
INTERVENTION

An Evaluation of the Decision by World Athletics on Whether or Not to Ban the Nike Vapor Fly Racing Shoe in 2020

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Nike developed the VaporFly 4% racing shoe as part of the 2017 Breaking-2 Project. The designation of 4% within the VaporFly name, as well as results from elite and recreational runners, indicate that the shoe provides a conferred advantage of 4% in race settings over leading competitor brands (Reynolds 2018). Mounting evidence suggests that there is validity to this claim and that it is more than just a marketing gimmick intended to create hype and boost sales. Since October of 2019, World Athletics has been rumoured to be drafting legislation to limit specifications of racing shoes (Francis 2019) in order to mitigate any advantage the VaporFly may provide to athletes. An official ruling came down from World Athletics on 31 January 2020 that amends the rules for governing competition shoes for elite athletes (World Athletics 2020). The rule change addresses aspects of the VaporFly technology and aims to clear up future issues on racing shoe specifications. In this intervention we highlight important factors that World Athletics considered in its decision and how the ruling will impact athletics.

Keywords: running; marathon; Vaporfly; regulations; racing shoe; World Athletics

Introduction

The Nike VaporFly was designed and worn by athletes as part of the Breaking-2 Project, a Nike sponsored undertaking seeking to lower the marathon world record below two-hours (Rhodes 2017). As part of the Breaking-2 project, every aspect of the VaporFly shoe was designed to improve a runner's economy by approximately 4%. Nike narrowly missed the two-hour mark during the Breaking-2 project's first attempt in Italy, on a Monza track. Nike then released the VaporFly to the public in the summer of 2017. The VaporFly retail price of \$250 per pair was not a deterrent to avid runners who rushed to purchase them. The high sales demand quickly made the VaporFly one of 2017's most popular and hard-to-get shoes. The scarcity of the VaporFly at retail outlets caused athletes to push the market value up and pay considerably greater sums, as much as \$1,000 or more, for the shoes through resale sites (Abbate 2017). The early success of the VaporFly proved to be more than just hype. Peer-reviewed research indicated that prototypes, tested on elite athletes, did in fact lower the energetic cost of running by approximately 4%. The authors made a bold prediction that top marathon runners wearing the VaporFly could run substantially faster and would be the first athletes to run under two-hours in the marathon (Hoogkamer et al. 2017). This prediction was accurate and came a full two-years before Eliud Kipchoge wore the AlphaFly, a VaporFly iteration, while completing the marathon in 1:59:41. Kipchoge's feat during the INEOS 1:59 Challenge with the AlphaFly, as well as the success of the VaporFly, are what led to the recent 31 January 2020 World Athletics decision regarding competitive racing shoes for elite athletes.

Advantage Provided

The first, and most obvious, question that World Athletics faced was addressing whether the VaporFly conferred a real, and unfair, advantage or whether the shoe was just a marketing gimmick used to create hype. According to a randomized crossover study performed in 2019 on highly trained male and female distance runners, the VaporFly significantly improves running economy (Barnes 2019). Runners were asked to perform a series of time trials wearing each of the following three shoes: the VaporFly, track spikes, and the leading competitive racing shoe. Running economy in the VaporFly was better than in either of the other shoes. The VaporFly improved running economy by 2.5% and 4.2% when compared to the track spike and the leading competitor's racing shoe, respectively.

Improving an individual's running economy can have a positive impact on athletic performance. Improvement of running economy, however, does not necessarily constitute an unfair advantage. This is true even if the improvement

in running economy comes through the use of advances in shoe technology. The mechanism by which the running economy is improved is an important consideration to make. Hunter et al. performed a study investigating running economy and biomechanics in marathon racing shoes (Hunter et al. 2019). In this study the VaporFly improved running economy by two methods. The first improvement made by the VaporFly was conferred by physiological means. Wearing the VaporFly reduced the oxygen uptake required to run at a sustained pace of approximately 6-minutes-per-mile. The second improvement the VaporFly conferred was by biomechanical means. The VaporFly significantly changed an individual's running economy by varying their stride length, plantar flexion velocity, and centre of mass vertical oscillation while running at 6-minutes-per-mile in comparison to the test shoes. This second, biomechanical mechanism, was likely looked at closely by World Athletics when considering updates to the rules and standards of the sport.

The specific process through which the Nike VaporFly improves running economy is just beginning to be understood. The most recent peer-review literature on the subject indicates that the VaporFly improves running economy from the interaction between the superior energy storage (and return) of the 'React foam with the lever-like effects of the carbon-fibre plate in the midsole. Together the two create a stiffening effect on the metatarsal phalangeal joint that likely leads to the observed biomechanical improvement on running economy (Hoogkamer 2019).

VaporFly in Action

According to the limited peer-reviewed literature available, the VaporFly shoe appears to improve the running economy of elite athletes. In practice this advantage extends to the masses. As reported by the *New York Times*, a competitor wearing the VaporFly ran 4-to-5% faster than a runner wearing average shoes, and 2-to-3% faster than runners wearing the leading competitive racing shoe (Quealy and Katz 2019). Quealy and Katz's analysis is important because it included over 100,000 data points from publicly accessed Strava records. The quantity of data allowed for the most substantial analysis to date and made it possible to control for factors including runner ability, race conditions, and race course. The message was very clear: runners wearing Nike VaporFly shoes ran faster after controlling for potential confounding variables.

An advantage of 4% provided by equipment such as the VaporFly is considerable. In the mind of the public the verdict was already in before World Athletics made an announcement in January. Runners switched to the VaporFly in masses and according to Quealy and Katz's *New York Times* article the share of sub three-hour marathoners wearing the VaporFly has grown to 41%. It is unprecedented for a single brand and model of shoe to be worn by such a high percentage of racers. A few important points will be made regarding the high percentage of athletes now wearing VaporFly at all levels of competition. All else being equal, an individual capable of running three-hours who then gains a 4% advantage will take the equivalent of almost eight minutes off their time. This means that an individual running 3:00:00 would be able to run approximately 2:52:00 and an individual previously running 3:08:00 could hope to run 3:00:00. The three-hour marathon is an important mark. It represents a competitive sub-elite female time. It also marks the open male age group (18–39) qualifying time for the Boston Marathon. Finally, a three-hour marathon is generally considered a lifetime goal for many marathoners. For a well-trained sub-elite male a competitive time is approximately 2:30:00. A 4% time reduction would result in a time of approximately 2:24:00. Elite male runners running world class times of 2:05:00 could reasonably expect to run close to 2:00:00 with a time reduction of 4%. In every instance, based on the available information, it is in the athlete's best interest to switch the VaporFly if attempting a quality performance.

Sports Comparison

This is not the first time technology has been considered for its advantage in running or in sport more broadly. Approximately twenty years ago the major commotion in sport was over the clap skates worn by speed skaters (Mantell 1997). The clap skate allowed the Dutch national team to dominate at the international level in the 1997 World Championships. The clap skates were believed to relieve tension on the quadriceps muscles. The clap skates improved skater economy by roughly 5% (Houdijk et al. 2000) and cost almost 50% more (Mantell 1997) than competitor brands. This makes the clap skate and its mechanism of action in skating, as well as cost, strikingly similar to the VaporFly and its impact in running. The clap skates were ultimately banned at the short track level but not at the long track level.

A ban on the Speedo LZR Racer swimsuit came after athletes set world records in the pool at the 2008 Beijing Olympics. The swimsuit provided an unfair advantage by trapping air, adding buoyancy, and reducing drag (Morrison 2012). The design of the Speedo LZR Racer conferred such extreme advantages, cost so much more than comparative Lycra suits and wore out so quickly that the term 'technological doping' was being used in descriptions of the suit (Tang 2008). Despite the LZR Racer ban, Speedo continued research on swimsuit technology in an effort to legally push the limits of technology in sport. There is an important distinction between the LZR Racer and the VaporFly. The LZR Racer acted in a way that improved the environment external to the racer. In simple language the LZR Racer made swimming easier. The VaporFly did not change the external racing environment of the individual athlete at all.

Rules of Sport

Professional and amateur track and field – as well as road-running and trail-running – events are governed by World Athletics rules internationally, as well as national member bodies such as USA Track and Field (USATF) in the United States and UK Athletics in Great Britain. The national member federations are bound by World Athletics regulations,

and as such, any professional or amateur athlete competing in any sanctioned event must comply with World Athletics rules and regulations.

World Athletics outlines detailed regulations for all aspects of sanctioned competitions in its 'Constitution and Book of Rules', most recently amended as of 31 January 2020 (previously 1 November 2019). Requirements as to footwear are outlined Under Rule 5 of Book C titled 'Technical Rules.' Prior to the recent update detailed specifics were provided for elements such as number of spikes in track competitions and sole thickness for high jump and long jump, but for purposes of relevance to the VaporFly the rule was somewhat more ambiguous and previously stated: 'athletes may compete barefoot or with footwear on one or both feet. The purpose of shoes for competition is to give protection and stability to the feet and a firm grip on the ground. Such shoes, however, must not be constructed so as to give athletes any unfair assistance or advantage. Any type of shoe used must be reasonably available to all in the spirit of the universality of athletics.' The rules also stated that 'where evidence is provided to World Athletics that a type of shoe being used in competition does not comply with the Rules or the spirit of them, it may refer the shoe for study and if there is non-compliance may prohibit such shoes from being used in competition.' It is this provision that seems to have led to the investigation into the VaporFly and recent rule amendments.

World Athletics announced its determination on 31 January 2020 with a press release describing the new rule modifications. Key provisions of said modifications included mandates that: 'the sole must be no thicker than 40 mm' and 'the shoe must not contain more than one rigid embedded plate or blade (of any material) that runs either the full length or only part of the length of the shoe. The plate may be in more than one part but those parts must be located sequentially in one plane (not stacked or in parallel) and must not overlap'. To address the influence of VaporFly technology on track and field events the new modifications also includes a stipulation stating that 'for a shoe with spikes, an additional plate (to the plate mentioned above) or other mechanism is permitted, but only for the purpose of attaching the spikes to the sole, and the sole must be no thicker than 30mm'.

In creating these new modifications to Rule 5 of Book C World Athletics likely looked at two factors. The clarifications regarding stack height and the inclusion of carbon-plates are in response to the questions concerning whether the VaporFly confers 'any unfair assistance or advantage'. The current amendment allows the Nike VaporFly Next% specifications to remain legal while effectively banning the AlphaFly prototype worn by Eliud Kipchoge at INEOS 1:59. World Athletics likely did not ban the VaporFly available already because the mechanical improvement to running economy came from the interaction of the shoe with the metatarsal-phyangeal joint and not through the mechanical action of the shoe alone (Hoogkamer 2019). The specifications appear also to make it clear that further modifications to the shoe could cross into a situation where the mechanical action of the shoe alone would provide the performance advantage.

The second factor likely considered was the stipulation that any shoe must be 'reasonably available to all'. It is easy to evaluate this stipulation as it applies to current technology. The VaporFly 4% and Next% models, unlike the AlphaFly prototype, are freely available for sale online and at retail locations globally (Francis 2019). An argument could be made that Nike's technology patents on component parts of the VaporFly shoe prevent athletes sponsored by Nike's competitors from having the same access. The fact remains that such endorsement contracts are voluntary arrangements on the part of the athlete. The prohibitive price of the VaporFly is also a decision an individual must consider when purchasing a racing shoe. The 31 January 2020 rule modifications now clarify that 'from 30 April 2020, any shoe must have been available for purchase by any athlete on the open retail market (online or in store) for a period of four months before it can be used in competition'. While this modification does not drastically change the 'reasonably available to all' clause other than to institute the four-month requirement, its inclusion does indicate that World Athletics intends to prohibit the previously common use of prototypes in competitions. Notably, this mandate will not be in effect for the 2020 editions of the Tokyo and London Marathons as well as the United States Olympic Marathon Trials.

The amendments to Rule 5 of Book C by World Athletics also appear to provide a confirmation that the VaporFly, in whole or in part, do not represent a 'mechanical aid' under Section 6.3.4 of their Technical Rules, which prohibits 'the use of any mechanical aid, unless the athlete can establish on the balance of probabilities that the use of an aid would not provide them with an overall competitive advantage over an athlete not using such aid.' It was a previous iteration of this rule that formed the crux of the case of Oscar Pistorius. Mr. Pistorius, was a South African double amputee track athlete who became involved in a dispute with World Athletics over his use of the *Cheetah Flex-Foot* below the knee prosthetics in competitions against able bodied athletes. The World Athletics investigation ruled that said prosthetics contravened the rule (IAAF 144.2e) in place at the time which prohibited 'any technical device that incorporates springs, wheels, or any other element that provides the user with an advantage over another athlete not using such a device.' Mr. Pistorius appealed the ruling to the Court of Arbitration for Sport, which ultimately reversed the decision by finding that World Athletics had failed to meet the burden of proof in establishing that the specific prosthetic in question conferred 'an overall competitive advantage over an athlete not using such aid. (CAS 2008). World Athletics has since eliminated the language referencing 'springs' and now addresses only shoes and 'mechanical aid' as addressed above.

Summary

Based on the current research and analysis there seems to be overwhelming evidence that the VaporFly provides athletes who wear them with a considerable boost in athletic performance. The impact of the VaporFly on the sport of athletics over the past half-decade led to the 31 January 2020 update to the standards provided by World Athletics Rule

5 of Book C pertaining to Technical Rules of the Sport. As the new rule stands, current iterations of the Nike VaporFly worn by athletes in sanctioned competitions are reasonably available to all and do not provide a specific mechanical advantage. As such, they will continue to be available for use in competition. Athletes who voluntarily enter into a sponsorship with another shoe company do so with the understanding that they must wear the competitor's footwear. Athletes not supported by a sponsorship are free to purchase whichever footwear they feel best meets their performance demands. In response shoe companies have already begun testing their own technology in an effort to keep their products competitive on the competitive stage and in the market place. The updated World Athletics rules create a more level playing field in two important ways. The first is that updated specifications mitigate the ability of future shoes to enter into the territory of 'unfair mechanical advantage'. The second aspect of the ruling commences on 30 April 2020 as 'any shoe must have been available for purchase by any athlete on the open market (online or in store) for a period of four months before it can be used in competition.' This potentially more controversial aspect of the ruling will have an impact on the use of racing shoes, and the long established use of prototypes, by elite athletes in competition.

The 31 January 2020 amendments to the rules of the sport by World Athletics are historical but not unprecedented in the history of sport or athletics. The ruling as it stands appears to include several important compromises and distinctions have been applied by other governing bodies throughout history. Similar to the ruling in speed skating the specific action through which the biomechanical advantage was attained was evaluated. As with clap skates, for the sake of endurance sports the advantage was likely deemed fair primarily because of how the technology interacted with an individual's body. This is an important distinction when compared to the ruling on the Speedo LZR racing suits. In the case of the LZR suits the specific mechanic advantage was created external to an individual's body and resulted from an interaction between the suit and the environment. The use of the Nike VaporFly Next% specifications as the basis for the new amendments point to the significance of this new technology on the sport of athletics and the compromise that World Athletics was forced to consider when rendering a decision. The Nike VaporFly has become so prevalent amongst the public that a retroactive ban would be difficult, and costly, to enforce. Further the widespread use of the VaporFly in elite competition allowed for world records in distances including the 10k, half-marathon, and marathon all to be set in the shoe. The ruling by World Athletics allows the current world records to stand, as they are, and does not force an unpopular retroactive change to the record books.

The decision by World Athletics is also in line with their final ruling in the case regarding Mr. Pistorius's use of the Cheetah Flex-Foot below the knee prosthetics. The 'mechanical aid' clause can only be invoked when shoes are non-compliant with Rule 5 of Book C. Rule 6.3.3 as it is written states that 'shoes complying with Rule 5 of the Technical Rules' are explicitly allowable. World Athletics avoided further discussion of mechanical advantage by amending Rule 5 and using the Nike VaporFly Next% specifications as the model for the current updates. As such, the current VaporFly satisfies Rule 5 by design. Satisfaction of Rule 5 allows continued use of the VaporFly already available to the public. Future judgements on the VaporFly providing any mechanical advantage would need to be backed by further peer-reviewed literature and would also require further amendments to the current World Athletics rules and codes. The amendments would need to allow Technical Rule 6.3.3 to take precedence over, or to be evaluated without consideration to, Technical Rule 5.

A final and important consideration is the popularity of both the Breaking-2 Project and INEOS1:59 Challenge. These projects allowed for collaborative work to be done between shoe companies and athletes that pushed the boundaries of the sport. The projects also garnered funding from companies without direct interest in athletics. It is possible the creation of the Nike VaporFly and intervention by World Athletics will create an unintended inflection point for the sport of athletics. Similar projects may provide funding, as well as greater public interest in the competitive pursuits and developments of world class runners. As records are set in this environment a new set of standards could be kept. This would represent an environment with greater similarity to other professional sports.

Note

Cover thumbnail illustration: publicity image, © Nike.

Competing Interests

The authors have no competing interests to declare.

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