Performance differences when using 26- and 29-inch-wheel bikes in Swiss National Team cross-country mountain bikers

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4 authors:

Thomas Steiner
Swiss Federal Institute of Sport Magglingen SFISM

Beat Müller
Swiss Federal Institute of Sport Magglingen SFISM

Thomas Maier
Datahouse

Jon Peter Wehrlin
Swiss Federal Institute of Sport Magglingen SFISM

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Performance differences when using 26- and 29-inch-wheel bikes in Swiss National Team cross-country mountain bikers

Thomas Steiner, Beat Müller, Thomas Maier and Jon Peter Wehrlin

Section for Elite Sport, Swiss Federal Institute of Sports, Magglingen, Switzerland

ABSTRACT

The purpose of this study was to analyse the effect of bike type – the 26-inch-wheel bike (26″ bike) and the 29-inch-wheel bike (29″ bike) – on performance in elite mountain bikers. Ten Swiss National Team athletes (seven males, three females) completed six trials with individual start on a simulated cross-country course with 35 min of active recovery between trials (three trials on a 26″ bike and three trials on a 29″ bike, alternate order, randomised start-bike). The course consisted of two separate sections expected to favour either the 29″ bike (section A) or the 26″ bike (section B). For each trial performance, power output, cadence and heart rate were recorded and athletes' experiences were documented. Mean overall performance (time: 304 ± 27 s vs. 311 ± 29 s; $P < 0.01$) and performance in sections A ($P < 0.001$) and B ($P < 0.05$) were better when using the 29″ bike. No significant differences were observed for power output, cadence or heart rate. Athletes rated the 29″ bike as better for performance in general, passing obstacles and traction. The 29″ bike supports superior performance for elite mountain bikers, even on sections supposed to favour the 26″ bike.

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KEYWORDS
Mountain bike; off-road cycling; power output; performance; bicycle wheel size

Introduction

Modern mountain biking in the form of multiple lap cross-country (XCO) racing has been part of the Olympic Games since Atlanta in 1996 (Impellizzeri & Marcora, 2007). Technological advances since that time include more effective front and rear suspension and disc brakes for mountain bikes (MTBs). In the last few years, the introduction of 29-inch-wheel bikes (29″ bike) as compared to the traditional XCO bike with 26-inch wheels (26″ bike) has prompted a debate about their respective benefits. This debate was intensified noticeably after Czech rider Jaroslav Kuhlavy won the first MTB World Cup race in May 2011 on a 29″ bike and went on to dominate the 2011 World Cup season. Several studies have compared MTB suspension systems (Faiss, Praz, Meichtry, Gobelet, & Deriaz, 2007; Herrick, Flohr, Wenos, & Saunders, 2011; MacRae, Hise, & Allen, 2000), investigated the influence of MTB mass on simulated off-road cycling (Berry, Koves, & Benedetto, 2000) or evaluated the rolling resistance of MTB tyres (Bertucci, Rogier, & Reiser, 2013). However, to date, only one study has compared MTBs of differing wheel sizes (Macdermid, Fink, & Stannard, 2014), showing that 29-inch wheels are 19 s (or 3%) faster over a purpose-built course of 1890 m and a completion time of ~10 min. That study does not, however, represent a true comparison of the 26″ bike and the 29″ bike, since all athletes were riding the same 29-inch frame and only the wheel size was changed. Moreover, although those participants were competitive at national level, it is uncertain whether these results are transferable directly to elite MTB athletes, as no equivalent scientific data are available to verify any possible benefits of the 29″ bike for elite MTB athletes.

Based specifically on investigations conducted with road bikes, the MTB industry has advanced a range of theoretical claims affirming the benefits of the 29″ bike. Among these claims, larger wheels are said to have a lower rolling resistance than smaller wheels (Di Prampero, 2000; Faria, Parker, & Faria, 2005; Kyle, 2003), and to roll more easily over obstacles because of their decreased angle of attack (Kyle, 2003). The latter is not supported by Macdermid et al. (2014) who reported increased accelerations in vertical and horizontal planes for 29-inch wheels when compared to 26-inch wheels; however, velocity was not identical for both wheel sizes. Another advantage of larger wheels is the higher angular momentum due to a higher rotating mass, which is advantageous in rough terrain sections where 29-inch wheels lose less speed than 26-inch wheels. In addition, bigger wheels tend to have a better traction by virtue of a longer tyre contact patch. However, the 29″ bike can also be seen to have some potential drawbacks. The bigger wheels and the total bike have an increased weight, increasing the work against gravity on uphill sections (Berry et al., 2000). Furthermore, increased wheel weight implies a higher rotating mass, making bigger wheels slower to accelerate and harder to brake due to the higher angular momentum (Kyle, 2003). Additionally, the frames and wheels of 26″ bikes can be more stiffly constructed, with consequent advantages for acceleration and cornering (Kyle, 2003), while the less stiff 29″ bike frame is a potential source of dissipation of energy generated by the cyclist (Nielens & Lejeune, 2004). Based on such considerations, and with

CONTACT Thomas Steiner thomas.steiner@baspo.admin.ch

reference to the characteristics of the different World Cup XCO courses, athletes made their bike choice subjectively. The aim of this study, therefore, was to analyse the effect of riding a 26″ bike or a 29″ bike on both performance and athletes' experiences of riding characteristics, as a basis for objective decision-making about optimal bike setup for Swiss National Team MTB-XCO athletes.

Methods

Participants

Seven male and three female (mean ± SD: age 25.9 ± 5.9 years, height 171.0 ± 2.9 cm, weight 64.8 ± 4.6 kg) members of the Swiss National MTB-XCO Team participated, all competing at the highest international level (Olympic Games, World Championships, European Championships or World Cup). With 14.7 ± 4.7 years of experience, participants were very experienced in competitive riding. Written informed consent of the athletes was obtained prior to any testing. All experimental procedures were approved by the Institutional Review Board of the Swiss Federal Institute of Sports, and the study was conducted according to the recommendations of the Helsinki Declaration.

Study protocol

On one test day, each athlete performed three trials individually using their own 26″ bike and three trials using their own 29″ bike in alternate order (randomised start-bike), on a purpose-built simulated MTB-XCO course. Athletes were asked to undergo the same preparation as for a competition, and to complete all trials as fast as possible. Performance (time, speed), power output, cadence and heart rate were measured during the trials. Between trials, athletes rated the riding characteristics of the bikes and rode for 30 min on cycling rollertracks to actively recover in preparation for the next trial. Athletes received no feedback on performance, and personal cyclometers, watches and GPS devices were not allowed throughout the whole procedure. On the test day, athletes had the opportunity to train on the course for 30 min prior to testing. Air temperature during testing was stable between 5.8°C and 6.6°C, barometric pressure ranged from 978 to 981 mbar and relative humidity was 91%–93%, with no rain or wind.

Cross-country course

The cross-country course was installed by the Swiss National MTB coach in Gränichen, Switzerland, at 480 m above sea level. To fulfil one complete trial, participants had to ride two laps on the course. One lap (length: 615 m, ascent: 14 m) comprised two separate sections assumed to favour either the 29″ bike (section A, 348 m) or the 26″ bike (section B, 267 m) (Figure 1). Section A consisted of more straights, downhills, wide turns and a rougher surface (roots, stones), and Section B consisted of more uphills and more tight, winding trails. In building the course, the aim was to ensure a similar time requirement for sections A and B. In order to integrate the first section A of every trial without compromise to the analysis, athletes started the heat about 30 m before the starting line (at number 1 encircled in Figure 1). In this way, riders made a flying start and passed the starting line (where official timekeeping started) at a similar speed as after the first lap. A measuring wheel device (Gottlieb Nestle GmbH, Dornstetten, Germany) and the barometric altimeter of the Joule data-logger (Joule 2.0, Powertap, Madison, WI, USA) were used to characterise the course.

Bike characteristics

All athletes rode their own 29″ bike or 26″ bike, equipped with a powermeter (Powertap, Madison, WI, USA), for each trial. Average bike weights, including the Powertap wheels, differed ($P < 0.05$) between the 26″ bike (9.2 ± 0.5 kg) and the 29″ bike (10.1 ± 1.0 kg). All athletes were using hardtail bikes with only front suspension. Every bike represented the manufacturer's top edition cross-country race bike (26″ and 29″ bike and tyres of the same brands per athlete). Geometric differences between the two bike types were chosen by the manufacturer for XCO racing with different wheel sizes. Individual race preferences for tyre type, tyre pressure and gearing were enquired prior to the study, and settings were held constant by the mechanics throughout the procedure. Average tyre pressure was not significantly different ($P = 0.250$) between the 26″ bikes (1.69 ± 0.12 bar) and the 29″ bikes (1.66 ± 0.08 bar).

Outcome measures

Performance

Time was recorded (Stopstar 2, Hanhart, Germany) for the different sections, for the first and the second laps and for the whole trial. Using measured distance and recorded time, average speeds were calculated for all sections of the course.

Power output and cadence

The mounted Powertap wheels (Powertap, Madison, WI, USA) measure power output by means of strain gauges at the rear hub of the bicycle. The Powertap has previously been validated (Bertucci, Duc, Villerius, Pernin, & Grappe, 2005; Gardner et al., 2004) and is considered as suitable for the monitoring of power output while cycling. During each trial, data were continuously sampled and stored at 1 Hz on a data logger (Joule 2.0, Powertap, Madison, WI, USA) located in the back pocket of the cycling jersey. Four Powertap wheels were available on the test day: two 26-inch and two 29-inch Powertap wheels and each athlete always used the same 26- or 29-inch Powertap wheel. Since accuracy can differ between different Powertap hubs (Gardner et al., 2004), the accuracy of the four Powertap wheels was validated 1 week before and 2 weeks after the test day. All wheels were consecutively mounted on a road bike equipped with a calibrated SRM powermeter (Schoberer Rad Messtechnik (SRM), Jülich, Germany), and a member of staff performed stages of 3 min duration on a large treadmill (ST Innovation GmbH, Leipzig, Germany), at different inclinations (2.5°, 4°, 5.5°) and constant speed (4.5 $m \cdot s^{-1}$). Gearing was adjusted for all stages so that pedalling cadence was ~90 RPM

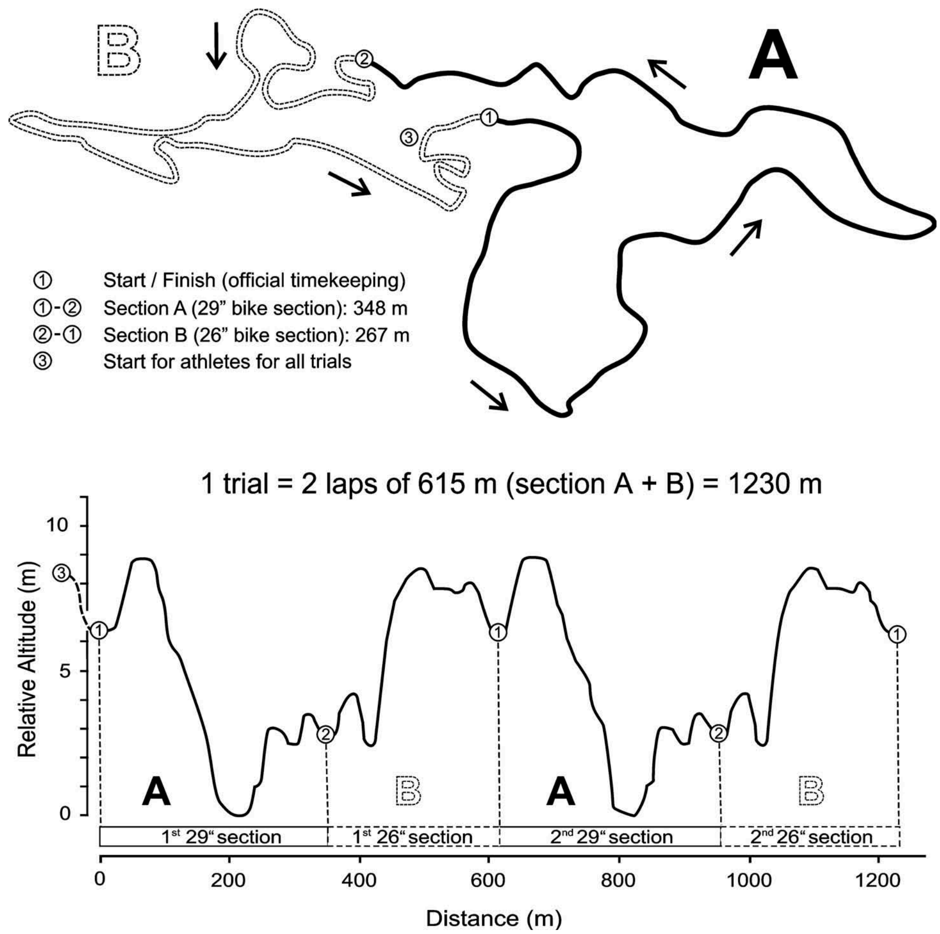

Figure 1. Outline and profile of the purpose-built cross-country mountain bike course used during the study, including the different sections that might be expected to favour either 29-inch-wheel bikes (29" bike section A) or 26-inch-wheel bikes (26" bike section B). Athletes had to ride two laps on the course to complete a full trial and started at 3 (encircled) to cross the starting line with a flying start at 1 (encircled).

and power outputs amounted to ~150 W, ~250 W and ~350 W, respectively. Power output was averaged between minute 1.5 and 2.5 for all stages, and comparisons were then made among the four Powertap wheels and the SRM crank. Average correction factors for the Powertaps in relation to the SRM were generated (+0.3% 1st 26" bike wheel; +1.3% 2nd 26" bike wheel; +2.3% 1st 29" bike wheel; +5.0% 2nd 29" bike wheel) and applied when analysing the power output data from the field tests. Physical work was calculated as the product of average power output and time taken to complete a given section of the course.

Heart rate

Heart rate was continuously recorded with a Powertap chest belt and stored at 1 Hz on a data logger (Joule 2.0, Powertap, Madison, WI, USA).

Riding characteristics

Immediately after each trial, athletes rated their experience of the riding characteristics of the different bikes, using a questionnaire with Visual Analogue Scale items (Aitken, 1969). Athletes rated six different riding characteristics, indicating a position on a continuous 100 mm line between two endpoints (0 = very bad to 10 = very good). The rated riding characteristics of the bikes were as follows: (1) overall performance, (2) cornering, (3) roots, (4) straights, (5) traction and (6) riding characteristics overall.

Statistical analysis

All statistical analyses were performed using a statistical package (SigmaStat, Version 3.5, San Jose, CA, USA). As performance (time and speed) data were not normally distributed, non-parametric Wilcoxon signed-rank tests were used to compare performance between the two bike sizes. For all other comparisons (power output, cadence, heart rate, work, laps, bike weights, tyre pressure and Visual Analogue Scale data), paired *t*-tests were applied. For each bike size, the different trials were subjected to a repeated measures analysis of variance (ANOVA), and the typical error for all parameters was calculated as the standard deviation of difference scores divided by $\sqrt{2}$ (Hopkins, 2000) and expressed as a percentage of the mean (%TE). Correlation analyses were performed using the Pearson Product Moment. A magnitude-based inference approach (Hopkins, Marshall, Batterham, & Hanin, 2009) was used to assess the magnitude of change in performance. Calculation of the likelihood of substantial performance change (i.e. more extreme than the smallest worthwhile change in performance time of MTB-XCO races reported as 1.2% (Paton & Hopkins, 2006)) was based on the distribution of percentage changes in performance (Hopkins et al., 2009). Unless otherwise stated, results are expressed as mean ± SD. The significance level was set at $P < 0.05$ for all analyses.

Results

Performance

On average, athletes were 7.5 s faster when using the 29″ bike (3.2–11.8 s (95% CL), $P < 0.01$) than when using the 26″ bike. This corresponds to a performance gain of 2.4% (1.1%–3.8%). The average speed was 0.3 km · h^{-1} higher on the 29″ bike (0.2–0.5 km · h^{-1}, $P < 0.01$) than on the 26″ bike while there were no differences in power output, cadence, time spent not pedalling, work and heart rate over the whole course (Table 1). The 29″ bike was faster, both over the whole course and when sections were considered separately.

Individual comparisons revealed that all participants were faster when using the 29″ bike than when using the 26″ bike (Figure 2) and that the individual fastest trials were all completed on a 29″ bike. Individual performance gain was neither correlated with athletes' height ($r = 0.51$, $P = 0.130$), athletes' weight ($r = 0.06$, $P = 0.867$), nor with the difference between the bike weights ($r = 0.58$, $P = 0.078$).

The likelihood that the measured performance gain when using the 29″ bike is of practical benefit amounts to 97%, which corresponds to a probabilistic descriptor of "very likely".

Reliability of measurements

For all investigated parameters, no statistical difference was found in comparing the three trials completed with the same bike. Performance for trials 1, 2 and 3 on the 26″ bike was 313 ± 30 s, 310 ± 28 s and 310 ± 29 s ($P = 0.430$), and on the 29″ bike it was measured at 304 ± 27 s, 302 ± 26 s and 304 ± 27 s ($P = 0.432$), respectively. TE was 1.54% (26″ bike) and 1.15% (29″ bike) for performance (time and speed), 2.35% (26″ bike) and 2.17% (29″ bike) for power output, 3.35% (26″ bike) and 2.72% (29″ bike) for cadence, 1.92% (26″ bike) and 1.60% (29″ bike) for physical work, and 0.65% (26″ bike) and 0.93% (29″ bike) for measured heart rate.

Riding characteristics

Athletes rated the 29″ bike significantly better than the 26″ bike for rolling over obstacles such as roots ($P < 0.01$), for having better traction ($P < 0.01$) and for performance in general ($P < 0.05$) (Table 2). No statistically significant differences were found for cornering, riding straights and overall riding characteristics.

Discussion

The purpose of this study was to compare and analyse the effect on performance in elite MTB-XCO athletes when using a 26″ bike or a 29″ bike during simulated cross-country racing. The major findings from this study were that (1) for the same power output, the 29″ bike was significantly faster than the 26″ bike, both over the whole course and for each section of the course; and (2) this superior performance was in line with the athletes' subjective ratings, which indicated that the 29″ bike was advantageous for almost all riding characteristics.

All athletes were on average faster when using the 29″ bike than when using the 26″ bike, and achieved all their fastest trials on the 29″ bike evenly distributed over the six trials. This indicates that athletes did not suffer fatigue over the six trials, nor did they show any training or learning effect, as confirmed by the low typical errors for all measured parameters. Interestingly, small and light riders could profit to the same extent from 29″ bikes as taller and heavier riders. Athletes were asked to complete all trials as fast as possible, and the reproducibility of the trials was very good (average TE of 1.3% for performance and 2.3% for power output) as compared to MTB World Cup-specific within-subject variations of 2.4% for males and 2.5% for females (Paton & Hopkins, 2006). The short duration of the trials, the MTB competition-specific course and the high performance and motivation levels of the athletes all contributed to good reliability. It should be emphasised that athletes who trained considerably less on the 29″ bike prior to the study also gained an advantage from the bigger bikes.

Assuming that the within-subject CV for World Cup MTB-XCO races (Paton & Hopkins, 2006) has remained stable since 2001 (even though race durations have been reduced by about 30 min), it would appear that the use of the 29″ bike rather than the 26″ bike is very likely to be of practical benefit. Extrapolating the performance gain of 2.4% to a typical race duration of 94 min (average male winner time of all MTB-XCO World Cup races in 2013), the effect would equate to a gain of 135 s (62–214 s) and an average improvement of 9 places (4–14 places). It is reasonable to assume that the observed effect would be constant over the whole duration of a race, as the performance gain observed in this study was not associated

Table 1. Averaged values of analysed parameters for both bike types for whole trials and for section A (29-inch-wheel specific section) and section B (26-inch-wheel specific section).

	Overall		Section A		Section B	
	26″	29″	26″	29″	26″	29″
Time (s)	311 ± 29	304 ± 27**	76 ± 7	74 ± 6***	80 ± 8	78 ± 7*
Speed (km · h^{-1})	14.4 ± 1.3	14.7 ± 1.2**	16.6 ± 1.4	17.0 ± 1.4***	12.2 ± 1.1	12.5 ± 1.0*
Power (Watt)	264 ± 48	263 ± 48	277 ± 54	275 ± 52	251 ± 42	252 ± 44
Cadence (rpm)	67.8 ± 4.5	68.8 ± 5.9	68.4 ± 5.8	69.3 ± 6.5	67.4 ± 3.8	68.3 ± 6.0
Zero cadence (%)	24.2 ± 4.5	23.6 ± 4.6	26.2 ± 5.2	25.3 ± 4.8	22.3 ± 4.3	22.0 ± 4.9
Work (kJ)	80.8 ± 8.5	78.9 ± 8.6	20.8 ± 2.5	20.1 ± 2.4	19.7 ± 1.8	19.3 ± 2.0
HR (beats · min^{-1})	175 ± 11	175 ± 10	170 ± 12	170 ± 11	179 ± 11	179 ± 10

Values are presented as mean ± SD; 26″: 26-inch-wheel bike, 29″: 29-inch-wheel bike; Zero cadence: time spent not pedalling. Significantly different to the 26″ bike for the given section of the course (*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$).

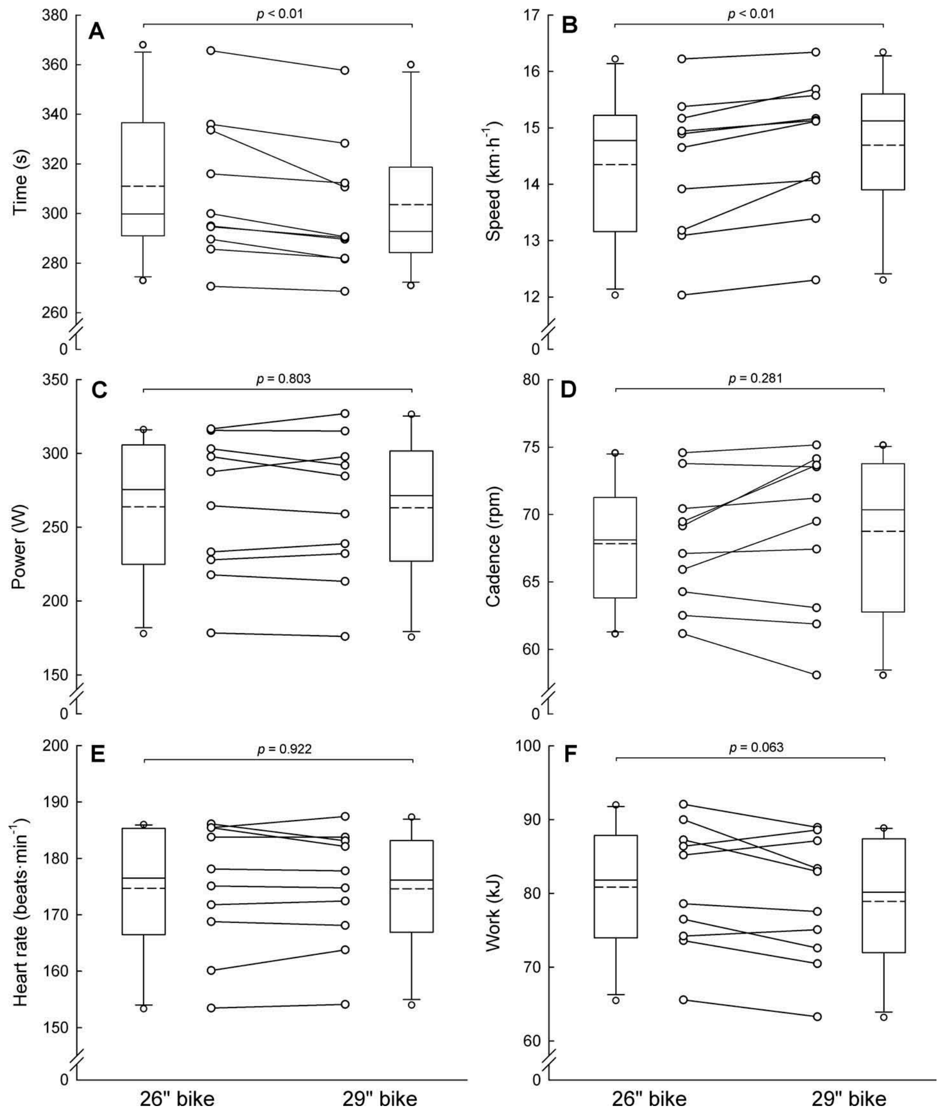

Figure 2. Differences in time (A), speed (B), power output (C), cadence (D), heart rate (E) and work (F) between 26-inch wheel bikes (26″ bike) and 29-inch wheel bikes (29″ bike). In the box-plots, dashed lines indicate mean scores and solid lines indicate median scores. Ends of boxes define 25th and 75th percentiles, and error bars define 10th and 90th percentiles. Data points outside this range are displayed as white dots. White points between box-plots illustrate the subjects' individual scores (n = 10).

Table 2. Athletes' experiences rated on a Visual Analogue Scale from 0 (very bad) to 10 (very good) in reference to overall performance, cornering, roots, straights, traction and overall riding characteristics for the two bike types (values averaged over three trials on the same bike type).

Bike	Performance	Cornering	Roots	Straights	Traction	Riding characteristics overall
26″	5.9 ± 1.5	6.4 ± 1.7	5.5 ± 1.7	6.6 ± 1.4	5.3 ± 2.0	6.1 ± 1.7
29″	7.0 ± 1.2*	7.1 ± 1.2	7.4 ± 0.7**	7.2 ± 1.3	7.4 ± 1.1**	7.3 ± 1.2

Values are presented as mean ± SD; 26″: 26-inch-wheel bike, 29″: 29-inch-wheel bike.
Significantly different to the 26″ on the given criterion (*P < 0.05; **P < 0.01).

with higher power outputs. Admittedly, the aforementioned improvement would be possible only if all other competitors were using a 26″ bike, but already at the 2012 Olympic Games, about 70% of the top 10 (males and females combined) were riding a 29″ bike (Macdermid et al., 2014).

The observations and assumptions from this study accord with Macdermid et al. (2014), who reported a 3% performance gain when using 29-inch wheels as compared to 26-inch wheels, over a longer simulated race duration of about 625 s. This gain was not associated either with higher power outputs or with higher heart rate values. Macdermid et al. (2014) primary aim was to quantify differences in vibrations between the wheel sizes, and all athletes were using the same 29-inch frame. However, the results indicate that athletes at a lower performance level can also profit at least as much from bigger wheels as the elite athletes measured in the present study. This profit seems to be independent of the characteristics of different sections of the course, because Macdermid et al. (2014) reported that the 29-inch wheels were faster (though not significantly so) on both uphill and downhill sections, and proved significantly faster on all sections in our study.

Hence, a possible negative influence of the increased bike weight of the 29″ bike in sustained periods of climbing may not be a factor because of the 29″ bike's other possible advantages.

It can be hypothesised that the better ratio of speed to power output of the 29″ bike is accounted for mainly by a reduction of rolling resistance due to the greater circumference of the wheel, and by the reduced energy loss as a result of its greater tyre volume (Macdermid et al., 2014) and/or better traction. Since speed of the 29″ bike was higher than that of the 26″ bike with a similar power output, total resistance of the 29″ bike must have been reduced. The total resistance when cycling comprises four components: air resistance, rolling resistance, gravity and inertia (Olds, 2001). The 29″ bike would certainly not have positively influenced air resistance (due to greater speed), gravity (due to greater weight of the system) or inertia (due to greater weight and greater rotating mass), and rolling resistance is therefore the only component that could potentially reduce total resistance. And because rolling resistance is one of the major determinants of performance in mountain biking – equating, for instance, to about 25% of total resistance on a road with a 5.9% slope when riding 5 $m \cdot s^{-1}$ with a knobby tyre (Bertucci et al., 2013) – the optimisation of rolling resistance is clearly crucial, especially given that the percentage of total resistance accounted for by rolling resistance is even higher on rough surfaces (Bertucci & Rogier, 2012). Off-road rolling resistance depends not only on the circumference of the wheel but also on the angle of attack and tyre pressure, which seem to influence rolling resistance differently than on-road (Bertucci & Rogier, 2012). Because tyre pressure was not different between the two bike sizes in the present study, the influence of the greater circumference of the wheel and the different angle of attack appear to be the cause for a reduced off-road rolling resistance of the 29″ bikes. Again, because the relationship between power output and speed in mountain biking (unlike road cycling) may change according to the technical ability of the rider (Impellizzeri & Marcora, 2007), the better speed-to-power ratio in riding a 29″ bike may also originate in superior technical ability, probably because better traction means less dissipation of power generated by the cyclist due to slippage. This reduced slippage may be due to the longer tyre contact patch between tyres and surface, or to the geometrical advantages of the 29″ bike (longer wheelbase and lower bottom bracket in relation to wheel axle centrelines). Both of these factors simplify riding on rough terrain sections or moving out of the saddle in steep uphill climbs. In the present study, the assumption of better traction is supported by athletes' ratings of the 29″ bike's traction as better than that of the 26″ bike. These subjective ratings can be regarded as highly valid, as athletes had substantial competitive experience and a remarkable international level. The 29″ bike achieved better ratings in terms of all riding characteristics – even though prior to the study, athletes trained less on average on the 29″ bike, and were rather sceptical about its potential benefits. Clearly, in some or even most situations, the advantages of the 29″ bike outweigh possible drawbacks such as greater wheel weight or slower acceleration.

Because the aim of the present study was to provide an objective basis for decision-making by elite MTB-XCO athletes about optimal bike setup, athletes was given the opportunity to ride their own bicycles and to choose tyre type and pressure individually to maximise the riding characteristics of the respective bike. While this setup guarantees a valid comparison of the overall performance of the two bike types, it is not possible to entirely separate the results into effects of the wheel size alone or other factors associated with the choice of a different bike type (geometric differences, tyre type, tyre pressure etc.). Additionally, it can be argued that another limitation of the study is the relatively short duration of a trial, raising the question of whether the observed effects are transferable to race durations of 90 min. We contend that the benefits of the 29″ bike are in fact transferable to longer race durations, by virtue of the similarity of power outputs and pedalling patterns between the 29″ bike and the 26″ bike (i.e. similar cadence and similar time spent not pedalling). Another critical issue concerns whether the 29″ bike was insufficiently penalised for its increased weight, given that uphill sections in this study were significantly shorter than in MTB-XCO competitions. During competitions, more time is spent climbing than descending (Abbiss et al., 2013), and reductions as small as 1 kg in bicycle mass have been reported to influence the climbing performance of road race cyclists (Howe, 1995). In the present study, however, bike weights differed by only 0.9 kg and weight differences between the bike types had no influence on the magnitude of the benefit. It has been shown that in MTB-XCO competitions, technical uphill cycling ability may be a more important determinant of off-road cycling performance than non-technical uphill cycling ability (Abbiss et al., 2013). Our purpose-built course had no non-technical uphill sections, which provides important insights into the relevant key performance indicators in MTB-XCO racing and demonstrates that the 29″ bike is also faster in sections that might be expected to favour the 26″ bike. This is supported by Macdermid et al. (2014) who showed that 29″ bikes are faster in non-technical as well as in technical uphill sections where an advantage of the 26″ bike might be expected. Further research is needed in order to understand which factors – rolling resistance, traction, geometrical differences – may be responsible for the benefits offered by the 29″ bike, to verify whether these effects are transferable to races of 90 min duration and to integrate the intermediate bike wheel size of 27.5 inches into the comparisons.

Conclusion

The results of the present study indicate that the 29″ bike offers advantages over the 26″ bike for all elite MTB-XCO athletes, even on course sections that might be expected to favour the 26″ bike. The benefits of the 29″ bike are most pronounced on courses where traction between tyre and surface, passing of small obstacles (tree roots, stones) and positive overall riding characteristics of the bike are important. For these reasons, we support the use of the 29″ bike for all elite MTB-XCO athletes.

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Disclosure statement

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