

Article

The External Workload of Thoroughbred Horse Racing Jockeys

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Abstract: The objectives of this study were to quantify the external workload of thoroughbred racing jockeys in relation to their experience and racing performance. The number of rides of 786 jockeys and apprentices who rode in 407,948 flat and 13,648 jumps racing starts over 14 seasons were examined. Jockey work (ride numbers, seasons riding) and performance characteristics (race falls or wins) between cohorts with low (1–10), middle (10–200) and high (>200) numbers of rides per season were compared. Flat racing apprentices had more rides per season (25, interquartile range [IQR] 7–97 vs. 14, IQR 3–222, $p < 0.001$) but fewer rides per race day (2, IQR 1–4 vs. 4, IQR 2–6, $p < 0.001$) than flat racing jockeys. Flat racing jockeys in the high workload cohort (23%) were responsible for 83% of the race-day rides, riding in a median of 375 (IQR 283–520) races per season. These jockeys had half the fall rate (Incidence rate [IR] 1.0, 95% CI 0.9–1.1) and 1.4 times the success rates per 1000 rides (IR 98, 95% CI 97–99) than jockeys in the low and middle workload cohorts ($p < 0.05$). Most jockeys had light workloads, greater risk of injury and lower winning rates than the smaller cohort of jockeys with heavier workloads. This disparity in opportunity and success between cohorts indicates inefficiencies within the industry in recruitment and retention of jockeys. These data provide a foundation to further studies investigating jockey competition-specific fitness and its effect on both riding success and reducing injury risk.

Keywords: horse; fitness; rider performance; thoroughbred racing; jockey; equestrian athlete

1. Introduction

Thoroughbred racing is a major international sport that is of significant economic importance in 47 countries worldwide. In New Zealand, it employs ~35,000 people, contributes ~1% towards gross domestic product (~NZ\$1.4 billion) and attracts in excess of 350,000 spectators per year [1]. Thoroughbred racing is divided into flat and jumps racing, each operating with minimum riding weights, facilitated by a handicapping system to enable equal competition, where better performing horses are allocated higher weights to equalize the chances of all competitors [2]. Flat races are shorter than jumps races, occur year round and comprise 96% of the total number of races in New Zealand, whereas jumps races occur only during the winter season and include up to 25 obstacles [3]. In New Zealand, there is a median of 2934 (interquartile range [IQR] 2734–2949) flat races per year, with approximately 10 races per race day. There are 122 (IQR 114–132) jumps races per year, with approximately 2 races per race day [4].

At an industry level, much of the appeal of the thoroughbred industry is based on tradition and the maintenance of traditional practices. Attention on the sustainability of the industry has primarily focused on the impact of these traditional practices on the horse, rather than a broader context of all industry participants [5–7]. Indeed, there appears to have been limited focus on how the workplace practices and physiological challenges of jockeys (high perceived workload and maintenance of low body weights) are sustainable within the industry, both from a health and safety and economic perspective. Jockeys have the responsibility of controlling both their individual riding performance as well as the performance of the horse, racing at speeds exceeding 60 kmh^{-1} on race day [8–10]. Added to this is the risk of falling from the horse, with incidence rates (per 1000 starts) of 1.2 for flat and 53–100 for jumps racing [4]. Jockeys must comply with the weight allocation of each horse they ride, with minimum riding weights of 52 and 63 kg in operation for flat and jumps jockeys, respectively. Apprentice jockeys are young professional jockeys who serve a four-year apprenticeship and are given a weight allowance of 1–4 kg (based on their previous wins) under the weight assigned to the horse to compensate for their inexperience in race riding [2]. In the 2018/19 racing season, there were 146 jockeys who won at least one race and 47 registered apprentices.

Uncommon to athletes in other sports, jockeys have the unique demand placed on them to remain in peak physical condition and maintain a low weight, on a daily basis, with no off season [11]. Prescribing an optimal physical training load for an athlete depends on selecting an appropriate workload measure and quantifying the current workload status of the athlete [12,13]. Race riding provides significant stress on the athlete (internal workload) with mean heart rates (HR) during a race of 90–98% their maximal HR (achieved at exhaustion), and respiration rates of 50 ± 7 breaths per min for flat racing jockeys [11,14]. Mean heart rates are over 80% maximal for national hunt (jumps) racing jockeys with no significant period of recovery between races [15]. This suggests that during a race day, jockeys experience intermittent periods of intense cardiovascular load amongst sustained periods of elevated heart rate.

The external workload of an athlete quantifies the amount of work they perform [12,13]. The amount of external work performed by jockeys varies with the number of races ridden per race day and race days per season. Jockeys in the United States (USA) reported an average of 4.6 ± 1.7 rides per day and approximately 650 rides per year [16]. Similarly, flat racing jockeys in Britain are qualitatively reported to compete in up to 5–7 races per day, up to 7 days a week with no defined off season [10,17,18]. Jockeys in New Zealand and Australia have been reported to have varying numbers of rides per week, riding 1–8 rides in 2–4 race meetings per week or 1–30 rides per week, and working (in horse-related activities) 6 days a week [8,19]. A study of retired jockeys in Victoria, Australia, highlighted the large disparity between the number of rides of the top 25 jockeys who had on average four times the earnings of the majority ($n = 110$) of registered jockeys and were responsible for 70% of the total number of race-day rides [8].

The physiological workload during a single race of a jockey has been previously investigated, but the external workload of jockeys over a racing season has not been quantitatively measured and is important in both the prevention of jockey injury (due to falls or gradual onset due to repetitive loading) and when designing physical training programmes. At an industry level, it is important to understand the workflow and engagement of the participants in order to manage recruitment of apprentice jockeys and efficient utilisation of human resources. Based on the literature published and anecdotal observations, there may be a disequilibrium in the opportunities for participation in race day rides, and thus career success. Therefore, the aims of this study were to determine the workload (based on number of race-day rides) for jockeys and apprentices in New Zealand and to compare the characteristics and performance of jockeys with low, middle and high external workloads.

2. Materials and Methods

Data from all thoroughbred race starts between 1 August 2005 and 17 April 2019 were supplied by New Zealand Thoroughbred Racing (NZTR), the governing body for thoroughbred racing in New

Zealand. A racing season began on 1 August and ended on 31 July. Data were provided at the ride level and the following variables were extracted and used for further analysis: date of race; horse carried and assigned weight; jockey name, gender and age; race outcome (in the form of jockey falls or wins). Hurdle and steeplechase races were combined into one category of jumps races to allow comparison between flat and jumps races. For clarity, external workload in this study refers to the number of competitive race-day rides ridden by a jockey.

Derived variables were jockey and apprentice status. Carried weight refers to the weight carried by the horse during the race. For the purposes of this study, an apprentice was defined as a rider whose horses' carried weight during a race was ≤ 1 kg from the handicap weight assigned to the horse (i.e., indicating the jockey had a weight allowance of ≥ 1 kg). Jockeys were categorised into three evenly populated cohorts of 'high', 'middle' and 'low' numbers of rides per season. For flat and jumps racing, respectively, 200 or 25 rides per season were assigned to the high workload cohort, jockeys who rode 10–200 or 5–25 rides per season were assigned to the middle workload cohort and those who rode 1–10 or 1–5 rides per season were assigned to the low workload cohort. After characterising the cohorts for flat and jumps racing jockeys, all subsequent analyses were conducted for flat racing jockeys and apprentices only, due to the smaller number of rides by jumps racing participants.

The integrity of the data was checked using histograms and scatter plots, where outliers or points of interest were compared with the official NZTR database. Descriptive statistics were used to describe the data at population and seasonal (yearly) levels in terms of numbers of rides and seasons riding, stratified by flat and jumps races and by jockey and apprentice status. Mean and standard deviation (SD) were used to describe normally distributed population level data. Median and IQR were used to describe continuous data that were non-normally distributed and counts and percentages were used to describe categorical data. Frequencies per year of race start appearances were used to describe the jockey characteristics (gender and experience) in workload cohorts. Linear regression was used to calculate changes in median number of rides over the study period. Incidence rates were calculated based on the number of falls or wins and number of rides during the time period and expressed as a rate per 1000 rides. Normality was assessed using an Anderson–Darling test and Kruskal–Wallis tests for significance were used to compare differences between groups. Post hoc tests for significance between groups were assessed with the χ^2 -test for frequency data and Mann–Whitney U tests for continuous data.

Analyses were conducted in RStudio (version 3.5.1, 2018; R Foundation for Statistical Computing, Vienna, Austria) with the level of significance set at $p < 0.05$.

3. Results

During the period 1 August 2005–17 April 2019, there were 37,596 flat races over 4459 race days and 1528 jumps (897 hurdle and 631 steeple) races over 536 race days. There was a total of 421,596 ride opportunities, of which 407,948 were flat racing starters and 13,648 jumps racing starters. There was a mean (\pm SD) of 21 ± 1 flat racing days per month, year round. Jumps races had a defined season from March to July (winter) with an average of 7 ± 1 jumps racing days for each of these months. The average number of ride opportunities per season was $30,942 \pm 2226$ and this decreased after the 2008/9 season in a linear relationship at a rate of 843 (3%) opportunities per season ($R^2 = 0.96$).

Data were collected on 786 jockeys and apprentices, the majority of which ($n = 757$, 96%) rode in flat races. Only 177 (23%) rode in a jumps race. During each racing season, there were an average of 190 ± 7 jockeys and 89 ± 7 apprentices that rode in at least one race. The median age of jockeys riding a race was 30 years (IQR 24–38, $n = 330,988$) and for apprentices was 22 years (IQR 19–25, $n = 81,687$). Male jockeys accounted for 69% of race rides and 61% of the total number of registered jockeys or apprentices over the study period.

Rides for both jockeys and apprentices had a skewed distribution, with a small number of jockeys who had large numbers of rides, and a large number of jockeys who had low numbers of rides (Table 1). Flat racing jockeys had more race days per season and rides per race day than jumps racing jockeys,

and the majority of jockeys and apprentices rode for only two seasons. Flat racing jockeys had a greater variation in workload than flat racing apprentices. Jumps racing jockeys had a higher workload than jumps racing apprentices.

Table 1. Median and Interquartile Range (IQR) numbers of seasons riding, rides per race day, race days and rides per season for jockeys and apprentices stratified by race type from 1 August 2005 to 17 April 2019.

Variable		Flat Races	Jumps Races	<i>p</i> *
		Median (IQR)	Median (IQR)	
Seasons race riding	Jockeys	2 (1–5)	2 (1–5)	0.7
	Apprentices	2 (1–3)	2 (1–3)	0.2
	<i>p</i> value	<0.001	<0.001	
Race days per season	Jockeys	10 (2–62)	6 (2–15)	<0.001
	Apprentices	15 (5–40)	5 (2–11)	<0.001
	<i>p</i> value	<0.001	0.04	
Rides per race day	Jockeys	4 (2–6)	2 (1–3)	<0.001
	Apprentices	2 (1–4)	1 (1–2)	<0.001
	<i>p</i> value	<0.001	<0.001	
Rides per season	Jockeys	14 (3–222)	9 (3–32)	0.7
	Apprentices	25 (7–97)	7 (2–16)	0.02
	<i>p</i> value	<0.001	0.09	

* *p* values calculated using Kruskal–Wallis test for non-normally distributed data.

The median number of rides per season for flat racing jockeys decreased by 8% per season ($R^2 = 0.7$) whilst that for flat racing apprentices increased by 3% ($R^2 = 0.4$, $p < 0.001$) over the study period, as shown in Figure 1. The median number of rides per season for apprentices in their last season (before becoming jockeys) was 216 (IQR 29–415), whereas the median number of rides in their first season riding as a licensed jockey was 74 (IQR 12–170, $p = 0.2$).

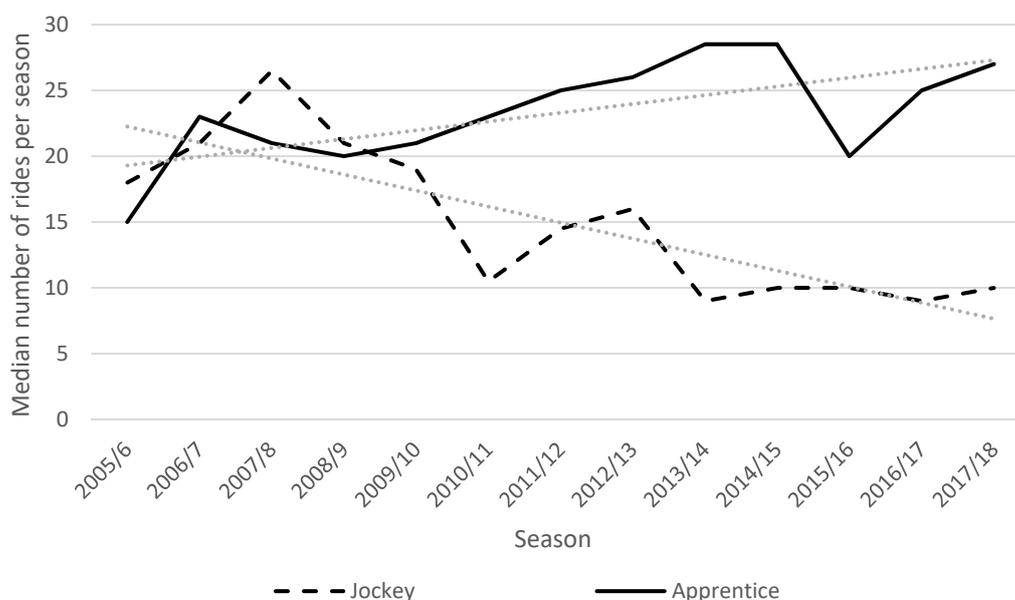


Figure 1. Median number of rides for flat racing jockeys and apprentices from 1 August 2005 to 31 July 2018.

Low, Middle and High Workload Cohort

The maximum number of rides in one season by one flat racing jockey was 1173. Jockeys in the high workload cohort were more likely to be male and fully licensed jockeys than jockeys in the low or middle workload cohorts (Table 2). High workload cohort flat racing jockeys were able to consistently meet the low weights assigned to their horses. High workload cohort jockeys rode for more seasons and had half as many falls and more (1.4 times for flat and 1.3–2.7 times for jumps) wins per season than jockeys in the middle and low workload cohorts.

Table 2. Characteristics of jockeys with low (1–10 or 1–5), middle (10–200 or 5–25) and high (>200 or >25) number of rides per season stratified by flat and jumps racing, respectively, from 1 August 2005 to 17 April 2019.

	Flat			<i>p</i> *	Jumps			<i>p</i> *
	Low	Middle	High		Low	Middle	High	
Frequency of observations (%)								
Female	415 (41%) ^a	371 (34%) ^b	239 (30%) ^c	<0.001	44 (22%) ^{ac}	25 (13%) ^{bc}	36 (17%) ^{bc}	0.005
Male	595 (59%)	709 (66%)	561 (70%)		256 (78%)	169 (87%)	172 (83%)	
Apprentice Jockey	366 (24%) ^a 1153 (76%)	605 (48%) ^b 660 (52%)	137 (17%) ^c 649 (83%)	<0.001	127 (38%) ^a 205 (62%)	123 (45%) ^{ab} 148 (55%)	41 (22%) ^c 145 (78%)	<0.001
Median (IQR)								
Rides per season	3 (1–6) ^a	38 (20–98) ^b	375 (283–520) ^c	<0.001	2 (1–3) ^a	13 (9–18) ^b	48 (34–64) ^c	<0.001
Race days per season	2 (1–4) ^a	21 (12–39) ^b	94 (72–114) ^c	<0.001	2 (1–3) ^a	7 (5–10) ^b	21 (16–26) ^c	<0.001
Rides per race day	1 (1–1) ^a	2 (1–2) ^b	4 (3–5) ^c	<0.001	1 (1–2) ^a	2 (1–2) ^b	2 (2–3) ^c	<0.001
Number of seasons in workload cohort	1 (1–2) ^a	2 (1–3) ^b	3 (1–6) ^c	<0.001	1 (1–2) ^a	1 (1–2) ^a	3 (1–5) ^b	<0.001
Number of seasons riding	1 (1–2) ^a	3 (2–5) ^b	6 (4–10) ^c	<0.001	1 (1–1) ^a	2 (2–4) ^b	6 (4–8) ^c	<0.001
Jockey age (yrs) at first appearance	24 (21–31) ^a	22 (20–27) ^b	23 (19–31) ^c	<0.001	23 (20–27) ^a	23 (21–27) ^a	23 (20–26) ^a	0.5
Horse carried weight (kg)	65 (56–68) ^a	56 (54–58) ^b	56 (55.5–56.5) ^c	<0.001	65 (63–66) ^a	65 (63–65) ^a	65 (63–66) ^a	0.3
Incidence Rate (95% Confidence Interval)								
Falls per 1000 rides	2.4 (1.1–4.5) ^a	2.1 (1.8–2.5) ^a	1.0 (0.9–1.1) ^b	0.01	131 (105–164) ^a	85 (75–96) ^b	63 (59–68) ^c	<0.001
Wins per 1000 rides	67 (59–75) ^a	70 (68–72) ^a	98 (97–99) ^b	<0.001	44 (29–66) ^a	95 (85–107) ^b	120 (114–126) ^c	<0.001

* *p* value calculated from Kruskal–Wallis test; values with different superscripts are significantly different within rows, *p* < 0.05.

The high workload cohort of flat racing jockeys comprised 23% of the total number of jockeys riding in flat races but accounted for the majority (83%) of race-day rides (Figure 2). Flat racing jockeys who were classified as riding in the high workload cohort at least once during the study period spent a median of three seasons (IQR 1–6) riding in the high workload cohort, but spent a median of two seasons (IQR 1–3) riding in the middle workload cohort and a median of 0 seasons (IQR 0–1) riding in the low workload cohort during their riding career.

There was a median of 59 (IQR 56–63) flat racing jockeys in the high workload cohort each season (Figure 3), with a median of 13 (IQR 10–14) jockeys entering and 14 (IQR 11–16) jockeys leaving the high workload cohort each season. The total number of rides by these jockeys was highest in the 2009/10 season (*n* = 28,079, median 406, IQR 304–543), but subsequently decreased linearly by 910 rides per season ($R^2 = 0.9$).

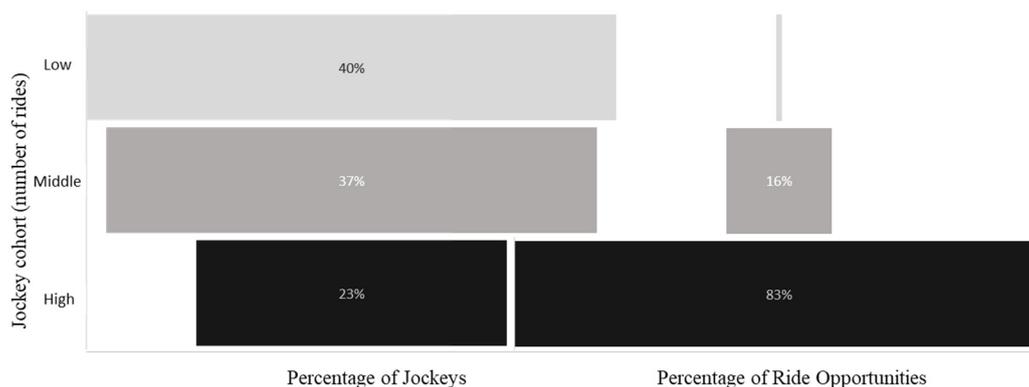


Figure 2. Percentages of flat racing jockeys and total number of flat racing rides for low (1–10), middle (10–200) and high (>200 rides per season) workload cohort jockeys from 1 August 2005 to 17 April 2019.

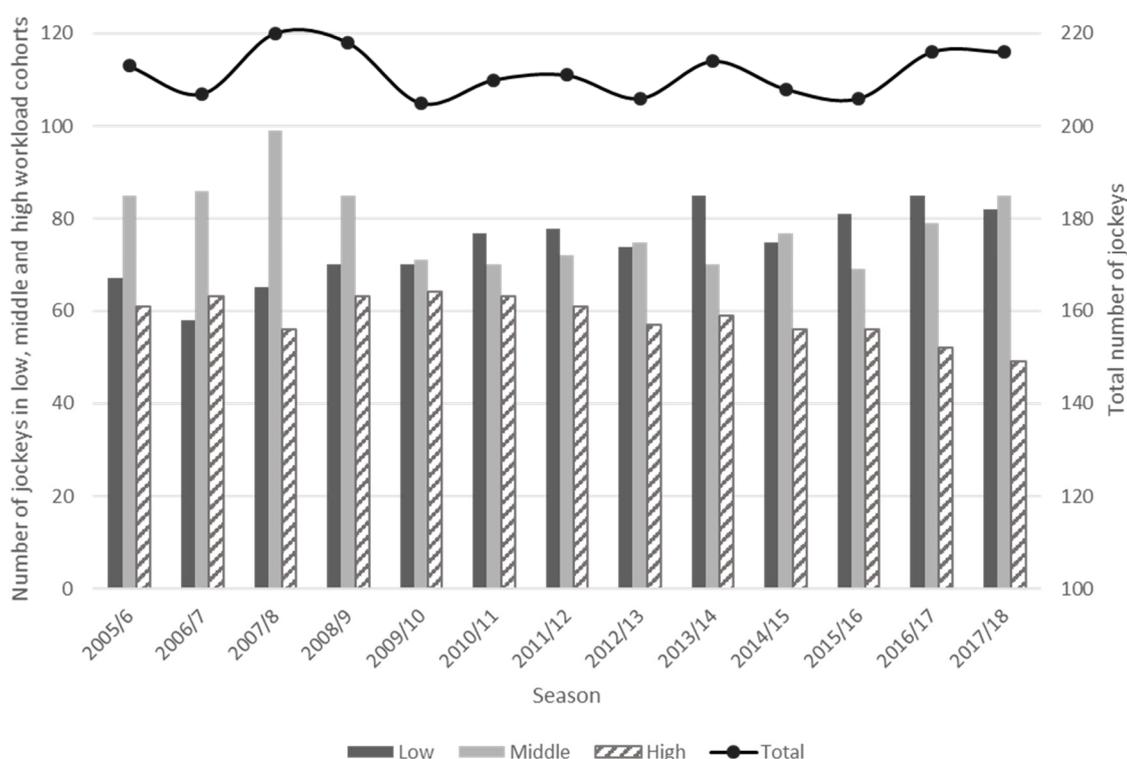


Figure 3. Numbers of flat racing jockeys in low (1–10), middle (10–200) and high (>200 rides per season) cohorts from 1 August 2005 to 17 April 2019.

There was a median of 77 (IQR 71–85) flat racing jockeys in the middle workload cohort and 75 (IQR 69–82) flat racing jockeys in the low workload cohort each season (Figure 3). The majority of jockeys in each of these groups changed each season, with less than half of jockeys remaining for more than one season in either cohort.

4. Discussion

This study provides a unique starting point to understanding the jockey ‘athlete’ workload. Most jockeys and apprentices rode in flat races, with opportunities year round, and no off season. There was a large proportion of jockeys who rode very few race days per season, indicating that the majority of jockeys had a very light and sporadic workload, lasting only 1–3 years. This suggested that there was an excess of jockeys competing for the fixed number of ride opportunities. This disequilibrium in ability to compete has implications for the recruitment of new participants to the industry and sustainability of the workforce.

Jockeys with low racing workloads likely supplement their work as jockeys with extra track work (daily exercise of race horses) or stable-hand duties, as occurs with failed apprentices in Britain [18,20]. Due to their low workload, they are likely also to be inexperienced in race day riding, which has been linked to horse performance [21,22]. It has been identified that riding a race is more physically demanding than riding daily track work [23] and jockeys rarely participate in additional off-horse physical training regimes except as a measure to reduce weight [17–19]. The higher incidence rate for falls in the low workload cohort indicates that if these jockeys are not partaking in sufficient extra physical training, or competition-specific exercise, they may not be physically or mentally prepared to meet the demands of riding in a race. The higher rate of falls predisposes them to greater injury risk, subsequent time out of racing, and this lack of physical and mental preparation would limit race success. The compounding of these factors with reduced competition-specific exercise in addition to inexperience, may explain, in part, the much greater rate of loss of athletes from this cohort.

Workload for flat racing jockeys varied more than for apprentices who had a more consistent seasonal workload. This may have been due to the weight allowance apprentices claim, giving them an advantage over jockeys in securing rides (horses carrying less than their assigned weight have an advantage). However, apprentices still had fewer rides per race day than jockeys, which could be a recognition by the trainers who secure their rides of their lack of experience and physical preparedness to compete at the level of the high workload cohort of jockeys with multiple races per race day. Indeed, jumps racing apprentices had a significantly lower workload than jockeys, indicating that their weight advantage may not be as important as the experience of the fully licensed jockey in the longer and more demanding race.

Apprentices in their ultimate year of apprenticeship were more likely to have a higher number of rides per season than in their first-year riding as a jockey, though the difference was not significant. Apprentices have trainer support to secure rides, in addition to having a weight allowance, both of which are lost when they become jockeys. The loss of these bonuses may make the transition into professional sport difficult, resulting in a lighter workload during their first professional jockey year than during their apprenticeship. Industry support for apprentice jockeys moving out of their apprenticeship may facilitate a greater proportion of jockeys moving more successfully into professional sport.

4.1. High Workload Cohort Jockeys

The workload of the relatively small group of jockeys in the high workload cohort was higher than that of the majority of jockeys, and this bias is similar to findings in Australia and the USA [8,16]. However, the workload of these New Zealand jockeys, riding competitively twice weekly, was less than that qualitatively reported for Britain [10,17,18]. This could be due to the higher number and greater geographical concentration of races in Britain, providing more riding opportunities.

During their career, jockeys in the high workload cohort spent little time riding fewer than 200 rides per season, with minimal exchange in and out of this group with the low and middle workload cohorts. Similar to that observed in other sports such as baseball [24], a successful jockey's career appears to be characterised by a rapid ascent and decline in workload (ride numbers), demonstrating a compressed work career. In addition, these jockeys were successfully able to meet low riding weights, indicating an ability to maintain a consistent bodyweight year round. Time spent by high-performing jockeys in the middle and low workload cohorts may reflect time off due to injury or ride infringements. However, this information was not included in the dataset.

The large numbers of jockeys competing for a fixed number of ride opportunities, results in high selectivity for the jockeys able to perform at a high level. Jockeys in all cohorts began race riding in their 20s. In North American professional sports, there is an age specific range of maximum performance [24,25], and this age may enable them to meet the physical demands of horse racing more successfully and for longer than those beginning at a later age. These data indicate that there may be an optimal number of race rides required to maintain the competition-specific fitness and conditioning required to compete safely and successfully in this sport. Prospective research is required to identify

this threshold. Early selection of and support for candidates who are able to join this high workload cohort would reduce risk to both horse and rider and loss of athletes from the sport.

Both an athlete's total workload and chronic workload (changes in load over time) are related to injury risk, with spikes in activity resulting in higher likelihood of injury and high chronic workloads associated with lower injury risk [12]. The consistent flat racing schedule observed in New Zealand allows continuous opportunities for jockeys to compete and minimizes the risks of spikes in workload. However, jumps races are seasonal, and this may, in part, contribute to the higher rate of falls by jumps racing jockeys. Any greater risk of a fall in jumps racing due to "lack of practice" is further exacerbated by the greater inherent risk of a fall in jumps racing due to longer races and therefore greater time spent at risk, as well as the nature of jumping a fence during a race, increasing the chance of a jockey becoming unseated [7,26,27]. The majority of jockeys compete sporadically and do not have a sufficient workload to prepare them for them for the higher levels of the sport without additional physical training.

Lack of conditioning may not only be an obstacle to a jockey's progression in the industry but an important factor in their risk of falling from the horse and thus potentially sustaining career ending injuries [4,28,29]. This observational study provides an initial external workload from which further research is required to understand the current level of training (internal and external workloads) undertaken by apprentices and jockeys and to determine whether it is sufficient to meet the demands of the sport. These data are required in the formation of a physical conditioning programme to optimally prepare the jockey for their demanding race schedules and reduce potential injury risk.

4.2. Limitations

This study was based on retrospective data and thus the analysis was restricted to variables that could be quantified with this data. There are a number of factors which may influence or limit a jockey's workload and career, such as lack of talent, struggles with weight restriction and injury. To quantify the effect of these, a prospective study and access to data outside the scope of this project are required. In some cases, data are presented as summative cases across years and there may be some individuals who are initially represented as apprentices and subsequently as jockeys as they progress through their career. The collection of data across 14 seasons should ameliorate this limitation to some extent.

5. Conclusions

The external workload of flat racing jockeys was higher than for jumps racing jockeys. The majority of flat racing jockeys had a very light seasonal workload of fewer than 14 races per season and rode for two years. These data indicate an inability to obtain sufficient rides to develop, let alone sustain, a viable career as a jockey. Compounding this, these jockeys were associated with a greater risk of falling (and thus injury) and less success than jockeys with higher workloads, which may be due to lack of "race day specific" conditioning and experience (skill). A small number of jockeys were responsible for the majority of flat racing starts, rode at consistently low weights and rode for 6 years or more, indicating that they were able to maintain competition-specific fitness levels to enable successful performance in their sport. This study provides a unique foundation in understanding the jockey's 'athlete' workload, the importance of which has ramifications for the jockey's career, both in terms of success and injury prevention.

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