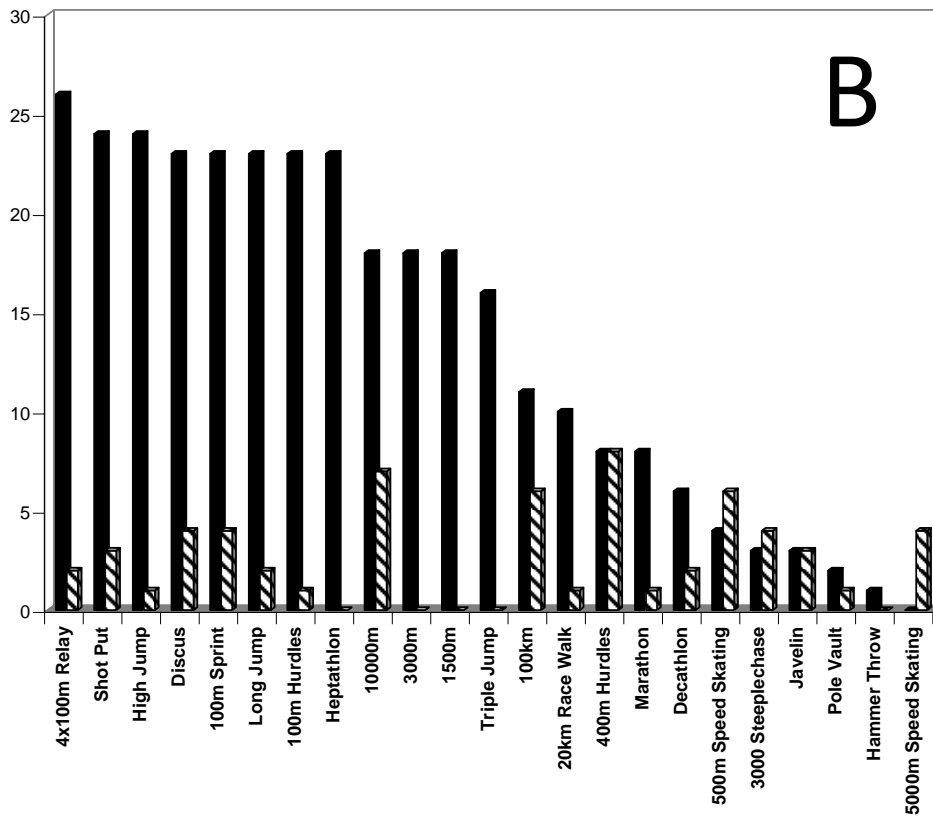
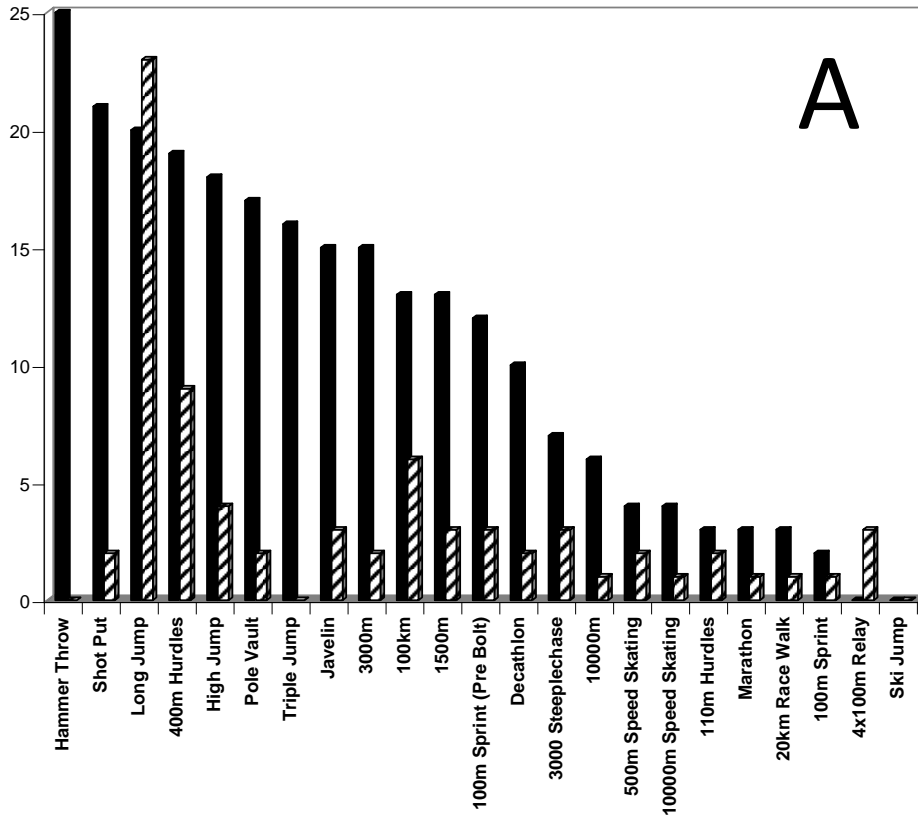


Figure 7: Years since world record (black) vs. years since previous world record (striped) for males (A) and females (B) in various disciplines; note generally lower values for winter sports

4. Discussion

There are two different explanations for the above results. Firstly, what the above results would seem to indicate is that the so called ‘performance enhancing’ agents utilised by said athletes do not seem to be having the desired effect. Moreover, these results indicate that the use of doping agents may in fact effectively be having a detrimental effect on the athletes; seemingly indicating that ‘natural’ human abilities would outperform the potentially doping ‘enhanced’ athletes. This counterintuitive conclusion is particularly supported by the analysis of Olympic gold medal and world record times/distances. Figures 1D, 2B, 2D, 3A, 3C and 4D very clearly demonstrate some rather extreme differences in the extrapolated pre-doping era results vs. the actually achieved post-doping era results.

One would expect to see a gradual decline in times and increase in distances until a human ability limit asymptote is reached at which point unaided/unenhanced improvement would not be possible. It can be said that this is realised for the most part in the winter sports assessed in this paper but not in the summer disciplines. Furthermore, one would expect to see significant improvements in time times/distances set in the modern era over the pre 1930s (or 1960s) predictions for a number of reasons. Firstly the move from amateur to professional sports; this move should have brought with it vast improvements in the performance of athletes, many of which base their whole life on such performance and as such would afford extra effort into the endeavour of improving results. Similarly, the improvements in training techniques and material sciences, each of which are clearly proven to enhance performance (Howartson and van Someren, 2008; Roi and Bianchedi, 2008). Additionally, the 2nd half of the 20th century has seen rapid development in the fields of molecular biology, and as such one could expect

enhancements to biological characteristics of athletes, their anatomical structure and physiology many of which may well be considered not to be doping. Moreover, the advancements in scientific monitoring of athletes, structured training and fine tuning of techniques all should add to the improvement of results. Such improvements would seem to be realised to some extent in winter sports. Advancements in wax, ski design, skate structure and technique has resulted in significant and continuous improvements in some cases.

Why then do the results in summer sports seem to indicate the contrary? There is no continuous improvement to an asymptote. In fact at points, a clear degradation of results can be observed. One such example is the 2000 Olympics gold medal result for the women's 100m sprint, this result is even poorer than the gold medal result obtained in the 1968 Olympics, the first year of doping testing in the Olympics. Similarly, one would expect that the Olympics would be the highlight of most athletes' careers as such it would be expected that an athlete's best results should be obtained at the Olympics. This would seem not to be the case. Whilst it is true that external factors may play a role in a single Olympics, such factors are unlikely to occur at multiple consecutive Olympics. As such it seems that some unknown quantity must be also contributing to the overall trend. One of those contributing factors could be doping. The fact that as can be seen in figures 1F, 2F, 3E, and 3F complex trend lines are required to even begin to ascertain a trend of results would seem to further support this assessment.

Reference to figures 7A and 7B further supports this assessment. Firstly, in both cases winter sports events are in the lower halves of the graphs, and secondly, the so called strength sports (e.g. shot-put, hammer throw etc.) are in the first few places. This would seem to coincide with the perception that winter sports are in general 'cleaner' sports or at least that doping may not be as widespread as in many of the summer sports (WADA, 2010). Furthermore, these results indicate that the strength sports (which would seemingly almost yearly be

embroiled with a doping scandal), may have more widespread use of doping agents. Two possible reasons for this phenomenon exist, firstly, that strength sports unlike many winter sports focus on a primary skill, that of strength; as such any athlete seeking to enhance their performance knows exactly what to target, a singular primary method. Winter sports on the other hand involve a plethora of different techniques and abilities including stamina, endurance, strength, agility, precision to name but a few. This therefore means that any such doping would be much harder to conduct in winter sports in any foreseeably beneficial manner. As such any athlete participating may be more prone to detection due to the assortment of agents needed to enhance multiple skills. Therefore, winter sports athletes may see such action as being without benefit and thus may be deterred from engaging in the practice, or at least engage in it to a lesser degree than in other sports. This would seem to support current statistics in the area of detected doping frequencies, skating and skiing 0.27 and 0.71 respectively vs. athletics and weightlifting 0.78 and 2.42 respectively in adverse analytical findings (WADA, 2010). Therefore, perhaps it can be said that an athlete's decision to dope may be primarily or at least to a large part determined by perceptions, the perception that doping is needed to win (Cycling News, 2008; Cycling News, 2010), the perception that doping helps (Lentillon-Kaestner and Carstairs, 2010), the perception that doping is easy, or the perception that they can easily target specific beneficial skills for enhancement (Lentillon-Kaestner, 2011), the perception that the likelihood they will be caught is less than the likelihood they will benefit (Uvacsek, et. al., 2011), the perception that benefits outweigh the risks (Mroczkowska, 2009) the perception of anti-doping tests detection success rate, the perception that they will get away with any action that there will be no consequences (Piffaretti, 2011) the perception of the extent to which sporting success brings prestige and prosperity (Piffaretti, 2011).

On the other hand there seems to be a possible explanation for the apparent lack of doping in winter sports which may fit in with the very foundations and structure of many winter sports. To elaborate, take the 100m sprint in the summer games, whether an athlete wins is based on their time directly; it is a simple measure of who gets to the finish line first. Many winter sports on the other hand are a combination of time, points systems and courses selected by officials. Take ski jumping for example; it is a combination of distance points based on judge's votes of style, selection of gates by judging panel also plays a role etc. Recent disputes between teams and officials relating to undesirable and/or sudden gate changes demonstrate the changing nature of winter sports courses. Alpine Skiing has similar components, official designed courses which change per run combined with the time factor. Athletes may see doping in such sports as futile since there are many other factors that would also need to be manipulated to change results. Once again this may indicate that an athlete's perception of their external and internal environments plays a big part in their decision to dope or not. This conclusion would seem to be supported to some extent by the statistics. WADA statistics on sports with judges voting systems seem to have slightly lower levels of adverse analytical results. Gymnastics are one such example with a 2010 percentage of 0.52%.

Therefore can it not be concluded that perhaps these perceptions need to be broken before any true evolution and progress can be made in the fight against doping. One must, however, say that the question remains are these truly just perceptions? It may be that other factors also contribute to an athlete's decision to dope. Furthermore, are these perceptions widespread in the sporting industries or more so in some disciplines as opposed to others. If so why then do some athletes dope and others not; is it merely personality components such as risk aversion or are there issues of the team setting, such as suggested by Lentillon-Kaestner and Carstairs

(2010), or sport specific factors which influence these actions? As such more encompassing industry wide research is needed not focusing on one or two disciplines but the entire sporting domain, incorporating all nations and types of athletes, in order to obtain the true extent of the problem and the source. There are also concerns with the effectiveness of current anti-doping testing practices which appear to be ineffective. It has been stated by numerous sources that current doping detection statistics do not fully represent the state of doping in sports (Cycling News, 2011). Furthermore, extant literature contains information pertaining to the approximate success rates of doping test or test reliability (Erotokritou-Mulligan, et. al., 2007; Graham, et. al., 2008). These figures suggest the actual success rate of some tests may in fact be as little as 4%, on average it would seem less than 50% would be reasonable to conclude. Admissions of doping by some athletes who had long and prominent careers without ever testing positive to a banned substance further demonstrate the ineffectiveness of anti-doping practices. Persons such as Marion Jones, Tim Montgomery, Andre Agassi, Ken Caminiti, Rolf Aldag, Heike Drechsler, Vitali Klitschko, and Bjarne Riis freely admitted to using banned substances during their careers. This may demonstrate that the past state of anti-doping legislation and practices would seem to be in place to simply ease the minds of spectators. This situation may well still continue.

Why then have numerous historical examples of effective performance enhancing practices come to the fore; the German Democratic Republic (GDR) being one such example (Franke & Berendonk, 1997). That is to say there have been examples showing the performance enhancing effects of doping. The answer may well be that in those cases, the doping was officially approved, well-planned and executed with advanced scientific and medical expertise, that is to say it was not random athletes personally selecting doping agents without clear information as to the effects or outcomes. Furthermore, despite this, why does the above

analysis show that post 1932 results do not match that of pre-1932 in many disciplines? Should not situations such as that with East Germany have brought the result back to those extrapolated from early results? Whilst it can be observed that there is a subtle influence on results during the periods of these scandals, the impact is minimal and do not influence results to the expected level. This warrants further study, but perhaps it comes down partially to athlete psychology. The psychological state of an athlete is believed to contribute to performance (Vealey, 2001; Hays, Thomas, Maynard & Bawden, 2009). Perhaps some athletes, knowing they are achieving results by means which are unethical, have a subconscious barrier to increased performance, an intangible holding them back... This would therefore assume that athletes are generally ethical and governed by internal checks and balances and that the decision to dope is therefore influenced primarily by external influences such as suggested by Hardie, Shilbury, Ware et. al. (2010), economic or prestige factors or even perceived discipline performance expectation.

From an organisational and marketing perspective, the results in this paper demonstrate a concerning element. If the results obtained since the 1930's are skewed by unreported and undetected doping then it can be suggested that the extent of this practice not only affects athletes and sporting organisations but also spectators as a whole. That is to say, if results obtained from doping are in fact degraded, then this in some cases will be depriving spectators of the sight of top level human performance. In turn this constrained athletic ability may result in some spectators turning away from what they may see as 'boring' sports. So therefore, not only does doping tarnish the names of sports or sporting organisations, but the consequence of this for a sporting organisation or discipline is obvious, reduced revenue from spectators and lower spectator numbers, two components vital to an organisation in modern day sports.

Finally, it can be concluded that the results of this paper further support two key findings by Hermann and Henneberg (2012). 1) Perhaps systematic, scientifically supported doping where all effects are fully known, may aid in improving an athlete's performance, but that 2) perhaps the clandestine nature of modern doping means that athletes are limited in their chances to dope, in the range of substances available and do not have full support of sports scientists and medical practitioners to ensure such results. The consequence of this second point may be use of ineffective doping strategies and perhaps even in some cases harmful with regards to performance in some disciplines. So whilst individual researchers can see individual improvements in results we cannot see this in overall results. These results which show no obvious improvements can be interpreted only as indicating statistically there was no effect of doping on overall performance. The only explanation is that doping may produce a minor improvement in one aspect of performance but in other areas it may be having detrimental effects, which in turn outweigh the positives. Were doping so successful as popularly assumed and as widespread as recent "scandals" indicate one would observe in the results massive improvements.

5. Conclusion

In conclusion, it would seem that the results obtained in the research can be explained by two possible means. Firstly, that there is evidence that doping practices employed by athletes today, may in fact not be helping results even to the extent that they may be harming them. Secondly, that it is possible that doping is far more widespread than previously thought in the sporting industry. If the results obtained since the 1930's are skewed by unreported and undetected doping then it can be suggested that the extent of this practice not only affects

athletes and sporting organisations but also spectators as a whole. This research highlights the need for further study into the true amount and causes of doping on an industry wide scale. Similarly, it appeals for changes to the current anti-doping legislation and testing. Finally and perhaps most importantly, this research calls upon the need to tackle the various perceptions held by athletes and sporting organisations as to doping. By tackling these perceptions one may be able to make significant advances into stamping out doping.

6. Perspective

- These results may provide a greater understanding that doping does not produce better results, thus potentially altering an athlete's perception of doping.
- Furthermore it may indicate that current techniques used to prevent doping are ineffective and doping is more widespread than initially thought.
- It questions the motives behind an athlete's reason and decision to dope, and suggests it is based on perceptions to a large extent
- Current anti-doping legislation and testing needs revision
- Doping may harm organisational revenue in more ways than originally considered

Acknowledgments

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Paper 3 - Title: Anti-doping systems in sports are doomed to fail: a probability and cost analysis

Running title: Anti-doping systems are doomed to fail

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Abstract

Objective: Doping in sports now seems to be more widespread despite testing. The objective is to assess the effectiveness and cost effectiveness of the current anti-doping system.

Methods: A probability and cost analysis was performed. Using calculations based on official world-level data of positive doping test results, sensitivity and frequency of testing in 93 categories of sport, and estimates of numerical characteristics (frequency, window of detectability, test predictability)

Results: A low probability of doping detection was demonstrated; 0.029 for doping once a week by a single random test with average sensitivity (40%) and window of detectability of 48 hours. With 12 tests a year probability of detection of continuous doping is ~33%. To detect 100% of doping in one year 16-50 tests per athlete must be done costing ~\$25,000.

Conclusion: Testing is not economically viable for effective detection. Changes are thus required to the current system to combat sophisticated doping techniques.

Keywords: WADA, statistics, ineffective, policy, cost analysis, probability, doping, cheats

1. Introduction

The year 1968 saw the International Olympic Committee's (IOC) first true attempt to combat doping in sport [1]. A number of international sporting organisations had attempted to address the issue of doping in sports before this point, one notable example being the International Association of Athletic Federations (IAAF). These early attempts however proved to be little more than hopeful, as they lacked a key component necessary for such anti-doping systems; anti-doping testing. Similarly, even the IOC's early attempts were, it can be argued, ambitious but ultimately lacked substance. It is well known that early anti-doping testing was, at best, rudimentary and, perhaps, did little more than keep up the appearance of combatting the issue of doping. The IOC's decision to finally introduce measures to curb doping, was in response to numerous doping related deaths and controversies. Whilst, these attempts were ambitious, in many ways they simply have not lived up to the promise they once had. Numerous high profile scandals, such as East Germany [2], China [3], and more recently Lance Armstrong and US Postal [4] only revealed years after the fact, have shown the fragility of the anti-doping system both past and present.

It has been suggested by a number of different peoples in the sporting arena, including officials, athletes, and scientists, that the current (and past) anti-doping systems are both ineffective and inefficient. Furthermore, current doping detection statistics, in some sports, under represent the true extent of doping in sports [5]. This demonstrates that there is a need for an assessment of various factors influencing the success of anti-doping systems. There has been considerable work produced on the factors influencing an athlete's decision to dope [6,7], the reasons behind doping [8,9], and consequences of doping [8,10]. However, little work has been produced to actually assess the factors within the sporting and anti-doping system which may influence the effectiveness and efficiency of anti-doping testing. It is true

that the anti-doping system as a whole can be argued as to also include the education of anti-doping, the programs in place to attempt to deter doping etc. However, it should be pointed out that it can also be argued that testing and the science behind the testing leading to detection or not, is the primary tool in anti-doping. Education is definitely of help, but without a means to find any wrongdoing education alone would not prevent doping. As such this paper primarily focuses on testing as the pivotal element of the anti-doping system. Therefore, one must ask the question, despite the apparent efforts of sporting bodies for almost a century, why does doping continue to be a problem? Why is it that even today when testing is widespread, random out-of-competition testing is performed, prohibited lists are updated regularly and experts are consulted on the systems to be used, why do these problems persist? Perhaps this is simply because irrespective of the system in place some people will always want to cheat. Or perhaps the problems lie within the anti-doping system itself, an inherent flaw within... This paper sets out to investigate this question, to assess the current anti-doping system and to determine if there are indeed issues with its very structure, or rather if factors of the real world impact its efficiency and effectiveness.

To elaborate, one key component of the current anti-doping system is test sensitivity. There seems to be some debate on this area and it tends to be a somewhat contentious issue amongst scientists. The success rate of anti-doping testing has been reported in some cases to be less than 10%, and on average less than 50% [11,12]. Whilst this figure is not definitive on the balance of probabilities, based on the available information, this seems to be a reasonable estimate. This is but one example of the issues in anti-doping systems, upon further investigation the issues appear to expand exponentially. Current testing systems are influenced by numerous factors of the sporting world that simply cannot be restrained by theoretical frameworks and the best hopes of policy formers. Test success rates, doping techniques aimed at deliberate circumventing of testing (e.g. micro-dosing), and in some

cases minimalistic sample collection due to economic restraints are all examples of the real world (and evolving nature) of sports and doping, that makes inflexible rules on paper fail in everyday life. Consequently anti-doping practices are less effective in their mission than one would hope; the simple reality of it is that not all dopers are caught; the issues with US Postal are testament to this fact. If one then adds to these factors the additional evolving factors of the sporting world, window of detection and randomisation of selection for testing, one begins to get the picture as to the current state of doping detection; a less than optimal system. The aim of this research is, therefore, to assess the extent to which the current anti-doping systems are effective and efficient in their task of deterring, preventing and detecting anti-doping infringements. Unlike other papers, this research does not focus solely on the psychology of the athlete, the fear or threat factor, or even a discussion of issues with punishment as a means of deterrent. Rather this paper analyses the effectiveness and efficiency of anti-doping systems with the assistance of statistics and realities of human biology. Moreover, this paper seeks to assess whether the realities of the sporting world and athletes action manage to invalidate the anti-doping practices or demonstrate inherent flaws in the system. The reasons being, that if such issues do exist in the current system and these issues are able to be demonstrated, perhaps this will aid policy makers and organisations to amend the legislation. The eventual end result of this research is hopefully to ensure a fairer sporting environment for all participants, through the creating of policies that are both more efficient and effective in detection and prevention.

1.1 Anti-doping policies and realities

It is prudent to begin with an outline of some of the key arguments as to the existence of anti-doping systems and furthermore, the opinions of the current level of success and issue of these policies as far as they exist.

Of the assortment of factors argued as being the reasons behind the creation and existence of anti-doping, the three most commonly included reasons are, 1) athlete's health, 2) fairness and equality, and 3) sports should be a representation of a person's natural abilities. Many of the international policies in sports contain some or all of these points as justification of their existence, the *WADA Code* [13] and *UNESCO International Convention against Doping in Sport* [14] are two such examples. What is more, there is also the inclusion of such terms as 'with the potential to' enhance etc. "potential" is such an ambiguous term it is no doubt that there is much debate on the issue.

1.1.1 Human Health

To begin with the health argument, the *WADA code* [13] lists health as (one of) the 'fundamental rationale[s] for the world anti-doping code'. The *UNESCO International Convention against Doping in Sport* [14], states it is "Concerned by the use of doping by athletes in sport and the consequences thereof for their health' in its preamble. It is well reported that some doping agents do indeed have harmful effects, if not through their use then through their abuse [10, 15]. Beastall et. al. demonstrated the deadly outcome of injection of insulin in a healthy adult. Despite this, however, there is ample evidence that suggests that a number of substances listed on the WADA prohibited list have little to no evidence that they can cause harm. One such example can be seen in the recently banned Xenon gas. Some

research [16] claims that it is in fact beneficial to human health and may provide ‘long term benefit’ with regard to strokes. In fact, many of the substances which are now abused as doping agents began their life as medicaments. Similarly, vitamins in sports are not banned substances. It is often argued that vitamins are necessary in order for athletes to be able to compete at the highest level, implying that without them athletes would not be able to recover as quick or perform as well (does this not sound like performance enhancing?). Vitamins are deemed safe, yet abuse of vitamins can be as harmful as the abuse of banned doping substance. There is ample evidence to support the idea that high doses of some vitamins can indeed result in negative health effects [17, 18, 19].

1.1.2 Fairness and Equality

Similar arguments can be found with fairness and equality. These two concepts are often argued as being the backbone of anti-doping policy, the reason for its existence and the primary mission of the policies. It is often difficult to define exactly what the meanings of these terms are. They differ from person to person, depending on their own sets of values and morals. Furthermore, they are in effect intangibles; they have no physical substance and are often fluid in nature. Perhaps, however, one of the most useful definitions of what fairness and equality is and to a larger extent morality in sport can be found in the works of Kuchler, who defines it as accepting the ‘opponent as a partner’, ‘keeping in the rules’, values victory no higher than their attitudes to opponents, refuses dishonour and inequality, and goes about it all good-heartedly [20].

Yet it can be said that sports, by its very nature, are not fair or equal. Athletes are never provided with the same opportunities to advance and compete. Athletes from third world nations or developing nations are automatically at a disadvantage be it because of

dietary reasons, economic, or even access to training and opportunities to perform. Similarly, there is segregation between genders/sex and age. One could ask, if an athlete wants to compete with others of any background, sex or age and meet the performance requirements should they not be able to, without first gaining permission, and hoping permission will be granted. It is as if the very structure of sports promotes the idea that it is not a right but rather a privilege that one must earn and fight for. If this is the case, then it goes against everything claimed, not only by anti-doping policies but, also against the very spirit of sports.

1.1.3 Natural Abilities

Finally, the notion that sports should be a representation of a person's natural abilities. This concept is self-explanatory. However, like the previous two concepts there is much debate about it being touted as one of the primary reasons for anti-doping policy. To begin with, there is a question of what exactly constitutes natural abilities. Moreover, there is the debate about what constitutes an alteration of a person's natural abilities. Much like the arguments outlined previously with regard to vitamins and doping practices, one must assess what constitutes enhancement and an alteration. Take vitamins again as an example. There would be those that consider the benefits that vitamins bestow upon an athlete (recovery, dietary supplementation etc.) as an indication that their performance is no longer natural. This is because, without these supplements, the athletes would not be able to perform at the high level, or at least not as long as they do, and it would take longer to regain the chance of performing at this level again. Similarly as an example, there is the before mentioned argument of Xenon. One of the reasons this practice is banned is because it can be used as a form of performance enhancement. Yet it should be pointed out that Xenon is argued as performance enhancing; it simulates the effects of EPO doping. Its use is argued to stimulate

Hypoxia Inducible Factors (HIF) particularly HIF-1 α and as such it benefits the athlete in the same way as EPO doping. Yet it should be said that similar gains can be achieved through altitude training. Altitude training is, however, not a banned practice. If the aim of anti-doping is to preserve the fairness and natural abilities of an athlete, should not this form of training also be deemed to be altering the performance of the athlete and as such be banned? Similar arguments can be made for the use of caffeine, headache tablets, sleeping tablets and any assortment of proteins or other similar dietary supplements. These items are not banned, and are commonly used by athlete to help recover, sleep, block pain etc. all of which they would not 'naturally' be able to do without the use of the pharmaceutical or supplementary items.

1.2 Effectiveness according to some experts

There has also been some recent argument by some high level athletes that, despite the current anti-doping systems, even if they are effective, testing is at best rare. To elaborate, Chris Froome criticised the lack of anti-doping testing over a two week period during a key training camp for himself and two other high level cycling athletes [21,22]. Similarly in 2011 it was reported by Gerard Vroomen (2009-2010 head of Cervelo Test Team cycling), that 'I have not heard of a rider being tested for the biological passport between the end of the 2010 Tour and April 2011' [23]. This was later supported by Michael Ashenden a member of the UCI passport panel that stated 'It's correct that the observation made by Gerard Vroomen matches with my experience. I have noticed a significant gap between tests in some of the profiles I have reviewed' [24]. This would therefore indicate that despite the justification behind anti-doping policies, their goals are less likely to be achieved if they are not even being performed, irrespective of the issues surrounding the system.

This seems to indicate that there is much controversy as to the justification of anti-doping policies. This is especially true given the fact that the systems, as they currently operate, place a large number of restrictions on the personal liberties and privacy of athletes. Examples of which can be seen with the *whereabouts requirement* [25] (14.V.18), *biological passport* [26] (14.VI.120) and the *rules governing urine collection* [27] (7.2.4.). In fact Kayser, Mauron and Miah [28] suggested that ‘current anti-doping measures potentially introduce problems of greater impact than are solved’. Their paper critically assesses current anti-doping policies and concludes that they are in many ways based on a weak foundation. Naturally one would expect by this point in the development of anti-doping systems, the systems (as they currently are) would be finely tuned to ensure that they are effective and efficient in their goals. Furthermore, that they are successful in deterring doping and detecting it when it does occur. The realities are however, unfortunately quite different. There are factors inherent in the sporting systems and the testing practices as they exist that impact the success of anti-doping.

1.3 Window of Detection

Window of Detection is in reference to the time frame in which a substance remains detectable in a human body before it is broken down/absorbed and it is no longer possible to detect if an illegal substance has been used. Extant literature would seem to indicate that this figure, using the current testing at the disposal of WADA and anti-doping agencies worldwide, would range from as little as 12 hours to a maximum of 120 hours. On the lower end of this scale 12-24 hours. Research conducted by Bidlingmaier, Wu, & Strasburger [29] showed that more contemporary forms of hGH, when administered by subcutaneous methods, return to baseline within 20 hours maximum following administration. They further outline

that in some cases the window of these agents, when administered intramuscularly may even be as low as 8 hours. This has serious consequences for detection, particularly when coupled with the apparently increasing method of micro doping. Moreover, microdoping especially with recombinant human erythropoietin (rHuEPO) have been shown to fall into this low window of detectability also [30,31]. It was reported by Asheden et. al. [30] that microdosing reduced the window of detection of rHuEPO to as little as 12 hours. What this means is that should an athlete decide to dope immediately before long distance endurance event, such as the Le Mans 24 hour race, then by the time they are finished any trace of the substance would be removed. More concerning is the combination of these two pieces of research, micro doping with hGH. If intramuscular administration of hGH already has a window of 8 hours micro doping will reduce this further. This means that doping immediately before a race; particularly an endurance event, such as a cycling stage, would mean that the agent would be undetectable well before the end of the event.

It has been found that for the more commonly found doping agents such as steroids and regular doses of rHuEPO that a greater window of detection is obtained, 48-72 hours [31, 32,33]. The plasticizer di-(2-ethylhexyl)phthalate (DEHP) (not a doping agent but argued as being evidence of blood doping) can also be grouped into this category. Research by Monfort, et. al. [34] demonstrated that these metabolites remain in the system only up to 48 hours after infusion.

Finally, even some of the more ‘traditional’ substances of doping such as hGH when applying contemporary techniques of detection still have a somewhat limited window. It has been reported by Erotokritou-Mulligan, et al., [11] that the use of markers such as type 3 pro-collagen (P-III-P) for the detection of hGH may increase the window of detection to around 120 hours.

It should be pointed out that there is some research which demonstrates a longer window of detection of around 18-20 days. This research relates to some forms of methyltestosterone metabolite M2 [35] and oxandrolone metabolite 17 β -hydroxymethyl-17 α -methyl-18-nor-2-oxa-5 α -androsta-13-en-3-on (OX M1) [36]. Yet it should be pointed out that other metabolites of methyltestosterone [35] and the ‘parent drug oxandrolone and its isomer epioxandrolone’ were only detectable for about 3days, which supports the findings of other research and justifies the use of the estimated figures in this research. However, in order to provide a more comprehensive view of the situation, calculations for these figures can be found in the proceeding sections.

1.4 Test Sensitivity

Test sensitivity refers to the accuracy of testing. That is to say, if for example 100 tests were performed on samples with doping agents in them what percentage of them are likely to be classified as containing doping agents. It is next to impossible to have any technique that is 100% accurate, in any and all cases of chemical testing there is some margin for error; false positives are an example of common errors that are known to occur. Upon closer inspection of the literature, which is at times apprehensive to outline the exact percentages of accuracy, one begins to obtain a clearer image of the current situation.

The highest rates of success of doping detection have been reported as being between 60% and 80% success rate. It has been reported by Powrie, et al., [37] that these levels could be obtained with cases of the more classical doping substance of hGH, when using N-terminal extension peptide of procollagen type III markers for detection, so contemporary techniques for classical problems. Yet other papers have reported far less encouraging results. Erotokritou-Mulligan, et al., [11] reported that other forms of growth hormones such as hGH

even when combined with the use of Insulin Growth Factor-1 (IGF-I) and P-III-P only resulted in a success rate of 40%. Worse still (and perhaps a worst case scenario) were the findings by Graham, et al., [12], who reported that tests, conducted on both non-steroidal hormones and hGH, in some cases resulted in a successful detection rate of only 10%. This is extremely concerning for those in the fight against doping. These figures would seem to indicate that a majority of testing is at best hit or miss. Thus perhaps many doped athletes are slipping through the cracks.

1.5 Doping Regime

Doping regime is in reference to the actual frequency of doping as performed by athletes deciding to partake in the practice. Given the illegality of doping, and the potential for criminal prosecution in some countries including Austria (*Gesamte Rechtsvorschrift für Anti-Doping-Bundesgesetz, 2007*) [38], France (*Code du sport, 2012*) [39] and Italy (*Disciplina della tutela sanitaria delle attività sportive e della lotta contro il doping, 2000*) [40], there is considerable apprehension by some athletes to reveal exactly the doping methods and frequencies used. Given this, information is limited, but some evidence does still exist. Graham et. al. [12] reported that the doping regime of an anonymous UK champion was continuous, multiple times per week, that is to say regular doses when 'required' to ensure maximal performance. Further information is either lacking or ambiguous, but it is safe to say that given the intellect of athletes, some will be using doping agent intermittently so to attempt to ensure evasion of detection.

1.6 Predictability of Testing

Test predictability is the likelihood that an athlete choosing to partake in doping is able to predict when the anti-doping sample will be required. To elaborate, if an athlete chooses to dope, it is highly unlikely they will do so without some level of thought going into both the decision to dope and the decision as to when to use the banned substances. In the case of the latter, the decision as to when to use, will be based in part on the likelihood that they will be tested or not within the window of detectability period. This likelihood can be argued as being primarily based on the past rates of anti-doping sample collection. That is to say how frequently they and other athletes around them have been selected for sample collection. The literature does not and more than likely is not able to list the figures for an athlete's belief of when they will be tested and so alternative source data must be used to make this determination. As such reference to the statistics available from various nation anti-doping agencies (NADA) and the world anti-doping agency is needed to make this determination. These sources demonstrate vastly differing numbers relating the amounts of testing performed on various athletes in their care. It has been reported that these figures range from 2 through to 24 tests a year [41,42,43,44]. These figures are dependent on a number of factors. These include, the athlete in question, their rates of success in the events they compete, policies of the NADA, and more than likely the economic realities and resources available to the NADA. What this indicates is that the athlete in question is able to make approximate estimates on when they are likely to be tested, for example during a major competition, or before, or more generally when in a month they are likely to receive an out-of-competition test. All of which contributes to their decision making process and as such the predictability of testing.

2. Methods

This research contains two different approaches to assessing the current effectiveness of the anti-doping system; these being a probability and a cost analysis of the current system of testing.

Probability analyses are a useful tool to attempt to gain a better view of probable outcomes based on a set of uncertainties. They are often used, along with costs analyses, as a useful tool for assessment of effectiveness in health system research [45,46,47]. The initial step required was to conduct research into the factors influencing the successfulness of anti-doping testing using the current system. This was performed by examining extant literature on the topic. Information pertaining to factors involved in anti-doping testing and doping practices used by athletes was collected from official documents by anti-doping agencies, academic papers, media releases etc. Sources are quoted in the information that follows. It was found that an assortment of factors influence the probability doping will be detected, and as such it was necessary to attempt to quantify these factors. Anti-doping testing does not always result in a positive detection even if an athlete may be engaging in doping. The factors relate to the sporting world impact the actual real life test success. These factors were determined to be as follows based on the literature as outlined previously; a) window of detection, b) test sensitivity, c) doping regime, and d) predictability of testing.

Given the realities, certain conclusions can be made as the necessary parameters to make up the formula to assess probability of success of the anti-doping system. Each of these influences can be considered a variable contributing to the probability of doping detection in a single test. The realities are, a) the window of detection is limited, b) sensitivity of tests is mostly low, c) doping substances may be used intermittently by athletes to help avoid detection, and also d) athletes may guess when a test will occur. The total probability of

detection will be a product of probabilities of the four contributing variables, window of detection (W), test sensitivity (S), doping regime (D), and predictability of testing (T). Given this, the second step was to construct a formula demonstrating the likelihood of detection of doping, based on these factors. This formula is as follows:

$$P = W \times S \times D \times T$$

Where:

W= window of detection in hours expressed as a fraction of a week assuming week or 168 hours = 1

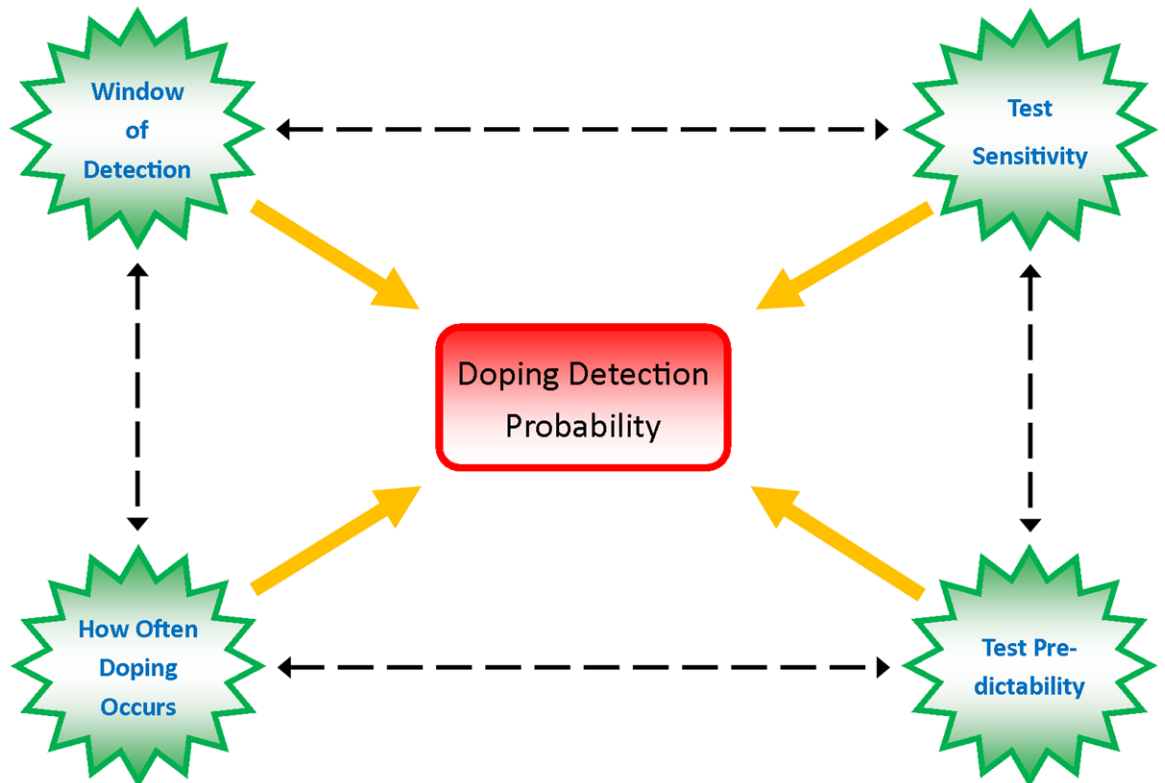
S= test sensitivity

D= how often doping occurs, 1.0 being continuous use and fractions indicating intermittent use

T= test predictability per person per week, expressed as the number of tests that could be expected per year divided by the number of weeks in the year (52).

For example a test with a window of detection of 24 hours i.e. 0.14 in a week, with 40% test sensitivity with a person continuously doping i.e. 1.0 in each week, and predictability of 0.25 because random tests occur on average once a month will produce an overall probability of 0.014 of a random test to be successful. This means that the probability of a random test to be unsuccessful is 0.986, close enough to certainty in most situations. This concept is depicted graphically in figure 1 and demonstrates the relationship between the four elements and their influence on the probability of doping detection. It shows that each element affecting the probability of doping detection also has an impact on each other element. For example, the window of detectability impacts an athlete's doping regime and test predictability. As too does test sensitivity. An athlete's doping regime is also impacted by the test predictability, and so on.

Figure 1: Graphic representation of the factors influencing the probability of detection and their relationship to one another



There are a number of reasons why the literature is apprehensive to reveal definitive numbers pertaining to some of these variables. These reasons include, but are not limited to, the clandestine nature of doping, the lack of dedicated research into each of these components, and apprehension of publication of controversial findings with regard to doping, to name but a few. Thus a range of estimates was used. The estimates used for this research are found in table 1, and are based on the findings in the literature as outlined previously:

Table 1: Doping probability formula parameters, estimates and drug types

| Variable | Estimated Values | Drug Types |
|--------------------------------------|---|--|
| Window of detectability | 12 – 24 hours | hGH, micro doping |
| | 48 – 72 hours | rHuEPO |
| | 120 hours | common agents, rHuEPO, DEHP |
| | | new techniques for old agents |
| Test sensitivity | 10% | non-steroidal hormones and |
| | 40% | hGH |
| | 60-80% | hGH (with IGF-I, P-III-P) |
| | | hGH (N-terminal extension peptide of procollagen type III) |
| Doping Regime | 1.0 (continuous) 0.5 (intermittent) | |
| Test predictability (tests per year) | 2 | |
| | 6 | |
| | 9 | |
| | 12 | |
| | 24 | |

Similarly, a majority of the substances relate to Androgenic Anabolic Steroid (AAS) and Growth Hormone (GH). EPO, blood doping and stimulants are used and can all be very effective methods of doping. Unfortunately given the somewhat contemporary origins of some of these substances, the lack of funding for doping research in some cases and the

general clandestine nature of doping, research in these areas does not provide sufficient information to make a reliable assumption.

The odds of detection per year were calculated as the inverse of the probability of detection in a single test multiplied by the number of tests during a year. The odds of detection in the entire career were based on the assumption of a career of 15 year duration with the annual probabilities unchanging. Thus these odds were an inverse of 15 times the probability of detection per year times the number of tests per year.

The final step in this research was to conduct a cost analysis. This was done in order to attempt to ascertain the feasibilities of anti-doping testing given the realities of the sporting world. A cost analysis is a useful tool for this as it takes into consideration economic realities from numerous sources and can help paint a more complete and tangible picture of what really is happening in reference to real world economics. Cost (and economics) analyses of doping are useful tools when it comes to assessing sports related expenses, and have been used by a number of internationally renowned experts in sports as a tool for assessing efficiency [48,49,50]. The analysis for this research was a two-step process. Firstly it was necessary to determine the amount of testing needed to, in all probability, actually detect doping when it occurs. Following this these numbers were then assessed in light of the costs associated with standardised urine testing, with figures available from the Australian Sports Anti-Doping Authority. More details relating to these figures are outlined in the relevant sections following.

3. Results and Discussion

3.1 Odds of Doping Detection

A series of calculations have been performed using values as established from the literature as were outlined previously in the methods section, these calculations can be seen in table 2. The column entitled Sport with detection rate matching odds, is an indication of those sports which have a detection rate which coincides to the figures provided by WADA and its adverse analytical findings (see table 3). It was decided to use the WADA adverse analytical finding (AAF) figures instead of Anti-Doping Rule Violation (ADRV) figures as this research relates to the detection of doping agents not justifications of how they entered the athletes' system and thus subsequent legal and ethical considerations.

Table 2: Probabilities of doping detection

| Window of Detection(hrs) | Test Sensitivity | Doping Regime (weekly) | Test predictability per person per week | Probability of detection in a single test | Number of tests (per year) | Odds of escaping detection | Odds of escaping detection in 15yrs career | Sport with detection rate matching odds |
|--------------------------|------------------|------------------------|---|---|----------------------------|----------------------------|--|---|
| 12 | 0.4 | 1 | 0.25 | 0.0071 | 12 | 12:1 | 1:1 | |
| 18 | 0.4 | 1 | 0.25 | 0.0107 | 12 | 8:1 | 1:1 | |
| 48 | 0.4 | 1 | 0.25 | 0.0286 | 12 | 3:1 | 0:1 | |
| 72 | 0.4 | 1 | 0.25 | 0.0429 | 12 | 2:1 | 0:1 | |
| 120 | 0.4 | 1 | 0.25 | 0.0714 | 12 | 1:1 | 0:1 | |
| 12 | 0.4 | 1 | 0.038 | 0.0011 | 2 | 461:1 | 31:1 | |
| 18 | 0.4 | 1 | 0.038 | 0.0016 | 2 | 307:1 | 20:1 | |
| 48 | 0.4 | 1 | 0.038 | 0.0043 | 2 | 115:1 | 8:1 | Sailing, Athletics |
| 72 | 0.4 | 1 | 0.038 | 0.0065 | 2 | 77:1 | 5:1 | Basketball, Archery, Cycling, |

| | | | | | | | | | Rugby |
|-----|-----|-----|-------|---------------|---|--------|-------|-------------------------|-------|
| 120 | 0.4 | 1 | 0.038 | 0.0109 | 2 | 46:1 | 3:1 | | |
| 12 | 0.8 | 1 | 0.038 | 0.0022 | 2 | 230:1 | 15:1 | | |
| 18 | 0.8 | 1 | 0.038 | 0.0033 | 2 | 154:1 | 10:1 | Aquatics, Sailing | |
| 48 | 0.8 | 1 | 0.038 | 0.0087 | 2 | 58:1 | 4:1 | Basketball , Cycling | |
| 72 | 0.8 | 1 | 0.038 | 0.0130 | 2 | 38:1 | 3:1 | | |
| 120 | 0.8 | 1 | 0.038 | 0.0217 | 2 | 23:1 | 2:1 | | |
| 12 | 0.1 | 1 | 0.038 | 0.0003 | 2 | 1842:1 | 123:1 | | |
| 18 | 0.1 | 1 | 0.038 | 0.0004 | 2 | 1228:1 | 82:1 | | |
| 48 | 0.1 | 1 | 0.038 | 0.0011 | 2 | 461:1 | 31:1 | | |
| 72 | 0.1 | 1 | 0.038 | 0.0016 | 2 | 307:1 | 20:1 | | |
| 120 | 0.1 | 1 | 0.038 | 0.0027 | 2 | 184:1 | 12:1 | Shooting | |
| 12 | 0.1 | 0.5 | 0.038 | 0.0001 | 2 | 3684:1 | 246:1 | | |

| | | | | | | | | |
|-----|-----|-----|-------|---------------|----|--------|-------|------------------------|
| 18 | 0.1 | 0.5 | 0.038 | 0.0002 | 2 | 2456:1 | 164:1 | |
| 48 | 0.1 | 0.5 | 0.038 | 0.0005 | 2 | 921:1 | 61:1 | |
| 72 | 0.1 | 0.5 | 0.038 | 0.0008 | 2 | 614:1 | 41:1 | Bobsleigh |
| 120 | 0.1 | 0.5 | 0.038 | 0.0014 | 2 | 368:1 | 25:1 | |
| 12 | 0.4 | 0.5 | 0.038 | 0.0005 | 2 | 921:1 | 61:1 | |
| 18 | 0.4 | 0.5 | 0.038 | 0.0008 | 2 | 614:1 | 41:1 | Bobsleigh |
| 48 | 0.4 | 0.5 | 0.038 | 0.0022 | 2 | 230:1 | 15:1 | Fencing |
| 72 | 0.4 | 0.5 | 0.038 | 0.0033 | 2 | 154:1 | 10:1 | Aquatics. Athletics |
| 120 | 0.4 | 0.5 | 0.038 | 0.0054 | 2 | 92:1 | 6:1 | Cycling, Rugby |
| 12 | 0.4 | 0.5 | 0.25 | 0.0036 | 12 | 23:1 | 2:1 | |
| 18 | 0.4 | 0.5 | 0.25 | 0.0054 | 12 | 16:1 | 1:1 | Bridge |
| 48 | 0.4 | 0.5 | 0.25 | 0.0143 | 12 | 6:1 | 0:1 | Bodybuild ing |
| 72 | 0.4 | 0.5 | 0.25 | 0.0214 | 12 | 4:1 | 0:1 | |

| | | | | | | | | |
|-----|-----|-----|-------|---------------|----|------|-----|--|
| 120 | 0.4 | 0.5 | 0.25 | 0.0357 | 12 | 2:1 | 0:1 | |
| 12 | 0.5 | 0.5 | 0.5 | 0.0089 | 24 | 5:1 | 0:1 | |
| 18 | 0.5 | 0.5 | 0.5 | 0.0134 | 24 | 3:1 | 0:1 | |
| 48 | 0.5 | 0.5 | 0.5 | 0.0357 | 24 | 1:1 | 0:1 | |
| 72 | 0.5 | 0.5 | 0.5 | 0.0536 | 24 | 1:1 | 0:1 | |
| 120 | 0.5 | 0.5 | 0.5 | 0.0893 | 24 | 0:1 | 0:1 | |
| 12 | 0.4 | 0.5 | 0.125 | 0.0018 | 6 | 93:1 | 6:1 | Triathlon |
| 18 | 0.4 | 0.5 | 0.125 | 0.0027 | 6 | 62:1 | 4:1 | Equestrian , Rugby |
| 48 | 0.4 | 0.5 | 0.125 | 0.0071 | 6 | 23:1 | 2:1 | Boules, Billiards, Motorcycl e Racing, Powerlifiti ng |
| 72 | 0.4 | 0.5 | 0.125 | 0.0107 | 6 | 16:1 | 1:1 | Bridge, Sambo |
| 120 | 0.4 | 0.5 | 0.125 | 0.0179 | 6 | 9:1 | 1:1 | |

| | | | | | | | | |
|-----|-----|-----|-------|---------------|---|------|-----|--|
| 12 | 0.4 | 1 | 0.125 | 0.0036 | 6 | 47:1 | 3:1 | Weightlifting, Rollersport, Golf |
| 18 | 0.4 | 1 | 0.125 | 0.0054 | 6 | 31:1 | 2:1 | Airsports |
| 48 | 0.4 | 1 | 0.125 | 0.0143 | 6 | 12:1 | 1:1 | Muay Thai |
| 72 | 0.4 | 1 | 0.125 | 0.0214 | 6 | 8:1 | 1:1 | |
| 120 | 0.4 | 1 | 0.125 | 0.0357 | 6 | 5:1 | 0:1 | |
| 12 | 0.4 | 0.5 | 0.188 | 0.0027 | 9 | 41:1 | 3:1 | Weightlifting |
| 18 | 0.4 | 0.5 | 0.188 | 0.0040 | 9 | 28:1 | 2:1 | Morocycl e racing |
| 48 | 0.4 | 0.5 | 0.188 | 0.0107 | 9 | 10:1 | 1:1 | |
| 72 | 0.4 | 0.5 | 0.188 | 0.0161 | 9 | 7:1 | 0:1 | |
| 120 | 0.4 | 0.5 | 0.188 | 0.0269 | 9 | 4:1 | 0:1 | |

| | | | | | | | | |
|-----|-----|-----|-------|---------------|---|------|-----|------------------|
| 12 | 0.4 | 1.0 | 0.188 | 0.0054 | 9 | 21:1 | 1:1 | Kickboxin g |
| 18 | 0.4 | 1.0 | 0.188 | 0.0081 | 9 | 14:1 | 1:1 | Muay Thai |
| 48 | 0.4 | 1.0 | 0.188 | 0.0215 | 9 | 5:1 | 0:1 | Bodybuild ing |
| 72 | 0.4 | 1.0 | 0.188 | 0.0322 | 9 | 3:1 | 0:1 | |
| 120 | 0.4 | 1.0 | 0.188 | 0.0537 | 9 | 2:1 | 0:1 | |

If one were to therefore use a set of commonly encountered values ($W= 48$, $S = 0.4$, $D=1$ and $T=0.25$) to calculate a probability of doping detection in one random test, one gets $p= 0.029$; meaning that in a single test there is only approximately a 2.9% chance of doping being detected.

When this is then extrapolated to yearly detection, if one were to select 12 tests a year as an average, then this results in a detection rate of approximately 34% or an odds ratio of 3:1. This indicates that there is in fact a 66% chance of a doped athlete not being detected, quite good odds for someone willing to take a risk. This calculation is based on an assumption that tests are done completely randomly without prior warning and without predictability. Where an exact date of a test is predictable, the risk of detection would decline even further, even with 12 tests per year. Similarly, if one incorporates the extended window of detection of 21 days, one obtains the following, 21 days x 0.4 sensitivity, intermittent doping of 0.5, and predictability of 0.125, resulting in an overall probability of 0.075 meaning that even in this case there is only a 7.5% chance of being detected in a single test or 92.5% chance of escaping detection. Assuming continuous doping this figure comes down to 85% that is still far away from 50/50 risk taking.

This makes the risk potentially psychologically acceptable to the “doper” [51]. To elaborate, it would seem less likely that an athlete who feels that they have a high probability of getting caught would partake in doping. On the other hand athletes who feel that there is a high probability they will escape detection would be more likely to engage in doping. This is because they may well feel that the result of doping would bring significant rewards without significant risk, the notion of a cost-risk ratio. It can be argued that despite the inherent flaws in the anti-doping systems, this is one feature that provides the most benefit, the impression that anti-doping is effective. Even if it is not, the sheer power of an athlete believing it is, may, in some cases deter them from engaging. This is the notion of cost-risk ratio, the idea

that athletes weigh up the costs of the likelihood of getting caught and the consequence if they do vs. the benefits if they don't. It would seem that as the current anti-doping systems are structured and the problems associated with detection, some athlete may see the benefits significantly outweighing the risks.

However, similarly to this notion of fear and deterrence, there is another element of anti-doping testing which contributes to its effectiveness but is not directly related to success of detection. This concept relates back to Foucault's Panopticon [52] and more recently the work by Haggerty and Ericson's [53] on surveillant assemblage. This notion presents the idea that the panopticon (or other forms of surveillance) results in a decline of undesirable behaviours. One could say it is a form of negative reinforcement. This concept having its origins in a theoretical prison system, purports that an inmate watched or believing they are watched (even if they are not) are less likely to engage in negative behaviours. This, as it relates to sports, would seem to be reasonable, for even if anti-doping is not effective per se, perhaps the mere existence of testing may deter some athletes from doping for fear they might possibly be caught as they are always being watched. There are, however, two problems that exist here. Firstly, some people prefer the notion of being watched, the idea that it is more of a challenge to 'beat the system'. Secondly, in some areas of the world, capital punishment still exists for certain crimes. Some states of the United States are one such example. Moreover, the United States, being one the world's, most technologically advanced nations have ample systems of surveillance of its citizens in place, not only video but there are also numerous organisations which exist to this end. Despite this reality, crimes are still committed, murders are still committed, even with the death penalty in place and constant surveillance. The thought that simply watching someone will eliminate the darker sides of human nature is both unrealistic and delusional. It may, in some limited cases, work, but if someone is determined enough to cheat they will find a way despite all the surveillance and punishments possible.

What the above results indicate is that by using current statistics it would seem that the likelihood of being caught doping is somewhere between 0.1 and 10% in a single test. To put this in perspective, the most complete and considered official current statistics pertaining to adverse analytical findings are provided by the World Anti-Doping Agency [54]. These findings, per sport, range anywhere from 0 to about 18% [41]. This would seem to indicate that given the findings of this research, the extent to which doping occurs is very high. Theoretically, using these figures, if one were to assume that 100% of athletes dope, because of the limited window of detection, low test sensitivity and infrequent testing, it is likely to have result in 2.9% of adverse findings only. To elaborate, according to the calculations, if $W = 0.29$ (48hours), $S = 0.4$, $D = 1$ and $T = 0.25$, one obtains a 2.9% chance of doping detection in a single test. Therefore if one was to then again refer to the statistics available from WADA a sport with an adverse analytical finding of 2.9% (such as is closely the case with darts) would seem to indicate that given these conditions a vast majority of athletes in that sport were engaged in doping. Assuming tests were completely random and every athlete doped regularly, then the percentage of positive test findings (adverse analytical findings) would be low, roughly corresponding to actual data published by WADA.

This indicates two things. 1) that doping is far more widespread than official figures would lead one to believe and 2) that the current system of anti-doping testing is inadequate to eliminate doping. This supposition is supported by a number of officials [55] in the sporting arena, some athletes [56] and numerous others involved in sports including academics [28,57]. It should be noted that scientific literature does not always quote specific examples. For this reason they must be searched for in websites and popular literature. This is why such examples were used above. Illicit activities can hardly be researched systematically and this is why formal scientific literature does not provide relevant information. As outlined previously it can be said that it appears as though anti-doping policies are in place more for reasons of

perceptions and deterrence through fear then for any effective and efficient scientific merit. This lends further support for the assertions by Hermann & Henneberg, [58] as to the relationship both perceptions and image has to modern sports, their participants and anti-doping.

3.2 Rates of Doping

Table 3 demonstrates current WADA statistics relating to adverse analytical results.

Table 3: Adverse Analytical Findings % for an assortment of sports [41]

| Discipline | Adverse Analytical Findings % | Discipline | Adverse Analytical Findings % |
|--------------------------|--------------------------------------|-------------------|--------------------------------------|
| Aikido | 0.00 | Hockey | 1.32 |
| Air sports | 3.09 | Judo | 1.13 |
| Archery | 1.47 | Kendo | 0.00 |
| Athletics | 0.78 | Kickboxing | 4.97 |
| Baseball | 1.99 | Motorcycle racing | 4.15 |
| Basketball | 1.45 | Muay Thai | 8.11 |
| Biathlon | 0.00 | Netball | 0.83 |
| Billiards | 4.24 | Powerboating | 0.00 |
| Bobsleigh | 0.16 | Powerlifting | 4.88 |
| Bodybuilding and fitness | 18.09 | Rowing | 0.23 |
| Boxing | 1.94 | Rugby | 1.39 |
| Bridge | 6.00 | Skiing | 0.71 |
| Cycling | 1.19 | Sleddog | 3.70 |
| Darts | 2.70 | Weightlifting | 2.42 |

| | | | |
|----------|------|-----------|------|
| Football | 0.48 | Wrestling | 1.23 |
| Golf | 2.04 | Wushu | 1.68 |

Whilst it should be pointed out that, by WADA’s own admission, these data are not entirely complete; they do still provide a reasonable approximation of the extent of findings in each discipline. When the figures in table 3 are compared to the calculations in table 2, table 4 can be thus derived.

Table 4: Actually reported adverse analytical findings and corresponding possible doping characteristics under assumption that all athletes in a given sport apply doping

| Sport | Adverse Analytical Findings | Corresponding doping characteristics if all athletes dope | | |
|------------|-----------------------------|---|---------------|------------|
| | | Window of Detection | Test Accuracy | Dosage |
| Air Sports | 3.09 | 18 | 40% | Continuous |
| Archery | 1.47 | 48 | 40% | Continuous |
| Baseball | 1.99 | 48 | 40% | Continuous |
| Bobsleigh | 0.16 | 72 | 10% | Interval |
| Cycling | 1.19 | 48 | 80% | Continuous |
| Football | 0.48 | 48 | 40% | Interval |
| Rowing | 0.23 | 48 | 10% | Continuous |

These comparisons demonstrate the assumptions under which the current doping rates would represent a mere portion of the actual doping rates. Continuous or intermittent in table 4 are based on those in table 2. Cycling can be used as one such example; WADA statistics indicate a 1.19% adverse analytical test result for the sport. If we then use the assumption that there is an 48 hour window of detection of the agents used, a 80% accuracy of testing, doping

agents are used continuously and athletes can predict testing in a week knowing that they will be tested about 3 times a year, this allows the possibility to calculate that about 100% of cyclists would be participating in doping. This is done in the following manner, 48 hour window ($48/168 = 0.286$) x sensitivity of 0.8 x continuous regime (1.0) x test predictability $0.0576 = 1.32\%$. If WADA statistics indicate that in cycling just over 1.0% adverse analytical findings are made then this indicates that a significantly higher proportion of athletes in the sport are participating in doping and due to restrictions of the anti-doping system are simply not getting detected. Whilst it is unrealistic to suggest that all cyclists are using doping agents, the suggestion does remain that the figures do not truly represent actual rates of doping. Similar, are the results seen with baseball. Whilst it should be pointed out that this sport historically did not conform to the WADA guidelines for anti-doping testing they still performed some anti-doping tests, some of which are indeed used by other sports. The results are similar to that of cycling. These conclusions are supported by findings of the *Mitchell Report* which stated that '[t]he use of steroids in Major League Baseball was widespread' [59]. Moreover, the same report acknowledged the fact that not all substances are detectable (in the case of the Mitchell Report the researchers were referring to hGH) [59]. It also concluded that 'Baseball does not need and cannot afford to engage in a never-ending search for the name of every player who ever used performance enhancing substances' [59]. This could be argued as indicating two things. Firstly, that doping use in Baseball was so widespread it would be next to impossible to make a complete list. Second, perhaps that given the nature of doping detection, clandestine nature of doping and the opposition faced by the researchers [59: SR7] such an investigation would be next to impossible.

3.3 Testing Requirements

The fact that tests are not working well is illustrated by WADA's recent decision to increase the length of doping bans from 2 to 4 years when the 2015 code comes into force in 2015 [60] with the aim of increasing the deterrent effect of the penalty. In law enforcement this practice it is usually performed when detection of a wrongdoing is ineffective. Some research, however, has claimed that increasing the penalty for a wrongdoing will have no impact on the criminal behaviour [61,62]. On the other hand it could be argued that this increase was to attempt to combat the perceived unfairness of current bans, which could result in Olympic athletes not missing a single Olympics. This, however, would depend on when the ban was passed out. Furthermore, professional sports being what they are currently, it is unlikely that a top level professional athlete after missing 2 seasons would be at the same level of fitness as before, especially race fitness. As such a ban of 2 years would still have an effect on their actual success rate. 4 years may amplify this effect, but one must be careful that if the athlete is to be given a second chance, the length of suspension is not too long.

As such this research demonstrates that a new approach to anti-doping policy is needed. Given the current realities of doping in professional sports, the question remains, what regime is required to begin to combat doping?

Table 5: Doping testing needed (per year per athlete) to reliably detect doping. Based on current WADA figures and doping characteristics as outlined in table 4, and examples of costs per year (using urine tests) per athlete for reliable detection of doping

| Sport | Tests Needed | Approximate Cost |
|--------------|---------------------|-------------------------|
| Air Sports | 43 | € 25,112.00 |
| Archery | 22 | € 12,848.00 |
| Baseball | 50 | € 29,200.00 |

| | | |
|-----------|----|-------------|
| Bobsleigh | 50 | € 29,200.00 |
| Cycling | 16 | € 9,344.00 |
| Football | 30 | € 17,520.00 |
| Rowing | 43 | € 25,112.00 |

Table 5 depicts the number of tests needed per year to detect doping effectively. This was calculated using the figures and assumptions provided in table 2. The results of Table 5 indicate that the number of doping tests in many sports will need to be unrealistically increased in order to effectively combat doping. Indications are such that should anti-doping testing remain unchanged legislation would need to be modified to accommodate the realities of doping. One interesting point worth investigating in table 5 is the number of yearly tests needed per athlete to detect doping (with relative effectiveness) in cycling. The theoretical figures would seem to indicate 16 tests per year would be sufficient to do so. Currently in cycling, either through the UCI, or the national anti-doping agencies, some athletes would no doubt already submit this many samples. One would normally expect that the most successful and high profile athletes would normally be the ones that would be subjected to such a large number of tests a year. This, however, may be questionable, given the statements outlined previously by Chris Froome and the lack of testing he and other top cyclists experienced. Even if this was an isolated case and testing over that small period was lacking, and throughout the rest of the year testing is extensive why then are many doping cases in cycling being revealed only through self-admission rather than positive tests? One possible argument can be seen with the revelations in the Lance Armstrong case there are a number of other factors which play a role in successful detection. These factors are such that they cannot be easily quantified. These factors include third party involvement, warnings of upcoming testing, role of money etc. It should also be pointed out that if athletes are able to manipulate

tests then this would make it even harder to detect doping. This does not necessarily mean tampering with sample collection, or tampering with the samples after collection (which still may occur despite measures taken to prevent this), but rather for example athletes may take doping agents immediately after testing, knowing that it is unlikely they will be tested again soon. If athletes can partly predict when tests are going to occur and/or can manipulate testing then it will lower probability of detection in a single test and this strengthens this papers argument. There may also be specific effects of the method of doping or testing that would deviate somewhat from the simple calculations.

3.4 The Cost of Effective Anti-Doping

If one then focuses on the testing required per year, per athlete, for effective detection, the next step is to then extrapolate this into real world financial figures. Put simply, it is necessary to make a cost determination of such an increase in the testing regime and thus a determination of the cost of an effective and efficient means of doping detection.

Furthermore, reference again to Table 5, one can also see the total cost per athlete per year of doping tests needed to reliably detect doping , is on average €21,190.86 (USD 28,676.30). This is an average based upon the number of tests needed which ranges from 16 to 50 depending on the discipline. This uses approximate urine test cost figures as available through Australian Sports Anti-Doping Authority (ASADA) [63] of about €584 (AU\$738, USD 692.59) per test (blood and EPO testing costs are higher). Urine tests were chosen as they are most commonly used test for doping detection and the least expensive. Other testing, such as blood testing, has higher costs associated with it and therefore any calculations would produce greater costs/numbers. There is some argument that blood testing required for the Athletes Biological Passport (ABP) is cheaper, but given the added difficulties in analysis and

collecting blood samples, the trained staff needed etc. it seems that in the long run even ABP blood testing would cost more than urine. The lower figures were used in the calculations simply to demonstrate that even at the lowest level the costs associated with effective testing would amount to an astronomical figure. The approximate total cost per year for all athletes in a given nation to be subject to such tests, is subject to the nation in question. If one is to take as an example Germany, and one refers to their website for appropriate data relating to the testing pool, one begins to see the scale. Current data shows that Germany's athletes number around the 4000 [42], this however, does not including the national testing pool of athletes). Given these figures the total funds would need to exceed 84 Million Euros (€84,763,428.57 or about USD\$114,715,721.16). The German National Anti-Doping Associations total annual revenue was €4,570,062 (USD 6,184,576.60) for the year ending 2010 [42], this would result in a €80,193,366.57 (USD 108,514,946.82) shortfall.

What is more, this figure incorporates only the actual cost of tests, it does not take into account the additional costs associated with anti-doping testing. These would include, but not be limited to, hiring sample collection staff, collection materials, Out of Competition travelling for collection, physical resources etc. Therefore, what this shows is that the level of testing needed to effectively detect doping is economically unfeasible. Whilst it is likely true that some of the cost of testing will be borne by the national federations themselves, it does, however, seem highly unlikely that all the levels of funding needed for complete testing will be available given economic realities. Sports may be a lucrative area but there are still realities about real world economics and financing that demonstrate that despite the figures involved, the level of funding needed to make an effective testing regime is infeasible.

3.5 Biological Passport and Forensic Testing

One cannot assert to having fully addressed the ineffectiveness of the current anti-doping system without addressing the existence and usage of both the Athlete Biological Passport (ABP) [64] and an assortment of forensic methods such as hair testing. WADA outlines the ABP as,

The fundamental principle of the Athlete Biological Passport (ABP) is to monitor selected variables (‘biomarkers of doping’) over time that indirectly reveal the effect of doping, as opposed to the traditional direct detection of doping by analytical doping controls.

In effect the ABP is a tool for keeping track of the changing variables in human physiology. Unlike conventional testing it does not directly determine the existence of doping substances in the body system but instead considers its indirect consequences. This method is often argued as being the next generation in anti-doping testing; a more effective test, one with greater potential than conventional testing [64,65,66]. Yet there is ample evidence that supports the notion that, like conventional testing, the ABP is far from perfect and as such supports the supposition that current anti-doping is ineffective.

To begin with, there is the debate surrounding indirect testing. It is true that in some cases doping can be detected without directly discovering the substance in the blood. This is done through indirect blood or urine biomarkers [65,66,67]. However, these same markers can also be an indication of an assortment of other causes from illness, medical assistance, training techniques, physiological uniqueness of an individual etc. [68,69]. It does not in

every case indicate the use of banned substances. Despite this the athlete still needs to, in effect, prove their innocence.

An additional issue with the ABP can be found in the research by Ashenden, Gough, Garnham, Gore & Sharpe [70]. Their research involved the intravenous injection of recombinant human erythropoietin (rhEPO) into 10 subjects for up to 12 weeks. Results of the study found that in microdose amounts EPO was undetectable in the ABP. If the ABP at present is not even detecting what it was introduced to detect then one can quite clearly conclude that it is ineffective.

Further issues with the ABP have been reported in areas one may not normally expect to be such a major factor contributing to ineffectiveness. Banfi [71], has reported the ABP may be affected by an assortment of factors such as:

‘Quality control of the instruments is not completely assured. Analytical variability is not appropriately considered in the program. The seasonal changes of the hematological parameters, due to training and competitions, are not calculated. Statistical analysis, based on a Bayesian-like program, not available to the scientific community, does not follow the classical decision making approach of medicine and science...’

All of these factors indicate that at present the ABP has its shortfalls and may in fact currently not be an effective tool for anti-doping, or at least not to the level it should be.

Furthermore, a number of key international experts in the area of cycling have criticised yet another issue with the ABP. As outlined previously, both Gerard Vroomen former head of Cervelo TestTeam and international anti-doping expert Michael Ashenden reported a lack of testing with regard to the ABP. This lack of testing demonstrates that the current system is ineffective; be that because testing is inaccurate, imprecise or simply not occurring (perhaps due to economic reasons). These could explain the drop in extreme blood

values in cyclists since the introduction of the ABP. If there are long periods of no testing then of course the more extreme values are likely to be missed.

It has also been argued that there has been more Anti-Doping Rule Violations (ADRVs) in cycling since the introduction of the ABP. Even if there are more ADRVs in cycling, the actual number of athletes sanctioned because of the ABP remains extremely low. In this regard can it be said that the ABP is having the desired effect? If athletes who are under the ABP are being found to have questionable results, and as such brought up on charges for anti-doping violations, but still are not being sanctioned, then is the program really helping the state of affairs or simply making them worse ?.

In the case of modern forensic testing, there is still some debate as to tests' effectiveness. WADA for example still has not certified the use of forensic testing methods, such as hair analysis, in their anti-doping systems. There are some issues with hair testing. Unlike urine or blood, hair is not always present and available for testing. This can be because of baldness or shaving by the athlete. Similarly, it is simply not possible to detect all the same substances as urine or blood testing does. Or is the decision not to sanction hair testing due to the cost? Would it not cost significantly more (at present) to undertake such analyses? More research is required to ascertain the effectiveness and efficiency of various forms of forensic testing, but the reality is at present that these techniques are not used (for whatever reason) and as such cannot be said to be part of the current anti-doping system. There is one case worth mentioning, the case of Richard Gasquet. In order to clear his name, he ordered an independent hair analysis to determine the presence of cocaine in his system. This was accepted by the Court of Arbitration in Sport (CAS). The reality remains this acceptance was not issued by WADA nor the International Tennis Federation (ITF), and what is more, the test was negative. Gasquet later admitted use but argued it was inadvertent and no fault of his

own, this was accepted by the CAS [72]. Overall this brings into question the effectiveness of the hair testing.

4. Limitations and Future Research

In November 2013 WADA's Foundation Board meeting [73] decided on the introduction of a Steroidal Module into the ABP. This method of profiling may change the effectiveness of the current anti-doping testing. At this point there is too little evidence to determine its current effectiveness and so more testing and time is needed. One can, however, say that if the same problems arise with the Steroidal Module as with haemoglobin; the same scientific issues and ethical issues are involved, then the findings of this research will be strengthened. Similarly if WADA decided to confirm the use of hair and/or similar forensic testing methods, further research will be needed to assess how this may change the effectiveness of anti-doping testing. One key limitation to this research is the difficulty finding specific figures relating the four variables for the formula. The clandestine nature of doping made obtaining exact figures impossible and as such estimates were used. Exact figures would ensure a more complete picture could be painted.

5. Conclusions

The primary conclusion that can be drawn from this research is that the current system of anti-doping is, given the realities of the sporting world, ineffective at reaching the desired goals. This is assuming the primary goal of the anti-doping system is to eliminate doping, irrespective of whether this is because of the athletes health, fairness and equality or natural ability arguments. Furthermore, it would seem that should the current system of anti-doping remain, significant increases would need to be made in the testing levels; this in turn would

require a significant increase in revenue for anti-doping collection and testing. This may be economically impossible and thus other solutions to the ubiquitous problem of doping may need to be sought, outside of individual scientific tests. The alternative is to invest additional funds into the development of more advanced, efficient and effective tests for the detection of doping. If it were possible to increase the test reliability, the window of detectability and the range of substances that could be detected, this would mean the increase of the number of tests could be more modest. Such an increase may well be affordable. On the other hand, this would still not eliminate the issues with test predictability or corruption and as such further demonstrates the current system needs work in order to become both efficient and effective in deterring and punishing doping. The ABP appears to be the solution to the problem but further analysis reveals that it has its shortcomings just like chemical testing. Overall it would seem that the current system, as it stands, needs to be reconsidered and reworked in order to be effective and efficient.

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Paper 4 - Title: Classical positions on doping and their usefulness to modern sports policy

Running Header: Classical positions on doping

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Abstract

Doping has in recent years become a widespread issue throughout the sporting arena. Numerous historical cases of systematic doping are only now coming to light years after the events have taken place. Despite the recent plethora of doping cases, it can be said that this is not a new phenomenon. Practices which could be deemed to be doping have been occurring since ancient times. Although it can be said that doping has only recently become a major problem for the sporting world, now requiring significant financial and human capital investments. The problems faced in the sporting world with doping must be tackled in a new, more effective and efficient manner. This paper assesses classical positions on doping in order to determine if such policies can be used as a means to better tackle modern doping cases and can be integrated into modern anti-doping policy. In particular this paper focuses on the entertainment role and the position sports had in classical society as a means of analysis.

Keyword: Doping, Athens, Rome, Fates, Arena

1. Introduction

It is well known that doping is a widespread concern in modern day sports encompassing a large number of its participants (Hermann & Henneberg, 2012). Hardly a year passes without a major doping scandal emerging from one sport or another. Recent scandals such as with Lance Armstrong and US postal (USADA, 2012), the Festina affair (Christiansen²⁰⁰⁵), Operation Puerto (Cycling News, 2013), East Germany (Franke & Berendonk, 1997), the Chinese Swimmers Case (Jeffery, 2008), Professional Baseball and Football in the United States (Mitchell, 2007), all demonstrate both the widespread issue and the major problems with doping in modern sports. Yet, while each new scandal seems to elicit surprise and indignation on the part of some sectors of the public, looking back over the course of human history, we find many examples of ‘performance enhancement’ in sport during every era. One such set of examples comes from the classical period.

It is possible to argue that ‘doping’ was certainly taking place in ancient times (Waddington, & Smith, 2009). During the classical period, for example, athletes before the Olympic Games in Ancient Greece would consume sheep’s testicles in order to gain the advantages from the testosterone held within and gladiators had special diets aimed at improving performance (not only for health reasons). These practices were such that, one could argue, ‘doping’ per se, was as widespread in classical times as it is today, perhaps more so...

Doping is a catch all phrase used today not really considered in classical times. Whilst it is true that athletes and sports participants, in the classical period, took substances that, under current anti-doping legislation, may be deemed prohibited (e.g. testosterone), one cannot retrospectively attribute modern legislature to historical events. This is especially true given that many of the doping agents available today were not available in classical times

(e.g. EPO). Yet, given the realities of human nature, and the economics of gladiatorial and athletic competitions in the classical period, can one really believe that similar actions did not occur. Therefore, if one can argue that the actions of the classical athletes were in fact not dissimilar to modern ‘doping’ and as such did occur, why then was it not viewed in the same negative light as today? Why is the modern sporting arena so obsessed with doping? Why then were not vast amounts of money spent in classical times to prevent such actions occurring? Why were scandals not continuously being revealed to the public? Some may argue that it is because doping did not happen in the classical period. If this is the case then it assumes two things; 1) that modern humans have significantly lower moral standards than the classical world (which given the very existence of the Arena seems unlikely) or 2) that despite the continuance of a number of social elements, though deplorable, still remain today (such as slavery etc.), sports and doping were elements that just happened to appear in the modern era. As Higgins put it when referring to classical horse ‘doping’,

“[C]harriot races and other equestrian sports were an important and highly competitive element of the Games and, as training and fitness targets would have been no less important then than they are today, it is not unreasonable to assume dietary manipulation and additives were regularly used” (Higgins, 2006)

Therefore, perhaps the lack of doping as an issue is more likely due to the practices and policies of the time. Alternatively, there may have been something about the position sport played in classical society and, in turn, how athletes were viewed by the public. Could the entertainment aspect have been the factor removing the issues now seen surrounding doping. In other words, if the primary focus of the activity (sports) is supposed to be that of

entertainment then doping need not be considered an issue, unless it can be shown that through the use of such agents the spectacle is diminished. Therefore, was the entertainment aspect of sports, and the emphasis placed on it, such as to eliminate the issue of doping in sports? If so is an introduction of similar policies and practices, and an emphasis on these very aspects of sports, useful as a basis for removing the issue of doping?

This article aims to explore some of these questions and issue, in two ways. First, it seeks to instil the lessons that can be learned from the classical experience, those that may assist in informing and directing modern sports policy. Second, it offers an attempt to ascertain the extent to which classical policies and practices can be utilised to aid in eliminating the issue of doping in modern sports. The Classical period is useful for such an exercise, for obvious reasons, the primary of which is that it constitutes, for many, the origin of modern sports.

In order to achieve this, this paper contains four Parts. Part 2 comprises a comparative analysis of the similarities between gladiatorial and classical sports and modern sports. Part 3 offers an assessment of evidence drawn from the Classical period on issues of doping or a doping-like nature. Part 4 outlines policy implications and recommendations for modern sports. Finally, part 5 provides some concluding reflections.

1.1. Why?

Before venturing into the realm of analysis, it would be prudent to first briefly outline the key reasons for the existence of anti-doping policies. Moreover, this section will explain why modern policy makers should even care about the classical position on ‘doping’.

There are a plethora of arguments for the existence of anti-doping policies. The most often argued of these include a) fairness, b) health of athletes, and c) spirit of sports. These justifications can be found in numerous international conventions, regulations and agreements (WADA, 2009) and by some academics (Richie, 2012).

The first of these, fairness, seems to be quite an obvious and straightforward concept. It is the notion that without anti-doping policies some athlete would act in a manner that creates an imbalance in sport, an inequality between athletes. However, this assumes that sports without doping would be inherently fair and equal. The reality of sports and humans is very different. The sporting arena and to a larger extent human society is and always has been unfair. The phrase ‘survival of the fittest’ as coined by Spencer, was not just something created to sound good in literature. The realities of life and sports are such that, unfairness exists and is likely to always exist. In a sporting context, disparity of fairness and equality can be found in numerous aspects of the sporting world. Perhaps the most obvious of these is between athletes of differing nations. The athlete’s from least developed and developing nations are instantly in a position unequal to that of developed nations. Even amongst the developed nations, athletes from nations that invest more funding towards sports are at an advantage then those from a poorer developed nation. Access to resources, training, travel, development programs etc. all demonstrates the inequality of sports. Similarly, various systems and rules in sports create unfairness. Disparities between female and male sporting pay (Kosofsky, 1993), segregation of disabled athletes (even if able to compete at the same level as able bodied athletes), age segregation all demonstrate this inherent unfairness. Some of these elements were, in the classical period, as they are now, despite the lack of anti-doping policies, and yet doping was not such an issue. As such perhaps the fairness argument loses steam.

The second argument is health of athletes. There is considerable evidence to support that idea that some doping agents can indeed cause harm to an athlete if misused (Kohler, Thevis, Schänzer, & Püschel, 2008). However, it can also be said that many of the substances used in doping originally had a medical purpose. What is more, many of the agents argued as being banned for reasons of potential health issues, it would seem, have little evidence to support the claims (beta-2 agonists are one such example), and as such there is considerable debate on the inclusion of some agents on the banned list (Korkia, 1999). Similarly can it not be argued that the abuse of anything can bring about issues of human health? This includes vitamins and supplements, both of which are allowed in sports, and also training. The classical positions on such things were not all that different to the modern; human health was important then as it is now. It would seem only logical; the owner of a gladiatorial school would hardly want their fighters to die prematurely given all the time, resources and effort invested in their training. As such it would seem that even in the absence of anti-doping policies in the classical period, human health was still protected.

The final argument is that of morality or spirit of sports. It has been suggested that the moral spirit of the games is one of the primary reasons for anti-doping policy in modern sports. One must ask then does this mean that ancient athletes lacked morality? Moreover, does this then imply that modern athlete's morality is such that without anti-doping policies they could not be trusted to remain honest? The use of doping like substances were not considered to be against the spirit of the games in the classical period, they were, simply not even considered or discussed save for training and instruction purposes. In the modern period, it seems that morality is continuously raised, as though athletes are by their very nature, evil and untrustworthy. Perhaps one of two things should occur then, 1) anti-doping prevention programs should be aimed at addressing the issues of ethics and morality or 2) athletes should not be treated like they are criminals, expected to do wrong. The latter of the two approaches

may in turn be repaid with greater respect for the rules. It would seem apt to now progress to explaining why modern policy makers should even care about the classical position on 'doping', as the popular saying goes;

"Those who cannot remember the past are condemned to repeat it" - George Santayana

However, in an attempt to use more academic rigour in such an argument, one can perhaps be persuaded by simple reference to the similarities between the classical and modern 'games'. Crowther (2007) for example has demonstrated the striking similarities which exist between modern and ancient sports and practice. As such, it seems apt to progress to the first point of this paper.

2. Similarities between classical sports and modern sports

Some may say that there is minimal difference between sports as they were during the classical period and what is familiar today. Reid (2006) points out that some athletes today 'actually cultivate their status as entertainers'. This observation would seem to be particularly true in the cases of professional wrestlers where the primary focus of the sport is that of entertainment. In fact, there is no attempt to hide this facet of the sport. Many professional wrestling bodies use the value of entertainment as a means of promotional marketing. Examples can be seen in the fact that the world's largest, most renowned, and profitable wrestling entity, World Wrestling Entertainment (WWE), even has the term in their company name, and moreover uses promotional phrases such as, *'Sports-entertainment's greatest good*

guys' (WWE, 2014), and *'The scariest Superstars in sports-entertainment history'* (WWE, 2014)

In this way, modern sports can be seen as not differing significantly from its classical origins. Similarities can also be seen between modern athletes and their gladiatorial counterpart with regards to hero worship. It is well known that gladiators very much adopted this philosophy also; there are numerous cases of the hero worship of famous gladiators (Hopkins, 1983) as such it further demonstrates the primary role of entertainment of the arena. Modern athletes are also often the focus of much hero worship (Holt, 1996; Wann, Melnick, Russel, & Pease, 2001; WADA, 2012). However, the Lance Armstrong case demonstrates that the risks of becoming a hero amongst the fans has its consequences; consequences that may not have existed in the classical period despite the similarities.

Yet in the same paper Reid (2006) also suggests that 'Gladiatorial combat... should not be esteemed as a good athletic contest because it purposely undermines competitors autonomy and dignity', perhaps that the entertainment aspect detracts from the athletic. This would seem to be a reasonable view amongst a number of sports scholars, the idea that gladiators and the *munera* (arena/gladiatorial games) are not truly athletes/athletics in their 'purest' form. When one, however, takes these two concepts and applies them to modern sports an interesting point can be made, firstly that of competitors' autonomy. One would be hard pressed to find a modern athlete who could be considered as truly autonomous, for a number of reasons. Firstly, there is the issue of restrictive contractual obligations (Goldstein, 1977). Some athletes contracts are so restrictive that, it can be said, the athletes have little to no freedom to act in the manner they may like. Some may say these requirements make them not altogether unlike slaves. Furthermore, there are the sporting rules governing transfers.

One such example can be seen in the National Football League's Free Agency Policies (NFL, 2013), which restrict player's rights in situations of trade. Moreover, regulation on what an athlete can and cannot consume, training requirements of teams etc. all indicate that the so called autonomy of a modern athlete is not that dissimilar to that of a participant in the *munera*. The second concept, competitors 'dignity', can also be questioned in modern sports, and more specifically through reference to modern anti-doping rules. It can be argued that the requirements on an athlete to comply with modern anti-doping obligations are in no way dignified. One such example can be seen in the case of Andy Schleck during the 2011 Tour de France. It has been reported that, after one stage, whilst having dinner, Andy Schleck was required to provide a urine sample to anti-doping officials immediately as per anti-doping regulations, but what is more, he was required to carry his sample through a busy restaurant (Schleck, 2011). This act was not in the best interests of human dignity, neither for Mr Schleck nor the patrons of the restaurant. Furthermore, the requirements for sample collection in general do not comply with the ideals of human dignity, this being the requirement to provide an urine sample whilst being observed by the official sample collector (WADA, 2010: 7.2.4). Whilst there may be reasons for the existence of these requirements in modern sports, it does show that current anti-doping regulations have issues of human dignity. Moreover using these criteria, it can be said, that modern athletes should not necessarily be deemed to be all that different to the classical gladiator. What this shows is that the issues of gladiatorial bouts, the practices aimed at introducing some form of control over the arena, and subsequently in order to ensure an entertaining spectacle, may still be present in modern sports.

The point on the sporting/gladiatorial participant's comparison of classical and modern sports can also be argued in a different manner. According to Livy (*The History of Rome*, 28.21), one key point of note in the games of New Carthage in 206 BC, were for the

inclusion of free participants. These participants, whom had voluntarily chosen to compete for an assortment of varying reasons (Gunderson, 1996), did so perhaps because of entertainment and self-promotion purposes. This demonstrates that not all gladiators and participants in the games were slaves. This further reinforces the similarities between the modern and classical sports. Moreover this reinforces the notion that the classical world placed considerable emphasis on the entertainment value and the appeasement of the crowd.

Poliakoff (1987:108), however, suggests that gladiatorial games should not even be classified as a sport because;

'a gladiator fighting to kill or disable his opponent and save himself in any manner possible is not participating in a sport but in a form of warfare for spectators'.

In a way modern sports are not entirely dissimilar to this view of the games. A modern athlete must fight for their sporting survival. Current sporting culture has been engineered to such that anything less than a win is often deemed as unacceptable (UNESCO, 2006). The result to an athlete for failure to win may be sporting 'death'. This is evident with the sheer number of relatively successful athletes who, despite great promise, fail to secure their jobs because that one big win eludes them (one example can be seen with Cristian Klien in Formula 1). Yet despite this view of the gladiatorial games, one scholar, Potter (1999), is of the opinion that the spectacle played a larger role in classical society than entertainment and death. For example, in the gladiatorial games, it was not a requirement that one of the gladiators died (Carter, 2003). Particularly in the latter years of the empire where the games were seen as

costly, death was undesirable (Carter, 2003). In fact, in the latter years of the Roman Empire, the games were considered so expensive that special cost cutting measures were introduced to combat the escalating costs; measures such as death were only by imperial decree (Carter, 2003). It could equally be argued that these steps were aimed at prolonging a competitor's life in order that the spectacle of the games were improved or maintained. The more famous a gladiator became, the more victories etc. the more money the trainer, their 'owner' and the games organiser would earn. Money was important then, as it is now, which goes to show more support for Moller's statement,

“we can cast aside the thought that the use of doping is a perversion that has become prevalent due to the dizzying sums of money that have flowed into sports” (Møller, 2009:32).

In the modern arena, a similar approach has been taken in Formula 1, policy changes aimed at cost cutting. As with the case of the gladiatorial arena, measures were taken in Formula 1 to improve the entertainment value. To elaborate during the late 1990's and early 2000's, Michael Schumacher was enjoying an almost incomparable run of success. At the time this was deemed to be perhaps 'boring', and in an attempt to 'combat' these results, changes were introduced to end his dominance and make the sport more 'entertaining', disregarding the spirit of sports. Similar changes have been introduced in the Dakar Rally event, changes were made to the motorbike categories (Amaury Sport Organisation, 2011) in an attempt to end the dominance of KTM. A less cynical view of this action is that it was done for reasons of entertainment, again neglecting the values of a) performance of the best and b) the spirit of sports. In this way, could it not be argued that, modern sports are not all that dissimilar to the classical arena, that entertainment plays a major role now as it did then?

Another point of similarity is that of the *summa rudis*, an official that could be considered the classical equivalent to a referee in boxing or mixed martial arts. Carter (2003) defined this person as a ‘technical expert’, whose role it was to stop combat before a death occurred, whilst still maintaining the entertainment value of the spectacle. They could even stop the fight before a gladiator surrendered, again similar to a modern referee. This may be in order to preserve the life of the athlete so that they could continue to fight again later, thus ensure the continuance of their value and the spectacle. It is, however, in this position that one can potentially observe the first avenue for classical sporting corruption. One such indication can be found in Diodoros from Amisus’ epitaph a gladiator in Asia Minor, where it states ‘the cunning treachery of the *summa rudis*’ as the reason for his death (Robert, 1940). Whilst obviously this may simply be an unhappy friend looking for someone to blame for his death, in this it can be seen as a potential avenue for the classical ‘athlete’ to gain unfair advantage over a competitor. It would not be unprecedented for a competitor to, in some way, convince the referee to provide a biased ruling, thus in effect may be an early form of cheating. These issues of corruption still exist in the modern sports; recent issues with World Cup host city voting are one such example (Lawton, 2011). These examples demonstrate the existence of corruption in the classical period, and indicate that if corruption existed why then would ‘doping’ in some form not? Moreover it therefore also demonstrates the existence of sporting phenomena which remain to this day.

The importance of the spectacle (and victory) saw that this act was not an isolated incident. Remijsen (2009) makes note of a ruler of Syracuse, Gelon, who had ‘paid the best sprinter of the moment to compete for Syracuse instead of his home town’. This is but one example of this practice; there are numerous other examples to be seen in the classical literature (*Pausanias, Description of Greece, 6.13.1; Pindar, Pythian, 1*). This observation

can be used to argue two points of this paper. Firstly, to emphasise the value of entertainment over fairness in sports; this act could be seen as an attempt to enhance the spectacle of the event. Gelon would have no doubt used the sprinter to win the favour of the crowd, a happy crowd, because of an entertaining event, would have no doubt be more supporting of his rule. Secondly this event demonstrates again, the similarity with modern sports. This similarity can be seen with the ‘Transfer of Allegiance’ allowance (IAAF, 2013), in particular, in modern athletics. This ‘allowance’ permits the transfer of nationalities of athletes, who once may have competed for their home nation, to then later, compete for a foreign nation. Why does this allowance exist, is it just so that a new citizen of a nation can compete for their new nation, or is it to enhance the chances of the nation to win? If it were just the former reason, then the situation where a person is simply provided with citizenship in order to compete for the nation would not occur, rather the citizenship would be acquired in the normal manner and later they could compete for their adopted nation. Once again this indicates that modern sports and classical spectacles are not all that dissimilar. Consequences and public responses relating to the two examples outlined above (Gelon of Syracuse and Diororos of Amisus), can be used as a means to measure the classical views on such occurrences. In both cases there would have no doubt been a general feeling of frustration aimed at the organisers, (at least from the town that the sprinter abandoned) but that at least in the eyes of the newly adopted town (the winning town) it would seem that the public view may have been such that the spectacle was more important than the details (they won!). Much like today’s spectator standards, it would seem that not too many spectators of a given sport would have an issue with an athlete from a foreign nation changing nationalities, especially if it was benefiting their own nation (this would of course depend on the sport, its role in that culture/nation, and the individual in question). Yet the question remains is this phenomena really the case, is the spectacle more

important than the spirit of the game, or is this just the perception of modern spectators? This is still to be shown.

There are also features relating to the structuring of modern sports, in which one can view similarities between its classical counterparts. Carter (2006) outlines the Gladiatorial Ranking system policies in place in 177 AD (*Senatus Consultum De Pretiis Gladiatorum Minuendis*). This legislation placed caps on gladiators' payments and their values based on their *munus* category. Obviously, these increased based on individual skills of the gladiators. With this, the *munera* could then be classified into one of four categories according to the overall costs. Could this have been introduced in order to better inform the spectators as to what to expect from the event, so that they were not unentertained due to high expectations and low outcomes? In any case, the gladiatorial games and their participants were not altogether different to modern athletes and sports. Numerous sports have in place ranking systems which either directly or indirectly impact of the athlete's value. Moreover, these ranks in turn impact participation at events, which events will contain which athletes, and one could say, indirectly the entertainment value of the event. Some sports, such as Rugby League (NRL) in Australia, adopt a similar approach and place salary caps on clubs (NRL, 2013). These are said to make the contest more fair and equal, but perhaps again the entertainment value is not altogether forgotten. The argument here is that without the cap, some teams would be undesirable to play for because of lack of money and success and other would prove to be too powerful thus diminishing the spectacle.

Finally, one key indicator of the similarity between modern sports and the arena, as well as, the importance entertainment plays on both, can be seen in the comments by some sports commentators. It has been suggested by some that sports are first and foremost an entertainment media (Keenan, 2011). Similarly, it has been suggested by Lumer (1995:8) that

“There is an... agreement between them that the players do their best in striving for victory, thereby usually giving an exciting competition, and that the spectators pay for this by money...”

Perhaps then the modern view of sports should change and along with it the position of performance enhancement. These are but a sample of the similarities between the classical games and modern sports, the list could be exhaustive including features such as athlete loans, insurance, funding etc. but it demonstrates that a common trend can be shown to exist between both modern and classical sports and the common trend of entertainment that runs between the two.

2.1 Athletes Health and Anti-doping

On somewhat of a side note, it is worth briefly discussing the notion of anti-doping as a means of protection of an athlete’s health. One of the primary reasons for the ‘necessity’ of modern anti-doping policy is said to be for the protection of an athlete’s health (WADA, 2009). However, this implies a number of things, for example; 1) Modern athletes need someone to protect their health because they are unable to make appropriate decisions. 2) Ancient sports and its participants did not care about their health. 3) Modern athletes care about their health more than then prestige and glory.

With regards to the first point, athletes make poor decisions; this simply does not hold the intelligence of an athlete in high esteem. Athletes are in most cases very intelligent people, they are required to be in order to strategise, plan and compete at the highest level in

their sport. With regards to the second point, that ‘classical athletes did not care for their health’; one can refer to the work by Kanz and Grossschmidt (2009), Longo et. al.(2008), and Eichholz, et.al.(1938). It has been well documented that ancient athletes had considerable emphasis placed upon their health, in addition to performance. Despite the realities of the area, which quite frankly meant that longevity was not all that common, let alone in everyday life. Competitor’s health was a key component of the classical sporting world. Health was important for longevity, as longevity helped to ensure income from entertainment. Thus it is possible for modern sports policy makers to learn or even be advised by the classical polices without neglecting health of the athletes. Finally, with regards to the notion that modern athletes care about their health more than prestige, one can turn their attention to the work by Goldman & Klatz (1992), where approximately half of the respondents stated they were willing to die after 5 years if they could be guaranteed success. What is more, a recent case in cycling involving the Polish cyclist Rafal Majka and his controversial comments regarding his selection for the Tour de France in 2014. Majka had only recently ridden the Giro de Italia (one of the three grand tours) and as such for reasons of health, (especially given his age) he expected to be rested. Tinkoff-Saxo (his team) selected him for the tour, which he felt demonstrated their lack of care with regards to his health (Eurosport, 2014). What this case demonstrates is the modern view in sports; winning at any cost.

This shows that whilst the protection of an athlete’s health is a noble goal, the classical position on the importance of human health is not one to be simply dismissed as primitive, nor do many modern athletes care solely about their health. Perhaps it is not doping that should be recognised as causing the greatest harm to health, but rather sports training and specialisation, or as Plato puts it,

'The athlete's nature is drowsy... and the least variation from his routine is liable to cause him serious illness' (Plato, Republic III, 404A)

3. Classical practices and their link to 'doping'

A key aspect of classical policies, relating to doping, can be seen in the diets of ancient Greek athletes and Roman gladiators. It was standard practice in Ancient Greece to use an assortment of natural substances such as herbs and fungi, honey, caffeine etc. in order to aid athletic performance (Papagelopoulos, Soucacos, & Mavrogenis, 2004). Likewise; gladiator's diets consisted of oats and barley. It has been shown that a diet of oats and barley produces, among other things, a subcutaneous layer of fat, which may have been particularly useful should a slash wound be inflicted on a combatant in a gladiatorial battle. This layer of fat acted as a type of barrier. There was a reduced chance of damaging muscle, veins and nerves and thus the Gladiator could heal quicker and/or continue to fight (Kanz, & Grossschmidt, 2009). This helped ensured two things, longevity and health of the athlete and the spectacle of the game. In fact, it has been suggested by Kanz & Grossschmidt (2009), that 'surface wounds look more spectacular' in gladiators who abided by the gladiatorial diet. It was suggested that they used the subsequent subcutaneous fat for entertainment purposes (Curry, 2008). Yet, it is the alternative benefits of these diets can be said to be of the most interest with regards to an assessment of doping in the classical period. The nature of the gladiatorial diet, including the vitamins and minerals, ensured that the gladiator was endowed with additional strength. Could this not be interpreted as a form of performance enhancements, and as such a form of doping?

Diets and the ingestion of substances were, in classical times, simply not considered a form of cheating. The aforementioned use of sheep's testicles as a form of testosterone ingestion is testament of this. In fact, such practices were encouraged and were part of the gladiatorial training. For example, in some sports, where weight was considered advantageous, such as wrestling, boxing etc. a forced diet was introduced (Manning, 1917). This was a change from the original dietary practices in these sports, where athletes would have had so called 'normal' diets including cheese, dried figs, and porridge (*Laertius, Lives of Eminent Philosophers, 8:12*). This dietary change can be said to have altered the focused for both the athlete and the spectator. A diet primarily focused on large quantities of meat, (more than likely for the protein), brought with it changes to the appearance of the athlete, their performance and the spectacle. Larger, stronger, 'better looking' athletes would have brought with them many more fans, more money, greater spectacle and greater prestige; a fact which is not lost in modern sports. Professional wrestling can be said to employ just such a policy, but this is not the only sport that uses this technique. Perhaps it was introduced for the very reason, that of performance enhancement and thus entertainment enhancement. One additional point to note is that these policies, and the subsequent training requirements, meant that poorer people were unable to compete (Manning, 1917). This again indicates that the entertainment value seemed to outweigh the spirit of the sports, mimicking in some ways the issues of modern sports.

3.1 Societal and Cultural Linkage

Given this, why then are the cases where the same agents are found in modern athletes such an issue today? Similarly, why is doping in general such an issue? Are not many of the practices of modern athletes all aimed at performance enhancement, i.e. altitude training,

vitamins, supplements... Why then are certain types of substances now considered taboo? Does this apparent contemporary desire for sports to appear as being a higher level of societal actualisation create a hypocritical phenomenon? Is entertainment now seen as such a base desire, not worthy of modern society, that all sports need to appear as being in the pursuit of higher ideals? It would seem to some extent that some modern society does view entertainment as a base desire not worthy of the 'enlightened' human. Evidence of this can be seen from responses and comments relating to professional wrestling. It has often been argued that professional wrestling is simply not a sport, or rather, is nothing more than a distraction without substance and simplistic in nature. Implying that if entertainment is involved, athletic competition cannot exist, that they are mutually exclusive components. Back to the original point, in the classical period the ingestion of chemicals, food stuffs etc. was not such an issue. Thus together this reasserts the initial point, perhaps this is because of the role the games played classical life; that of an entertainment media.

Yet there is one reference from Ancient Greece that may shed some light on why this was not an issue, at least in regards to Ancient Greece.

'To present yourself and contest in the stadium of Olympia you must be perfect. What does perfect mean teacher? Asks Filinos the athlete. The body, Filine, is cultivated with exercise, the soul with music and the mind with knowledge. This is the only way to make beauty. In beauty is tightly preserved the idea of man. Man is not only he who has a strong body, but he who has at the same time a beautiful soul and mind. Thus beauty is the expression of this completeness, and this perfection is the virtue. He who has virtue is perfect'. – Pindaros (op. cit. Arvaniti, 2007)

The previous narrative probably embodies the general philosophy of the time, the idea that there is more to athletic performance (unlike the philosophy in many sporting circles today) than just winning. It is the virtue of the soul and that of completeness that are the true measure of a person. So perhaps the primary 'policies' or anti-doping practices, at the time, were not legislative but rather social. That doping was not a problem because of the moral stance in society.

Another point that can be considered is another key component of the original Ancient Greek athletic tournaments. In the beginning, the Ancient Greek games were designed to be a means of showing respect to the ancient Greek Gods (Grandjean, 1997). Any practice aimed at intentionally cheating or misleading the sporting world, or any general unethical acts, may have been viewed as offending the Gods. This would not have been desirable for the athletes or the spectators. To elaborate *Homer* informs readers of the consequences of offending one of the Greek Gods,

'Apollo killed the sons with arrows from his silver bow, to punish Niobe, and Diana slew the daughters, because Niobe had vaunted herself against Leto (Homer, The Illiad - Book 24)

Niobe's pride and her offence towards *Leto*, resulted in the death of her family. Similar consequences can be found with *Aglauros'* offense to *Hermes*, who, as a result turned *Aglauros* to stone (*Ovid, Metamorphoses, 2, 812-832*). Finally the worst of all fates, *Tartarus*, awaited the greatest sinners, those who had the greatest transgressions against the Greek Gods. With consequences such as these it is no wonder most ancient Greeks would not have want to offend the Gods. As such, perhaps unethical acts such as doping were less common due to respect and fear of the ancient Gods. Alternatively, as it is known that substances that

are now considered to be doping agents were ingested, these acts were tolerated in Ancient Greece because to do anything else would be to suggest the athletes were disrespecting the Gods. Such an idea is something that, no doubt, would not have been readily accepted by the athletes or perhaps even their fans. Moreover, and more practically, it would have been impossible to regulate fully the dietary intake of all athletes throughout the ancient world. Consequently, the ancient Greeks may simply have been more realistic about this. If it cannot be effectively enforced don't make it an issue. This is a lesson that modern policy makers can perhaps take on board.

On the other hand, the Roman gladiators would have had an entirely different view on the concept. As outlined previously, it would seem that the primary focus of the arena was that of an entertainment media. It has been suggested that the arena was a means for Romans to attempt to exert some level of control over the chaotic world around them (Futrell, 1997). If this is the case, doping would not have been seen as a priority but rather an aspect of entertainment and another means of control. Furthermore, as can be seen on a number of gladiatorial epitaphs, where a gladiator's funeral was mentioned, it was not his opponent that was blamed for his death but rather the *Parcae/Moirai* (Fates) or alternatively it was his own fault (Carter, 2006). The Fates are said to descend from *Zeus* and *Themis* (Titan of Law) and as such embody concepts such as justice and lawfulness like that of their siblings (*Hesiod, Theogony, ll. 901-906*; Roman, & Roman, 2010). This is of particular note, because as they are argued as being the cause of many Gladiators deaths, perhaps one can align this concept with that of doping. This could be seen as the enactment of justice, order and lawfulness, on those that committed a transgression. A transgression, that whilst punishable, is not one that warranted the punishment of the Gods. This assertion is perhaps justified by the fact that not

all gladiatorial epitaphs made mention of the *Parcae* as being the cause of the Gladiators death.

In any case this would seem to indicate that again the role which the games played in society and the subsequent views of the people were external in nature. That is to say, external forces played a role in the life of people as opposed to just the individuals themselves. Basically they can be said to have had an external locus of control. This would justify the view that the arena was used as a mean of fulfilling the psychological need of control and that entertainment was the avenue for this. Basically if a person was not in control of their own fate, the spectacle and the entertainment was the only aspects that could be controlled.

4. Policy implications and recommendations

The classical Greek and Roman concepts of athletics and the arena seems to be one focused on external influences and entertainment values. As such, it is entertainment that can be said to be the primary tertium comparationis between the modern and classical sporting worlds. Not only do many of the same attributes exist in modern sports, but the same basic human psychological needs remain also. The key differences seem to be the role sports have in society, and spectator's views on it. The classical practices were such that, sports emphasised entertainment values as opposed to the individual actions of the participants. Whilst the individual and their skills were vital to the entertainment factor, this could be adjusted to ensure the spectators were overall satisfied. The long term destiny of the participants was, however, in the hands of the Fates. Furthermore, perhaps the inclusion of the *Parcae* on some gladiatorial epitaphs can be seen as evidence of the Gladiators 'transgressions'. An important point that can be drawn from the classical views and practices concerning sports is that of the spectators' views, values and expectations. If they come to the event expecting it to be

entertaining, despite other factors, then this is what they will demand. If like in modern sports they expect the event to be entertaining, fair, equal, natural, uncontrolled, and without influence, then anything less than this will create issues. In order to achieve the modern spectator's utopian view of a sporting event, it seems that one of two realities must be introduced into the modern sporting arena, either a) doping or b) corruption (or both). However, both of these factors in turn contradict the values and desires of the spectators. As such, given the realities of sports, the realities of human psychology, and the expectations of spectators, the problems in the modern sporting arena seems to be caused at least partially by a conflict of expectations. Therefore, it is recommended that one possible avenue to solving the problem of doping in modern sports, is to take a leaf from the classical standpoint, refocus expectations to that of the entertainment aspects, and as such exert more control over the sporting processes. If the spectacle of the sport is the key focus then steps will need to be taken to ensure this. This is especially true in an inherently chaotic and unpredictable setting. It is, however, unfeasible to expect that sports will fulfil every need and desire of the sporting community in every match. With regards to athlete's health, it should be said that the classical approach to sports was not altogether ignorant of the need for good human health. Why not then can the classical approach still be used with an evolution incorporating modern realities of pharmacology?

What seems clear is that the policies may have changed, and the application of societal issues may have also evolved, but the underlying concerns remain. It could be said that anti-doping policy is in place to attempt to retain or at least give the impression of some sort of control over a system which is by its very nature chaotic and unpredictable if left to run its natural course. The general societal fear of lack of control remains, and as such, anti-doping policy may be attempting to alleviate this concern. If this is the case, modern sports have simply replaced one principle of sports (entertainment) as a means of control with another;

anti-doping. As such, perhaps again what has to be changed are not the policies and laws in sports but rather the views of sports. A refocusing of towards the benefits of entertainment as opposed to some sort of higher societal actuating view may fulfil both roles. It will fulfil the role of eliminating the doping problem whilst still addressing the societal need to feel as though they (or someone) can control the uncontrollable. This may also further explain why currently there is such an issue with corruption in a number of sports. There is a general conflict between the psychological need of control over the chaotic and the need for fairness and honesty. As such any attempt to artificially influence the outcomes of a sport may be viewed as being unjust even if the actions are generally intended to aid the sport and the spectacle. It would therefore seem that doping itself is not the problem, but rather it may be seen to some as a solution to the problem that sports need to fulfil a multitude of conflicting expectations.

5. Conclusion

Overall three points were made in the preceding sections. 1) Modern sports and classical sporting contests are in essence the same. The similarities are striking; only the names and applications of the same principles have changed. Entertainment being one of the key classical components still exist, albeit, the views of it has changed. 2) Ancient practices on doping are not legislative in nature but social. The view of the sporting arena and its participant's, link with societal values of the classical period, this thereby may have resulted in a self-policing environment. 3) Anti-doping policies should not be purely based on legislature, but rather there needs to be a societal component incorporated in order to fully address the issue. Anti-doping as a means of control is ineffective and as such a refocusing needs to be made. Moreover, a refocusing of the societal view of sports to one more

orientated to that of professional wrestling may well eliminate the issues associated with doping.

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Paper 5 - Title: 'Pool of Responsibility': A new approach to doping prevention

Running Header: 'Pool of Responsibility'

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Abstract

Doping has been an issue for the greater part of a century. Current anti-doping policies involve punishment and chemical testing aimed at a single individual. Doping scandals show that it is rarely the fault of only an individual athlete particularly in a team scenario. Coaches, sports scientist and other athletes may all contribute to an athlete's decision to dope. A novel solution has been formulated, a 'pool of responsibility'; the idea that responsibility for doping is borne by all team-members not just the individual athlete. Case studies and examples from organisational and legal literature were used to justify the concept.

Keywords: Sports, Policy, Liability, Cycling, Armstrong, Self-managed teams

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There has been considerable debate for the better part of a century with regards to the most effective and efficient manner in which to prevent doping. Early debate centred around penalties based on competition bans. These eventually formed the basis for the anti-doping systems used today, a system based on punishment (fines and bans) and restrictions. Yet, the problem of doping and ways in which to combat it remains to this day. There is still much debate, on exactly what can be done to prevent doping. Yet to this day the notion of a response through punishment persists, as has been seen in cases such as the ‘Festina Affair’ (Christiansen, 2005), ‘Operation Puerto’ (Cycling News, 2013), and the US Postal Cycling Team Investigation (USADA, 2013a). In each of the above cases, and with many other major doping scandals, it was not only a single team member found to be doping, but rather it was a team-wide issue. In such situations it would seem logical to assume that additional external factors are involved in the decision to dope. These may be peer pressure, coach pressure, manager pressure, medical/scientific advice or just pressures of the sporting arena. If this is the case, then punishing only the athlete involved is not only unfair but also short-sighted. Moreover, it can be said that this also works against the prevention of doping. The purpose of this paper is to propose a novel approach to anti-doping legislation; a new concept which takes into account the realities of group decision-making and the pressures on an individual’s decision to dope or not. This paper will present the concept termed ‘pool of responsibility’, the idea placing the responsibility of doping in a team on all members of the team. This will be explored through use of case study examples and arguments from legal and organisational sources. This paper will, begin with a background to the arguments for the existence of anti-doping legislation and a critical analysis of these arguments, so to better set the scene to present the concept.

1. Anti-doping Arguments: A Critique

It is prudent to begin with the underlying question: What is the point of anti-doping policies? There are three primary arguments used to explain, and perhaps, to justify anti-doping policies; 1) fairness, 2) equality and 3) athlete health (WADA, 2009). Yet, there is evidence that indicates that there are, in fact, two additional plausible explanations for the existence of anti-doping policies, they are 4) appearance and perceptions and 5) revenue. To begin, it is prudent to attempt to present and assess each explanation in order to provide an appropriate background to enable the presentation of the proposition of a ‘pool of responsibility’.

1.1. Fairness and Equality

First of all, there is the fairness argument. The notion is that the introduction of doping agents by only some athletes in the sporting arena would create a situation that means the remaining athletes are not able to compete in a fair playing field. Each athlete should be able to compete without needing to dope and still be able to compete at the same level. However, the WADA *Code* (2009), UNESCO *Convention against Doping in Sport* (2005) and the IOC *fight against doping* (2014), all fail to define exactly what is meant by ‘fairness’ in sport. Nor do they apply the concept. It has been suggested by Lenk (1972) that in the context of sports, fairness takes on two different forms, ‘formal fairness’ and ‘informal fairness’. The former refers to athletes complying with the rules (letter of the law) and the latter refers to voluntary acts or sportsmanship (spirit of the law). Lumer (1995) defined it as ‘the moral norm for sports’. However, Kuchler provides the most useful statement for fairness as applicable to sport. He states:

'[W]hich in the situation of agon takes the opponent as a partner, in contest keeps the sense of playfulness, pays attention to keeping the rules and to equal chances, does not value victory higher than anything else, gives the right attitude towards victory and defeat, spurs on to exerting all one's energies, refuses dishonourable and unequal advantages, helps to overcome endured injustice, in all these situations and questions can decide generously and greatheartedly' (Kuchler, 1969:156)

In each example there is a tendency to refer to intangibles and the true spirit of human morality and sport.

The second explanation is equality. The concept of equality is the right of all athletes to play on a level playing field (Loland, 2002; Kayser, Mauron, & Miah, 2007), and, as such, the rules of sports are the means to this end. Rawls (1971) and Lenk (2007) both argue equality in a similar vein, and speak of 'equality of opportunities'. Similarly, König (1995) uses the phrase 'same chances to win' when discussing equality in sport. These are all noble concepts, and no doubt, the various anti-doping policy creators had concepts like these in mind when forming the legislation. However, if one now assesses the realities of the fairness and equality in the actual sporting world, a very different view can be seen.

Firstly, it has been suggested by Lumer (1995:12) that if one were to use football as an example of the realities of fairness, then

“ [I]f sportsmen have (tacitly) agreed on competing for a prize under certain conditions which exclude fouls and if then one of them plays foul, thereby increasing his chance of winning, this is a form of fraud.”

But, as detailed by Pilz (1988), in professional football, deliberate fouls are universally considered necessary for victory. If a player does not engage in this practice they are not considered to be good players, and, as such, fouling is actually a trained skill. Despite the fact that fouls are against the letter and spirit of the law, and are unfair, they still occur and are accepted by both players and spectators alike. Moreover, one can refer to athletes from developed nations verses developing or third world nations. It would be unfair to assert that all athletes have the same opportunities to compete, train and develop irrespective of the place of origin. Even if one discounts the effects of nutritional disadvantages during childhood development, there is still the issue of economic equality and access to the same facilities and resources upon becoming an athlete. Athletes from Nepal, for example, do not have the same opportunities to train and compete, or have access to the same level of coaching as athletes from the United States. Even in a less extreme case, an athlete from Slovenia (despite being a member of the European Union) may not be given the same opportunities to train nor have the same access to resources as an athlete from Great Britain. The reality is that sport is an economic endeavour and a business. It costs money to train and compete and not every country has the same resources available, nor does every country contribute the same resources to developing their national athletes. This also differs from sport to sport. For example, a Rugby player from Austria would never have equal opportunities to become a world class player same as an athlete from New Zealand or even Ireland, especially if they wanted to remain in the home nation to develop. More specifically, and relating to doping, there is an inequality with regards to access to medicaments and pharmaceuticals. As has been

demonstrated with USADA's investigation (USADA, 2013) into doping at US Postal as well as the development of Tetrahydrogestrinone (THG), athletes with direct access to pharmaceutical companies are at a significant advantage. There is also the separation of female and male athletes, disabled and able bodied athletes and age segregation in sports. If a player is of equal skill, should it matter if they are male or female, young or old etc. should they not be allowed to compete without having to fight for that right? Under current sporting regulation in many sports, there are rules that restrict those which can compete in certain organised events. Cycling for example is separated in to male and female tours (see *Tour de France* vs. *le Tour de Femme*). Furthermore, such realities are found in able and disabled competitions (see *Olympics* vs. *Paralympics*). To elaborate further, one can refer to the case of Oscar Pistorius, a disabled athlete who after a 5 year fight, successfully won the right to compete with able bodied athletes in the Olympics (Moreton, 2012). What is more, with the case of Pistorius, he was required to win the case to actually compete in sports at all due to his prosthetics legs (which some deemed to give him an unfair advantage) (*Pistorius v. IAAF*, 2008). Another such example can be seen in the case of *PGA Tour, Inc. v. Martin* (2001). In this case the court found that the PGA could not exclude Casey Martin from golfing events due to his disability (a heart condition that prevented him from walking between holes). Furthermore, reasonable steps should be taken to ensure the inclusion of disabled athletes in able bodied events. Whilst in these examples the plaintiff successfully won the right to compete, there is still the issue that it is not automatically allowed. So the question remains: is this complying with the ideals of fairness and equality, let alone basic human rights?

1.2. Athlete's Health

The final primary argument for the existence of anti-doping policies is the concept of athlete's health. There have been numerous pieces of research that have demonstrated the harmful effects of certain substances used for doping (Beastall, Gibson, & Martin, 1995; Kohler, Thevis, Schänzer, & Püschel, 2008). Similarly, it is argued in each piece of anti-doping legislature, that one of the primary reasons for anti-doping policies is in order to protect the health of athletes due to the negative health effects of doping agents. There is significant evidence demonstrating the harmful consequences of some doping products (Beastall, Gibson, & Martin, 1995; Kohler, Thevis, Schänzer, & Püschel, 2008). There is little debate on the serious health side effects (including death) of well-established doping agents such as steroids (Kicman and Gower, 2003; James & Gower, 2004) and Human Growth Hormones (Bengtsson, Eden, Ernest, Odén, & Sjögren, 1988; Haupt, 1993). However, there is still, some debate about exactly how harmful some doping agents truly are. There tends to be contradictory evidence in the cases of some banned doping agents as to whether they have the effects claimed. There is much debate about the inclusion/exclusion of some agents in the banned list (Korkia, 1999). Some agents such as beta-2 Agonists would seem to not have the same negative health impacts on users. In fact many of the doping agents used by athletes today, and historically, originally were used for medical purposes, and many still have health applications. It seems that the problem, in many cases, is not the use of the medicaments but rather the abuse. This may have something with the apparent modern social phenomena of 'popping pills'. It could be argued that, in the modern era, people may see pills as the cure for everything, and what is more, this carries over onto the apparent belief that 'more is better'. For example, if one pill helps provide a 20% improvement then 5 must provide a 100% improvement. It would seem that there is little sense that more is not always better, and so abuse occurs. Therefore, perhaps the source of some of the negative health issues are not the

agents themselves but rather the type and style of usage. Moreover, there is the rather considerable debate about Therapeutic Use Exemptions (TUE) (Kaufman, 2005; Orchard, Fricker, White, Burke, & Healey, 2006). If the agents are banned (with the assumption that they are damaging for human health), then an athlete acquires a TUE are these agents still harmful? If so then it is fine if the athlete is harmed, and if not then are they in fact not harmful, or only in some cases? One can refer to the before mentioned use of beta-2 Agonists as an example. It is a common agent for the management of asthma, yet it is also a banned substance. Numerous athletes use beta-2 Agonists to help with asthma (one such example being Alessandro Petacchi, who despite having a TUE was banned for 'too much use' of salbutamol). If this was harmful for human health, (which as outlined previously there is no evidence to support) why then is its use so widespread as means to manage asthma in the general population? It seems more likely that the agent is not banned for health reasons but rather an uncertainty as to its performance enhancing possibilities.

1.3. Appearances, Perceptions and Revenue

There are two additional arguments to be discussed here, with regard to the existence of anti-doping policies. These are rarely considered but would seem to be almost as plausible as the primary justifications for the existence of anti-doping legislation. These arguments are appearance and perceptions, and revenue. These two concepts, whilst different, do indeed tie in with one another.

Appearance and perceptions, refers to the idea that anti-doping, as it is currently structured and implemented, (chemical testing and punishments) is largely ineffective in so far as to actually be effective in detecting and subsequently eliminating doping. This is supported by researchers (Kayser, Mauron & Miah, 2007) as well as officials, retired and banned athletes

(Cycling News, 2010a: 2012). As such, this raises the question; if this is the generally accepted belief now, then is the purpose of anti-doping simply to give the appearance of a fair, equal and honest competition? Do sporting officials and policy makers, knowing the ineffectiveness of anti-doping policies, only continue to use them so as to put the spectator's minds at ease? To elaborate, one can refer back to the International Association of Athletic Federations (IAAF) initial introduction of anti-doping in 1928 as well as the IOC's first anti-doping legislation. Both policies were introduced knowing that they did not have any testing available or at least no effective testing (WADA, 2010). As such, one could say that the purpose of the legislation was twofold, 1) to try and scare athletes to not dope, and 2) to try to convince spectators that they should keep watching because the sports were 'clean'. It can be argued that this also relates to the latter concept of revenue. If the aim of anti-doping is to simply give the impression of fairness, equality and honesty in the minds of spectators, is this simply to ensure continued viewership and thus sustainable revenue. Do sporting officials believe that spectators want some level of fairness in sports and without it they would simply turn off (it remains to be shown if this idea is true, do spectators even care)? If this is the case then perhaps it explains the inclusion of ineffective anti-doping policies.

2. 'Pool of Responsibility': A Novel Approach

There have been numerous opinions and differing ideas on what is the best way to solve the doping problem. Some have suggested simply increasing the penalties for doping (WADA, 2012), others have suggested that changes are needed in the psychology of the athletes (Petróczi & Aidman, 2008; Ehrnborg & Rosen, 2009; Hermann & Henneberg, 2013). Others still have suggested that major changes are needed to the way in which sports are run and structured (Cycling News, 2010; 2011).

The fact that anti-doping testing is not working well with regards to effectiveness or rather as a deterrent is illustrated by WADA's recent decision to increase the length of doping bans from 2 to 4 years (WADA, 2012) with the aim of increasing the deterrent effect of the penalty. In law enforcement this practice is usually performed when detection of a wrongdoing is ineffective. Some research, however, has claimed that increasing the penalty of an infraction will have no impact on the criminal behaviour (Tsebelis, 1990). There are some who doubt if this practice is even effective in criminal matters. As Arizona pitcher Brad Ziegler stated when discussing penalties for doping in sport,

"There are 32 states that have the death penalty for murder, and murders happen in those states every single day. It's not going to stop people from committing the crime, even if you have a death penalty," (Ziegler, 2014)

Does simply increasing the length of ineffective penalties truly work, there is much debate, but it would seem that in some cases the answer is simply no.

2.1. The Concept

The solution being offered here has been termed the 'pool of responsibility'. The suggestion here is that policy-makers should incorporate the notion of a 'pool of responsibility' at the national level. What this means is that accountability and responsibility for anti-doping initiatives would need to be taken by sporting organisations and athletes on a national level. Such responsibility would need to be borne not only by the athlete caught doping but would then need to be extended to include those directly associated with the athlete. This may

include, but not be limited to, coaches, medical practitioners, teammates, sports scientists etc. This may, at first, appear to be a somewhat controversial solution, especially given the historical events involving group responsibility. Yet similarly controversial legal doctrines have become common place throughout the world. One such example can be seen with the Market-share liability doctrine in US tort law (Geistfeld, 2006).

Given the realities of the sporting world it is difficult to demonstrate a specific case where the actions and decisions of an athlete are truly independent and without influence and involvement from others. Numerous studies have demonstrated that, when it comes to decisions with regard to doping by professional athletes, the decision is, to some extent, influenced by teammates, coaches and medical practitioners (Lentillon-Kaestner, & Carstairs, 2010; Neeraj, Maman, & Sandhu, 2011; USADA, 2012; Morente-Sanchez, & Zabala, 2013). As such, it would only be fair that if others are involved, responsibility should be shared by others, such as, teammates, coaches, medical practitioners and sports scientists to name but a few.

Exactly who is to be held accountable may differ from case to case, and as such any legislation would need to allow for such flexibility in applying liability to other individuals. However, certain legal minimums of relationship to the accused, role in the accused decision to dope, role in the accused sporting life, influence 'level' and situations specifics about the doping would need to be determined before implementing any such legislation.

With reference to this theme of relationship to the accused, it seems reasonable that this be taken into consideration when looking at doping cases and the 'pool of responsibility'. More specifically, what if it can be shown that the athlete and the medical practitioner, sports scientist or coach had a particularly close relationship, one of trust? If the athlete relied upon the person (particularly a medical practitioner or sports scientist) when discussing

supplements for ingestion, would it not be reasonable to expect that person knows what they are doing and would not provide the athlete with illegal substances. Under current anti-doping legislation the concept of strict liability applies the athlete needs to know what they are ingesting. It is well known that *ignorantia legis neminem excusat* (ignorance of the law is no excuse), but if the athlete, in a position of trust, reasonably relied upon the other, it would seem to be reasonable that the individual that betrayed that trust, at the very least, also be held liable for the decision of the athlete to dope.

2.2. The Organisational Arena

Such policies and practices are widely used throughout the global business world. It is not only common place to have systems of group responsibility incorporated into business operations but, in fact, it is arguably the preferential choice when it comes to organisational sustainability and success (Reed, Lemak, & Meroc, 2000; Curry, & Kadasah, 2002). These are not the only environments where one can see systems in place which require greater group responsibility; the military is another such example. Specifically one can refer to the concept of ‘Organizational Responsibility’ as coined by Crawford (2007:198). This idea holds that individuals in bureaucratic institutions such as the military do not act alone; there are others up the chain of command that are also involved. There have been numerous examples of scholars comparing sports to war (Dupre, 1987; End, Kretschmar, Campbell, Mueller, & Dietz-Uhler, 2003; Mangan, 2003).

There are, however, further possible advantages to the introduction of a ‘pool of responsibility’. To further justify the concept of the ‘pool of responsibility’, one can refer to organisational literature. Numerous studies have shown the positive impacts group responsibility and accountability have on the decision-making and the overall productivity of

teams and groups (Cohen, & Ledford, 1994; Guzzo, & Dickson, 1996). This is of importance for obvious reasons, the most obvious of which is productivity, which, in turn provides numerous benefits with regards to organisational success, which is a primary measure of performance in a sporting team. Furthermore, by extension, this is also a key determinate for staff retention and organisational sustainability. These studies demonstrate the importance of autonomous or self-managed teams and the role self-policing has had on positive group cohesion (Terborg, Castore, & DeNinno, 1976) and group norms (McGrath, 1984). Standing alone, the concepts of high group cohesion and strong group norms may re-enforce a doping culture. However, when these are moderated by group responsibility and accountability, the combination of these concepts may create an environment promoting ethical decision-making, thus reducing the likelihood of doping. This would need further investigation to determine if this reality could be realised in the sporting world as it is with the rest of the organisational world. Would it not therefore be feasible and reasonable to implement such policies in sports; each athlete would be required to share the responsibility to the group and to themselves. Given the arguments for the concept, the answer would appear to be yes. Moreover, the benefits of high group cohesion will provide avenues for improving and sustaining performance of the team. This approach would, on this argument, encourage greater desire on behalf of the sporting team to provide increased organisational support, in an attempt to prevent widespread ramifications of doping. The benefits of organisational support to the employee are vast but include aspects such as increased motivation (O'Driscoll, & Randall, 1999), loyalty/commitment (Shore, & Wayne, 1993) and performance (Randall, Cropanzano, Bormann, & Birjulin, 1999), all of which may aid in reducing an athlete's willingness to dope for fear of group ramifications and loyalty/commitment to the organisation. Whilst this would be based on the individual's personal motivations, it does potentially appeal to the athlete's sense of morality; when the consequences of one's actions are limited to one's self,

individuals may be more willing to take risks. Similarly, Breivik (1992) analysed doping in sport with reference to the prisoner's dilemma. The prisoner's dilemma is basically the idea that in real life situations two individuals, even if it might be in their own interests to do so, may not cooperate. That is to say self-interest, the pursuit of individual reward and the belief that they will be at a disadvantage if they do not act. An athlete's decision to dope or not is influenced by their perceptions on the actions of other athletes. If they choose not to dope they may feel that they will be at the disadvantage; if they do they are more likely to get benefit. This concept is well supported by a number of athletes following receiving a ban for doping, that they felt they needed to dope in order to be competitive because everyone else was also doping (Cycling News, 2008, 2010b). As such the concept of a 'pool of responsibility' removes this 'prisoner's dilemma' issue.

Somewhat similar is the concept of duress under law. It is the concept that an individual performed an act (illegal in nature which they would not normally) due to threat or other similar pressure (normally violence) against the person in question. Specifically related to the case of doping, one can refer to contract law. Duress in contract law can take the form of economic duress (Hale, 1943). It can be therefore argued that in sports doping case, there may be situations where athletes are pushed into doping. This pressure may come from coaches, managers etc. and as such under such law, it would seem reasonable that the athlete have the defence of duress. As such the pool of responsibility concept is further reinforced. In such cases where it can be proven that another person is forcing the decision making of the athlete, it would seem only fair that they are held liable and so should be punished.

2.3. The Case Studies

An analysis of cycling in the context of a ‘pool of responsibility’ can be performed. In the event that a single cyclist was detected to have taken a banned substance and subsequently banned, the consequences would also be extended to other riders on the team and also include coaches, medical practitioners and sports scientists in the team. Exactly what these consequences would be would have to be determined, but for example, it would include some form of ban for the others involved also. Depending on the sport and the number of athletes involved, the level of responsibility would need to be increased to the national level simply because anything less and perceived benefits of doping may remain greater than the perceived consequences of being caught, and as such will not result in a change an athlete’s actions. These two concepts, a) athlete’s perceptions, and perhaps more significantly b) the cost-risk-ratio are two of the greatest barriers to successful anti-doping legislation. To elaborate, under the legislation guiding many current sport disciplines, the consequences of a positive test for doping agents are limited to the individual involved. The consequences to the organisation, be it national associations, or be it the employer, are limited. Cycling can be used again as an example. Under current *Union Cycliste Internationale* (UCI) legislation (UCI, 2012a; UCI, 2012b) the consequence to the team for a doping infringement is firstly disqualification of the team from the event itself (part 14 s327) (seemingly applied randomly) and, secondly, a loss of the world tour points collected by the athlete (part 2, s 2.15.040). There is no responsibility taken by the team members, coach, or other persons involved in the team. No tour points are deducted from the group of riders who should have been looking out for other members of the team to ensure that they did not use a banned substance. The Alberto Contador Vendasco case provides us with an example. The impact to Saxo Bank (his team) was simply that the ban placed upon Contador resulted in a loss of the points collected during his ban. The team did not lose its pro team licence. It could be said that, given the importance of Contador to Saxo

Bank (the fact that he was the captain and the 'protected' rider), one would expect his suspension to bring significant detrimental impacts to the team. Yet the reality is that even in this case, the impact of his suspension was far less widespread than one would necessarily think. Saxo Bank still has a pro team licence and, in fact in 2013, obtained a new major sponsor/owner, Tinkoff (Cycling News, 2013b). Furthermore, perhaps it could be said that had the concept of a 'pool of responsibility' been in place during the Lance Armstrong era in cycling (and thus the rule applied to the US Postal cycling team), there is a strong possibility that Lance Armstrong would not have been able to avoid detection for as long as he did, or perhaps this concept may have even prevented doping at the team level altogether.

Yet another case which demonstrates the ineffectiveness of individual responsibility on anti-doping legislation and penalties, (and realistically with the anti-doping legislation itself) can be seen with baseballer Jhonny Peralta. Peralta was implicated in the Biogenesis scandal, and as a result of his complicity received a 50 match ban. This in itself seems somewhat insignificant given the percentage of the baseball season this represents (less than 1/3 of a single season), hardly impacting the playing career of a professional baseballer. What is more, Peralta, upon returning to the sport is reported to be now earning more than \$50 million US over 4 years. In fact, the end result, in this case, shows that there is significant advantage to be had by engaging in doping. If you are not caught then you have a successful and lucrative career, and if you are caught then you have a successful and more lucrative career upon your return. This thought seems to be shared by a number of other baseball players. Brad Ziegler commented "*It pays to cheat... Thanks, owners, for encouraging PED use*" (Ziegler, 2013). David Aardsma said "*Apparently getting suspended for PED's means you get a raise. What's stopping anyone from doing it? #weneedtomakeachange,*" (Aardsma, 2013). As a result of the controversial situation involving Peralta, the Major League Baseball Players Association made changes to its Joint Drug Agreement. The new changes were in a similar vein to the

WADA changes; increased penalties, as well as some additional restrictions following players' return after the ban (MLBPA, 2014). The problem here is that the consequences of the ban are still limited to the individual. It remains to be seen if there are additional incentives to discourage doping from the team and coaches' perspective.

A new approach to anti-doping policy with regards to policing and deterrence is needed. Given the current realities of doping in professional sports, the question remains, what new regime is required to combat doping?

| Sport | Number of co-responsible athletes if tests are at current level |
|--------------|--|
| Air Sports | 32 |
| Archery | 68 |
| Baseball | 50 |
| Bobsleigh | 625 |
| Cycling | 84 |
| Football | 208 |
| Rowing | 435 |

Table 1: The number of individual athletes needing to be held responsible if a single athlete is detected doped - based on current WADA figures.

Table 1 depicts the 'pool of responsibility' calculated as an inverse of actual adverse analytical findings. The concept of the 'pool of responsibility' indicates how many other individual athletes would need to take responsibility for doping if one were to be discovered by a test, provided the current testing regime of anti-doping was to remain. These indications are such, that should anti-doping testing remain unchanged (that being chemical testing solely), one would all but expect some potential dopers to slip through the cracks. As such,

legislation may need to be developed to accommodate the reality that anti-doping policies as they currently stand fall short of catching all abusers.

The situation which exists in sports today is basically the opposite to the concept of a 'pool of responsibility', basically an 'inverse pool of responsibility'. As it stands today, teams, coaches, sponsors, managers etc. pressure athletes to 'achieve at all costs'. This sometimes results in doping at which point the responsibility is borne solely by the athlete in question, the other involved parties disclaim any responsibility. This can be an effective strategy in sports, as doping detections only occur occasionally, whereas the 'benefits' of having a doped athlete can bring significant financial and promotional prestige to the team. Therefore, if each athlete is significantly doped (and the chances of detections are still small), and the responsibility is confined to the individual in question, the benefits again outweigh the consequences. This creates the perfect environment to promote a culture of doping. Such realities have been realised in a number of US sports such as Baseball as outline above.

2.4. The Legal Arena

The concept of individuals taking responsibility when wider responsibility is more appropriate is well documented in policing and governmental literature (Wakefield & Fleming, 2009). The term 'responsibilization' refers to the concept that bodies, such as government agencies, pass off responsibility or tasks and duties to individuals. Examples include police taking on a range of security and protection roles that were not originally their responsibility, or individuals being asked to look out for their own safety when it should be ensured by other bodies such as police (Wakefield & Fleming, 2009). This appears to be the case in sports. Athletes have the sole responsibility for doping infractions, even in cases where more appropriately wider responsibility is both beneficial and fairer given the realities

of sports. There are a number of issues with the responsabilization approach to policing doping. These include a) individualising problems with systematic origins (Wakefield & Fleming, 2009), and b) blaming of victims (Wakefield & Fleming, 2009). To elaborate firstly, athletes are made solely responsible for doping irrespective of whether or not external factors are influencing them. One such example can be seen in the Lance Armstrong case, where as it was claimed by athletes, cycling had an inherent and pre-existing culture of doping (Albergotti & O'Connell, 2012). As such, external factors clearly play a role. Secondly, given this, athletes may well be deemed to be victims of an out of control system, as such they themselves, the victims to some extent, are therefore held responsible. Such is the state of professional sports, especially given the concept of strict liability, which is applied in cases of doping. Introducing a policy of group responsibility and reducing the concept of responsabilization would not only theoretically reduce this likelihood of such occurrences and thus prevent doping, but would help eliminate some of the unfairness inherent in the sporting world.

A 'pool of responsibility' approach provides a great incentive for the team as a whole to prevent such events occurring again, and the lack of such incentive may in fact limit the level of organisational support provided to combat doping. One may think that the consequences of a major doping scandal would have a series of intangible impacts on the team (such as a loss of reputation in the face of spectators, fans and potential investors). In reality, as the Contador case demonstrates, the popularity of a team (in this case Saxo Bank) and the athlete, following such scandals, appears to be potentially even higher. It is not always off putting to potential investors. Similar effects have been realised with the case of other cyclists including Valverde, Vinokurov, Basso etc. These effects of increased popularity are seemingly realised in cases where there appears to be ambiguity regarding the athlete's intent to dope, yet irrespectively, sanctions are imposed. Spectators may feel sorry for such athletes and as such

their popularity apparently increases, like with the cases outlined above. This in turn would result in a lower desire to abstain from doping as there is little consequence with significant gains. Again, what is the point of anti-doping policies? Are they simply to boost revenue (sports are seen as fair and therefore resulting in a greater number of spectators), or rather to protect the health of athletes and the fairness of the sport? It would appear that in the case of some people it is the former rather than the latter. What is more, as demonstrated in the above cases, real world issues associated with sports law, anti-doping policies and punishment for infringements, often result in decisions that appear to be somewhat hypocritical or varying, depending on the athlete. This may, in many cases, be causing more problems in sport than they are rectifying.

The notion of extended responsibility is not an alien concept in law. Under US law there is a legal doctrine known as a Toxic Tort. As Henderson defines it “Toxic torts are defined as those in which persons assert causes of action seeking compensation for one or more adverse health effects resulting from exposure to one or more toxic substances” (Henderson, 1990:69). In essence the responsibility of the injury caused to the plaintiff is borne by the defendant, for example pharmaceutical companies. This law dates back to 1973 with the landmark case *Borel v. Fibreboard Paper Products Corp* and subsequently saw the extension to include pharmaceutical companies in *Daubert v. Merrell Dow Pharmaceuticals Inc*. Difficulties usually arise in such cases due to two reasons. Firstly, in such cases, the plaintiff is required to demonstrate a causal link between the injury and the exposure. This often proves difficult, as there is often a plethora of other factors which may also be argued as either being possible contributors to the injury or simply it is difficult to prove such a causal link. Secondly, a number of issues arise with the assessment of scientific evidence in addition to the assessment of the testimony of the expert witnesses (Foster, Bernstein, & Huber; 1993). No doubt there is contradictory scientific evidence relating to the exact consequences and

relationship between the pharmaceutical (or chemical) and the supposed injury. Whilst this may indeed present an issue in civil cases involving exposure to potential chemicals, this may present less of a problem in doping cases. This can be demonstrated by the ample evidence outlined previously with regards to the harmful effects of some doping agents. In fact, one of the primary arguments for the existence of anti-doping legislation is for the protection of human health (UNESCO, 2005; WADA, 2009).

In a similar vein to the above outlined legal doctrine, one can find in US law, two additional related legal concepts, *alternative liability* and *market-share liability*. Both of these doctrines see a shift in the concept of strict liability, a broadening of the concept (Harvard Law Review, 1981). In these situations the burden of proof switches from the plaintiff to the defendants. In the case of *alternative liability*, multiple defendants can be held liable even if only one was responsible for the injury. In such situations it is the responsibility of the innocent defendant, in a group of defendants, to prove they did not cause the injury (*Summers v. Tice, 1948*). Similarly, *market-share liability* shifts the burden of proof away from the plaintiff and onto the defendant. In this doctrine, manufactures, particularly pharmaceutical companies, may be held jointly liable, even if only a single defendant caused the injury in question (Sheffert, 1983). What makes this doctrine so different from a normal tort is that the plaintiff need not know from which defendant the injury originated (*Sindell v. Abbott Laboratories, 1980*), liability is then apportioned to manufacturers according to their market share. There are, however, naturally some conditions that must be met in order for the principle of *market-share liability* to be upheld. Firstly, a substantial representation of the market must be in the court (the defendants). Secondly, the products must be interchangeable. Thirdly, the defendants in question would need to be active in the market in the timeframe outlined in the case. Finally, the plaintiff's inability to assign liability to a specific manufacturer must not be their own fault. If one were to then apply this to a doping situation it can be demonstrated that

it would be feasibly. A substantial representation of those involved in the sporting arena and directly relating to the athlete accused of doping could be obtained. This may include any or all of the following; the coaches, managers, medical practitioners, sports scientists, pharmaceutical companies and team mates etc. The second and third point would be obvious. The fourth could relate to the athlete trusting the doctor or sports scientist to do no harm, or just listen to the coach without knowledge of the product injected/used etc. In any case it demonstrates that systems of increased responsibility and liability already exist and are accepted as legally binding principles. As such, the extension of this notion to the sporting area does not seem such a big stretch. Moreover, there were two statements made in the court's ruling in the *Sindell* case which would seem to be particularly apt and appropriate if applied in a sporting situation,

" . . . defendants are better able to bear the cost of injury resulting from the manufacture of a defective product" (Sindell v. Abbott Laboratories: 600),

". . .as between an innocent plaintiff and negligent defendants, the latter should bear the cost of the injury" (Sindell v. Abbott Laboratories, 1980: 600).

Moreover, perhaps it can be said that the introduction of such a system of anti-doping in sports, may also increase the sporting stakeholder's willingness to actively prevent doping, similar to the suggestion by Sheffet (1983:38) in the *Sindell* case, 'such a policy will increase manufacturers' incentives to produce safe products'.

3. 'Pool of Responsibility': The Application

In practice the application of the theory of a 'pool of responsibility' could potentially take on many different forms or structures. Obviously there would need to be a level of flexibility in its initial formation. With the introduction of a 'pool of responsibility' it is possible that the bans for athletes found to be doping could remain at current WADA levels (4 years), and simply supplemented with additional consequences. Therefore, whilst there are potential alternatives available the suggestions for the application on the principle of a 'pool of responsibility' are as follows:

- 1) Always apply UCI rule part 14 s327, if an athlete is found to be doped on a team then the whole team needs to be disqualified from the event, not just the athlete in question, without exception.
- 2) Uniformity in sentencing and punishment is needed; ambiguity and unfair decisions result in greater long-term problems with regard to doping.
- 3) Athletes in the team for the last year should be excluded from competition for a period. This period may be shorter than the detected athlete, but must still be a period that would impact their sporting life, so no benefit is gained by doping.
- 4) All coaches who were responsible for the training of the team, for the last year before the positive doping detection should face a suspension, for at least as long as the athlete in question. If it can be shown that the coach abused the position of trust they were in with the athlete, and/or influenced the athlete to partake in doping, then the coach in question should receive a ban at least double that of the athlete.

5) All medical practitioners who for the year prior to the positive doping detection, who advised athletes in the team, should face suspension. Again, if it could be shown that they abused the position of trust they had with the athlete, and/or advised or influenced the athlete to dope they should also face deregistration from the medical profession.

6) All sport scientists responsible for advising the team for the year prior to the positive doping detection, should face suspension. Again, if it could be shown that they abused the position of trust they had with the athlete, and/or advised or influenced the athlete to dope they should also face a lifetime ban.

As such, the realities of sports are such that decisions athletes make to engage in doping rarely are void of others influence or participation. The recommendations take into consideration these realities, and as such those influencing the athlete need to be taken into consideration when doping punishment is dealt. Current anti-doping legislation is largely ineffective as it stands, this fact is demonstrated by reference to the fact that punishments are simply being increased to try and combat it. If it is to remain it needs to be supplemented with additional penalties, to make the athletes think twice about doping before they partake. The plethora of organisational literature and examples demonstrating the importance and benefits of group responsibility and autonomy, demonstrate the usefulness of a 'pool of responsibility' to anti-doping policies. The evidence is significant enough to justify the incorporation of a 'pool of responsibility' into the current anti-doping legislation. It should prove to be more effective when coupled with the current approach. A 'pool of responsibility' would appear to be the most effective solution given the current anti-doping systems (chemical testing and punishment). The benefits of such a system should aid in preventing doping scandals before they are revealed only years after the occurrences.

Conclusions

Overall it has been demonstrated that the concept of wider group responsibility; a 'pool of responsibility' is neither an alien nor illegal concept. Whilst it is considered by some to be controversial, it can be found to be used in the military, wider business world and in numerous manifestations in the legal arena. It is well documented by athletes, officials and researchers that the factors influencing doping are not as simple as the notion of strict liability would have one believe. In most doping cases, external players, influence and in many situations directly contribute to an athlete's decision to dope. Factors such as pressures of the sporting world, coaches and peer pressure, 'suggestions' by medical practitioners and sports scientists etc. As such does it not seem reasonable that the responsibility and liability of an athlete found to have doped is not borne solely by them? For is this not an unfair outcome given the sporting realities. Furthermore, it has been demonstrated that there are numerous examples from the business world that show the plethora of benefits that can be realised from a group responsibility system. One could hope that in the best case scenario it may eliminate doping and continues to maintain the sustainability and excitement that is sport.

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Ziegler, B. (2014): Interview with Yahoo Sport, in '*MLB toughens drug agreement after Biogenesis*', March 28th 2014. Retrieved 29th April 2014, from
<http://sports.yahoo.com/news/mlb-toughens-drug-agreement-provisions-204209339--mlb.html>.

Impacts of this research

Despite the recentness of this research and the short time since publication of the works, one can see the widespread impact this research has had in the area of sports, particularly with regards to citations and media coverage.

1. Citations

Firstly in regards to citations, the works by this author included in this thesis has to date received the following citations:

| |
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| Chester, N., & Mottram, D. R. (2014). Future issues concerning drug use in sport. <i>Drugs in Sport</i> , 26. |
| Chester, N., & Wojek, N. (2014). Regulation of antidoping in sport. <i>Drugs in Sport</i> . |
| Jiang, W., U., (2014), Evaluation study on training of 100m sprint athletes based on improved DS evidence theory, <i>Journal of Chemical and Pharmaceutical Research</i> , 6(5), 1321-1326. |
| Maennig, W., (2014), Inefficiency of the Anti-Doping System: Cost Reduction Proposals, <i>Substance Use & Misuse</i> , 49:1201–1205 |
| Moston, S., Engelberg, E. T., & Skinner, J., (2014), Perceived incidence of drug use in Australian sport: a survey of athletes and coaches, <i>Sport in Society</i> , (ahead-of-print), 18 (1) |
| Outram, S., M., (2013), Discourses of performance enhancement: Can we separate performance enhancement from performance enhancing drug use?, <i>Performance Enhancement & Health</i> , 2(3), 94-100. |
| Siniarska, A., & Wolański, N., (2013), Early sport specialization: how and when to evaluate body build and composition predisposed to sport achievement, <i>Antropomotoryka</i> , 62. |
| Wilson, J. K., and Pomfret, R., (2014), <i>Public policy and professional sports: international</i> |

| |
|--|
| <i>and Australian Experiences</i> , London: Edward Elgar Publishers, (Chapter 7) |
| Zucchetti, G., Candela, F., & Villosio, C., (2014), Psychological and social correlates of doping attitudes among Italian athletes, <i>International Journal of Drug Policy</i> , doi:10.1016/j.drugpo.2014.07.021 |

2. Media Coverage

Media throughout the world have dedicated time and space to this research. The author has been interviewed by numerous media corporations and outlets worldwide. These include:

| | |
|-------------|--|
| 2014 | Runner’s World – Researchers Say Drugs Unlikely to Improve 100-Meter Times, available at http://www.runnersworld.com/elite-runners/researchers-say-drugs-unlikely-to-improve-100-meter-times |
| 2014 | Swimming Science – Friday Interview: Aaron Hermann Discusses Doping in Sports, available at http://www.swimmingscience.net/2014/05/doping-swimming.html# |
| 2013 | ABC News Adelaide, Australia – Study concludes foolproof drug testing in sport 'prohibitive' |
| 2013 | The World Today, Australia – Testing inadequate to tackle doping: researcher |
| 2013 | Channel 7 News Adelaide, Australia – Drug cheats slipping through, research shows |
| 2013 | The Advertiser, Australia – Flawed drug tests are failing to detect doping athletes, Adelaide University study concludes |

Appendix C demonstrates an overview of media coverage within Australia obtained by the research included in this thesis. This list is not complete but it provides an impression on the impact of the research to date.

3. Other Impacts

Furthermore, the author has been approached by numerous sporting officials and school children throughout the world seeking further information or comment on a number of aspects of this research. Examples of interested parties include officials from the Union Cycliste Internationale.

Findings of the Research

Overall this thesis contributes new findings regarding effects of doping on sport achievements and offers novel and new ideas to the area of anti-doping and to the sporting arena in general. Firstly, it demonstrates two key discoveries with regards to the current state of doping in the sporting arena. 1) Doping when practiced in a clandestine manner, without clear knowledge or understanding of the substances, usage and dosages and without 'proper' support is not working as desired with regards to improving results. That the effects may in fact be harming results as they target certain aspects of human biology which make performance in a given sport more difficult to achieve to the desired level with the desired results. 2) Doping is in fact a widespread major problem; it is not confined to only a few individuals or to a few popular sports but is present in many sports throughout the world. Furthermore, it was discovered that whilst winter sports are not doping free, doping does seem to be a more widespread problem in summer sports, a revelation which deserves further investigation.

These discoveries should contribute to the prevention of doping in the sporting arena in a number of ways. The primary of these being that if athletes realise that doping will not help them obtain the results they desire, they may choose not to participate in doping due to the potentially fatal health consequences and/or penalties relating to positive detections. Otherwise, this may help prevent doping by demonstrating that doping is indeed widespread, thus calling on changes to the current systems. This is especially true when coupled with the research and findings from paper 3.

Moreover, this thesis supports the supposition by a number of sporting officials and athletes who feel doping is widespread and that the current systems are ineffective. This research proves that current anti-doping systems of testing and detection are at best inefficient and ineffective. Anti-doping systems are structured in such a way that a single test will, in almost all cases, not detect a doped athlete. Realities of human biology, science, and factors influencing doping and anti-doping testing all contribute to the problems that currently exist. It is one's hope that this revelation will instil a desire to make the systems more effective and efficient by taking into consideration the realities of human biology, science and the factors influencing doping.

Conclusions

The research shows that the current systems of anti-doping are such to be economically unfeasible to combat doping in an effective manner. The current state of science and testing means that, in order for the current approach to be effective, testing and funding would need to be increased to such an extent as to make anti-doping, and sports in general, almost economically impossible. There are simply too many factors of human biology, too many advances in drug development and too few completely effective methods of detection to rely primarily on testing as a means of control alone. External factors influencing an athlete's decision to dope are having the effect as to make testing little more than a waste of resources. Improvements are needed in detection methods to even begin to come close to acting as a deterrent. Given the current state of doping throughout the sporting world, that is to say the apparent widespread nature of doping, current systems do not appear to be working as an effective deterrent. This may well be because the athletes who may consider doping know all too well that the current testing and detection systems are at best hit and miss. They may well be well educated in methods of circumventing the systems because of the imprecisions and inconsistencies. This supposition would need to be further investigated but the body of evidence that currently exists, for example with the Lance Armstrong case, it seems as though this is known to athletes. Perhaps this is why so many athletes are willing to experiment with doping without true understanding of which agents can enhance which. Furthermore, without clear understanding of the interaction between the agents and the human body. As a result this may go to explain the findings of the first two papers. That results of 'doped' athletes does not differ to that of 'non-doped' athletes because of this lack of clear understanding. The willingness to experiment (with the hope of improvements), because of the ineffective testing, coupled with the illegality of doping (meaning athletes cannot get access to complete information as they may need), creates a vicious cycle of doping. The ineffective systems

means more doping will be attempted, this however in turn will mean results are impacted, which in turn will mean spectators are not satisfied (this also requires additional research), which in turn puts more pressure on managers and coaches to have their athletes perform, which in turn again means they resort to attempted doping to try and help, which may result in supported and structured doping programs still being used... this is depicted in figure 1.

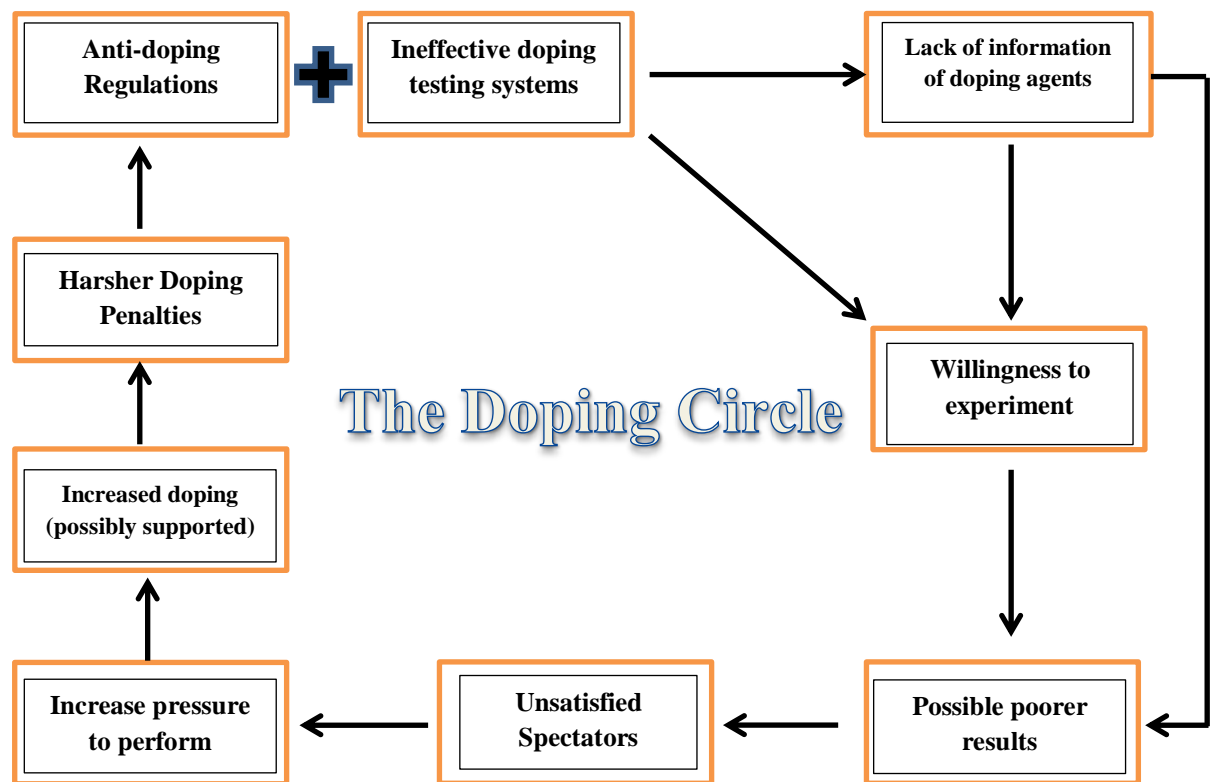


Figure 1: The doping circle

The reality of the doping circle means that in order to combat doping, many officials, anti-doping personnel and anti-doping researchers call upon additional funding to increase the numbers of tests done. As the research in this thesis shows, this alone will not improve the chance of detection, act as a deterrent or lessen the rate of doping unless there are dramatic improvements in the effectiveness of testing. As the system currently stand, an increase in the

number of testing apparently will result in two outcomes, firstly, the practice becoming even more clandestine and secretive. This will in turn simply reinforce the current self-perpetuating cycle of doping; a lack of information, a lack of results equals more doping and potentially supported doping. Secondly, this will simply result in a loss of capital; the additional funds focusing on an increase in the number of tests will not improve the testing success and, as such, will simply act as means to waste capital. This is not unlike throwing more money into unprofitable stocks, in the hope that eventually the stocks will turn around... the money is simply lost. These realities need to be considered in order to better enhance anti-doping policies and to better deter doping.

Despite these realities there is something that can be done enhance the current anti-doping policies and systems. This thesis also demonstrates that, in order to combat doping there are a few different approaches which can be taken to change the policies and laws. In effect one of two approaches can be taken, in an assortment of combinations. Firstly, a restructuring of how sports are seen by spectators to that more of an entertainment medium may benefit in reducing or removing doping issues. The modern role of sport in society is such that it is in conflict with many of the modern societal ideals. Views of what role sports play in modern society and what role an athlete has in sports, directly impact an athlete's decision to dope. The view that success in sports are a measure of a person's worth and achievements are related to the value of the person and their success in life, means that doping will be relied upon more and more in an attempt to gain recognition and psychological fulfilment. The classical position of sports was such that doping was not considered an issue because sports were an entertainment medium. This finding, one would hope, would help to make spectators, athletes and all those involved in sports reassess their views of sport. No longer should doping be seen as a means to an end, but rather either as a moral and ethical atrocity or simply one

aspect of an entertainment medium thus eliminating the issues with it. This should change one key element, spectator's views. If spectators no longer see sports as some search for purity and honesty then they may be more inclined to accept doping for the goal of the spectacle. This in turn either eliminates some of the pressures on athletes to dope because a spectacle can be achieved in many different ways not just through doping or, at the very least, it removes the issue with doping being a problem in the eyes of spectators.

Finally, a potentially more beneficial method, especially given the possible negative health effects of some doping agents, is to take a more encompassing view to doping punishment. To eliminate doping, a harsher approach may need to be taken also. The realities of numerous historical doping scandals and the fact that multiple individuals are often involved, and the limited role this concept plays in current anti-doping policy, this thesis proposes a series of policy changes to expand the responsibility and liability for doping infringements. It suggests that not only should the individual caught on the doping agent be considered to be the sole responsible party but rather the investigation should be extended, and liability also extended to include any external party directly involved in the action.

That is not to say with the individual who is discovered on the doping agent, but rather those that supported this decision. Those people in athletes circle of advisors who assisted with the practice of doping, need to be held accountable. This will in effect cut off the athletes support base and as such they would need to rely on a more trial and error method of doping if they still want to do it. This approach of experimentation of doping, as has been shown in papers 1 and 2, often has the unfortunate side effect that the athlete will not always obtain the results they seek. This lack of results will in turn directly affect their careers and as a consequence

employability. Such athletes may well find themselves without a job in effect reducing the doping in the given sport.

Moreover, changes in the laws to make those supporting doping more accountable would result in a greater willingness to combat the doping within the team. Managers and coaches will be more inclined to provide additional organisational support for the athlete to not dope. This added organisational support, will not only educate the athlete but also provide them with a great sense of value, that the organisation really cares about them and their future.

Basically, the research finds that current laws need to be made more strict not against the athlete but those involved in the athlete's circle of influence. Through this method, the idea that others need to take liability for their actions, it should aid in helping people realise that they cannot act without conscience, without fear of reprisal for their unethical decisions, and as such will go a long way to help prevent acts of blatant disregard for the laws and policies of sport and those of human morality and decency.

To sum up, this research not only demonstrates the widespread nature of doping in the modern sporting world but it also creates new approaches to combat, and more importantly, prevent doping. It incorporates real world variables and factors influencing the anti-doping arena, which may have previously been overlooked, and incorporates them into practically useful suggestions for changes to the current anti-doping systems. In all, it will go towards changing the way doping is perceived and, as a consequence, reduce the likelihood that doping will occur. This in turn will not only improve the sporting world, equality between

athletes, fairness and morality, and the spectacle of sports but also, given the nature of sports today, hopefully help greater understanding and relations between nations who view sports as a key aspect of their identity.

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Appendix A – Published version of: The Doping ‘Myth’ - Anti-Doping Systems in Sports are not improved by 'doping', International Journal of Drug Policy, 24: 110–114

Hermann, A. & Henneberg, M. (2013) The doping myth: 100m sprint results are not improved by 'doping'.

International Journal of Drug Policy, v. 24(2), pp. 110-114

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Appendix B – Published version of: Anti-Doping Systems in Sports are Doomed to Fail: A Probability and Cost Analysis. *Journal of Sports Medicine and Doping Studies*, 4: 148. doi:10.4172/2161-0673.1000148



Anti-Doping Systems in Sports are Doomed to Fail: A Probability and Cost Analysis

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Abstract

Objective: Doping in sports now seems to be more widespread despite testing. The objective is to assess the effectiveness and cost effectiveness of the current anti-doping system.

Methods: A probability and cost analysis was performed. Using calculations based on official world-level data of positive doping test results, sensitivity and frequency of testing in 93 categories of sport, and estimates of numerical characteristics (frequency, window of detectability, test predictability)

Results: A low probability of doping detection was demonstrated; 0.029 for doping once a week by a single random test with average sensitivity (40%) and window of detectability of 48 hours. With 12 tests a year probability of detection of continuous doping is ~33%. To detect 100% of doping in one year 16-50 tests per athlete must be done costing ~\$25,000.

Conclusion: Testing is not economically viable for effective detection. Changes are thus required to the current system to combat sophisticated doping techniques.

Keywords: WADA; Statistics; Ineffective; Policy; Cost analysis; Probability; Doping; Cheats

Introduction

The year 1968 saw the International Olympic Committee's (IOC) first true attempt to combat doping in sport [1]. A number of international sporting organisations had attempted to address the issue of doping in sports before this point, one notable example being the International Association of Athletics Federations (IAAF). These early attempts however proved to be little more than hopeful, as they lacked a key component necessary for such anti-doping systems; anti-doping testing. Similarly, even the IOC's early attempts were, it can be argued, ambitious but ultimately lacked substance. It is well known that early anti-doping testing was, at best, rudimentary and, perhaps, did little more than keep up the appearance of combatting the issue of doping. The IOC's decision to finally introduce measures to curb doping, was in response to numerous doping related deaths and controversies. Whilst, these attempts were ambitious, in many ways they simply have not lived up to the promise they once had. Numerous high profile scandals, such as East Germany [2], China [3], and more recently Lance Armstrong and US Postal [4] only revealed years after the fact, have shown the fragility of the anti-doping system both past and present.

It has been suggested by a number of different peoples in the sporting arena, including officials, athletes, and scientists, that the current (and past) anti-doping systems are both ineffective and inefficient. Furthermore, current doping detection statistics, in some sports, under represent the true extent of doping in sports [5]. This demonstrates that there is a need for an assessment of various factors influencing the success of anti-doping systems. There has been considerable work produced on the factors influencing an athlete's decision to dope [6,7], the reasons behind doping [8,9], and consequences of doping [8,10]. However, little work has been produced to actually assess the factors within the sporting and anti-doping system which may influence the effectiveness and efficiency of anti-doping testing. It is true that the anti-doping system as a whole can be argued as to also include the education of anti-doping, the programs in place to attempt to deter doping etc. However, it should be pointed out that it can also be argued that testing and the science behind the testing leading to detection or not, is the primary tool in anti-doping. Education is definitely of help, but without a means to find any wrong doing education alone would not prevent doping. As such this paper primarily focuses on testing as

the pivotal element of the anti-doping system. Therefore, one must ask the question, despite the apparent efforts of sporting bodies for almost a century, why does doping continue to be a problem? Why is it that even today when testing is widespread, random out-of-competition testing is performed, prohibited lists are updated regularly and experts are consulted on the systems to be used, why do these problems persist? Perhaps this is simply because irrespective of the system in place some people will always want to cheat. Or perhaps the problems lie within the anti-doping system itself, an inherent flaw within this paper sets out to investigate this question, to assess the current anti-doping system and to determine if there are indeed issues with its very structure, or rather if factors of the real world impact its efficiency and effectiveness.

To elaborate, one key component of the current anti-doping system is test sensitivity. There seems to be some debate on this area and it tends to be a somewhat contentious issue amongst scientists. The success rate of anti-doping testing has been reported in some cases to be less than 10%, and on average less than 50% [11,12]. Whilst this figure is not definitive on the balance of probabilities, based on the available information, this seems to be a reasonable estimate. This is but one example of the issues in anti-doping systems, upon further investigation the issues appear to expand exponentially. Current testing systems are influenced by numerous factors of the sporting world that simply cannot be restrained by theoretical frameworks and the best hopes of policy formers. Test success rates, doping techniques aimed at deliberate circumventing of testing (e.g. micro-dosing), and in some cases minimalistic sample collection due to economic restraints are all examples of the real world (and evolving nature) of sports and doping, that makes inflexible rules on paper fail in everyday life. Consequently anti-doping practices are less effective in their mission than one

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would hope; the simple reality of it is that not all dopers are caught; the issues with US Postal are testament to this fact. If one then adds to these factors the additional evolving factors of the sporting world, window of detection and randomization of selection for testing, one begins to get the picture as to the current state of doping detection; a less than optimal system. The aim of this research is, therefore, to assess the extent to which the current anti-doping systems are effective and efficient in their task of deterring, preventing and detecting anti-doping infringements. Unlike other papers, this research does not focus solely on the psychology of the athlete, the fear or threat factor, or even a discussion of issues with punishment as a means of deterrent. Rather this paper analyses the effectiveness and efficiency of anti-doping systems with the assistance of statistics and realities of human biology. Moreover, this paper seeks to assess whether the realities of the sporting world and athletes action manage to invalidate the anti-doping practices or demonstrate inherent flaws in the system. The reasons being, that if such issues do exist in the current system and these issues are able to be demonstrated, perhaps this will aid policy makers and organizations to amend the legislation. The eventual end result of this research is hopefully to ensure a fairer sporting environment for all participants, through the creating of policies that are both more efficient and effective in detection and prevention.

Anti-doping policies and realities

It is prudent to begin with an outline of some of the key arguments as to the existence of anti-doping systems and furthermore, the opinions of the current level of success and issue of these policies as far as they exist.

Of the assortment of factors argued as being the reasons behind the creation and existence of anti-doping, the three most commonly included reasons are, 1) athlete's health, 2) fairness and equality, and 3) sports should be a representation of a person's natural abilities. Many of the international policies in sports contain some or all of these points as justification of their existence, the WADA Code [13] and UNESCO International Convention against Doping in Sport [14] are two such examples. What is more, there is also the inclusion of such terms as 'with the potential to' enhance etc. "potential" is such an ambiguous term it is no doubt that there is much debate on the issue.

Human health: To begin with the health argument, the WADA code [13] lists health as (one of) the 'fundamental rationale's for the world anti-doping code'. The UNESCO International Convention against Doping in Sport [14], states it is "Concerned by the use of doping by athletes in sport and the consequences thereof for their health' in its preamble. It is well reported that some doping agents do indeed have harmful effects, if not through their use then through their abuse [10,15]. Beastall et al. demonstrated the deadly outcome of injection of insulin in a healthy adult. Despite this, however, there is ample evidence that suggests that a number of substances listed on the WADA prohibited list have little to no evidence that they can cause harm. One such example can be seen in the recently banned Xenon gas. Some research [16] claims that it is in fact beneficial to human health and may provide 'long term benefit' with regard to strokes. In fact, many of the substances which are now abused as doping agents began their life as medicaments. Similarly, vitamins in sports are not banned substances. It is often argued that vitamins are necessary in order for athletes to be able to compete at the highest level, implying that without them athletes would not be able to recover as quick or perform as well (does this not sound like performance enhancing?). Vitamins are deemed safe, yet abuse of vitamins can be as harmful as the abuse of banned doping substance. There is ample evidence to support the idea

that high doses of some vitamins can indeed result in negative health effects [17-19].

Fairness and equality: Similar arguments can be found with fairness and equality. These two concepts are often argued as being the backbone of anti-doping policy, the reason for its existence and the primary mission of the policies. It is often difficult to define exactly what the meanings of these terms are. They differ from person to person, depending on their own sets of values and morals. Furthermore, they are in effect intangibles; they have no physical substance and are often fluid in nature. Perhaps, however, one of the most useful definitions of what fairness and equality is and to a larger extent morality in sport can be found in the works of Kuchler, who defines it as accepting the 'opponent as a partner', 'keeping in the rules', values victory no higher than their attitudes to opponents, refuses dishonour and inequality, and goes about it all good-heartedly [20].

Yet it can be said that sports, by its very nature, are not fair or equal. Athletes are never provided with the same opportunities to advance and compete. Athletes from third world nations or developing nations are automatically at a disadvantage be it because of dietary reasons, economic, or even access to training and opportunities to perform. Similarly, there is segregation between genders/sex and age. One could ask, if an athlete wants to compete with others of any background, sex or age and meet the performance requirements should they not be able to, without first gaining permission, and hoping permission will be granted. It is as if the very structure of sports promotes the idea that it is not a right but rather a privilege that one must earn and fight for. If this is the case, then it goes against everything claimed, not only by anti-doping policies but, also against the very spirit of sports.

Natural abilities: Finally, the notion that sports should be a representation of a person's natural abilities. This concept is self-explanatory. However, like the previous two concepts there is much debate about it being touted as one of the primary reasons for anti-doping policy. To begin with, there is a question of what exactly constitutes natural abilities. Moreover, there is the debate about what constitutes an alteration of a person's natural abilities. Much like the arguments outlined previously with regard to vitamins and doping practices, one must assess what constitutes enhancement and an alteration. Take vitamins again as an example. There would be those that consider the benefits that vitamins bestow upon an athlete (recovery, dietary supplementation etc.) as an indication that their performance is no longer natural. This is because, without these supplements, the athletes would not be able to perform at the high level, or at least not as long as they do and it would take longer to regain the chance of performing at this level again. Similarly as an example, there is the before mentioned argument of Xenon. One of the reasons this practice is banned is because it can be used as a form of performance enhancement. Yet it should be pointed out that Xenon is argued as performance enhancing; it simulates the effects of EPO doping. Its use is argued to stimulate Hypoxia Inducible Factors (HIF) particularly HIF-1 α and as such it benefits the athlete in the same way as EPO doping. Yet it should be said that similar gains can be achieved through altitude training. Altitude training is, however, not a banned practice. If the aim of anti-doping is to preserve the fairness and natural abilities of an athlete, should not this form of training also be deemed to be altering the performance of the athlete and as such be banned? Similar arguments can be made for the use of caffeine, headache tablets, sleeping tablets and any assortment of proteins or other similar dietary supplements. These items are not banned, and are commonly used by athlete to help recover, sleep, block pain etc. all of which they would not 'naturally' be able to do without the use of the pharmaceutical or supplementary items.

Effectiveness according to some experts

There has also been some recent argument by some high level athletes that, despite the current anti-doping systems, even if they are effective, testing is at best rare. To elaborate, Chris Froome criticised the lack of anti-doping testing over a two week period during a key training camp for himself and two other high level cycling athletes [21,22]. Similarly in 2011 it was reported by Gerard Vroomen (2009-2010 head of Cervelo Test Team cycling), that 'I have not heard of a rider being tested for the biological passport between the end of the 2010 Tour and April 2011' [23]. This was later supported by Michael Ashenden a member of the UCI passport panel that stated 'It's correct that the observation made by Gerard Vroomen matches with my experience. I have noticed a significant gap between tests in some of the profiles I have reviewed' [24]. This would therefore indicate that despite the justification behind anti-doping policies, their goals are less likely to be achieved if they are not even being performed, irrespective of the issues surrounding the system.

This seems to indicate that there is much controversy as to the justification of anti-doping policies. This is especially true given the fact that the systems, as they currently operate, place a large number of restrictions on the personal liberties and privacy of athletes. Examples of which can be seen with the whereabouts requirement [25] (14.V.18), biological passport [26] (14.VI.120) and the rules governing urine collection [27] (7.2.4.). In fact Kayser, Mauron and Miah [28] suggested that 'current anti-doping measures potentially introduce problems of greater impact than are solved'. Their paper critically assesses current anti-doping policies and concludes that they are in many ways based on a weak foundation. Naturally one would expect by this point in the development of anti-doping systems, the systems (as they currently are) would be finely tuned to ensure that they are effective and efficient in their goals. Furthermore, that they are successful in deterring doping and detecting it when it does occur. The realities are however, unfortunately quite different. There are factors inherent in the sporting systems and the testing practices as they exist that impact the success of anti-doping.

Window of detection

Window of Detection is in reference to the time frame in which a substance remains detectable in a human body before it is broken down/absorbed and it is no longer possible to detect if an illegal substance has been used. Extant literature would seem to indicate that this figure, using the current testing at the disposal of WADA and anti-doping agencies worldwide, would range from as little as 12 hours to a maximum of 120 hours. On the lower end of this scale 12-24 hours. Research conducted by Bidlingmaier, Wu, & Strasburger [29] showed that more contemporary forms of hGH, when administered by subcutaneous methods, return to baseline within 20 hours maximum following administration. They further outline that in some cases the window of these agents, when administered intramuscularly may even be as low as 8 hours. This has serious consequences for detection, particularly when coupled with the apparently increasing method of micro doping. Moreover, micro doping especially with recombinant human erythropoietin (rHuEPO) have been shown to fall into this low window of detectability also [30,31]. It was reported by Asheden et al. [30] that micro dosing reduced the window of detection of rHuEPO to as little as 12 hours. What this means is that should an athlete decide to dope immediately before long distance endurance event, such as the Le Mans 24 hour race, then by the time they are finished any trace of the substance would be removed. More concerning is the combination of these two pieces of research, micro doping with hGH. If intramuscular administration of hGH already has

a window of 8 hours micro doping will reduce this further. This means that doping immediately before a race; particularly an endurance event, such as a cycling stage, would mean that the agent would be undetectable well before the end of the event.

It has been found that for the more commonly found doping agents such as steroids and regular doses of rHuEPO that a greater window of detection is obtained, 48-72 hours [31-33]. The plasticizer di-(2-ethylhexyl) phthalate (DEHP) (not a doping agent but argued as being evidence of blood doping) can also be grouped into this category. Research by Monfort, et al. [34] demonstrated that these metabolites remain in the system only up to 48 hours after infusion.

Finally, even some of the more 'traditional' substances of doping such as hGH when applying contemporary techniques of detection still have a somewhat limited window. It has been reported by Erotokritou-Mulligan, et al., [11] that the use of markers such as type 3 pro-collagen (P-III-P) for the detection of hGH may increase the window of detection to around 120 hours.

It should be pointed out that there is some research which demonstrates a longer window of detection of around 18-20 days. This research relates to some forms of methyltestosterone metabolite M2 [35] and oxandrolone metabolite 17 β -hydroxymethyl-17 α -methyl-18-nor-2-oxa-5 α -androst-13-en-3-on (OX M1) [36]. Yet it should be pointed out that other metabolites of methyltestosterone [35] and the 'parent drug oxandrolone and its isomer epioxandrolone' were only detectable for about 3 days, which supports the findings of other research and justifies the use of the estimated figures in this research. However, in order to provide a more comprehensive view of the situation, calculations for these figures can be found in the proceeding sections.

Test sensitivity

Test sensitivity refers to the accuracy of testing. That is to say, if for example 100 tests were performed on samples with doping agents in them what percentage of them are likely to be classified as containing doping agents. It is next to impossible to have any technique that is 100% accurate, in any and all cases of chemical testing there is some margin for error; false positives are an example of common errors that are known to occur. Upon closer inspection of the literature, which is at times apprehensive to outline the exact percentages of accuracy, one begins to obtain a clearer image of the current situation.

The highest rates of success of doping detection have been reported as being between 60% and 80% success rate. It has been reported by Powrie et al., [37] that these levels could be obtained with cases of the more classical doping substance of hGH, when using N-terminal extension peptide of procollagen type III markers for detection, so contemporary techniques for classical problems. Yet other papers have reported far less encouraging results. Erotokritou-Mulligan et al., [11] reported that other forms of growth hormones such as hGH even when combined with the use of Insulin Growth Factor-1 (IGF-I) and P-III-P only resulted in a success rate of 40%. Worse still (and perhaps a worst case scenario) were the findings by Graham et al., [12], who reported that tests, conducted on both non-steroidal hormones and hGH, in some cases resulted in a successful detection rate of only 10%. This is extremely concerning for those in the fight against doping. These figures would seem to indicate that a majority of testing is at best hit or miss. Thus perhaps many doped athletes are slipping through the cracks.

Doping regime

Doping regime is in reference to the actual frequency of doping

as performed by athletes deciding to partake in the practice. Given the illegality of doping, and the potential for criminal prosecution in some countries including Austria (Gesamte Rechtsvorschrift für Anti-Doping-Bundesgesetz, 2007) [38], France (Code du sport, 2012) [39] and Italy (Disciplina della tutela sanitaria delle attività sportive e della lotta contro il doping, 2000) [40], there is considerable apprehension by some athletes to reveal exactly the doping methods and frequencies used. Given this, information is limited, but some evidence does still exist. Graham et al. [12] reported that the doping regime of an anonymous UK champion was continuous, multiple times per week, that is to say regular doses when 'required' to ensure maximal performance. Further information is either lacking or ambiguous, but it is safe to say that given the intellect of athletes, some will be using doping agent intermittently so to attempt to ensure evasion of detection.

Predictability of testing

Test predictability is the likelihood that an athlete choosing to partake in doping is able to predict when the anti-doping sample will be required. To elaborate, if an athlete chooses to dope, it is highly unlikely they will do so without some level of thought going into both the decision to dope and the decision as to when to use the banned substances. In the case of the latter, the decision as to when to use, will be based in part on the likelihood that they will be tested or not within the window of detectability period. This likelihood can be argued as being primarily based on the past rates of anti-doping sample collection. That is to say how frequently they and other athletes around them have been selected for sample collection. The literature does not and more than likely is not able to list the figures for an athlete's belief of when they will be tested and so alternative source data must be used to make this determination. As such reference to the statistics available from various nation anti-doping agencies (NADA) and the world anti-doping agency is needed to make this determination. These sources demonstrate vastly differing numbers relating the amounts of testing performed on various athletes in their care. It has been reported that these figures range from 2 through to 24 tests a year [39-44]. These figures are dependent on a number of factors. These include the athlete in question, their rates of success in the events they compete, policies of the NADA, and more than likely the economic realities and resources available to the NADA. What this indicates is that the athlete in question is able to make approximate estimates on when they are likely to be tested, for example during a major competition, or before, or more generally when in a month they are likely to receive an out-of-competition test. All of which contributes to their decision making process and as such the predictability of testing.

Method

This research contains two different approaches to assessing the current effectiveness of the anti-doping system; these being a probability and a cost analysis of the current system of testing.

Probability analyses are a useful tool to attempt to gain a better view of probable outcomes based on a set of uncertainties. They are often used, along with costs analyses, as a useful tool for assessment of effectiveness in health system research [43-47]. The initial step required was to conduct research into the factors influencing the successfulness of anti-doping testing using the current system. This was performed by examining extant literature on the topic. Information pertaining to factors involved in anti-doping testing and doping practices used by athletes was collected from official documents by anti-doping agencies, academic papers, media releases etc. Sources are quoted in the information that follows. It was found that an assortment of factors influence the probability doping will be detected, and as such it was necessary to attempt to quantify these

factors. Anti-doping testing does not always result in a positive detection even if an athlete may be engaging in doping. The factors relate to the sporting world impact the actual real life test success. These factors were determined to be as follows based on the literature as outlined previously; a) window of detection, b) test sensitivity, c) doping regime, and d) predictability of testing.

Given the realities, certain conclusions can be made as the necessary parameters to make up the formula to assess probability of success of the anti-doping system. Each of these influences can be considered a variable contributing to the probability of doping detection in a single test. The realities are, a) the window of detection is limited, b) sensitivity of tests is mostly low, c) doping substances may be used intermittently by athletes to help avoid detection, and also d) athletes may guess when a test will occur. The total probability of detection will be a product of probabilities of the four contributing variables, window of detection (W), test sensitivity (S), doping regime (D), and predictability of testing (T). Given this, the second step was to construct a formula demonstrating the likelihood of detection of doping, based on these factors. This formula is as follows:

$$P = W \times S \times D \times T$$

Where:

W = window of detection in hours expressed as a fraction of a week assuming week or 168 hours = 1

S = test sensitivity

D = how often doping occurs, 1.0 being continuous use and fractions indicating intermittent use

T = test predictability per person per week, expressed as the number of tests that could be expected per year divided by the number of weeks in the year (52).

For example a test with a window of detection of 24 hours i.e. 0.14 in a week, with 40% test sensitivity with a person continuously doping i.e. 1.0 in each week, and predictability of 0.25 because random tests occur on average once a month will produce an overall probability of 0.014 of a random test to be successful. This means that the probability of a random test to be unsuccessful is 0.986, close enough to certainty in most situations.

This concept is depicted graphically in Figure 1 and demonstrates

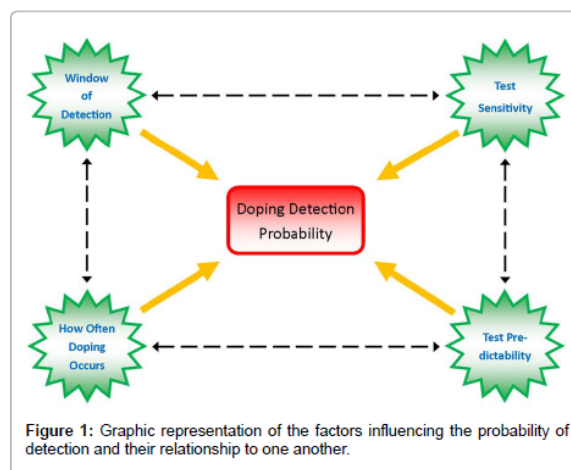


Figure 1: Graphic representation of the factors influencing the probability of detection and their relationship to one another.

the relationship between the four elements and their influence on the probability of doping detection. It shows that each element affecting the probability of doping detection also has an impact on each other element. For example, the window of detectability impacts an athlete's doping regime and test predictability. As too does test sensitivity. An athlete's doping regime is also impacted by the test predictability, and so on (Figure 1).

There are a number of reasons why the literature is apprehensive to reveal definitive numbers pertaining to some of these variables. These reasons include, but are not limited to, the clandestine nature of doping, the lack of dedicated research into each of these components, and apprehension of publication of controversial findings with regard to doping, to name but a few. Thus a range of estimates was used. The estimates used for this research are found in table 1, and are based on the findings in the literature as outlined previously (Table 1).

Similarly, a majority of the substances relate to Androgenic Anabolic Steroid (AAS) and Growth Hormone (GH). EPO, blood doping and stimulants are used and can all be very effective methods of doping. Unfortunately given the somewhat contemporary origins of some of

these substances, the lack of funding for doping research in some cases and the general clandestine nature of doping, research in these area's does not provide sufficient information to make a reliable assumption.

The odds of detection per year were calculated as the inverse of the probability of detection in a single test multiplied by the number of tests during a year. The odds of detection in the entire career were based on the assumption of a career of 15 year duration with the annual probabilities unchanging. Thus these odds were an inverse of 15 times the probability of detection per year times the number of tests per year.

The final step in this research was to conduct a cost analysis. This was done in order to attempt to ascertain the feasibilities of anti-doping testing given the realities of the sporting world. A cost analysis is a useful tool for this as it takes into consideration economic realities from numerous sources and can help paint a more complete and tangible picture of what really is happening in reference to real world economics. Cost (and economics) analyses of doping are useful tools when it comes to assessing sports related expenses, and have been used by a number of internationally renowned experts in sports as a tool for assessing efficiency [48-50].

The analysis for this research was a two-step process. Firstly it was necessary to determine the amount of testing needed to, in all probability, actually detect doping when it occurs. Following this these numbers were then assessed in light of the costs associated with standardized urine testing, with figures available from the Australian Sports Anti-Doping Authority. More details relating to these figures are outlined in the relevant sections following.

Results and Discussion

Odds of doping detection

A series of calculations have been performed using values as established from the literature as were outlined previously in the methods section, these calculations can be seen in Table 2. The column entitled Sport with detection rate matching odds, is an indication of

| Variable | Estimated Values | Drug Types |
|--------------------------------------|---|--|
| Window of detectability | 12 – 24 hours 48 – 72 hours 120 hours | hGH, micro doping rHuEPO common agents, rHuEPO, DEHP new techniques for old agents |
| Test sensitivity | 10% 40% 60-80% | non-steroidal hormones and hGH hGH (with IGF-I, P-III-P) hGH (N-terminal extension peptide of procollagen type III) |
| Doping Regime | 1.0 (continuous) 0.5 (intermittent) | |
| Test predictability (tests per year) | 2 6 9 12 24 | |

Table 1: Doping probability formula parameters, estimates and drug types.

| Window of Detection(hrs) | Test Sensitivity | Doping Regime (weekly) | Test predictability per person per week | Probability of detection in a single test | Number of tests (per year) | Odds of escaping detection | Odds of escaping detection in 15yrs career | Sport with detection rate matching odds |
|--------------------------|------------------|------------------------|---|---|----------------------------|----------------------------|--|---|
| 12 | 0.4 | 1 | 0.25 | 0.0071 | 12 | 12:1 | 1:1 | |
| 18 | 0.4 | 1 | 0.25 | 0.0107 | 12 | 8:1 | 1:1 | |
| 48 | 0.4 | 1 | 0.25 | 0.0286 | 12 | 3:1 | 0:1 | |
| 72 | 0.4 | 1 | 0.25 | 0.0429 | 12 | 2:1 | 0:1 | |
| 120 | 0.4 | 1 | 0.25 | 0.0714 | 12 | 1:1 | 0:1 | |
| 12 | 0.4 | 1 | 0.038 | 0.0011 | 2 | 461:1 | 31:1 | |
| 18 | 0.4 | 1 | 0.038 | 0.0016 | 2 | 307:1 | 20:1 | |
| 48 | 0.4 | 1 | 0.038 | 0.0043 | 2 | 115:1 | 8:1 | Sailing, Athletics |
| 72 | 0.4 | 1 | 0.038 | 0.0065 | 2 | 77:1 | 5:1 | Basketball, Archery, Cycling, Rugby |
| 120 | 0.4 | 1 | 0.038 | 0.0109 | 2 | 46:1 | 3:1 | |
| 12 | 0.8 | 1 | 0.038 | 0.0022 | 2 | 230:1 | 15:1 | |
| 18 | 0.8 | 1 | 0.038 | 0.0033 | 2 | 154:1 | 10:1 | Aquatics, Sailing |
| 48 | 0.8 | 1 | 0.038 | 0.0087 | 2 | 58:1 | 4:1 | Basketball, Cycling |

| | | | | | | | | |
|-----|-----|-----|-------|--------|----|--------|-------|--|
| 72 | 0.8 | 1 | 0.038 | 0.0130 | 2 | 38:1 | 3:1 | |
| 120 | 0.8 | 1 | 0.038 | 0.0217 | 2 | 23:1 | 2:1 | |
| | | | | | | | | |
| 12 | 0.1 | 1 | 0.038 | 0.0003 | 2 | 1842:1 | 123:1 | |
| 18 | 0.1 | 1 | 0.038 | 0.0004 | 2 | 1228:1 | 82:1 | |
| 48 | 0.1 | 1 | 0.038 | 0.0011 | 2 | 461:1 | 31:1 | |
| 72 | 0.1 | 1 | 0.038 | 0.0016 | 2 | 307:1 | 20:1 | |
| 120 | 0.1 | 1 | 0.038 | 0.0027 | 2 | 184:1 | 12:1 | Shooting |
| | | | | | | | | |
| 12 | 0.1 | 0.5 | 0.038 | 0.0001 | 2 | 3684:1 | 246:1 | |
| 18 | 0.1 | 0.5 | 0.038 | 0.0002 | 2 | 2456:1 | 164:1 | |
| 48 | 0.1 | 0.5 | 0.038 | 0.0005 | 2 | 921:1 | 61:1 | |
| 72 | 0.1 | 0.5 | 0.038 | 0.0008 | 2 | 614:1 | 41:1 | Bobsleigh |
| 120 | 0.1 | 0.5 | 0.038 | 0.0014 | 2 | 368:1 | 25:1 | |
| | | | | | | | | |
| 12 | 0.4 | 0.5 | 0.038 | 0.0005 | 2 | 921:1 | 61:1 | |
| 18 | 0.4 | 0.5 | 0.038 | 0.0008 | 2 | 614:1 | 41:1 | Bobsleigh |
| 48 | 0.4 | 0.5 | 0.038 | 0.0022 | 2 | 230:1 | 15:1 | Fencing |
| 72 | 0.4 | 0.5 | 0.038 | 0.0033 | 2 | 154:1 | 10:1 | Aquatics, Athletics |
| 120 | 0.4 | 0.5 | 0.038 | 0.0054 | 2 | 92:1 | 6:1 | Cycling, Rugby |
| | | | | | | | | |
| 12 | 0.4 | 0.5 | 0.25 | 0.0036 | 12 | 23:1 | 2:1 | |
| 18 | 0.4 | 0.5 | 0.25 | 0.0054 | 12 | 16:1 | 1:1 | Bridge |
| 48 | 0.4 | 0.5 | 0.25 | 0.0143 | 12 | 6:1 | 0:1 | Bodybuilding |
| 72 | 0.4 | 0.5 | 0.25 | 0.0214 | 12 | 4:1 | 0:1 | |
| 120 | 0.4 | 0.5 | 0.25 | 0.0357 | 12 | 2:1 | 0:1 | |
| | | | | | | | | |
| 12 | 0.5 | 0.5 | 0.5 | 0.0089 | 24 | 5:1 | 0:1 | |
| 18 | 0.5 | 0.5 | 0.5 | 0.0134 | 24 | 3:1 | 0:1 | |
| 48 | 0.5 | 0.5 | 0.5 | 0.0357 | 24 | 1:1 | 0:1 | |
| 72 | 0.5 | 0.5 | 0.5 | 0.0536 | 24 | 1:1 | 0:1 | |
| 120 | 0.5 | 0.5 | 0.5 | 0.0893 | 24 | 0:1 | 0:1 | |
| | | | | | | | | |
| 12 | 0.4 | 0.5 | 0.125 | 0.0018 | 6 | 93:1 | 6:1 | Triathlon |
| 18 | 0.4 | 0.5 | 0.125 | 0.0027 | 6 | 62:1 | 4:1 | Equestrian, Rugby |
| 48 | 0.4 | 0.5 | 0.125 | 0.0071 | 6 | 23:1 | 2:1 | Boules, Billiards, Motorcycle Racing, Powerlifting |
| 72 | 0.4 | 0.5 | 0.125 | 0.0107 | 6 | 16:1 | 1:1 | Bridge, Sambo |
| 120 | 0.4 | 0.5 | 0.125 | 0.0179 | 6 | 9:1 | 1:1 | |
| | | | | | | | | |
| 12 | 0.4 | 1 | 0.125 | 0.0036 | 6 | 47:1 | 3:1 | Weightlifting, Rollersport, Golf |
| 18 | 0.4 | 1 | 0.125 | 0.0054 | 6 | 31:1 | 2:1 | Airsports |
| 48 | 0.4 | 1 | 0.125 | 0.0143 | 6 | 12:1 | 1:1 | Muay Thai |
| 72 | 0.4 | 1 | 0.125 | 0.0214 | 6 | 8:1 | 1:1 | |
| 120 | 0.4 | 1 | 0.125 | 0.0357 | 6 | 5:1 | 0:1 | |
| | | | | | | | | |
| 12 | 0.4 | 0.5 | 0.188 | 0.0027 | 9 | 41:1 | 3:1 | Weightlifting |

| | | | | | | | | |
|-----|-----|-----|-------|--------|---|------|-----|------------------|
| 18 | 0.4 | 0.5 | 0.188 | 0.0040 | 9 | 28:1 | 2:1 | Morocycle racing |
| 48 | 0.4 | 0.5 | 0.188 | 0.0107 | 9 | 10:1 | 1:1 | |
| 72 | 0.4 | 0.5 | 0.188 | 0.0161 | 9 | 7:1 | 0:1 | |
| 120 | 0.4 | 0.5 | 0.188 | 0.0269 | 9 | 4:1 | 0:1 | |
| 12 | 0.4 | 1.0 | 0.188 | 0.0054 | 9 | 21:1 | 1:1 | Kickboxing |
| 18 | 0.4 | 1.0 | 0.188 | 0.0081 | 9 | 14:1 | 1:1 | Muay Thai |
| 48 | 0.4 | 1.0 | 0.188 | 0.0215 | 9 | 5:1 | 0:1 | Bodybuilding |
| 72 | 0.4 | 1.0 | 0.188 | 0.0322 | 9 | 3:1 | 0:1 | |
| 120 | 0.4 | 1.0 | 0.188 | 0.0537 | 9 | 2:1 | 0:1 | |

Table 2: Probabilities of doping detection.

| Discipline | Adverse Analytical Findings % | Discipline | Adverse Analytical Findings % |
|--------------------------|-------------------------------|-------------------|-------------------------------|
| Aikido | 0.00 | Hockey | 1.32 |
| Air sports | 3.09 | Judo | 1.13 |
| Archery | 1.47 | Kendo | 0.00 |
| Athletics | 0.78 | Kickboxing | 4.97 |
| Baseball | 1.99 | Motorcycle racing | 4.15 |
| Basketball | 1.45 | Muay Thai | 8.11 |
| Biathlon | 0.00 | Netball | 0.83 |
| Billiards | 4.24 | Powerboating | 0.00 |
| Bobsleigh | 0.16 | Powerlifting | 4.88 |
| Bodybuilding and fitness | 18.09 | Rowing | 0.23 |
| Boxing | 1.94 | Rugby | 1.39 |
| Bridge | 6.00 | Skiing | 0.71 |
| Cycling | 1.19 | Sleddog | 3.70 |
| Darts | 2.70 | Weightlifting | 2.42 |
| Football | 0.48 | Wrestling | 1.23 |
| Golf | 2.04 | Wushu | 1.68 |

Table 3: Adverse Analytical Findings % for an assortment of sports [41].

those sports which have a detection rate which coincides to the figures provided by WADA and its adverse analytical findings (Table 3). It was decided to use the WADA adverse analytical finding (AAF) figures instead of Anti-Doping Rule Violation (ADRV) figures as this research relates to the detection of doping agents not justifications of how they entered the athletes' system and thus subsequent legal and ethical considerations (Table 2).

If one were to therefore use a set of commonly encountered values ($W=48$, $S=0.4$, $D=1$ and $T=0.25$) to calculate a probability of doping detection in one random test, one gets $p=0.029$; meaning that in a single test there is only approximately a 2.9% chance of doping being detected.

When this is then extrapolated to yearly detection, if one were to select 12 tests a year as an average, then this results in a detection rate of approximately 34% or an odds ratio of 3:1. This indicates that there is in fact a 66% chance of a doped athlete not being detected, quite good odds for someone willing to take a risk. This calculation is based on an assumption that tests are done completely randomly without prior warning and without predictability. Where an exact date of a test is predictable, the risk of detection would decline even further, even with 12 tests per year. Similarly, if one incorporates the extended window of detection of 21 days, one obtains the following, 21 days x 0.4 sensitivity, intermittent doping of 0.5, and predictability of 0.125, resulting in an overall probability of 0.075 meaning that even in this case there is only a 7.5% chance of being detected in a single test or 92.5% chance of escaping detection. Assuming continuous doping this figure comes down to 85% that is still far away from 50/50 risk taking.

This makes the risk potentially psychologically acceptable to the "doper" [51]. To elaborate, it would seem less likely that an athlete who feels that they have a high probability of getting caught would partake in doping. On the other hand athletes who feel that there is a high probability they will escape detection would be more likely to engage in doping. This is because they may well feel that the result of doping would bring significant rewards without significant risk, the notion of a cost-risk ratio. It can be argued that despite the inherent flaws in the anti-doping systems, this is one feature that provides the most benefit, the impression that anti-doping is effective. Even if it is not, the sheer power of an athlete believing it is may in some cases deter them from engaging. This is the notion of cost-risk ratio, the idea that athletes weigh up the costs of the likelihood of getting caught and the consequence if they do vs. the benefits if they don't. It would seem that as the current anti-doping systems are structured and the problems associated with detection, some athlete may see the benefits significantly outweighing the risks.

However, similarly to this notion of fear and deterrence, there is another element of anti-doping testing which contributes to its effectiveness but is not directly related to success of detection. This concept relates back to Foucault's Panopticon [52] and more recently the work by Haggerty and Ericson's [53] on surveillant assemblage. This notion presents the idea that the panopticon (or other forms of surveillance) results in a decline of undesirable behaviours. One could say it is a form of negative reinforcement. This concept having its origins in a theoretical prison system, purports that an inmate watched or believing they are watched (even if they are not) are less

likely to engage in negative behaviors. This, as it relates to sports, would seem to be reasonable, for even if anti-doping is not effective per se, perhaps the mere existence of testing may deter some athletes from doping for fear they might possibly be caught as they are always being watched. There are, however, two problems that exist here. Firstly, some people prefer the notion of being watched, the idea that it is more of a challenge to 'beat the system'. Secondly, in some areas of the world, capital punishment still exists for certain crimes. Some states of the United States are one such example. Moreover, the United States, being one of the world's, most technologically advanced nations have ample systems of surveillance of its citizens in place, not only video but there are also numerous organizations which exist to this end. Despite this reality, crimes are still committed; murders are still committed, even with the death penalty in place and constant surveillance. The thought that simply watching someone will eliminate the darker sides of human nature is both unrealistic and delusional. It may, in some limited cases, work, but if someone is determined enough to cheat they will find a way despite all the surveillance and punishments possible.

What the above results indicate is that by using current statistics it would seem that the likelihood of being caught doping is somewhere between 0.1 and 10% in a single test. To put this in perspective, the most complete and considered official current statistics pertaining to adverse analytical findings are provided by the World Anti-Doping Agency [54]. These findings, per sport, range anywhere from 0 to about 18% [41]. This would seem to indicate that given the findings of this research, the extent to which doping occurs is very high. Theoretically, using these figures, if one were to assume that 100% of athletes dope, because of the limited window of detection, low test sensitivity and infrequent testing, it is likely to have result in 2.9% of adverse findings only. To elaborate, according to the calculations, if $W=0.29$ (48hours), $S=0.4$, $D=1$ and $T=0.25$, one obtains a 2.9% chance of doping detection in a single test. Therefore if one was to then again refer to the statistics available from WADA a sport with an adverse analytical finding of 2.9% (such as is closely the case with darts) would seem to indicate that given these conditions a vast majority of athletes in that sport were engaged in doping. Assuming tests were completely random and every athlete doped regularly, then the percentage of positive test findings (adverse analytical findings) would be low, roughly corresponding to actual data published by WADA.

This indicates two things. 1) That doping is far more widespread than official figures would lead one to believe and 2) That the current system of anti-doping testing is inadequate to eliminate doping. This supposition is supported by a number of officials [55] in the sporting arena, some athletes [56] and numerous others involved in sports including academics [28,57]. It should be noted that scientific literature does not always quote specific examples. For this reason they must be searched for in websites and popular literature. This is why such examples were used above. Illicit activities can hardly be researched systematically and this is why formal scientific literature does not provide relevant information. As outlined previously it can be said that it appears as though anti-doping policies are in place more for reasons of perceptions and deterrence through fear than for any effective and efficient scientific merit. This lends further support for the assertions by Hermann & Henneberg, [58] as to the relationship both perceptions and image has to modern sports, their participants and anti-doping.

Rates of doping

Table 3 demonstrates current WADA statistics relating to adverse analytical results.

Whilst it should be pointed out that, by WADA's own admission,

| Sport | Adverse Analytical Findings | Corresponding doping characteristics if all athletes dope | | |
|------------|-----------------------------|---|---------------|------------|
| | | Window of Detection | Test Accuracy | Dosage |
| Air Sports | 3.09 | 18 | 40% | Continuous |
| Archery | 1.47 | 48 | 40% | Continuous |
| Baseball | 1.99 | 48 | 40% | Continuous |
| Bobsleigh | 0.16 | 72 | 10% | Interval |
| Cycling | 1.19 | 48 | 80% | Continuous |
| Football | 0.48 | 48 | 40% | Interval |
| Rowing | 0.23 | 48 | 10% | Continuous |

Table 4: Actually reported adverse analytical findings and corresponding possible doping characteristics under assumption that all athletes in a given sport apply doping.

these data are not entirely complete; they do still provide a reasonable approximation of the extent of findings in each discipline. When the figures in Table 3 are compared to the calculations in Table 2, Table 4 can be thus derived.

These comparisons demonstrate the assumptions under which the current doping rates would represent a mere portion of the actual doping rates. Continuous or intermittent in Table 4 are based on those in Table 2. Cycling can be used as one such example; WADA statistics indicate a 1.19% adverse analytical test result for the sport. If we then use the assumption that there is an 48 hour window of detection of the agents used, a 80% accuracy of testing, doping agents are used continuously and athletes can predict testing in a week knowing that they will be tested about 3 times a year, this allows the possibility to calculate that about 100% of cyclists would be participating in doping. This is done in the following manner, 48 hour window ($48/168=0.286$) \times Sensitivity of $0.84 \times$ continuous regime (1.0) \times test predictability $0.0576 = 1.32\%$. If WADA statistics indicate that in cycling just over 1.0% adverse analytical findings are made then this indicates that a significantly higher proportion of athletes in the sport are participating in doping and due to restrictions of the anti-doping system are simply not getting detected. Whilst it is unrealistic to suggest that all cyclists are using doping agents, the suggestion does remain that the figures do not truly represent actual rates of doping. Similar, are the results seen with baseball. Whilst it should be pointed out that this sport historically did not conform to the WADA guidelines for anti-doping testing they still performed some anti-doping tests, some of which are indeed used by other sports. The results are similar to that of cycling. These conclusions are supported by findings of the Mitchell Report which stated that 'the use of steroids in Major League Baseball was widespread' [59]. Moreover, the same report acknowledged the fact that not all substances are detectable (in the case of the Mitchell Report the researchers were referring to hGH) [59]. It also concluded that 'Baseball does not need and cannot afford to engage in a never-ending search for the name of every player who ever used performance enhancing substances' [59]. This could be argued as indicating two things. Firstly, that doping use in Baseball was so widespread it would be next to impossible to make a complete list. Second, perhaps that given the nature of doping detection, clandestine nature of doping and the opposition faced by the researchers [59] such an investigation would be next to impossible.

Testing requirements

The fact that tests are not working well is illustrated by WADA's recent decision to increase the length of doping bans from 2 to 4 years when the 2015 code comes into force in 2015 [60] with the aim of increasing the deterrent effect of the penalty. In law enforcement this practice it is usually performed when detection of a wrongdoing is ineffective. Some research, however, has claimed that increasing the

| Sport | Tests Needed | Approximate Cost |
|------------|--------------|------------------|
| Air Sports | 43 | € 25,112.00 |
| Archery | 22 | € 12,848.00 |
| Baseball | 50 | € 29,200.00 |
| Bobsleigh | 50 | € 29,200.00 |
| Cycling | 16 | € 9,344.00 |
| Football | 30 | € 17,520.00 |
| Rowing | 43 | € 25,112.00 |

Table 5: Doping testing needed (per year per athlete) to reliably detect doping. Based on current WADA figures and doping characteristics as outlined in table 4, and examples of costs per year (using urine tests) per athlete for reliable detection of doping.

penalty for a wrongdoing will have no impact on the criminal behavior [61,62]. On the other hand it could be argued that this increase was to attempt to combat the perceived unfairness of current bans, which could result in Olympic athletes not missing a single Olympics. This, however, would depend on when the ban was passed out. Furthermore, professional sports being what they are currently, it is unlikely that a top level professional athlete after missing 2 seasons would be at the same level of fitness as before, especially race fitness. As such a ban of 2 years would still have an effect on their actual success rate. 4 years may amplify this effect, but one must be careful that if the athlete is to be given a second chance, the length of suspension is not too long.

As such this research demonstrates that a new approach to anti-doping policy is needed. Given the current realities of doping in professional sports, the question remains, what regime is required to begin to combat doping?

Table 5 depicts the number of tests needed per year to detect doping effectively. This was calculated using the figures and assumptions provided in Table 2. The number of tests needed was calculated as an inverse of T (predictability) required to achieve 100% detection with given windows of detection, continuity/intermittency of use and test reliabilities. The results of Table 5 indicate that the number of doping tests in many sports will need to be unrealistically increased in order to effectively combat doping. Indications are such that should anti-doping testing remain unchanged legislation would need to be modified to accommodate the realities of doping. One interesting point worth investigating in Table 5 is the number of yearly tests needed per athlete to detect doping (with relative effectiveness) in cycling. The theoretical figures would seem to indicate 16 tests per year would be sufficient to do so. Currently in cycling, either through the UCI, or the national anti-doping agencies, some athletes would no doubt already submit this many samples. One would normally expect that the most successful and high profile athletes would normally be the ones that would be subjected to such a large number of tests a year. This, however, may be questionable, given the statements outlined previously by Chris Froome and the lack of testing he and other top cyclists experienced. Even if this was an isolated case and testing over that small period was lacking, and throughout the rest of the year testing is extensive why then are many doping cases in cycling being revealed only through self-admission rather than positive tests? One possible argument can be seen with the revelations in the Lance Armstrong case there are a number of other factors which play a role in successful detection. These factors are such that they cannot be easily quantified. These factors include third party involvement, warnings of upcoming testing, role of money etc. It should also be pointed out that if athletes are able to manipulate tests then this would make it even harder to detect doping. This does not necessarily mean tampering with sample collection, or tampering with the samples after collection (which still may occur despite measures taken to prevent this), but rather for example athletes may take doping

agents immediately after testing, knowing that it is unlikely they will be tested again soon. If athletes can partly predict when tests are going to occur and/or can manipulate testing then it will lower probability of detection in a single test and this strengthens this papers argument. There may also be specific effects of the method of doping or testing that would deviate somewhat from the simple calculations.

The cost of effective anti-doping

If one then focuses on the testing required per year, per athlete, for effective detection, the next step is to then extrapolate this into real world financial figures. Put simply, it is necessary to make a cost determination of such an increase in the testing regime and thus a determination of the cost of an effective and efficient means of doping detection.

Furthermore, reference again to Table 5, one can also see the total cost per athlete per year of doping tests needed to reliably detect doping , is on average €21,190.86 (USD 28,676.30). This is an average based upon the number of tests needed which ranges from 16 to 50 depending on the discipline. This uses approximate urine test cost figures as available through Australian Sports Anti-Doping Authority (ASADA) [63] of about €584 (AU\$738, USD 692.59) per test (blood and EPO testing costs are higher). Urine tests were chosen as they are most commonly used test for doping detection and the least expensive. Other testing, such as blood testing, has higher costs associated with it and therefore any calculations would produce greater costs/numbers. There is some argument that blood testing required for the Athletes Biological Passport (ABP) is cheaper, but given the added difficulties in analysis and collecting blood samples, the trained staff needed etc. it seems that in the long run even ABP blood testing would cost more than urine. The lower figures were used in the calculations simply to demonstrate that even at the lowest level the costs associated with effective testing would amount to an astronomical figure. The approximate total cost per year for all athletes in a given nation to be subject to such tests, is subject to the nation in question. If one is to take as an example Germany, and one refers to their website for appropriate data relating to the testing pool, one begins to see the scale. Current data shows that Germany's athletes number around the 4000 [42], this however, does not including the national testing pool of athletes). Given these figures the total funds would need to exceed 84 Million Euros (€84,763,428.57 or about USD\$114,715,721.16). The German National Anti-Doping Associations total annual revenue was €4,570,062 (USD 6,184,576.60) for the year ending 2010 [42], this would result in a €80,193,366.57 (USD 108,514,946.82) shortfall.

What is more, this figure incorporates only the actual cost of tests, it does not take into account the additional costs associated with anti-doping testing. These would include, but not be limited to, hiring sample collection staff, collection materials, Out of Competition travelling for collection, physical resources etc. Therefore, what this shows is that the level of testing needed to effectively detect doping is economically unfeasible. Whilst it is likely true that some of the cost of testing will be borne by the national federations themselves, it does, however, seem highly unlikely that all the levels of funding needed for complete testing will be available given economic realities. Sports may be a lucrative area but there are still realities about real world economics and financing that demonstrate that despite the figures involved, the level of funding needed to make an effective testing regime is infeasible.

Biological passport and forensic testing

One cannot assert to having fully addressed the ineffectiveness of the current anti-doping system without addressing the existence

and usage of both the Athlete Biological Passport (ABP) [64] and an assortment of forensic methods such as hair testing. WADA outlines the ABP as,

The fundamental principle of the Athlete Biological Passport (ABP) is to monitor selected variables ('biomarkers of doping') over time that indirectly reveal the effect of doping, as opposed to the traditional direct detection of doping by analytical doping controls.

In effect the ABP is a tool for keeping track of the changing variables in human physiology. Unlike conventional testing it does not directly determine the existence of doping substances in the body system but instead considers its indirect consequences. This method is often argued as being the next generation in anti-doping testing; a more effective test, one with greater potential than conventional testing [64-66]. Yet there is ample evidence that supports the notion that, like conventional testing, the ABP is far from perfect and as such supports the supposition that current anti-doping is ineffective.

To begin with, there is the debate surrounding indirect testing. It is true that in some cases doping can be detected without directly discovering the substance in the blood. This is done through indirect blood or urine biomarkers [65-67]. However, these same markers can also be an indication of an assortment of other causes from illness, medical assistance, training techniques, physiological uniqueness of an individual etc [68,69]. It does not in every case indicate the use of banned substances. Despite this the athlete still needs to, in effect, prove their innocence. An additional issue with the ABP can be found in the research by Ashenden, Gough, Garnham, Gore & Sharpe [70]. Their research involved the intravenous injection of recombinant human erythropoietin (rhEPO) into 10 subjects for up to 12 weeks. Results of the study found that in microdose amounts EPO was undetectable in the ABP. If the ABP at present is not even detecting what it was introduced to detect then one can quite clearly conclude that it is ineffective.

Further issues with the ABP have been reported in areas one may not normally expect to be such a major factor contributing to ineffectiveness. Banfi [71] has reported the ABP may be affected by an assortment of factors such as:

'Quality control of the instruments is not completely assured. Analytical variability is not appropriately considered in the program. The seasonal changes of the hematological parameters, due to training and competitions, are not calculated. Statistical analysis, based on a Bayesian-like program, not available to the scientific community, does not follow the classical decision making approach of medicine and science.'

All of these factors indicate that at present the ABP has its shortfalls and may in fact currently not be an effective tool for anti-doping, or at least not to the level it should be.

Furthermore, a number of key international experts in the area of cycling have criticised yet another issue with the ABP. As outlined previously, both Gerard Vroemen former head of Cervelo TestTeam and international anti-doping expert Michael Ashenden reported a lack of testing with regard to the ABP. This lack of testing demonstrates that the current system is ineffective; be that because testing is inaccurate, imprecise or simply not occurring (perhaps due to economic reasons). These could explain the drop in extreme blood values in cyclists since the introduction of the ABP. If there are long periods of no testing then of course the more extreme values are likely to be missed.

It has also been argued that there has been more Anti-Doping Rule Violations (ADRVs) in cycling since the introduction of the ABP.

Even if there are more ADRVs in cycling, the actual number of athletes sanctioned because of the ABP remains extremely low. In this regard can it be said that the ABP is having the desired effect? If athletes who are under the ABP are being found to have questionable results, and as such brought up on charges for anti-doping violations, but still are not being sanctioned, then is the program really helping the state of affairs or simply making them worse ?.

In the case of modern forensic testing, there is still some debate as to tests' effectiveness. WADA for example still has not certified the use of forensic testing methods, such as hair analysis, in their anti-doping systems. There are some issues with hair testing. Unlike urine or blood, hair is not always present and available for testing. This can be because of baldness or shaving by the athlete. Similarly, it is simply not possible to detect all the same substances as urine or blood testing does. Or is the decision not to sanction hair testing due to the cost? Would it not cost significantly more (at present) to undertake such analyses? More research is required to ascertain the effectiveness and efficiency of various forms of forensic testing, but the reality is at present that these techniques are not used (for whatever reason) and as such cannot be said to be part of the current anti-doping system. There is one case worth mentioning, the case of Richard Gasquet. In order to clear his name, he ordered an independent hair analysis to determine the presence of cocaine in his system. This was accepted by the Court of Arbitration in Sport (CAS). The reality remains this acceptance was not issued by WADA nor the International Tennis Federation (ITF), and what is more, the test was negative. Gasquet later admitted use but argued it was inadvertent and no fault of his own, this was accepted by the CAS [72]. Overall this brings into question the effectiveness of the hair testing.

Limitation and Future Research

In November 2013 WADA's Foundation Board meeting [73] decided on the introduction of a Steroidal Module into the ABP. This method of profiling may change the effectiveness of the current anti-doping testing. At this point there is too little evidence to determine its current effectiveness and so more testing and time is needed. One can, however, say that if the same problems arise with the Steroidal Module as with haemoglobin; the same scientific issues and ethical issues are involved, then the findings of this research will be strengthened. Similarly if WADA decided to confirm the use of hair and/or similar forensic testing methods, further research will be needed to assess how this may change the effectiveness of anti-doping testing. One key limitation to this research is the difficulty finding specific figures relating the four variables for the formula. The clandestine nature of doping made obtaining exact figures impossible and as such estimates were used. Exact figures would ensure a more complete picture could be painted.

Conclusion

The primary conclusion that can be drawn from this research is that the current system of anti-doping is, given the realities of the sporting world, ineffective at reaching the desired goals. This is assuming the primary goal of the anti-doping system is to eliminate doping, irrespective of whether this is because of the athletes health, fairness and equality or natural ability arguments. Furthermore, it would seem that should the current system of anti-doping remain, significant increases would need to be made in the testing levels; this in turn would require a significant increase in revenue for anti-doping collection and testing. This may be economically impossible and thus other solutions to the ubiquitous problem of doping may need to be sought, outside of

individual scientific tests. The alternative is to invest additional funds into the development of more advanced, efficient and effective tests for the detection of doping. If it were possible to increase the test reliability, the window of detectability and the range of substances that could be detected, this would mean the increase of the number of tests could be more modest. Such an increase may well be affordable. On the other hand, this would still not eliminate the issues with test predictability or corruption and as such further demonstrates the current system needs work in order to become both efficient and effective in deterring and punishing doping. The ABP appears to be the solution to the problem but further analysis reveals that it has its shortcomings just like chemical testing. Overall it would seem that the current system, as it stands, needs to be reconsidered and reworked in order to be effective and efficient.

Acknowledgments

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Appendix C – Overview of media coverage arising from thesis research

| Date | Media Item Type | Media Outlet | Media Outlet State | Media Outlet Location | Program/Section Name | Headline | Summary | Interviewees |
|---------------------|-----------------|--------------|--------------------|-----------------------|----------------------|---|---|--------------|
| 26/07/2013 8:44 | AM Radio | 5AA | SA | Adelaide | Breakfast | Program preview: Mornings with Leon Byner - The SA Government wants the horticulture industry to cover the cost of expanded checking and quarantine facilities for fruit fly. - The child smacking de | Program preview: Mornings with Leon Byner - The SA Government wants the horticulture industry to cover the cost of expanded checking and quarantine facilities for fruit fly. - The child smacking debate. - A PhD student from Adelaide University says drug testing of athletes is pointless. | |
| 26/07/2013 12:08 | Online | NewsMaker | National | National | www.newsmaker.com.au | Anti-doping systems in sport doomed to fail | New research from the University of Adelaide shows that the probability of finding doping cheats in sport is so low, and the cost of testing so high, that sports authorities cannot hope to make any major inroads into the problem. | |
| 26/07/2013 12:13 | AM Radio | 2CC | NSW | Canberra | Afternoons | Smith reports that new Australian research by the University of Adelaide shows drug testing in sport will fail as the chance of catching doping cheats is very low. | Smith reports that new Australian research by the University of Adelaide shows drug testing in sport will fail as the chance of catching doping cheats is very low. | |
| 26/07/2013 12:13 | AM Radio | 4VL | NSW | Charleville | Afternoons | Smith reports that new Australian research by the University of Adelaide shows drug testing in sport will fail as the chance of catching doping cheats is very low. | Smith reports that new Australian research by the University of Adelaide shows drug testing in sport will fail as the chance of catching doping cheats is very low. | |

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| 26/07/2013 12:13 | AM Radio | 2GB | NSW | Sydney | Afternoons | Smith reports that new Australian research by the University of Adelaide shows drug testing in sport will fail as the chance of catching doping cheats is very low. | Smith reports that new Australian research by the University of Adelaide shows drug testing in sport will fail as the chance of catching doping cheats is very low. | |
| 26/07/2013 12:20 | Online | Nine MSN | National | National | wwos.ninemsn.com.au | Drug testing doomed to fail: research says | in sport will fail because the chance of catching doping cheats is so low that authorities can't make inroads into the problem, according to new research. University of Adelaide researchers have examined worldwide data of positive doping tests from 93... | |
| 26/07/2013 12:33 | FM Radio | ABC Tropical North | National | Mackay | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | AM Radio | 702 ABC Sydney | National | Sydney | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | FM Radio | ABC Western Plains NSW | National | Dubbo | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |

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| 26/07/2013 12:33 | AM Radio | ABC Central West NSW | National | Orange | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | FM Radio | ABC Coffs Coast | National | Coffs Harbour | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
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| 26/07/2013 12:33 | AM Radio | ABC New England North West | National | Tamworth | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
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| 26/07/2013 12:33 | AM Radio | Radio National | National | Brisbane | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
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| 26/07/2013 12:33 | AM Radio | ABC South East SA | National | Mt Gambier | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | AM Radio | ABC Riverland SA | National | Renmark | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | AM Radio | ABC South Coast WA | National | Albany | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | AM Radio | ABC South West WA | National | Bunbury | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | AM Radio | ABC Esperance | National | Esperance | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |

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| 26/07/2013 12:33 | AM Radio | ABC Goldfields WA | National | Kalgoorlie | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | AM Radio | ABC Midwest and Wheatbelt | National | Geraldton | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | AM Radio | Radio National | National | Perth | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | AM Radio | 720 ABC Perth | National | Perth | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | FM Radio | ABC Northern Tasmania | National | Launceston | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |

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| 26/07/2013 12:33 | AM Radio | Radio National | National | Hobart | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | AM Radio | 936 ABC Hobart | National | Hobart | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | FM Radio | ABC Darwin | National | Darwin | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | FM Radio | ABC Sunshine and Cooloolo Coasts | National | Sunshine Coast | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | FM Radio | ABC Gold and Tweed Coasts | National | Gold Coast | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |

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| 26/07/2013 12:33 | FM Radio | ABC Mildura - Swan Hill | National | Mildura | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | FM Radio | ABC Riverina | National | Wagga Wagga | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | AM Radio | ABC South East NSW | National | Bega | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | AM Radio | ABC Western Queensland | National | Longreach | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | FM Radio | ABC Wide Bay | National | Bundaberg | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |

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| 26/07/2013 12:33 | FM Radio | ABC North West Qld | National | Mt Isa | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | AM Radio | 666 ABC Canberra | National | Canberra | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | AM Radio | ABC Alice Springs | National | Alice Springs | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | FM Radio | ABC Gippsland | National | Sale | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | AM Radio | ABC Kimberley | National | Broome | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |

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| 26/07/2013 12:33 | AM Radio | ABC North West WA | National | Karratha | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | FM Radio | ABC Central Victoria | National | Bendigo | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | FM Radio | ABC Illawarra | National | Wollongong | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | AM Radio | ABC Eyre Peninsula and West Coast | National | Port Lincoln | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | AM Radio | Radio National | National | Adelaide | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |

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| 26/07/2013 12:33 | AM Radio | Radio National | National | Darwin | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | AM Radio | ABC Western Victoria | National | Horsham | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | FM Radio | ABC Goulburn Murray | National | Wodonga | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | FM Radio | ABC Ballarat | National | Ballarat | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | AM Radio | ABC Great Southern WA | National | Wagin | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |

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| 26/07/2013 12:33 | FM Radio | ABC Central Coast | National | Erina | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | FM Radio | ABC Shepparton | National | Shepparton | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 12:33 | AM Radio | Radio National | National | Canberra | The World Today | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that p | Aaron Hermann, Paper Author, Adelaide University, in an Adelaide University study, has found that anti doping testing is inadequate in eliminating doping. Hermann says doping is more widespread that people may think, adding that in many cases it may be harming athlete's performances. He also says the cost of testing does not justify its effectiveness. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 13:03 | AM Radio | ABC Alice Springs | NT | Alice Springs | 13:00 News | A study by the University of Adelaide reveals evidence that the current system of anti-doping testing in sport is inadequate. The research is based on the positive doping results from around the world | A study by the University of Adelaide reveals evidence that the current system of anti-doping testing in sport is inadequate. The research is based on the positive doping results from around the world across 93 sports. | Aaron Hermann, Paper Author, Adelaide University |
| 26/07/2013 13:03 | FM Radio | ABC Darwin | NT | Darwin | 13:00 News | A study by the University of Adelaide reveals evidence that the current system of anti-doping testing in sport is inadequate. The research is based on the positive doping results from around the world | A study by the University of Adelaide reveals evidence that the current system of anti-doping testing in sport is inadequate. The research is based on the positive doping results from around the world across 93 sports. | Aaron Hermann, Paper Author, Adelaide University |

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| 26/07/2013 12:10 | AM Radio | 5CS | SA | Port Pirie | Mornings | Interview with Aaron Herman, Adelaide University PhD student. Byner says Herman has released a study, claiming that anti-doping systems in sport are doomed. Herman says the system is 'better than n | Interview with Aaron Herman, Adelaide University PhD student. Byner says Herman has released a study, claiming that anti-doping systems in sport are doomed. Herman says the system is 'better than nothing' but is not effectively targeting the problem. He says it would be better to tackle the underlying causes of doping in sport. | Aaron Herman, Adelaide University PHD student |
| 26/07/2013 12:10 | AM Radio | 5RM | SA | Berri | Mornings | Interview with Aaron Herman, Adelaide University PhD student. Byner says Herman has released a study, claiming that anti-doping systems in sport are doomed. Herman says the system is 'better than n | Interview with Aaron Herman, Adelaide University PhD student. Byner says Herman has released a study, claiming that anti-doping systems in sport are doomed. Herman says the system is 'better than nothing' but is not effectively targeting the problem. He says it would be better to tackle the underlying causes of doping in sport. | Aaron Herman, Adelaide University PHD student |
| 26/07/2013 12:10 | AM Radio | 5AA | SA | Adelaide | Mornings | Interview with Aaron Herman, Adelaide University PhD student. Byner says Herman has released a study, claiming that anti-doping systems in sport are doomed. Herman says the system is 'better than n | Interview with Aaron Herman, Adelaide University PhD student. Byner says Herman has released a study, claiming that anti-doping systems in sport are doomed. Herman says the system is 'better than nothing' but is not effectively targeting the problem. He says it would be better to tackle the underlying causes of doping in sport. | Aaron Herman, Adelaide University PHD student |
| 26/07/2013 13:41 | Online | Adelaide Now | National | National | www.adelaidenow.com.au | 'Flawed' drug tests are failing to detect doping athletes, Adelaide University study concludes | DRUG testing in sport is flawed and scores of doping athletes are escaping detection because of poor check systems, an Adelaide University study has suggested. Also in this story News+ Oops! Please register or log in to continue. | |
| 26/07/2013 14:03 | AM Radio | ABC Broken Hill | SA | Broken Hill | 14:00 News | A study has found that full proof drug testing in sport would cost at least \$25,000 per athlete every year. The University of Adelaide study looked at the data of positive doping results from across t | A study has found that full proof drug testing in sport would cost at least \$25,000 per athlete every year. The University of Adelaide study looked at the data of positive doping results from across the world in 93 different sports. Maciej Henneberg, Anatomy Professor, University of Adelaide says the current testing regime in unreliable because of a number of factors. | Maciej Henneberg, Anatomy Professor, University of Adelaide |

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| 26/07/2013 14:03 | AM Radio | ABC North and West SA | SA | Port Pirie | 14:00 News | A study has found that full proof drug testing in sport would cost at least \$25,000 per athlete every year. The University of Adelaide study looked at the data of positive doping results from across t | A study has found that full proof drug testing in sport would cost at least \$25,000 per athlete every year. The University of Adelaide study looked at the data of positive doping results from across the world in 93 different sports. Maciej Henneberg, Anatomy Professor, University of Adelaide says the current testing regime in unreliable because of a number of factors. | Maciej Henneberg, Anatomy Professor, University of Adelaide |
| 26/07/2013 14:03 | AM Radio | ABC South East SA | SA | Mt Gambier | 14:00 News | A study has found that full proof drug testing in sport would cost at least \$25,000 per athlete every year. The University of Adelaide study looked at the data of positive doping results from across t | A study has found that full proof drug testing in sport would cost at least \$25,000 per athlete every year. The University of Adelaide study looked at the data of positive doping results from across the world in 93 different sports. Maciej Henneberg, Anatomy Professor, University of Adelaide says the current testing regime in unreliable because of a number of factors. | Maciej Henneberg, Anatomy Professor, University of Adelaide |
| 26/07/2013 14:03 | AM Radio | ABC Riverland SA | SA | Renmark | 14:00 News | A study has found that full proof drug testing in sport would cost at least \$25,000 per athlete every year. The University of Adelaide study looked at the data of positive doping results from across t | A study has found that full proof drug testing in sport would cost at least \$25,000 per athlete every year. The University of Adelaide study looked at the data of positive doping results from across the world in 93 different sports. Maciej Henneberg, Anatomy Professor, University of Adelaide says the current testing regime in unreliable because of a number of factors. | Maciej Henneberg, Anatomy Professor, University of Adelaide |
| 26/07/2013 14:03 | AM Radio | ABC Eyre Peninsula and West Coast | SA | Port Lincoln | 14:00 News | A study has found that full proof drug testing in sport would cost at least \$25,000 per athlete every year. The University of Adelaide study looked at the data of positive doping results from across t | A study has found that full proof drug testing in sport would cost at least \$25,000 per athlete every year. The University of Adelaide study looked at the data of positive doping results from across the world in 93 different sports. Maciej Henneberg, Anatomy Professor, University of Adelaide says the current testing regime in unreliable because of a number of factors. | Maciej Henneberg, Anatomy Professor, University of Adelaide |

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| 26/07/2013 14:03 | AM Radio | Radio National | SA | Adelaide | 14:00 News | A study has found that full proof drug testing in sport would cost at least \$25,000 per athlete every year. The University of Adelaide study looked at the data of positive doping results from across t | A study has found that full proof drug testing in sport would cost at least \$25,000 per athlete every year. The University of Adelaide study looked at the data of positive doping results from across the world in 93 different sports. Maciej Henneberg, Anatomy Professor, University of Adelaide says the current testing regime in unreliable because of a number of factors. | Maciej Henneberg, Anatomy Professor, University of Adelaide |
| 26/07/2013 14:03 | AM Radio | 891 ABC Adelaide | SA | Adelaide | 14:00 News | A study has found that full proof drug testing in sport would cost at least \$25,000 per athlete every year. The University of Adelaide study looked at the data of positive doping results from across t | A study has found that full proof drug testing in sport would cost at least \$25,000 per athlete every year. The University of Adelaide study looked at the data of positive doping results from across the world in 93 different sports. Maciej Henneberg, Anatomy Professor, University of Adelaide says the current testing regime in unreliable because of a number of factors. | Maciej Henneberg, Anatomy Professor, University of Adelaide |
| 26/07/2013 14:48 | Online | ABC Online | National | National | www.abc.net.au | Cost of foolproof drug tests in sport 'prohibitive' | Researchers say foolproof drug-testing in sport would be prohibitively costly. They estimate it would cost Australia \$25,000 or more annually for each athlete. A University of Adelaide study looked at global data on positive doping results across 93... | |
| 26/07/2013 14:45 | Online | Adelaide Now | National | National | www.adelaidenow.com.au | 'Flawed' drug tests are failing to detect doping athletes, Adelaide University study concludes | DRUG testing in sport is flawed and scores of doping athletes are escaping detection because of poor check systems, an Adelaide University study has suggested. Also in this story Cycling community in shock over O'Grady admission News+ Oops! Please... | |
| 26/07/2013 15:37 | FM Radio | ABC Central Coast | NSW | Erina | Drive | Interview with Rosie Turney(*), ABC about University of Adelaide research on drug use in sports. The research found it is extremely expensive to fully test athletes and drug testing is doomed. | Interview with Rosie Turney(*), ABC about University of Adelaide research on drug use in sports. The research found it is extremely expensive to fully test athletes and drug testing is doomed. | Rosie Turney(*), ABC |

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| 26/07/2013 15:37 | AM Radio | 702 ABC Sydney | NSW | Sydney | Drive | Interview with Rosie Turney(*), ABC about University of Adelaide research on drug use in sports. The research found it is extremely expensive to fully test athletes and drug testing is doomed. | Interview with Rosie Turney(*), ABC about University of Adelaide research on drug use in sports. The research found it is extremely expensive to fully test athletes and drug testing is doomed. | Rosie Turney(*), ABC |
| 26/07/2013 16:03 | AM Radio | ABC Alice Springs | NT | Alice Springs | 16:00 News | A University of Adelaide study has found foolproof drug testing in sport would cost at least \$25,000 per athlete every year. It also found the chance of an athlete being caught after one test was as l | A University of Adelaide study has found foolproof drug testing in sport would cost at least \$25,000 per athlete every year. It also found the chance of an athlete being caught after one test was as low as 3%. | Maciej Henneberg, Anatomy Professor, University of Adelaide |
| 26/07/2013 16:03 | FM Radio | ABC Darwin | NT | Darwin | 16:00 News | A University of Adelaide study has found foolproof drug testing in sport would cost at least \$25,000 per athlete every year. It also found the chance of an athlete being caught after one test was as l | A University of Adelaide study has found foolproof drug testing in sport would cost at least \$25,000 per athlete every year. It also found the chance of an athlete being caught after one test was as low as 3%. | Maciej Henneberg, Anatomy Professor, University of Adelaide |
| 26/07/2013 16:51 | AM Radio | ABC NewsRadio | National | Melbourne | Drive | ABC's Caroline Winter interviews with Aaron Hermann from Adelaide University. A young researcher has found anti-doping testing is inadequate in eliminating doping. An Adelaide University study investi | ABC's Caroline Winter interviews with Aaron Hermann from Adelaide University. A young researcher has found anti-doping testing is inadequate in eliminating doping. An Adelaide University study investigated worldwide data of positive doping tests across 93 sports. The research also found doping is far more widespread than thought and in some sports, dopings not even enhancing performance. Study's co-author Aaron Hermann talks about the research. | Aaron Hermann, Adelaide University |

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| 26/07/2013 16:51 | AM Radio | ABC NewsRadio | National | Brisbane | Drive | ABC's Caroline Winter interviews with Aaron Hermann from Adelaide University. A young researcher has found anti-doping testing is inadequate in eliminating doping. An Adelaide University study investi | ABC's Caroline Winter interviews with Aaron Hermann from Adelaide University. A young researcher has found anti-doping testing is inadequate in eliminating doping. An Adelaide University study investigated worldwide data of positive doping tests across 93 sports. The research also found doping is far more widespread than thought and in some sports, dopings not even enhancing performance. Study's co-author Aaron Hermann talks about the research. | Aaron Hermann, Adelaide University |
| 26/07/2013 16:51 | AM Radio | ABC NewsRadio | National | Adelaide | Drive | ABC's Caroline Winter interviews with Aaron Hermann from Adelaide University. A young researcher has found anti-doping testing is inadequate in eliminating doping. An Adelaide University study investi | ABC's Caroline Winter interviews with Aaron Hermann from Adelaide University. A young researcher has found anti-doping testing is inadequate in eliminating doping. An Adelaide University study investigated worldwide data of positive doping tests across 93 sports. The research also found doping is far more widespread than thought and in some sports, dopings not even enhancing performance. Study's co-author Aaron Hermann talks about the research. | Aaron Hermann, Adelaide University |
| 26/07/2013 16:51 | AM Radio | ABC NewsRadio | National | Perth | Drive | ABC's Caroline Winter interviews with Aaron Hermann from Adelaide University. A young researcher has found anti-doping testing is inadequate in eliminating doping. An Adelaide University study investi | ABC's Caroline Winter interviews with Aaron Hermann from Adelaide University. A young researcher has found anti-doping testing is inadequate in eliminating doping. An Adelaide University study investigated worldwide data of positive doping tests across 93 sports. The research also found doping is far more widespread than thought and in some sports, dopings not even enhancing performance. Study's co-author Aaron Hermann talks about the research. | Aaron Hermann, Adelaide University |
| 26/07/2013 16:51 | FM Radio | ABC NewsRadio | National | Canberra | Drive | ABC's Caroline Winter interviews with Aaron Hermann from Adelaide University. A young researcher has found anti-doping testing is inadequate in eliminating doping. An Adelaide University study investi | ABC's Caroline Winter interviews with Aaron Hermann from Adelaide University. A young researcher has found anti-doping testing is inadequate in eliminating doping. An Adelaide University study investigated worldwide data of positive doping tests across 93 sports. The research also found doping is far more widespread than thought and in some sports, dopings not even enhancing performance. Study's co-author Aaron Hermann talks about the research. | Aaron Hermann, Adelaide University |

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| 26/07/2013 16:51 | AM Radio | ABC NewsRadio | National | Newcastle | Drive | ABC's Caroline Winter interviews with Aaron Hermann from Adelaide University. A young researcher has found anti-doping testing is inadequate in eliminating doping. An Adelaide University study investi | ABC's Caroline Winter interviews with Aaron Hermann from Adelaide University. A young researcher has found anti-doping testing is inadequate in eliminating doping. An Adelaide University study investigated worldwide data of positive doping tests across 93 sports. The research also found doping is far more widespread than thought and in some sports, dopings not even enhancing performance. Study's co-author Aaron Hermann talks about the research. | Aaron Hermann, Adelaide University |
| 26/07/2013 16:51 | FM Radio | ABC NewsRadio | National | Gold Coast | Drive | ABC's Caroline Winter interviews with Aaron Hermann from Adelaide University. A young researcher has found anti-doping testing is inadequate in eliminating doping. An Adelaide University study investi | ABC's Caroline Winter interviews with Aaron Hermann from Adelaide University. A young researcher has found anti-doping testing is inadequate in eliminating doping. An Adelaide University study investigated worldwide data of positive doping tests across 93 sports. The research also found doping is far more widespread than thought and in some sports, dopings not even enhancing performance. Study's co-author Aaron Hermann talks about the research. | Aaron Hermann, Adelaide University |
| 26/07/2013 16:51 | AM Radio | ABC NewsRadio | National | Sydney | Drive | ABC's Caroline Winter interviews with Aaron Hermann from Adelaide University. A young researcher has found anti-doping testing is inadequate in eliminating doping. An Adelaide University study investi | ABC's Caroline Winter interviews with Aaron Hermann from Adelaide University. A young researcher has found anti-doping testing is inadequate in eliminating doping. An Adelaide University study investigated worldwide data of positive doping tests across 93 sports. The research also found doping is far more widespread than thought and in some sports, dopings not even enhancing performance. Study's co-author Aaron Hermann talks about the research. | Aaron Hermann, Adelaide University |

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| 26/07/2013 13:03 | FM Radio | Triple M | SA | Adelaide | 13:00 News | Local research into worldwide data of drug testing shows the chance of catching doping cheats is so low, authorities will struggle to get on top of the programme. Adelaide University experts say one s | Local research into worldwide data of drug testing shows the chance of catching doping cheats is so low, authorities will struggle to get on top of the programme. Adelaide University experts say one single drug test will catch a drug cheat 2.9% of the time. | |
| 26/07/2013 17:35 | Online | Herald Sun | National | National | www.heraldsun.com.au | 'Flawed' drug tests are failing to detect doping athletes, Adelaide University study concludes | DRUG testing in sport is flawed and scores of doping athletes are escaping detection because of poor check systems, an Adelaide University study has suggested. Keywords: check systems, performance-enhancing drugs, DRUG testing, yellow leader, testing.. | |
| 26/07/2013 18:09 | TV | WIN Riverland | SA | Berri | National Nine News | The Australian Olympic Committee has sacked Stuart O'Grady from the athletes Commission, and the Port Adelaide football club has dumped him as an ambassador. It comes as his oldest cycling rival, Brett Aitken, comes to terms with his shock admission of doping. An Adelaide University study has found anti-doping programmes have a detection rate of 33%. | The Australian Olympic Committee has sacked Stuart O'Grady from the athletes Commission, and the Port Adelaide football club has dumped him as an ambassador. It comes as his oldest cycling rival, Brett Aitken, comes to terms with his shock admission of doping. An Adelaide University study has found anti-doping programmes have a detection rate of 33%. | Aaron Hermann, Adelaide University Brett Aitken, cyclist |
| 26/07/2013 18:09 | TV | WIN Nine Mt Gambier | SA | Mt Gambier | National Nine News | The Australian Olympic Committee has sacked Stuart O'Grady from the athletes Commission, and the Port Adelaide football club has dumped him as an ambassador. It comes as his oldest cycling rival, Bret | The Australian Olympic Committee has sacked Stuart O'Grady from the athletes Commission, and the Port Adelaide football club has dumped him as an ambassador. It comes as his oldest cycling rival, Brett Aitken, comes to terms with his shock admission of doping. An Adelaide University study has found anti-doping programmes have a detection rate of 33%. | Aaron Hermann, Adelaide University Brett Aitken, cyclist |
| 26/07/2013 18:09 | TV | Channel 9 | SA | Adelaide | National Nine News | The Australian Olympic Committee has sacked Stuart O'Grady from the athletes Commission, and the Port Adelaide football club has dumped him as an ambassador. It comes as his oldest cycling rival, Bret | The Australian Olympic Committee has sacked Stuart O'Grady from the athletes Commission, and the Port Adelaide football club has dumped him as an ambassador. It comes as his oldest cycling rival, Brett Aitken, comes to terms with his shock admission of doping. An Adelaide University study has found anti-doping programmes have a detection rate of 33%. | Aaron Hermann, Adelaide University Brett Aitken, cyclist |

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| 26/07/2013 18:56 | Online | Yahoo! News Australia | National | National | au.news.yahoo.com | Drug cheats slipping through, research shows | In the wake of Stuart O'Grady's doping bombshell, Adelaide researchers say the majority of sporting cheats are slipping through the net. An Adelaide University study has found it is far too easy for athletes to beat the current testing regime, but... | |
| 26/07/2013 19:02 | Online | Herald Sun | National | National | www.heraldsun.com.au | 'Flawed' drug tests are failing to detect doping athletes, Adelaide University study concludes | DRUG testing in sport is flawed and scores of doping athletes are escaping detection because of poor check systems, an Adelaide University study has suggested. Keywords: official anti-doping data, testing regimes, authorities struggle, uphill battle... | |
| 26/07/2013 18:07 | TV | Southern Cross GTS/BKN Broken Hill | SA | Port Pirie | Seven News | Local researchers say the majority of sporting cheats are slipping through the net. An Adelaide University Analysis from the World Anti Doping Agency has found screening for drug cheats across nearly | Local researchers say the majority of sporting cheats are slipping through the net. An Adelaide University Analysis from the World Anti Doping Agency has found screening for drug cheats across nearly 100 sports is failing. They say athletes are not tested often enough. Port Adelaide has axed Stuart O'Grady from his role as a club ambassador and the Australian Olympic Committee fired O'Grady. Lance Armstrong, fmr Cyclist is facing similar problems. Live Strong Cancer Charity is struggling from falls in donations. | Aaron Hermann, Researcher Peter Campbell, Lawyer Prof Maciej Henneberg, Researcher |
| 26/07/2013 18:07 | TV | Central GTS/BKN Port Pirie | SA | Spencer Gulf | Seven News | Local researchers say the majority of sporting cheats are slipping through the net. An Adelaide University Analysis from the World Anti Doping Agency has found screening for drug cheats across nearly | Local researchers say the majority of sporting cheats are slipping through the net. An Adelaide University Analysis from the World Anti Doping Agency has found screening for drug cheats across nearly 100 sports is failing. They say athletes are not tested often enough. Port Adelaide has axed Stuart O'Grady from his role as a club ambassador and the Australian Olympic Committee fired O'Grady. Lance Armstrong, fmr Cyclist is facing similar problems. Live Strong Cancer Charity is struggling from falls in donations. | Aaron Hermann, Researcher Peter Campbell, Lawyer Prof Maciej Henneberg, Researcher |

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| 26/07/2013 18:07 | TV | Central GTS/BKN Port Lincoln | SA | Port Lincoln | Seven News | Local researchers say the majority of sporting cheats are slipping through the net. An Adelaide University Analysis from the World Anti Doping Agency has found screening for drug cheats across nearly | Local researchers say the majority of sporting cheats are slipping through the net. An Adelaide University Analysis from the World Anti Doping Agency has found screening for drug cheats across nearly 100 sports is failing. They say athletes are not tested often enough. Port Adelaide has axed Stuart O'Grady from his role as a club ambassador and the Australian Olympic Committee fired O'Grady. Lance Armstrong, fmr Cyclist is facing similar problems. Live Strong Cancer Charity is struggling from falls in donations. | Aaron Hermann, Researcher Peter Campbell, Lawyer Prof Maciej Henneberg, Researcher |
| 26/07/2013 18:07 | TV | Channel 7 | SA | Adelaide | Seven News | Local researchers say the majority of sporting cheats are slipping through the net. An Adelaide University Analysis from the World Anti Doping Agency has found screening for drug cheats across nearly | Local researchers say the majority of sporting cheats are slipping through the net. An Adelaide University Analysis from the World Anti Doping Agency has found screening for drug cheats across nearly 100 sports is failing. They say athletes are not tested often enough. Port Adelaide has axed Stuart O'Grady from his role as a club ambassador and the Australian Olympic Committee fired O'Grady. Lance Armstrong, fmr Cyclist is facing similar problems. Live Strong Cancer Charity is struggling from falls in donations. | Aaron Hermann, Researcher Peter Campbell, Lawyer Prof Maciej Henneberg, Researcher |

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| 26/07/2013 19:18 | TV | ABC1 | SA | Adelaide | ABC News | A study released by The University of Adelaide has shown that the chances of an athlete testing positive to performance enhancing drugs is as low as 3%. This comes after Stuart O'Grady admitted to dop | A study released by The University of Adelaide has shown that the chances of an athlete testing positive to performance enhancing drugs is as low as 3%. This comes after Stuart O'Grady admitted to doping. The World Anti Doping Authority statistics were used in the study. ASADA released a statement saying it realises that testing alone is not enough. | Aaron Herman, Report Author Prof Maciej Henneberg, University of Adelaide |
| 26/07/2013 20:40 | Online | Brisbane Times | National | National | www.brisbanetimes.com.au | Cheats can't be beaten, says study | Drug testing in sport will fail because the chance of catching cheats is so low that authorities can't make inroads into the problem, according to new research. The University of Adelaide has examined worldwide data of positive doping tests from 93... | |
| 27/07/2013 0:00 | Print | Adelaide Advertiser | SA | Adelaide | Sport | Testing for drugs 'doomed to fail' | | |
| 27/07/2013 0:00 | Print | Sydney Morning Herald | NSW | Sydney | Sport | Cheats can't be beaten, says study | | |
| 27/07/2013 0:00 | Print | The New Straits Times | KL | Malaysia | Sport | Doping controls doomed to fail | | |
| 27/07/2013 7:18 | TV | ABC News 24 | National | Melbourne | ABC News (Saturday) | A study by the University of Adelaide has found the chance of an athlete testing positive to performance enhancing drugs is as low as 3%. The report was released just 24 hours after Stuart O'Grady adm | A study by the University of Adelaide has found the chance of an athlete testing positive to performance enhancing drugs is as low as 3%. The report was released just 24 hours after Stuart O'Grady admitted doping in the 1998 Tour De France. Aaron Hermann, Report Author says athletes are able to avoid detection by timing their doping regimes. Prof Maciej Henneberg, University of Adelaide says the window of detection of many substances is very short. ASADA says testing alone is not enough, and must be combined with intelligence gathering to effectively detect doping. | Aaron Hermann, Report Author Prof Maciej Henneberg, University of Adelaide |

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| 27/07/2013 7:18 | TV | ABC News 24 | National | Regional NSW | ABC News (Saturday) | A study by the University of Adelaide has found the chance of an athlete testing positive to performance enhancing drugs is as low as 3%. The report was released just 24 hours after Stuart O'Grady adm | A study by the University of Adelaide has found the chance of an athlete testing positive to performance enhancing drugs is as low as 3%. The report was released just 24 hours after Stuart O'Grady admitted doping in the 1998 Tour De France. Aaron Hermann, Report Author says athletes are able to avoid detection by timing their doping regimes. Prof Maciej Henneberg, University of Adelaide says the window of detection of many substances is very short. ASADA says testing alone is not enough, and must be combined with intelligence gathering to effectively detect doping. | Aaron Hermann, Report Author Prof Maciej Henneberg, University of Adelaide |
| 27/07/2013 7:18 | TV | ABC News 24 | National | Brisbane | ABC News (Saturday) | A study by the University of Adelaide has found the chance of an athlete testing positive to performance enhancing drugs is as low as 3%. The report was released just 24 hours after Stuart O'Grady adm | A study by the University of Adelaide has found the chance of an athlete testing positive to performance enhancing drugs is as low as 3%. The report was released just 24 hours after Stuart O'Grady admitted doping in the 1998 Tour De France. Aaron Hermann, Report Author says athletes are able to avoid detection by timing their doping regimes. Prof Maciej Henneberg, University of Adelaide says the window of detection of many substances is very short. ASADA says testing alone is not enough, and must be combined with intelligence gathering to effectively detect doping. | Aaron Hermann, Report Author Prof Maciej Henneberg, University of Adelaide |
| 27/07/2013 7:18 | TV | ABC News 24 | National | Adelaide | ABC News (Saturday) | A study by the University of Adelaide has found the chance of an athlete testing positive to performance enhancing drugs is as low as 3%. The report was released just 24 hours after Stuart O'Grady adm | A study by the University of Adelaide has found the chance of an athlete testing positive to performance enhancing drugs is as low as 3%. The report was released just 24 hours after Stuart O'Grady admitted doping in the 1998 Tour De France. Aaron Hermann, Report Author says athletes are able to avoid detection by timing their doping regimes. Prof Maciej Henneberg, University of Adelaide says the window of detection of many substances is very short. ASADA says testing alone is not enough, and must be combined with intelligence gathering to effectively detect doping. | Aaron Hermann, Report Author Prof Maciej Henneberg, University of Adelaide |

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| 27/07/2013 7:18 | TV | ABC News 24 | National | Perth | ABC News (Saturday) | A study by the University of Adelaide has found the chance of an athlete testing positive to performance enhancing drugs is as low as 3%. The report was released just 24 hours after Stuart O'Grady adm | A study by the University of Adelaide has found the chance of an athlete testing positive to performance enhancing drugs is as low as 3%. The report was released just 24 hours after Stuart O'Grady admitted doping in the 1998 Tour De France. Aaron Hermann, Report Author says athletes are able to avoid detection by timing their doping regimes. Prof Maciej Henneberg, University of Adelaide says the window of detection of many substances is very short. ASADA says testing alone is not enough, and must be combined with intelligence gathering to effectively detect doping. | Aaron Hermann, Report Author Prof Maciej Henneberg, University of Adelaide |
| 27/07/2013 7:18 | TV | ABC News 24 | National | Regional Queensland | ABC News (Saturday) | A study by the University of Adelaide has found the chance of an athlete testing positive to performance enhancing drugs is as low as 3%. The report was released just 24 hours after Stuart O'Grady adm | A study by the University of Adelaide has found the chance of an athlete testing positive to performance enhancing drugs is as low as 3%. The report was released just 24 hours after Stuart O'Grady admitted doping in the 1998 Tour De France. Aaron Hermann, Report Author says athletes are able to avoid detection by timing their doping regimes. Prof Maciej Henneberg, University of Adelaide says the window of detection of many substances is very short. ASADA says testing alone is not enough, and must be combined with intelligence gathering to effectively detect doping. | Aaron Hermann, Report Author Prof Maciej Henneberg, University of Adelaide |
| 27/07/2013 7:18 | TV | ABC News 24 | National | Hobart | ABC News (Saturday) | A study by the University of Adelaide has found the chance of an athlete testing positive to performance enhancing drugs is as low as 3%. The report was released just 24 hours after Stuart O'Grady adm | A study by the University of Adelaide has found the chance of an athlete testing positive to performance enhancing drugs is as low as 3%. The report was released just 24 hours after Stuart O'Grady admitted doping in the 1998 Tour De France. Aaron Hermann, Report Author says athletes are able to avoid detection by timing their doping regimes. Prof Maciej Henneberg, University of Adelaide says the window of detection of many substances is very short. ASADA says testing alone is not enough, and must be combined with intelligence gathering to effectively detect doping. | Aaron Hermann, Report Author Prof Maciej Henneberg, University of Adelaide |

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| 27/07/2013 7:18 | TV | ABC News 24 | National | Canberra | ABC News (Saturday) | A study by the University of Adelaide has found the chance of an athlete testing positive to performance enhancing drugs is as low as 3%. The report was released just 24 hours after Stuart O'Grady adm | A study by the University of Adelaide has found the chance of an athlete testing positive to performance enhancing drugs is as low as 3%. The report was released just 24 hours after Stuart O'Grady admitted doping in the 1998 Tour De France. Aaron Hermann, Report Author says athletes are able to avoid detection by timing their doping regimes. Prof Maciej Henneberg, University of Adelaide says the window of detection of many substances is very short. ASADA says testing alone is not enough, and must be combined with intelligence gathering to effectively detect doping. | Aaron Hermann, Report Author Prof Maciej Henneberg, University of Adelaide |
| 27/07/2013 7:18 | TV | ABC News 24 | National | Regional Victoria | ABC News (Saturday) | A study by the University of Adelaide has found the chance of an athlete testing positive to performance enhancing drugs is as low as 3%. The report was released just 24 hours after Stuart O'Grady adm | A study by the University of Adelaide has found the chance of an athlete testing positive to performance enhancing drugs is as low as 3%. The report was released just 24 hours after Stuart O'Grady admitted doping in the 1998 Tour De France. Aaron Hermann, Report Author says athletes are able to avoid detection by timing their doping regimes. Prof Maciej Henneberg, University of Adelaide says the window of detection of many substances is very short. ASADA says testing alone is not enough, and must be combined with intelligence gathering to effectively detect doping. | Aaron Hermann, Report Author Prof Maciej Henneberg, University of Adelaide |
| 27/07/2013 7:18 | TV | ABC News 24 | National | Albany | ABC News (Saturday) | A study by the University of Adelaide has found the chance of an athlete testing positive to performance enhancing drugs is as low as 3%. The report was released just 24 hours after Stuart O'Grady adm | A study by the University of Adelaide has found the chance of an athlete testing positive to performance enhancing drugs is as low as 3%. The report was released just 24 hours after Stuart O'Grady admitted doping in the 1998 Tour De France. Aaron Hermann, Report Author says athletes are able to avoid detection by timing their doping regimes. Prof Maciej Henneberg, University of Adelaide says the window of detection of many substances is very short. ASADA says testing alone is not enough, and must be combined with intelligence gathering to effectively detect doping. | Aaron Hermann, Report Author Prof Maciej Henneberg, University of Adelaide |

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| 27/07/2013 7:18 | TV | ABC News 24 | National | Sydney | ABC News (Saturday) | A study by the University of Adelaide has found the chance of an athlete testing positive to performance enhancing drugs is as low as 3%. The report was released just 24 hours after Stuart O'Grady adm | A study by the University of Adelaide has found the chance of an athlete testing positive to performance enhancing drugs is as low as 3%. The report was released just 24 hours after Stuart O'Grady admitted doping in the 1998 Tour De France. Aaron Hermann, Report Author says athletes are able to avoid detection by timing their doping regimes. Prof Maciej Henneberg, University of Adelaide says the window of detection of many substances is very short. ASADA says testing alone is not enough, and must be combined with intelligence gathering to effectively detect doping. | Aaron Hermann, Report Author Prof Maciej Henneberg, University of Adelaide |
| 27/07/2013 8:50 | TV | ABC News 24 | National | Melbourne | Weekend Breakfast | A University of Adelaide study has revealed the chances of a cheating athlete testing positive to performance enhancing drugs is as low as 3%. Stuart O'Grady, Former Cyclist, has admitted to doping be | A University of Adelaide study has revealed the chances of a cheating athlete testing positive to performance enhancing drugs is as low as 3%. Stuart O'Grady, Former Cyclist, has admitted to doping before the 1998 Tour de France. Athletes would have to be tested up to 50 times per year to get a 100% rate of detection, costing \$25 000 per athlete. ASADA says that testing must be coupled with intelligence-gathering to detect doping in sport. | Aaron Hermann, Report Author Maciej Henneberg, University of Adelaide |
| 27/07/2013 8:50 | TV | ABC News 24 | National | Regional NSW | Weekend Breakfast | A University of Adelaide study has revealed the chances of a cheating athlete testing positive to performance enhancing drugs is as low as 3%. Stuart O'Grady, Former Cyclist, has admitted to doping be | A University of Adelaide study has revealed the chances of a cheating athlete testing positive to performance enhancing drugs is as low as 3%. Stuart O'Grady, Former Cyclist, has admitted to doping before the 1998 Tour de France. Athletes would have to be tested up to 50 times per year to get a 100% rate of detection, costing \$25 000 per athlete. ASADA says that testing must be coupled with intelligence-gathering to detect doping in sport. | Aaron Hermann, Report Author Maciej Henneberg, University of Adelaide |

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| 27/07/2013 8:50 | TV | ABC News 24 | National | Brisbane | Weekend Breakfast | A University of Adelaide study has revealed the chances of a cheating athlete testing positive to performance enhancing drugs is as low as 3%. Stuart O'Grady, Former Cyclist, has admitted to doping be | A University of Adelaide study has revealed the chances of a cheating athlete testing positive to performance enhancing drugs is as low as 3%. Stuart O'Grady, Former Cyclist, has admitted to doping before the 1998 Tour de France. Athletes would have to be tested up to 50 times per year to get a 100% rate of detection, costing \$25 000 per athlete. ASADA says that testing must be coupled with intelligence-gathering to detect doping in sport. | Aaron Hermann, Report Author Maciej Henneberg, University of Adelaide |
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| 27/07/2013 8:50 | TV | ABC News 24 | National | Regional Queensland | Weekend Breakfast | A University of Adelaide study has revealed the chances of a cheating athlete testing positive to performance enhancing drugs is as low as 3%. Stuart O'Grady, Former Cyclist, has admitted to doping be | A University of Adelaide study has revealed the chances of a cheating athlete testing positive to performance enhancing drugs is as low as 3%. Stuart O'Grady, Former Cyclist, has admitted to doping before the 1998 Tour de France. Athletes would have to be tested up to 50 times per year to get a 100% rate of detection, costing \$25 000 per athlete. ASADA says that testing must be coupled with intelligence-gathering to detect doping in sport. | Aaron Hermann, Report Author Maciej Henneberg, University of Adelaide |
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| 29/07/2013 6:48 | AM Radio | SBS Ethnic Radio | National | Melbourne | World News Australia | The University of Adelaide has found anti doping testing is inadequate, expensive and frequently inaccurate. Professor Maciej Henneberg has investigated world wide data of positive results of doping t | The University of Adelaide has found anti doping testing is inadequate, expensive and frequently inaccurate. Professor Maciej Henneberg has investigated world wide data of positive results of doping tests across 93 different sports. Henneberg says although sports authorities have created the perception of being tough on drugs, in reality, they are losing the doping war. He says it is difficult to find people who are doping and this is because the tests are unreliable. He discusses the window of detect abilities testing how long the doping substance remains in the body of an athlete. He says single, random drug tests caught cheats only about 3% of the time. He says we need to have a public pressure for drug use to be so unacceptable. | Professor Maciej Henneberg, University of Adelaide |
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| 30/07/2013 7:06 | AM Radio | 5AA | SA | Adelaide | Breakfast | Conlon comments on doping and sport saying that it really challenges peoples picture of their heroes. He comments on Stuart O'Grady, top sprinters and the whole Essendon saga. He says on top of the th | Conlon comments on doping and sport saying that it really challenges peoples picture of their heroes. He comments on Stuart O'Grady, top sprinters and the whole Essendon saga. He says on top of the that there is a report from the University of Adelaide about doping questioning how well the doping regime works. He introduces Professor Maciej Henneberg, University of Adelaide who says that what they found was that the probability of detection of cheating in sports is low. He comments that if testing occurs once a month then the chances that somebody who is actually doping will be detected in a single round of test are about 3%. He comments that Australian Anti-Doping Agency and World Anti-Doping Agency and various other agencies are doing a good job however as they create a perception that cheaters will be caught. He admits that to increase the rate of detection would require testing much more often would increase the price greatly. He says that anti-doping systems are not keeping up well with the new enhancing drugs that are appearing since micro-doping is very common which has low window of detectability. He says it is possible for a cyclist to take something to improve his improvement before it starts and when he finishes the race the substance will already be gone from his body. He says he believes the anti-doping agencies will eventually catch up however he believes that the sporting culture will need to be very profoundly change. | Professor Maciej Henneberg, University of Adelaide |
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