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# A threshold model to determine the association between race rides and fall risk for early career (apprentice) jockeys

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ABSTRACT

*Objectives:* To identify descriptors associated with success in apprentice jockeys and to determine optimum numbers of jockeys for safer race riding.
*Design:* Retrospective cohort study.
*Methods:* Incidence-rates for jockey falls and success (wins per 1,000 race-starts), time and number of races spent at different apprentice levels were calculated for 807 apprentice and professional jockeys over 19 years of Thoroughbred flat racing in New Zealand (n = 524,551 race-starts). Survival analysis was used to compare career progression for jockeys that fell and those that did not, and individual seasonal fall incidence-rates were modelled.
*Results:* Apprentices had the highest fall incidence-rate in their first year of race riding (2.4, interquartile range 1.7–3.2 vs 1.1, interquartile range 1.0–1.2, $p < 0.05$) and a lower success incidence-rate compared to non-apprentice jockeys (71, interquartile range 67–75 vs 97 interquartile range 96–98, $p < 0.05$). Jockeys who fell during their apprenticeship rode in more race rides to progress towards professional status than those who did not. There was an inverse power relationship between fall incidence-rate and race rides per season for jockeys, with the inflection point at 33 rides per season. Half (48 %) of the jockeys rode fewer than 33 rides per season.
*Conclusions:* There is a surplus number of jockeys, riding at high fall risk, produced than is required by the number of race riding opportunities. Greater investment into the fitness, education and selection of a smaller cohort of dedicated apprentices, may be beneficial to reduce the risk of early career fall or injury in jockeys and requires further investigation.


## Practical implications

- This study identifies key milestones (number of race rides) for jockeys to achieve in their early and professional race riding career to maintain sufficient race riding fitness to reduce fall risk.
- These milestones can provide licensing guidelines for the racing industry to assess the progression and suitability of apprentices to ride with lower fall risk.
- Jockeys who ride in over 33 race rides per season have a lower risk of falling during a race.
- There is a surplus number of jockeys produced than required to maintain safer race riding and career longevity for jockeys.

## 1. Introduction

Professional jockeys race horses at high speeds, working at maximum physiological capacity in a high risk sport.[1,2] They have the added responsibility of maintaining low body mass to meet the riding-weight classification of the horses they ride, usually between 50 and 60 kg for flat racing jockeys.[1,3,4] Jockey inexperience has been linked to greater likelihood of falling from a horse during a race,[6–8] thus apprentice jockeys are at greater risk of injury from those falls than their professional counterparts. Apprentice jockey education programmes aim to support and prepare jockeys both physically and mentally for this demanding job, but lack quantitative data to support milestone achievements to assess apprentice jockey suitability and progression.[9,10]

It has been shown that a higher number of race rides by a jockey not only increase the likelihood of a successful career, but a higher frequency of race riding increases "competition fitness" and reduces the risk of injury.[7,11,12] However, there is also a linear association between

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the number of race rides by a jockey on a race day and risk of falling,[7] indicating there is an upper limit of race rides that a jockey may complete before becoming fatigued (Fig. 1). Jockeys are financially motivated to ride as much as possible,[10] however inexperience and/or fatigue can both result in an increased chance that a jockey will make errors whilst race riding, which may result in the loss of the race, or even jockey fall.[13] An analogous threshold has been observed in elite rugby players, with players involved in 15–35 competitive matches at a lower risk of injury in the subsequent season than players both below and above this threshold.[14] This threshold provides an indication of the workload limits for these rugby players, by describing the acute (short term) to chronic (long term) workload ratio of these athletes.

Planning appropriate training load and management of loading patterns are important to guarantee a long sporting career.[15–17] Total training load is multifactorial, encompassing multiple biological constraints such as age, phenotype, previous injury history, chronic load, experience, psychological factors and physical and mental fitness.[18,19] These biological constraints may also contribute to injury risk from high training loads and highlight the importance of determining the optimum training load for athletes, below which the body is 'unfit' for the pressures of competition, and above which the risk of injury increases exponentially, due to 'overtraining'.[15]

Apprentices in New Zealand predominately ride in flat races during their four year full time apprenticeship.[9,20] Before progressing to an apprentice licence, aspiring jockeys must ride in a minimum of 25 satisfactory trial rides ('mock races') which are assessed by both the officially employed New Zealand Thoroughbred Racing (NZTR) regional riding mentor and local stewards from the racecourse. Once the apprentice licence has been awarded, apprentice jockeys ride in official races alongside professional jockeys with no restrictions. To account for their relative inexperience in race riding, apprentice jockeys are awarded a 'weight claim' of up to 4 kg, effectively reducing the weight carried by their horse during the race.[21] Apprentice weight claim is based on their experience as measured by previous wins. An apprentice may claim 4 kg for 0–9 flat wins, 3 kg for 10–39 flat wins, 2 kg for 40–79 flat wins and 1 kg for 80–139 flat wins.[22] Apprentice jockeys progress to professional status after 4 years of race riding regardless of how many wins they have achieved, if they fulfil all other criteria. Once an apprentice jockey graduates after their 4-year apprenticeship, they are no longer entitled to a weight claim.

Apprentice jockeys tend to use training rides to gain riding fitness, with top professional jockeys experiencing a level of race-specific exercise to which the majority of jockeys are inadequately exposed.[3,23,24] This highlights the importance of providing early training and measured race exposure opportunities to apprentice jockeys, which may help to establish effective work and fitness practices and routines.[25] These routines may be essential in forming the basis of a long and successful career in racing.

Determination of a theoretical threshold of races per season or raceday may provide guidelines to assess safer racing (less falls and thus lower injury risk), greater success and longer careers for jockeys involved in the industry. Therefore, the aim of this study was to identify key milestones/descriptors associated with success during the early careers of apprentice jockeys. A secondary aim was to determine the optimum number of jockeys in New Zealand based on these descriptors.

## 2. Methods

Jockey, horse and race data for every Thoroughbred flat race between 1 August 2004 and 31 July 2023 (19 racing seasons) were obtained from New Zealand Thoroughbred Racing (NZTR); the governing body for Thoroughbred racing in New Zealand. Jockeys who were not licensed in New Zealand ($n = 118$) were removed from the data. Jump races (3 % of all racing starts[7]) were removed from the analysis. Ethics was not required due to this being a retrospective study of official industry data published in the public domain.

For the purposes of this study, an apprentice was defined as any rider with a weight reduction of $>1$ kg from the handicap weight assigned to the horse. Professional jockeys have no weight reduction.

Normality of the data were assessed using a Shapiro–Wilk test and descriptive statistics (median and interquartile range, IQR) were used to describe the non-normally distributed data at a population level. Kruskal–Wallis tests for significance were used to compare differences between groups. Incidence rates (IRs) for falls and wins were calculated per 1000 race starts on a population level. Rides to win ratios were calculated for individual jockeys as the total number of rides divided by the number of wins in a licence category. Some jockeys did not achieve a win during a racing season or licence category, returning an infinite value. Time spent at risk (days since first race ride) in each licence category and rides per month were calculated for individual jockeys based on their first and last race dates in each licence category.

Seasonal IRs were calculated for individual jockeys within a racing season (beginning on the 1 August and ending on the 31 July). The relationship between seasonal IRs of jockey falls and the number of rides was

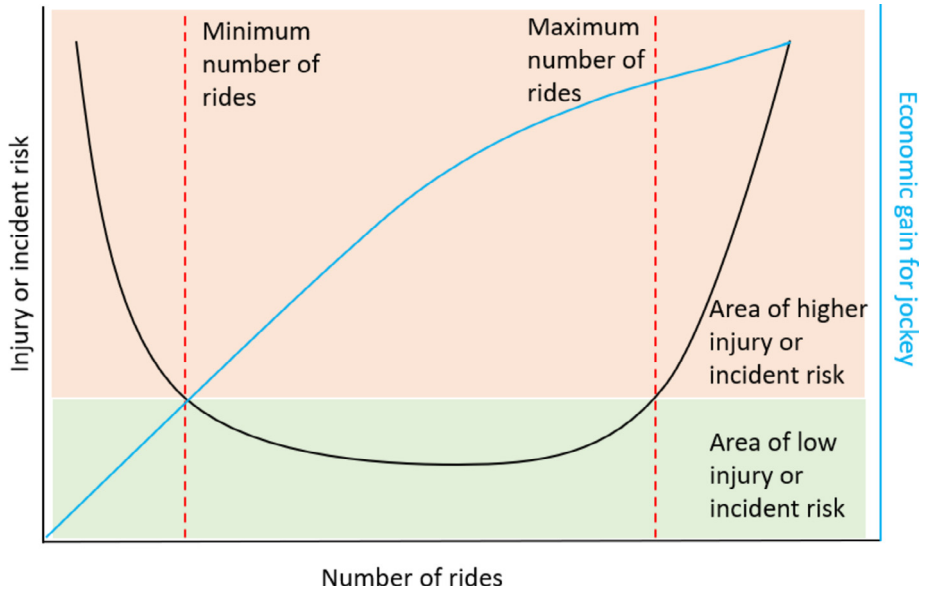


**Fig. 1.** Theoretical model of injury or incident risk association with race riding fitness and economic gain for the jockey (as measured by riding fees, and opportunity for winning stake money).

**Table 1**
Descriptors (median and IQR) and incidence rates per 1000 rides (95 % CI) of jockey falls and wins for professional jockeys (no weight claim) and apprentice jockeys with different weight claims (beginning the apprenticeship with a 4 kg claim and progressing to lower claim weights) riding in New Zealand Thoroughbred flat races during the 2004/05–2022/23 racing seasons.

| Descriptors | All jockeys | Professional | Apprentice | | | | |
|---|---|---|---|---|---|---|---|
| | | | Total | 1 kg claim | 2 kg claim | 3 kg claim | 4 kg claim |
| Number of jockeys[+] | 807 | 696 (86 %) | 498 (62 %) | 223 (27 %) | 306 (40 %) | 380 (47 %) | 343 (43 %) |
| Number of rides[+] | 524,551 | 386,395 (74 %) | 139,723 (27 %) | 31,920 (6 %) | 42,529 (8 %) | 45,560 (9 %) | 18,147 (3 %) |
| Number of falls[+] | 644 | 416 (65 %) | 228 (35 %) | 45 (7 %) | 61 (9 %) | 78 (12 %) | 43 (7 %) |
| Number of jockeys who had a fall (%) | 254 (31 %) | 147 (21 %) | 158 (32 %) | 38 (17 %) | 48 (16 %) | 66 (17 %) | 38 (11 %) |
| IR falls per 1000 rides (95 % CI) | 1.2 (1.1–1.3) | 1.1 (1.0–1.2)$^{1,a}$ | 1.6 (1.4–1.9)$^{2}$ | 1.4 (1.0–1.9)$^{a,b}$ | 1.4 (1.1–1.8)$^{a,b}$ | 1.7 (1.4–2.1)$^{b}$ | 2.4 (1.7–3.2)$^{b}$ |
| Number of wins | 48,704 | 37,381 | 11,426 | 2572 | 3614 | 3852 | 1285 |
| Number of jockeys who had a win (%) | 535 (66 %) | 365 (52 %) | 360 (72 %) | 123 (55 %) | 200 (65 %) | 261 (68 %) | 259 (76 %) |
| IR wins per 1000 rides (95 % CI) | 93 (92–94) | 97 (96–98)$^{1,a}$ | 82 (80–83)$^{2}$ | 81 (77–84)$^{b}$ | 85 (82–88)$^{b}$ | 85 (82–87)$^{b}$ | 71 (67–75)$^{c}$ |
| Median number of rides to win ratio* (IQR) | 18 (12–Inf) | 38 (12–Inf)$^{1,a}$ | 16 (11–Inf)$^{2}$ | 20 (12–Inf)$^{a}$ | 14 (10–Inf)$^{b}$ | 14 (10–Inf)$^{b}$ | 16 (10–74)$^{b}$ |
| Median time (months) spent at licence level (IQR) | 26 (6–83) | 26 (3–85)$^{1,a}$ | 22 (7–48)$^{2}$ | 11 (1–25)$^{b,c}$ | 12 (3–27)$^{b,c}$ | 13 (5–28)$^{b}$ | 9 (3–18)$^{c}$ |
| Median rides per month (IQR) | 5 (1–18) | 2 (1–20)$^{1,a}$ | 7 (2–19)$^{2}$ | 12 (1–42)$^{b}$ | 10 (2–32)$^{b,c}$ | 7 (2–19)$^{c,d}$ | 5 (2–11)$^{d}$ |

$^{1,2}$Means with differing superscripts differ ($p < 0.05$) between professional and apprentice levels.
$^{a,b,c}$Means with differing superscripts differ ($p < 0.05$) between professional and apprentice claim levels.
[+] Percentages in these rows are calculated as the percentage of each licence level using 'all jockeys' as the reference level.
* Rides to win ratio is the number of rides divided by the number of wins for an individual jockey. Some (34 %) jockeys do not achieve a win, returning an infinite value.

investigated using descriptive statistics and scatter plots. The model that provided best fit to the descriptive data was determined to be an inverse power regression with 95 % confidence intervals. Kaplan–Meier survival curves were used to estimate the number of rides jockeys spent at each claim allowance, with a steeper curve indicating a faster progression to the next level, and those jockeys who did not progress having a longer 'survival time'.

Optimum and theoretical numbers of jockeys were estimated using the most recent racing data, information provided by NZTR[26] and previous information on New Zealand jockeys which found that jockeys who rode in over 200 rides per season had a lower fall IR and higher success IR than jockeys with fewer rides.[12] Equations used for theoretical estimates are provided in Table 3. Analyses were conducted in RStudio (version 2023.12.1 + 402; R Foundation for Statistical Computing, Vienna, Austria) with the level of significance set at $p < 0.05$.

## 3. Results

During the 2004/05–2022/23 racing seasons, there were 807 domestic jockeys licensed to ride in 524,551 Thoroughbred flat racing starts in New Zealand. There were a median of 160 (IQR 154–166) professional and 80 (IQR 75–86) apprentice jockeys licensed each racing season. Professional jockeys had a median age of 32 years (IQR 26–39, n = 696), whilst apprentice jockeys had a median age of 23 years (IQR 19–26, n = 498).

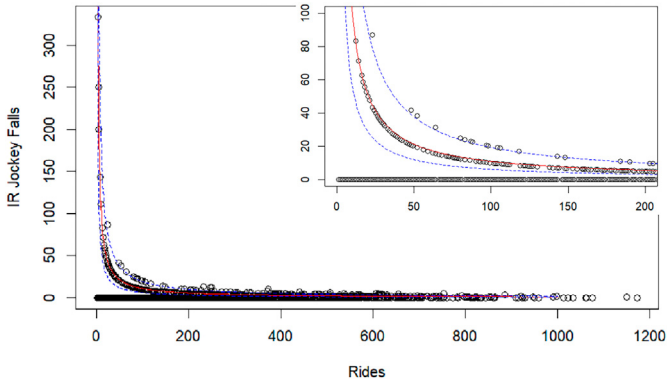


**Fig. 2.** Seasonal jockey fall incidence rates (IRs) and number of rides per season for jockeys who had a fall in New Zealand Thoroughbred flat races during the 2004/5–2022/23 racing seasons, with 95 % confidence intervals (dashed blue lines). Inset is zoomed in on the curve elbow. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Half of the jockeys were male (n = 470, 59 %), and male jockeys rode in 67 % (n = 350,610) of the race day starts. There were 343 apprentices (57 % male) who began their career with a 4 kg claim, and 223 apprentices (64 % male) progressed to a 1 kg claim. Apprentices with a 4 kg claim had a higher IR of falls and lower IR of wins than jockeys in other licence levels (Table 1). There were no differences in fall IRs between male and female jockeys either in total, or between the difference licensing levels ($p > 0.05$). Male professional jockeys (59 %) had a higher IR of wins per 1000 race rides (100, 95 % CI 99–101) than female professional jockeys (90, 95 % CI 88–92, $p < 0.001$). There was no difference in win IRs between male and female apprentice jockeys ($p > 0.05$).

A race day fall was experienced by 254 (31 %) of jockeys at least once during the study period. Jockeys who fell had a median of 1 (IQR 1–1, range 1–4) fall in a racing season. The individual IRs of falls per jockey, per racing season, decreased exponentially with the increasing number of rides ($R^2 = 0.93$, F-statistic 6693) (Fig. 2, Table 2). The elbow of the curve occurred at 33 rides in a racing season.

One third of apprentice jockeys had a fall during their apprenticeship (Table 1). Apprentice jockeys that fell early in their career required more race rides to obtain the necessary number of wins to decrease ('outride') their weight claim during their apprenticeship (Fig. 3). It took 55 rides for half the apprentice jockeys who did not fall to 'outride' their 4 kg claim, 130 rides to 'outride' their 3 kg claim, 170 rides to 'outride' their 2 kg claim and 20 rides to progress to professional jockey from a 1 kg claim. Apprentice jockeys who fell rode approximately 20 more starts to achieve the required 9 wins to progress from their starting 4 kg claim to a 3 kg claim. As an apprentice moved through the weight claims, this disparity in rides required became greater.

During the 2022/23 racing season, there were 24,693 racing starts. There were 184 (66/184, 36 % apprentice) jockeys licensed for race riding in New Zealand. Visiting jockeys (n = 53) rode in 345 race starts (345/24,693, 1 % of all racing starts). Half (89/184, 48 %) of New Zealand licensed jockeys rode in fewer than 33 race starts (median 5, IQR 2–13). One quarter of New Zealand licensed jockeys (46/184, 25 %) rode in more than 200 race starts (median 386, IQR 286–502). Table 3 describes the theoretical estimates of the numbers of jockeys and

**Table 2**
Model coefficients for the natural log of seasonal fall incidence rates (IRs) of jockey falls and number of rides for those jockeys that had a fall during New Zealand Thoroughbred flat races during the 2004/5–2022/23 racing seasons.

| Coefficients | Estimate | Standard error | t value | Pr(>\|t\|) |
|---|---|---|---|---|
| Intercept | 6.79 | 0.06 | 105.8 | <0.001 |
| ln (Rides) | −0.96 | 0.01 | −81.8 | <0.001 |

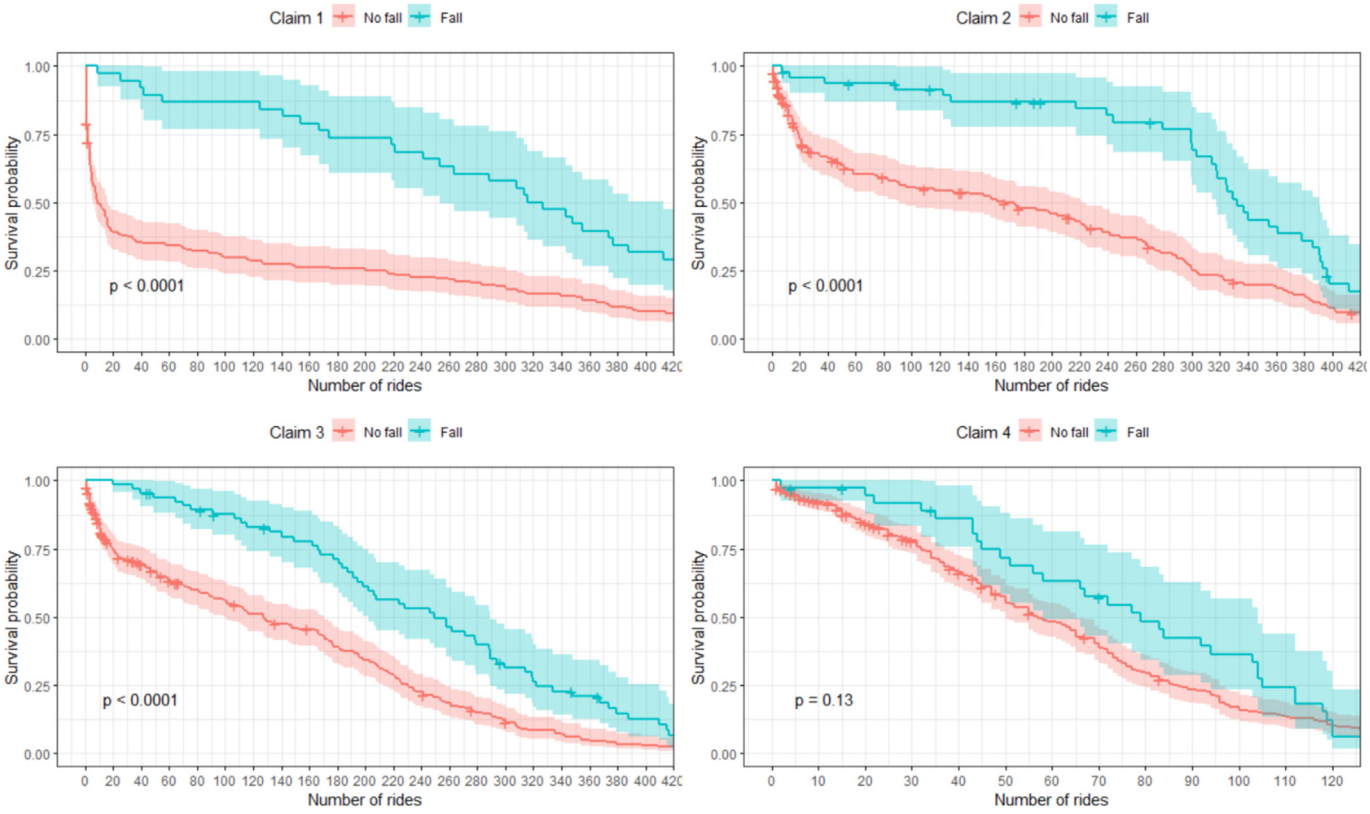


**Fig. 3.** The Kaplan–Meier survival curves for number of rides taken to progress to a lower weight claim (e.g. 4 kg claim to a 3 kg claim, as assessed by cumulative number of winning rides) for apprentice jockeys who had a fall compared to those who did not, during New Zealand Thoroughbred flat races between the 2004/05–2022/23 racing seasons. Shaded area indicates 95 % confidence intervals.

apprentices required to reduce the incidence of jockey falls in New Zealand flat racing, based on racing figures from the 2022/23 season. If all jockeys rode a maximum of 200 race rides per season, there is a 50 % surplus of jockeys in New Zealand. If all jockeys were guaranteed to earn a living wage in 2023 (i.e. assuming no wins/prize money and no trial rides) there was a 110 % surplus of licensed jockeys in New Zealand. The current numbers of apprentices training are more than required to replace the number of long career jockeys retiring, assuming the high attrition rate of apprenticeship completion was to remain constant. If the completion rate for apprentice jockeys was to increase to 100 %, the number of jockeys required to maintain a consistent level of long career jockeys is one quarter (24 %) of the current numbers of apprentices.

## 4. Discussion

This study provides key measurable riding parameters to assess both the early career progression of apprentice jockeys, and for professional jockeys. Apprentice jockeys at the beginning of their careers are at highest risk of falling of all jockeys. Their lower success rate, despite having a weight advantage (i.e. lower racing weight) over more experienced jockeys, reflects their lack of race riding experience. However, the

**Table 3**
Theoretical numbers of jockeys and apprentices required to reduce fall risk in New Zealand Thoroughbred flat racing, based on riding metrics from the 2022/23 racing season.

| Descriptor | Equation | Variable |
|---|---|---|
| Number of flat race starts per racing season (2022/23 season) | | 24,693 |
| Number of flat race starts by NZ jockeys | | 24,348 |
| Optimum number of jockey rides per year (lower fall IRs, higher success rate)[a] | | 200 (min level) |
| Economic viability (ride fee)[26] | | $176/race ride |
| Living wage 2023 in NZ[c] — estimate living wage $26/h | | $50,000/year |
| Race rides for jockeys to earn a living wage in NZ[b] (living wage/ride fee) | $50,000/176 | 284 rides/year = 6 rides/week. |
| Optimum number of jockeys riding (max number of jockeys for min fall rate [safety] or living wage [economics]) | =24,348/200<br>=24,348/284 | 122 (safety)<br>86 (economics) |
| Current number of jockeys riding per season (2022/23 season) | | 184 |
| Current number of jockeys riding >33 rides per season | | 95 (51 %) |
| Current number of jockeys riding >200 rides per season | | 46 (25 %) |
| Number of jockeys retiring each year (from 10+ career length cohort)[a] | | 4 |
| Number of apprentice jockeys required assuming 100 % completion | =4 * 4 year apprenticeship | 16 |
| Number of apprentices required assuming 40 % completion | =(4 * 4) / 0.4 | 40 |
| Number of apprentices required assuming 32 % will ride for 10+ years[a] | =(4 * 4) / 0.32 | 50 |
| Current number of apprentices (2023) | | 66 |

[a] These assumptions are based on data from Legg, Cochrane.[12]
[b] This doesn't take into account trial rides at $72 per ride, or race winnings (5 % of stake money).
[c] Living wage estimate from: https://www.procurement.govt.nz (as of Sept 2023).

majority of apprentice jockeys are on a competitive level with professional jockeys (with not significantly different fall rates, but lower success rates) after approximately 2 years of race riding, when they reach the 2 kg claim allowance. This highlights the importance of providing sufficient physical and mental preparation for these jockeys in order to support their entry into the professional sport.

Jockeys experience a myriad of stressors during their career, due to performance and competitive pressures, weight issues, time demands, locational difficulties, and interpersonal demands with trainers, other jockeys, and horse owners.[9,10,27] These stressors are likely to be greater for apprentice jockeys who fall early in their career, and result in the slower progression out of their claim levels. The fall event may result in injury, loss of confidence (in themselves, and from the owners/trainers), time off reducing their race exposure, and being offered lower quality horses to ride, all adding to the difficulties in progressing through an apprenticeship.[4] Therefore, implications for falls early on could be career ending for a young apprentice jockey, both physically and psychologically.

In addition to physical and mental stressors, there are multiple factors that may affect the fall risk in apprentice jockeys, such as the quality of the horse they ride (age, experience, grade and level of training), race type (stakes available, distance and field size) and track conditions.[6,7,28] These factors are mediated to some degree by the industry tendency to offer a higher proportion of race rides to apprentice jockeys in autumn and winter, when horses are likely to be more experienced (preparing for winter racing) and competing in slower races on heavier tracks, carrying heavier weights.[12] However, there are fewer total race opportunities on offer during these months in the racing calendar, compounding the issue of competition for race rides between jockeys, particularly at the beginning of their careers.

Apprentices at decreasing claim weights have increasing numbers of rides per month, as would be expected for jockeys progressing in their career. However, this number falls when they finish their apprenticeship, reflecting the loss of advantage when they both lose their weight claim and their affiliation with a trainer. Therefore, this highlights the importance of establishing a good reputation early in their careers, allowing them to build on this success to continue a long career.

Currently, there is no requirement to achieve a certain number of rides or wins to progress from an apprentice to professional status.[29] Therefore, jockeys may progress to professional status after 4 years, even if they still have a 1 or 2 kg claim. This explains the rapid progression to professional status (within 20 race rides) of half the jockeys with a 1 kg weight claim.

Providing a clear and comprehensive milestone framework and expectations early in the apprentice jockey training programme with greater investment into the support and education of individuals may aid in supporting these jockeys in the time they are most at risk. Currently, apprentices have a minimum number of 25 trial rides to prepare them to race ride, based on the discretion of approved industry trainers. In addition to riding in races, apprentices also ride in trials ('mock' races), however the number of trial rides they obtain after the initial threshold is reached is not regulated. During the period of highest risk (their first 2 years of race riding), it could be beneficial to reach and maintain a minimum level of trial rides (e.g. 200 trial rides per year or 16 per month) to simulate the race riding specific fitness that is equivalent to professional jockeys who experience safer riding.[11,13]

The higher rides to win rate (coupled with the low rides per month) for professional jockeys is a reflection of the disequilibrium within the industry,[11,12] with half of the licensed professional jockeys having fewer than 33 race rides per season. This highlights the disparity within the system, and provides evidence for creating a minimum riding threshold or fitness standard, not only for apprentice jockeys, but also for professional jockeys, in order to maintain riding fitness and keep their licences. This minimum threshold, based on jockey fall IRs, could theoretically reduce jockey fall IRs, by ensuring a minimum level of 'match fitness'. If jockeys were unable to reach this level, either due to weight restrictions, time off due to injury or suspension, or lack of reputation, they appear unlikely to succeed as long career jockeys.[12] Recognising this early in their careers may reduce the numbers of ill-prepared jockeys who are more likely to make riding errors, which can be detrimental to multiple jockeys and horses in a race. A key area for future research may be to investigate the interrelationship between jockey riding infractions and jockey fall and riding data.

Currently, apprentice training is largely reliant on trainer discretion, resulting in wide differences in the support available to a jockey, particularly in the acquisition of trial and race rides. There is an 'expectation' of a high fallout rate, where failed apprentice jockeys may be channelled into other jobs within the racing industry, which may benefit both the jockey and the industry indirectly. However, most jockeys in New Zealand have short careers, low workloads and a high injury risk from falling.[7,11,12] This study indicates that there is a surplus number of jockeys produced than is required by the number of rider opportunities. Limiting the numbers of apprentice jockeys to maintain a target number of working jockeys, though stricter selection criteria based on the consistency of anthropometric limitations of jockeys and physical fitness requirements,[20,30] may allow more intensive investment into the training and education of new apprentices. Additionally, if an optimum number of professional jockeys were maintained, the pressure to obtain rides, a major concern for all professional jockeys,[31] would be reduced. In association with a specialised apprentice training programme, these measures may help to retain and support jockeys in their career.

Specialised apprentice training has been shown to be effective in Australia where a structured training programme for apprentices reduced the annual rate of loss of apprentices from 25 % to 10 %.[32] Instigation of apprentice only races may be one avenue to provide the less experienced apprentice jockeys more opportunities to obtain race rides. Additionally, ensuring apprentices maintain a minimum number of 'trial' rides may help to maintain a certain level of 'competition-specific' fitness in these less experienced jockeys. In contrary to findings in Australia and Ireland,[5,6,28] there was no difference in fall incidence rate between male and female jockeys, at any licensing level. This may be due to the more equal opportunity in New Zealand offered to jockeys of both genders, however there is a tendency for male jockeys to have more success and form a higher proportion (70 %) of the successful jockey population in New Zealand.[11,12]

Jockeys are motivated to ride as frequently as possible, both to establish and maintain their reputation, as well as for personal financial well-being. This study identifies a minimum threshold level of race-day rides that a jockey should aim to compete annually to maintain their race-specific fitness. If jockeys are unable to attain this threshold number of rides, it appears they are unlikely to succeed as a long career jockey.[12] Future studies could determine a maximum threshold of the number of races for a jockey to minimise overexertion physically or mentally. This may be harder to describe due to the interplay between different stressors such as acute vs chronic fatigue, training and race-day preparation strategies, injury management and interpersonal relationships, and may depend more strongly on an individual's weight and performance.

### 4.1. Limitations

This study provides evidence of simple trends from a long-term comprehensive set of retrospective data. However, only variables within the data could be quantified, and qualitative factors which may influence a jockey's career progression, such as riding skill or talent, industry connections, weight control issues or previous or current injury were not considered. These omissions may be encompassed to a certain extent in the jockeys' ability to obtain race rides. Current apprentice training in New Zealand is regionally based, however it is in a current state of reform, heading to a more concentrated centralised system. This may give jockeys more equal opportunities and allow for more discretionary assessment of their potential for progression within their chosen career.

## 5. Conclusion

Early career apprentice jockeys are most at risk of falling during race riding. Apprentices are expected to progress to the next level of their apprenticeship within intervals of approximately 1 year, with increasing numbers of race rides each year, whilst achieving a win once every ~12 rides. Falling during these early years of race riding increases the numbers of rides required to progress through the apprenticeship and may inhibit the eventual progression of those jockeys that fall. Greater investment into the fitness, education and selection of a smaller cohort of dedicated apprentices may be beneficial to increase career retention and reduce the risk of early career fall or injury.

Professional jockeys riding in a minimum of 33 rides per season have a lower fall incidence rate and are likely to maintain sufficient racing fitness to participate in Thoroughbred flat racing in New Zealand. Currently, there are more jockeys licensed than are necessary to optimally compete economically or with low fall risk in races in New Zealand and half of these jockeys do not achieve the minimum threshold of 33 race rides per season. Reducing the number of licences available, or introduction of a minimum race ride threshold may reduce the number of jockeys, allowing a more equitable distribution of race rides throughout the remaining jockey population.

## CRediT authorship contribution statement

Conceptualisation: All authors, methodology: KAL, and formal analysis and data curation: KAL. All authors contributed to the drafting, revision and approval of the final manuscript.

## Confirmation of ethical compliance

Ethics was not required due to this being a retrospective study of official industry data published in the public domain.

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## Declaration of interest statement

The authors declare no conflict of interest.

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