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Original

EL IMPACTO DE LOS LIMITES DE PESO DEL RUGBY JUNIOR DE AUCKLAND EN LA RETENCIÓN DEL JUGADOR

THE IMPACT OF AUCKLAND JUNIOR RUGBY WEIGHT LIMITS ON PLAYER RETENTION

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RESUMEN

La comunidad de Rugby Nueva Zelanda sabe los problemas de salud y seguridad para niveles jóvenes y ha aplicado límites en cada grado de ataque para mínima el riesgo de heridas. Sin embargo, el sistema de evaluación actual ha creado un situación inútil en donde participantes pesados no puede jugar en sus grupos de año. Utilizando aproximadamente 20,000 observaciones de jóvenes en rugby por ocho temporadas (2009-2016), el estudio determina la probabilidad de un jugador joven Neozelandés puede regresar la temporada siguiente y aislar a las causas de comportamiento. Utilizando regresión logística y análisis de medidas repetidas, determinamos si participantes sobre la límite de pesadez para su nivel de año ser más probable a dejar jugando.

Investigando el impacto de la edad en relación al corto del primer de Enero, este estudio encontró tasas de cambio significas para cada nivel de edad (excepto 10 años) para niños que no juegan con sus iguales estadísticamente. Niños con 11 años que juegan en un nivel más alto pesado tiene una probabilidad 46% más dejar jugando en comparación de un jugador en el mismo nivel con sus iguales. Proporcionalmente estas cifras son pequeñas y afecta aproximadamente unas 3.5% de niños en Auckland. Sin embargo, una baja de jugadores generalmente junto con una tendencia clara y sistemática en que los niños paren jugando requiere que los guardianes de junior rugby tomen acciones pragmáticas. Por eso, el estudio presente recomienda que las relaciones entre niños de niveles mismos son considerando junto con los atributos pesados.

Palabras clave: Batir, Regresión, Medidas Repetidas

ABSTRACT

The New Zealand rugby community is aware of safety issues at the junior level and has applied weight limits for each tackle grade to minimise injury risk. However, the current weighting system has created an unaccommodating situation for heavier participants as they do not play within their peer group. Using approximately 20,000 observations of junior rugby players across eight seasons (2009-2016), the study determines the likelihood of a junior New Zealand player returning the following season and isolating the drivers of this behaviour. Applying logistic regression and repeated measures analyses to determine whether participants who are above the specified weight limit for their age group are more likely to leave the game.

Investigating the impact of age in relation to the January 1st cut-off, this study found statistically significant churn rates at all age levels, except 10 years, for children who do not play with their peers. Children 11 years old who are playing up a grade by weight are 46% more likely to churn, compared to a player who is in the same team as their peers. Proportionally, these numbers are small, impacting approximately 3.5% of children in Auckland. However, a decline in playing numbers generally along with a clear and systematic trend for children to leave the game requires custodians of the junior game to take pragmatic action. Therefore, the present study recommends that peer relationships are considered alongside weight attributes.

Keywords: Churn, Regression, Repeated Measures

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INTRODUCTION

The days of Rugby Union being New Zealand's most loved sport may be limited. Football in Auckland has recently overtaken rugby as the most popular sport for secondary school students in 2016 (Edens, 2017). To combat this Rugby New Zealand has reportedly developed a 5-year plan to target the large number of players that leave the sport in the transition from primary to secondary school (Chatterton, 2016). However, if this problem is to be solved in the long term, primary focus must be placed on retaining participation at a primary school level.

New Zealand is one of the only countries in the world that have a junior rugby competition that fosters weight bandings in their age-grade league. This system has been running in Auckland (Auckland Rugby, 2016), Wellington (WRFU Junior Club Rugby, 2017) and Christchurch for the past 5 years, with other countries such as Australia looking to adopt the process in 2017. The structure was put in place to reduce the risk of injury created by children facing players twice their size. However, individuals that are slightly heavier are put in an uncomfortable position as they are pushed up into a team with players up to three years older. The developmental stages of a primary school student can differ dramatically over a just few years, highlighting the impact this age gap can have on the player (World Rugby, 2013). Therefore, the aim of this study is to determine the likelihood of a junior New Zealand rugby player returning the following year and isolate the drivers of this behaviour.

Literature Review

World Rugby has looked at addressing the issue on an international scale and has discussed New Zealand's adoption of weight banding, which is commonly used in other contact sports internationally. In their discussion they raise a critical factor that our system fails to address, namely the importance of ensuring 'that the player in question is playing at a level that allows them to gain enjoyment from the game through ensuring they can play and understanding the game at the level prescribed, as well as being allowed to play with their friends and with children of their own physical and mental age' (World Rugby, 2013, p. 6).

New Zealand junior rugby weight limits have been a prominent topic in the media for the past couple of years. Numerous NZ Herald articles address the complaints of worried, angry or disappointed parents of players who are considering withdrawing their child from the game (Deane, 2014; Pollock, 2014; Moir, 2013). Others surround the risks of playing junior rugby without age-weight bandings, with reference to events involving a near fatal concussion (Deane, 2014) and the death of a New Zealand rugby player in 2013 (Harvey, 2016).

Differences in the physical development of children have never been as great as they are today, with the vast multiculturalism of players in New Zealand being the dominating factor. However, the more players that are lost due to size mismatch means that safety is reduced even further for those players who remain in the game (Deane, 2014).

Former Australian Roar player, John Coomer (2016), supports age-weight bandings as he says that currently, in solely age based competitions, it can be a case of effectively young men playing with and against boys and in the long run neither party is particularly benefited. Smaller players have their confidence crushed, whereas larger players, who have experienced a certain dominance in their younger years, come to a standstill when this advantage starts to fade. Commonly these players, due to relying on the advantage of their stature, miss out on essential early skill development (Coomer, 2016).

While the New Zealand age-weight system does have its merits, there are also consequences of these age-weight bandings not being optimally implemented, which is the main issue that this paper will address.

As an example, Moir et al relate the story of a 10-year-old boy from Porirua who has been forced to move up and play in the *Under-13* grade this season. Weighing in at 71kgs, he is told that he is 'too fat' to play for a team in his correct age group (*Under-11's*). Moving up two grades means he is suddenly exposed to pushing in scrums and a much rougher style of play. Subsequently he is looking to give up the game and move to a different sport because his club made him feel like an outcast and he could not play with his friends (Moir, 2013).

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The continuing growth in the variety of sports offered in primary and secondary schools is challenging the survival of rugby union. Over the next two decades, 60% of New Zealand's growth is predicted to come from the Auckland region, resulting in emerging regional trends region flowing out into New Zealand's next generation of adults (Edens, 2017). If rugby is going to remain our national sport immediate and effective changes must be made.

Research Intent

Through this study we aim to determine the likelihood of a junior New Zealand rugby player returning the following season and isolate the drivers of this behaviour. This is like understanding churn within a commercial setting.

A focus will be placed on establishing if children who are over the specified weight limit for their age group are more likely to leave the game. Additionally, we will investigate the impact of age in relation to the current date-of-birth cut-off (January 1st), as the Relative Age Effect suggests that players who are born later in the year are disadvantaged (World Rugby, 2013). Given that the current system holds the potential for a three-year age gap to be present between players in the same grade, it is likely that changes will need to be made. Implementing a system that successfully caters for both weight and age will hopefully increase the retention rate of players by decreasing the number of children who are losing passion for the sport due to being separated from their peers.

World rugby states that younger children (age 8-9) use adult feedback and evaluation to gauge their playing performance while older children (age 10-14) rely on feedback gained from peer group evaluation (World Rugby, 2013, p. 5). From a coaching perspective, this is another reason why playing with peers of a *similar* age is important. It becomes increasingly difficult for a coach to do their job if there is a wide range of cognitive and motivational maturity within the team. If a competitive atmosphere is created that is inappropriate for the developmental stage of the child they may begin to withdraw from the sport or, more importantly, become exposed to negative psychological effects caused by this aging mismatch (World Rugby, 2013).

Furthermore, the breaking up of peer groups can have a detrimental effect on a player's passion for the sport. At a younger age the driving force behind player participation is to be with their peers. Subsequently, restricting children from playing with their friends means they are probably less likely to participate altogether and switch to an alternative sport.

METHODS

Churn in the business world is typically defined as the loss of customers on a yearly basis which, from a business perspective, is crucial to understand as it directly affects the customer base and thus revenue. Predictive techniques such as logistic regression and decision trees are commonly used to identify at risk customers and the interpretation of the model structures help determine tactical and strategic responses to customer retention. This is like the research problem here — understanding the drivers behind churn for any sporting community is crucial to retain players. Linking the research intent with a practical approach shapes both data collection and manipulation. Previous studies include the analysis of factors influencing churn rates among sports season ticket holders (McDonald, 2010) and the computational analysis of churn in multiplayer online games (Borbora, 2015).

Data Analysis

The cleaned data contained 20,000 observations across 5 variables (churn, age, date of birth, day and indicator). Given the aim is to determine the likelihood of player churn and the drivers that affect this behaviour, the study will adopt a logistic regression analysis. Moreover, the regression model will consider two-way interactions as it is hypothesised that interactions between day, age and weight have a significant effect on churn.

Data Collection

Auckland Rugby Union provided data for all children aged 3 to 18 years who enrolled in Auckland junior rugby from 2009 to 2016. On the day of enrolment (January 1st for any given year) basic player information, such as Player ID, Weight, Date of Birth and Year of Registration, were recorded. Individual players could not be identified, but ID numbers

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provided the ability to anonymously track player participation across seasons to determine churn.

Players under the age of 7 have been removed from the dataset as they do not play tackle rugby and therefore are not influenced by age-weight bandings. Whilst players over 11 years old are affected by age-weight bands, as they move into a different competition governed by college, they have also been removed from the dataset.

Procedure

The data was cleaned to remove any impossible weight values. Following the initial cleaning procedure, regression diagnostic plots were produced to check for any further outliers or points of high influence or leverage. None of the points were found to have distinctly different leverage.

An R-script was then developed to parse the data set and calculate the following variables for each player:

1. Churn: An indicator of whether the player enrolled in the following rugby union season or not. Churn = 1 if the i-th player has churned, 0 otherwise.

2. Age: Age (in years) is regarded as a factor with 5 levels and was calculated using the difference between the year of registration and the player's date-of-birth. Age = Year of Registration - Year of Birth.

3. Day: Calendar day of the year that the player is born.

4. Indicator: A weight band indicator is used to map players whose weight is above or below the set weight limits for their age group. This allows identification of whether the weight categorization of a player has a statistically significant impact on the probability of churn. Auckland does not offer the possibility of moving down a grade, as is possible in Wellington and Christchurch; instead the -1 indicates a player who has played in the 'restricted' grade. The weight band indicator has been set as a factor with 3 levels. Ind = -1 if weight $<$ min, 0 if min $\leq$ weight $\leq$ max, 1 if weight $>$ max.

Methodology

Logistic regression can be used to predict a binary categorical response variable with categorical or continuous predictor variables (or both). Logistic regression is typically used in churn analysis to predict the probability an individual will churn (conversely, to be retained). This technique, most commonly used in consumer analysis, can also be used to predict the retention rate of sports players. In the present analysis, player churn is the binary response variable that we are trying to predict using player weight, age, a weight band indicator and their calendar day of birth as predictor variables.

Logistic Regression

Logistic regression is a form of generalized linear model with a logit link function and a binomial random component, typically fit using maximum-likelihood estimation. The logit function restricts the probability of churn, π_i, to between 0 and 1 while the dependent variables can take any real value.

Ordinary logistic regression relies on the assumption of independence of subject observations.

As the data tracks players across several seasons, a repeated measures framework will be implemented to allow for the repeated independent variables of each player, which we would expect to be correlated over time. Player identification numbers are used to place repeated observations into clusters.

Model Selection

To select the best model for predicting player churn the *'glmulti'* test in R-Studio was used to decide which variables should be retained or excluded from the model. The resulting output is several models ranked from the 'best' to the 'worst'. The model selection is based on the set Information Criterion, which in this case, was the AIC value.

To compare the five 'best' models several goodness of fit tests have been used to assist with further selection of the most desired model.

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Table 1. Logistic Regression Model Comparison

Order Selected	Model	AIC	Deviance (1-pchisq)	AUC (Roc plot)
1	$Y_{Churn} = \alpha + \beta_{Age} + \beta_{Weight} + (\beta_{Age} * \beta_{Weight}) + (\beta_{Ind} * \beta_{Weight})$	28681	0	0,7304
2	$Y_{Churn} = \alpha + \beta_{Age} + \beta_{Weight} + (\beta_{Ind} * \beta_{Weight})$	28695	0	0,7303
3	$Y_{Churn} = \alpha + \beta_{Age} + \beta_{Weight} + (\beta_{Weight} * \beta_{Day}) + (\beta_{Ind} * \beta_{Weight})$	28696	0	0,7305
4	$Y_{Churn} = \alpha + \beta_{Age} + \beta_{Weight} + \beta_{Day} + (\beta_{Ind} * \beta_{Weight})$	28696	0	0,7305
5	$Y_{Churn} = \alpha + \beta_{Age} + \beta_{Weight} + \beta_{Day} + (\beta_{Ind} * \beta_{Day})$	28715	0	0,73
Self-Selected Model	$Y_{Churn} = \alpha + \beta_{Age} + \beta_{Weight} + (\beta_{Ind} * \beta_{Age}) + (\beta_{Ind} * \beta_{Day})$	23909	0	0,7475

Because of the computational time required, models were tested with up to 4 parameters (including interactions) using the available variables. In addition, more complex models were prepared using variables identified as important from the initial glmulti screening along with practically relevant variables such as date of birth (*Day*).

Taking both model Akaike's Information Criterion (AIC) and practical importance into account, the best candidate model was selected as: $Y_{Churn} = \alpha + \beta_{Age} + \beta_{Weight} + (\beta_{Ind} * \beta_{Age}) + (\beta_{Ind} * \beta_{Day})$.

This model makes practical sense, having interaction terms with logical interpretations and the lowest AIC among the candidate models.

Additional goodness of fit tests also confirmed selection of the model. Wald chi-squared tests and significance are included in the standard output and confirmed statistical significance ($p<0.05$) for all variables in the selected model. Additionally, a test of joint significance of the predictors rejected the null hypothesis that there was no difference between the selected model and one with only an intercept ($p <0.0001$). The area under the curve (AUC) value of the receiver operating characteristic (ROC) curve was 0.748 indicating good predictive performance.

Likelihood-ratio tests were performed for nested models to test the effect of including additional parameters, with the null hypothesis that there is no significant difference between a reduced model and a model with additional parameters. Testing between the selected model with main effects only and the model including interactions gave a chi-squared test statistic χ^2 of 93.184 and p-value < 0.0001 (df = 12). Therefore, there is strong evidence to reject the null hypothesis at the 5% level and to include both interactions in the model.

Finally, we used a stepwise AIC routine to test for over fitting as the AIC value penalizes models with additional degrees of freedom, with the best model having the lowest AIC value. Removal of any of the variables (Ind, Age or Weight) resulted in a higher AIC score, indicating that the selected model was the best.

RESULTS

To adjust for the seasonality of the dataset we must allow for repeated measurement of players over time. The statistical method for extending the Generalized Linear Model to allow for repeated measurements can be performed using a Generation Estimating Equations (GEE) approach. Results are included in Table 2.

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Table 2. Table of Coefficients for Repeated Measures Model (diff: differences; *: p<0.05; **: p<0.01; ***: p<0.001)

			Estimate	Standard Error	z value	Pr(>|z|)	
(Intercept)			2,2187	0,2078	10,68	**< .0001**	***
Age	7		-4,5981	0,1524	-30,16	**< .0001**	***
	8		-3,7019	0,1337	-27,69	**< .0001**	***
	9		-3,6896	0,1293	-28,53	**< .0001**	***
	10		-2,9123	0,1221	-23,84	**< .0001**	***
	11		-2,6737	0,1195	-22,37	**< .0001**	***
	12		0	0	.	.	
Weight			0,0077	0,0036	2,12	**0,0337**	*
Day			-0,1079	0,0224	-4,82	**< .0001**	***
Age*Ind	7	0	0,3489	0,1534	2,27	**0,0229**	*
Age*Ind	7	1	1,0359	0,3871	2,68	**0,0075**	**
Age*Ind	7	-1	0	0	.	.	
Age*Ind	8	0	0,2368	0,1113	2,13	**0,0334**	*
Age*Ind	8	1	0,8894	0,2884	3,08	**0,002**	**
Age*Ind	8	-1	0	0	.	.	
Age*Ind	9	0	0,451	0,1125	4,01	**< .0001**	***
Age*Ind	9	1	0,7679	0,275	2,79	**0,0052**	**
Age*Ind	9	-1	0	0	.	.	
Age*Ind	10	0	0,1454	0,1101	1,32	0,1867	
Age*Ind	10	1	0,0524	0,2729	0,19	0,8498	
Age*Ind	10	-1	0	0	.	.	
Age*Ind	11	0	0,1656	0,1218	1,36	0,1742	
Age*Ind	11	1	1,0502	0,3286	3,2	**0,0014**	**
Age*Ind	11	-1	0	0	.	.	
Age*Ind	12	0	-0,015	0,2375	-0,06	0,9498	
Age*Ind	12	1	-0,0058	1,0125	-0,01	0,9955	
Age*Ind	12	-1	0	0	.	.	
Day*Ind		0	0,053	0,037	1,43	0,1524	
Day*Ind		1	0,0874	0,0889	0,98	0,3259	
Day*Ind		-1	0	0	.	.	

Interpretation of the model at each age and indicator level can be seen in Table 3 through the probability of Churn for each interaction. For players aged 7, 8, 9 and 11 years the probability of churning is statistically significant for Indicator 1; highlighting that players who are have been moved above their age grade, due to their weight, are more likely to leave the game. This effect is minimized at age 10 with minor differences present between the three indicators, this is most likely due to players who are disadvantaged by the weight bands already having left the game. The weight banding effect is reintroduced at age 11 where the probability of churning rises dramatically; approximately 62% of players who fall above their weight limit leave the game, a 30% increase on the previous year.

Overall, the repeated measures analysis clearly supports the hypothesis that the current age-weight bandings are negatively affecting player participation rates. This impact is prevalent in multiple age groups, clearly highlighting the unsustainable nature of these trends on the future of New Zealand Rugby.

Table 3. Churn Probabilities from Repeated Measures Model (diff: differences; *: p<0.05; **: p<0.01; ***: p<0.001).

Indicator	7	8	9	10	11
Below	0,0773007	0,1703145	0,1720596	0,3113533	0,3646588
Within	0.1056072 *	0.2054916 *	0.2449336 ***	0,342062	0,4024376
Above	0.1895203 **	0.3310521 **	0.3073302 **	0,3206404	0.6190622 **

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DISCUSSION

This analysis of the junior rugby weight limits in Auckland indicates that the current system is flawed, and that action needs to be taken to implement a new model.

The results of our findings show that the revised age-weight system should be based on the *school year group* of players (at the time of registration) rather than their *year of birth*. This means that rather than having a January 1st cut-off, it should be moved to June 1st to align with the New Zealand schooling year.

The aim of this is to try and keep players together with their peers rather than splitting the year groups in half, as the current system does. As stated by World Rugby, the aim of sport at the primary school level is for players to have fun and enjoy playing the game (World Rugby, 2013, p. 4). Ensuring that peers play together is more likely to increase player enjoyment and therefore increase retention. A further change to NZ junior rugby would be to extend the Auckland system, whereby players must be within one year of each other, to Wellington and Christchurch. Currently in these cities, age gaps of up to three years can be seen between players in the same grade. However, playing numbers may influence this action.

The weight limits in the suggested system are just a guide. For an accurate model to be developed a more in-depth analysis would need to be carried out to determine the specific weight bandings that should be put in place for each age group, potentially tailored by region.

Table 4. Revised model for *smaller* regions

School Year	Max Weight	Revised Grade
Year 1	Open grade	
Year 2	Open grade	
Year 3	32 kg	Year 4
Year 4	38 kg	Year 5
Year 5	44 kg	Year 6
Year 6	52 kg	Year 7
Year 7	55 kg	Year 8
Year 8	No maximum	-

Table 5. Revised model for *larger* regions

School Year	Max Weight	Revised Grade
Year 1	Open grade	
Year 2	Open grade	
Year 3 Restricted	25 kg	Year 3
Year 3	32 kg	Year 4
Year 4 Restricted	32 kg	Year 4
Year 4	38 kg	Year 5
Year 5 Restricted	38 kg	Year 5
Year 5	44 kg	Year 6
Year 6 Restricted	44 kg	Year 6
Year 6	52 kg	Year 7
Year 7 Restricted	52 kg	Year 7
Year 7	55 kg	Year 8
Year 8 Restricted	55 kg	Year 8
Year 8	No maximum	-

Limitations

The application of Model 2 (Table 5) may be limited depending on the size of the playing population. Smaller cities or rural areas of New Zealand may not have the opportunity to implement this system, as the ability to class players based on their weight relies on having enough registrations to split athletes up, while still maintaining viable teams.

Another limitation of this research is that Auckland Rugby runs off a different grading system to that of both Wellington and Christchurch. The weight banding structure used by Auckland is more static than the other two regions, in that a player may only move up one grade if heavier than the maximum weight, unlike the other regions where it is possible to move up two grades. If a player is lighter than the minimum weight, they are placed in a restricted team with lighter players their age. Subsequently, players in the Auckland region do not experience such extreme mixing of ages as can be seen in Wellington and Christchurch, where there is the possibility to have team mates spanning 3 school year groups.

This study has been limited to the Auckland dataset, yet we have still found statistical significance in our results. Therefore, we would expect results in Wellington and Christchurch to show that players are even more likely to drop out if they do not fall within their respective age-weight band.

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CONCLUSIONS

Overall the current age-weight banding system in Auckland junior rugby is flawed and has subsequently been proven to negatively affect player retention rates. The model was initially developed to try and improve the safety of the game, however only a select number of players are catered for, those who are slightly heavier are disadvantaged. Player enjoyment has been disregarded. Considering that, in Auckland alone, churn rates are statistically significant at all age levels (aside from age 10) for children who are not playing with their peers, is extremely concerning.

If individuals are moved up a grade at age 11 they are 46% more likely to leave the game, then a player who is in the same team as their peers. The loss of these players at such a young age is detrimental to the future of the sport.

Considering these results, we recommend that emphasis be placed on the school year rather than the player's birth year when forming grades.

As New Zealand Rugby participation numbers are in decline, pragmatic action will need to be taken immediately if the nation wants to avoid the loss of its most popular sport. Given that the framework used in Wellington and Christchurch is even more unstable than Auckland, it would be sensible for further investigation to be carried out in these regions, with the expectation that significant changes will need to be made.

From here an obvious next step would be to fully engage with New Zealand Rugby to carry out a more in-depth, nationwide study.

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