

Argentina vs. New Zealand: A Comparison of Physical Qualities and Anthropometric
Profiles in Male Rugby Union Academy Players

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Attestation of authorship

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Ethical approval

The Auckland University of Technology Ethics Committee (AUTEC) approved this research on 31/10/2025.

Ethics Application: 25/339.

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Abstract

Rugby union is a collision-based sport in which anthropometric and physical performance characteristics play an important role in player development and progression towards elite competition. Although previous research has extensively described the physical profiles of rugby players across playing levels and positions, limited research has directly compared academy players from different high-performance rugby nations. Therefore, this study aimed to compare the anthropometric and physical performance characteristics of male academy rugby union players from Argentina and New Zealand and to examine differences according to playing position.

Sixty-seven academy rugby players aged 18–20 years participated in the study (Argentina, $n = 34$; New Zealand, $n = 33$) and were classified as forwards or backs. Anthropometric measures included height, body mass, and the sum of six skinfolds. Physical performance assessments included estimated one-repetition maximum (1RM) squat, bench press, and weighted chin-up strength; countermovement jump (CMJ) height; 10 m and 30 m sprint times; and Bronco completion time. Descriptive statistics were calculated as mean $\pm$ standard deviation. Two-way analyses of variance were used to examine the effects of country, playing position, and country $\times$ playing position interactions.

Playing position was significantly associated with most anthropometric and physical performance variables. Forwards generally demonstrated greater body mass, a greater sum of six skinfolds, and greater absolute maximal strength, whereas backs achieved greater CMJ heights, faster sprint times, and faster Bronco completion times. Significant country $\times$ playing position interactions were identified for body mass ($p = .013$, $\eta^2p = .099$), the sum of six skinfolds ($p < .001$, $\eta^2p = .205$), estimated 1RM squat strength ($p = .021$, $\eta^2p = .085$), and allometrically scaled weighted chin-up strength ($p = .004$, $\eta^2p = .138$). New Zealand backs were 12.2 kg heavier than Argentinian backs (93.7 ± 10.8 vs. 81.5 ± 7.0 kg, $p = .044$). Argentinian forwards demonstrated a 28.6 mm greater sum of six skinfolds (92.5 ± 33.8 vs. 63.9 ± 15.6 mm, $p < .001$) and 22.9 kg greater estimated 1RM squat strength (193.5 ± 22.5 vs. 170.6 ± 19.3 kg, $p = .014$) than New Zealand forwards. Argentinian backs also demonstrated greater allometrically scaled weighted chin-up strength than New Zealand backs (7.13 ± 0.37 vs. 6.01 ± 0.48 1RM $\cdot$ kg $^{-0.67}$, $p < .001$).

Overall, playing position was more consistently associated with the anthropometric and physical performance characteristics examined than country. Although country effects and country $\times$ playing position interactions were identified for selected anthropometric and physical performance measures, no significant country differences were observed for several other variables. These findings reinforce the importance of position-specific and individualised athlete monitoring and provide contemporary reference data to inform evidence-based decision-making within academy rugby development programmes.

Chapter 1: Introduction and rationale

1.1 Background

Rugby union is a physically demanding, intermittent collision sport that requires players to repeatedly perform high-intensity running and collision-based activities throughout match play (Duthie et al., 2003). The nature and frequency of these activities vary according to playing position, creating distinct physical requirements for forwards and backs. Understanding the anthropometric and physical qualities demonstrated by rugby union players is therefore relevant to the design and implementation of long-term athlete development programmes, particularly within high-performance academy environments. Physical characteristics such as aerobic capacity, speed, maximal strength, power, and body composition are widely monitored to assess selected qualities relevant to performance, guide training prescription, and support the physical preparation of academy players for potential participation in professional competition (Owen et al., 2020).

These physical qualities are relevant because they may contribute to players' ability to meet the collision and running demands associated with their positional roles. Forwards are typically exposed to a greater frequency of contact events, including scrums, rucks, and tackles, and generally demonstrate greater body mass, maximal strength, and force-production capabilities. In contrast, backs typically demonstrate greater speed, acceleration, and power, which are relevant to the running and evasive activities associated with open-field play (Deutsch et al., 2007; Duthie et al., 2005). Although physical profiling does not directly quantify match demands, it can be interpreted alongside match-play research to assess selected capabilities relevant to position-specific performance. Consequently, profiling anthropometric and physical characteristics according to playing position has become a central component of performance monitoring in academy rugby environments.

Previous research has profiled youth and academy rugby players across several countries, including England (Darrall-Jones et al., 2015), South Africa (Durandt et al., 2006), and broader age-grade rugby populations within established development pathways (Till et al., 2014; Read et al., 2018; Owen et al., 2020). These studies have provided valuable reference data describing the anthropometric and physical characteristics of developing players and have highlighted the value of structured physical monitoring during key developmental stages. Longitudinal research has demonstrated improvements in selected physical qualities across adolescence, supporting the implementation of systematic physical preparation as players transition towards senior performance environments (Till et al., 2014; Jones et al., 2018). However, despite global participation in rugby union, relatively few studies have directly compared academy cohorts selected within contrasting national development systems, particularly in the Southern Hemisphere.

Comparing academy rugby players from Argentina and New Zealand provides an opportunity to identify similarities and differences in the anthropometric and physical performance characteristics demonstrated by players selected within two distinct national contexts. Both countries are recognised as Tier 1 rugby nations with

established high-performance pathways, yet their developmental structures differ. New Zealand operates within a highly integrated system linking school competitions, provincial unions, and professional franchises, providing players with access to structured strength and conditioning programmes. In contrast, Argentina has historically relied on club-based development pathways, with varying levels of access to high-performance resources during the earlier stages of player development. These contextual differences may be associated with variations in previous training exposure and physical preparation practices. However, because the present study uses a cross-sectional design, differences between the cohorts cannot be interpreted as evidence of changes over time or attributed directly to the effectiveness of either development system.

Examining players aged 18–20 years is particularly relevant because this period commonly precedes potential participation in senior or professional competition (Till et al., 2017). At this stage, players may encounter greater training loads, competition demands, and performance expectations and are therefore expected to demonstrate physical qualities relevant to higher-level participation. Contemporary country- and position-specific reference data may help practitioners contextualise individual player profiles and identify characteristics warranting further assessment or targeted physical preparation. These data may also complement talent identification processes, although they should not be used as isolated selection criteria. The characteristics demonstrated by academy cohorts may reflect biological maturation, relative age, body size, previous training exposure, and selection or retention practices, as well as their current training environment. Therefore, physical profiling should be interpreted alongside technical, tactical, psychological, developmental, and training-history information. When incorporated into repeated assessments, such data may help practitioners monitor individual responses, refine training priorities, and support long-term athlete development practices.

1.2 Purpose Statement

The primary purpose of this thesis was to examine the anthropometric profiles and physical qualities of male academy rugby union players aged 18–20 years from Argentina and New Zealand and to determine how these characteristics differed according to country and playing position. This investigation focused specifically on academy-level players for two key reasons.

First, limited research has examined the combined anthropometric and physical performance characteristics of academy rugby players approaching professional status, particularly within structured high-performance environments in Tier 1 rugby nations. Much of the existing literature has focused on either youth players in early developmental stages or senior professional athletes, with comparatively less attention given to the academy stage preceding potential participation in senior or professional rugby. Second, to the author's knowledge, no previous study has directly compared the anthropometric and physical performance profiles of academy rugby union players from Argentina and New Zealand, two Tier 1 Southern Hemisphere nations with distinct player

development structures. Argentina and New Zealand represent established high-performance rugby nations with distinct competitive structures, playing styles, and athlete development pathways. Differences in previous training exposure, physical preparation practices, and talent identification processes may be associated with variation in the physical characteristics demonstrated by players selected within each academy pathway.

Previous research has identified positional and competitive-level differences in variables such as body mass, body composition, strength, speed, power, and aerobic capacity across rugby populations. However, limited comparative research has examined these characteristics in academy players selected within different national systems. Investigating these variables may provide valuable insight into the physical profiles demonstrated by academy players within different environmental and developmental contexts. However, the cross-sectional design does not permit conclusions regarding how these qualities develop over time or the factors responsible for the observed differences.

Therefore, this thesis aimed to contribute to the current body of literature by providing comparative data on the anthropometric characteristics and physical qualities of academy rugby players from Argentina and New Zealand. Contemporary country- and position-specific reference data may complement talent identification processes, inform individualised physical preparation, and contribute to long-term athlete development models. However, these data should be interpreted alongside biological maturity, relative age, training history, and technical, tactical, psychological, and contextual information rather than being used as isolated indicators of player potential.

1.3 Research aims and hypotheses

The primary aim of this thesis was to investigate the anthropometric profiles and physical qualities of male academy rugby union players aged 18–20 years from Argentina and New Zealand. Specifically, this study aimed to describe and compare key anthropometric characteristics (e.g., body mass, height, and body composition) and physical performance measures (e.g., maximal strength, power, speed, and aerobic capacity) within this population. Characterising these qualities may provide reference information to support athlete monitoring and individualised physical preparation within high-performance academy environments. However, these measures represent only one component of player evaluation and should be interpreted alongside maturity, relative age, training history, and technical, tactical, psychological, and contextual factors.

A secondary aim of this thesis was to examine potential differences in anthropometric profiles and physical qualities between academy players from Argentina and New Zealand. Both countries are recognised as Tier 1 rugby nations with established high-performance pathways. However, differences in training exposure, physical

preparation practices, and selection processes may be associated with variation in selected anthropometric and physical performance characteristics.

Previous research has consistently reported positional differences in anthropometric and physical performance characteristics in rugby union, with forwards generally presenting greater body mass and absolute strength, while backs demonstrate higher levels of speed and power-related performance. Therefore, an additional aim of this thesis was to examine positional differences in anthropometric characteristics and physical qualities within this academy cohort. Identifying positional differences may provide further context regarding selected physical qualities relevant to specialised playing roles within academy rugby environments.

Based on the existing literature examining physical development in rugby union players, the following hypotheses were proposed:

1. Academy rugby players approaching professional status would demonstrate distinct anthropometric and physical performance profiles according to playing position.
2. Anthropometric characteristics would differ between academy players from Argentina and New Zealand, potentially reflecting population characteristics and differences in talent identification and selection processes.
3. Differences in physical performance characteristics, including strength, power, speed, and aerobic capacity, would be observed between academy players from Argentina and New Zealand.
4. Country and playing position would interact in their association with selected anthropometric and physical performance characteristics.

1.4 Structure of the thesis

Chapter 2 of this thesis presents a review of the current literature relating to anthropometric characteristics and physical qualities in rugby union. This chapter synthesises existing research examining positional differences and developmental trends in anthropometric profiles, as well as key physical performance measures relevant to rugby performance, including maximal strength, power, speed, and aerobic capacity. The review also identifies limitations within the existing literature and highlights the rationale for the present investigation.

Chapter 3 describes the methodology and results of an experimental cross-sectional study in which male academy rugby union players aged 18–20 years from Argentina and New Zealand completed a battery of anthropometric assessments and physical performance tests during the pre-season phase of their competitive season. This chapter outlines participant characteristics, testing procedures, and statistical analyses used to examine positional and between-country differences in physical qualities.

Chapter 4 presents a summary and interpretation of the findings in relation to the existing literature. Practical applications for high-performance rugby environments are discussed, alongside the limitations of the present study and recommendations for future research. The chapter concludes by outlining the potential implications of the findings for talent identification and long-term athlete development within elite rugby pathways.

Chapter 2: Physical Qualities and Anthropometric Profiles of Male Rugby Union Players from Tier 1 Nations: A Thematic Narrative Review

2.1 Introduction

The transition from academy to professional rugby represents a critical stage within long-term athlete development, during which players must meet increasingly demanding physical and anthropometric requirements (Till et al., 2017). In rugby union, progression to higher levels of competition has been associated with the interaction between anthropometric characteristics and physical qualities that enable players to tolerate repeated collisions, generate high levels of force, and sustain high-intensity actions throughout match play (Duthie et al., 2003; Till et al., 2017). However, progression to professional rugby is multifactorial and is also influenced by technical skill execution, tactical awareness, decision-making, psychological characteristics, durability, injury history, and the capacity to tolerate increasing training and competition loads.

A growing body of research examining physical qualities such as strength, power, speed, and aerobic capacity, alongside anthropometric characteristics including body mass, stature, and body composition, has improved understanding of the physical capabilities relevant to rugby union and informed strength and conditioning practice (Duthie et al., 2003; Owen et al., 2020). This knowledge has also played an important role in the development of long-term athlete development and talent identification programmes designed to prepare players for the increasing physical demands of professional competition (Till et al., 2017). However, physical profiling should be considered as one component of a broader player-development and selection process rather than as an isolated indicator of future playing success. While training adaptations and physical characteristics are well documented in youth and adolescent rugby populations, comparatively fewer studies have focused on high-performance academy players who are in the critical transition phase immediately prior to professional rugby (Till et al., 2017; Owen et al., 2020).

Academy rugby environments typically involve players aged 18–20 years who are approaching professional status and are exposed to training loads, performance expectations, and physical demands that increasingly resemble those of senior competition (Till et al., 2017; Owen et al., 2020). During this stage of development, players continue to refine physical qualities such as strength, power, speed, and aerobic capacity, while also developing anthropometric characteristics that support position-specific performance (Till et al., 2017). The development of these characteristics may be influenced by the interaction of training exposure, biological maturation, training age, and other physiological factors throughout this transitional phase. Although academy athletes are approaching physical maturity, individual variation in maturation status and development trajectories may continue to influence anthropometric and performance characteristics during late adolescence and early adulthood.

Argentina and New Zealand are both recognised as Tier 1 rugby nations with established high-performance pathways and successful histories of producing international-level players. Given their competitive standards

and professional performance outcomes, physical characteristics in academy players from these countries may be expected to be broadly comparable. However, the two nations operate within distinct cultural, environmental, and developmental contexts. Differences may exist in the roles of schools, clubs, provincial organisations, and national programmes, as well as in access to specialist coaching, strength and conditioning provision, athlete monitoring, and high-level competition. These structural and practical differences represent distinct player-development approaches and may be associated with variations in training exposure and physical preparation practices.

While a substantial body of research has described the physical characteristics of rugby players within individual countries, direct comparisons between academy populations from different Tier 1 rugby nations appear to be limited, particularly when comparable testing methods are used. Consequently, it remains unclear whether academy cohorts selected within different national environments demonstrate similar anthropometric and physical profiles. Examining these similarities and differences may provide valuable reference information for talent identification and athlete development practices. However, physical characteristics should complement, rather than independently determine, player-selection decisions.

Playing position is recognised as an important factor associated with anthropometric and physical profiles in rugby (Duthie et al., 2003; Till et al., 2017). Previous research has consistently reported that forwards tend to display greater body mass and absolute strength, whereas backs typically demonstrate superior speed and power-related characteristics (Duthie et al., 2003; Till et al., 2015). Understanding how these positional characteristics manifest within academy populations may provide valuable information for training prescription and the individualisation of physical preparation.

Therefore, the purpose of this literature review is to synthesise existing research on anthropometric profiles and physical qualities in rugby, with particular emphasis on positional differences, long-term athlete development, biological maturation, and the academy-to-professional transition. This review aims to provide a theoretical framework to support the investigation of similarities and differences between academy rugby players from Argentina and New Zealand and to contextualise the findings of the present thesis.

2.2 Literature review search methods

An electronic database search was conducted using PubMed, SPORTDiscus, Scopus, and Google Scholar to identify relevant peer-reviewed literature. The purpose of the search was to examine anthropometric characteristics and physical qualities in rugby union players, with particular emphasis on academy-level athletes and the transition towards professional competition.

The following search terms were used individually and in combination: rugby union, academy rugby, elite youth rugby, anthropometry, body mass, stature, body composition, skinfolds, strength, maximal strength, power, countermovement jump (CMJ), vertical jump, speed, sprint, acceleration, 10 m sprint, 30 m sprint, aerobic capacity, shuttle run, Bronco test, talent identification, and long-term athlete development. To reflect the comparative focus of the present thesis, additional search terms included geographical identifiers such as Argentina and New Zealand.

Additional studies were identified through screening the reference lists of relevant review papers and original research articles, as well as through electronic “related articles” searches. Due to the limited number of studies directly examining academy rugby players in Argentina and New Zealand, research conducted in other Tier 1 rugby nations was also included to provide contextual understanding of anthropometric characteristics and physical performance demands relevant to high-performance development pathways.

Given the limited availability of longitudinal and academy-specific research in rugby union populations, studies involving rugby league cohorts were also considered where appropriate, due to the similar physiological demands and collision characteristics observed across both codes. Inclusion of rugby league research provided additional context for commonly used physical performance tests and expected trends in developing players.

The inclusion criteria for the literature review were as follows:

1. studies involving rugby union or rugby league players;
2. reporting anthropometric characteristics (e.g., body mass, stature, skinfold thickness) and/or physical performance measures (e.g., strength, power, speed, aerobic capacity);
3. clearly described testing procedures and measurement methods; and
4. published in English language.

Priority was given to studies involving academy, elite youth, or professional rugby players, as well as research reporting the reliability and practical application of commonly used field-based testing methods. Where academy-specific literature was limited, studies involving senior professional players were included to provide contextual understanding of positional demands and expected physical characteristics. The literature was synthesised narratively and organised thematically according to anthropometric characteristics and key physical qualities to support the aims and hypotheses of the present thesis.

2.3 Anthropometry

The professionalisation of rugby union has led to substantial changes in the anthropometric characteristics of players, with increased emphasis placed on body size, lean mass, and physical robustness to meet the evolving demands of the modern game (Olds, 2001; Quarrie & Hopkins, 2007). Advances in strength and conditioning practices, nutrition, and sport science support have contributed to progressive increases in height and body mass across playing levels, particularly within high-performance development environments (Duthie et al., 2003). As players transition from school and club competitions into academy pathways, they are exposed to greater training loads and structured physical preparation programmes, which may contribute to increases in lean mass and reductions in relative body fat (Till et al., 2017; Darrall-Jones et al., 2015). These physical adaptations are considered important for coping with the increased collision frequency and intensity observed in elite rugby union.

Anthropometric differences between forwards and backs are consistently reported across both senior and youth rugby populations. Forwards are generally taller and heavier, possessing greater fat-free mass to meet the demands of scrummaging, tackling, and repeated contact situations (Duthie et al., 2003; Quarrie et al., 1996). Differences in body mass between positional groups are consistently reported, with forwards typically demonstrating substantially greater body mass than backs. In contrast, backs typically present lower body mass and reduced body fat levels, supporting greater speed and agility requirements associated with open-field play (Deutsch et al., 2007). These positional differences are evident during adolescence and may reflect the combined influence of biological maturation, selection practices, positional specialisation, and targeted strength and conditioning programmes (Till et al., 2017).

Biological maturation is an important consideration when interpreting anthropometric characteristics in academy rugby players. Considerable variation exists in the timing and tempo of maturation during adolescence, influencing stature, body mass, body composition, and physical performance. While most males attain adult stature between 16 and 18 years of age, growth may continue until approximately 20–21 years in later-maturing individuals. Consequently, players of the same chronological age may differ substantially in anthropometric characteristics despite similar training exposure and playing experience. Earlier-maturing athletes often display greater body mass, muscularity, and strength during adolescence, which may influence both selection and performance outcomes within youth rugby pathways (Malina et al., 2015; Till et al., 2017). Howard et al. (2016) demonstrated that biological maturation was positively associated with body mass, stature, peak power output, and sprint momentum in academy rugby union players, highlighting the influence of maturation on both anthropometric and performance characteristics during adolescence. Therefore, maturity-related differences should be considered when evaluating anthropometric profiles and interpreting physical development within academy rugby populations.

Variations in anthropometric characteristics have also been observed between rugby populations from different countries, suggesting potential influences of genetic background, environmental factors, and talent identification practices. Holway and Garavaglia (2009) reported substantial positional differences among Group 1 Argentine rugby union players, with front-row forwards exhibiting the greatest body mass (105.0 ± 10.0 kg), muscle mass (50.6 ± 5.4 kg), and mesomorphy ratings (8.1 ± 0.2), whereas scrum-halves displayed the lowest body mass (73.1 ± 5.7 kg) and stature (167.3 ± 3.9 cm). Furthermore, the Group 1 Argentine players were generally smaller than players competing in six of the leading teams at the 2003 Rugby World Cup, being between 3–11 cm shorter and 6–13 kg lighter across most playing positions (Holway & Garavaglia, 2009). In a longitudinal analysis of elite rugby players, Quarrie and Hopkins (2007) demonstrated substantial increases in player size following the professionalisation of rugby union, with the average body mass of elite forwards increasing from 102.3 kg to 111.1 kg and backs from 83.4 kg to 95.7 kg between 1995 and 2004. The stature of backs also increased from 180.3 cm to 182.9 cm during this period, reflecting the growing importance of body size in elite rugby performance. Together, these findings reinforce the importance of anthropometric characteristics in meeting the demands of high-level rugby competition. The anthropometric variation reported across these studies may reflect both biological diversity and systematic approaches to identifying and developing physically suitable athletes within high-performance environments.

Positional differences in somatotype have also been reported. Somatotype provides a descriptive classification of physique based on three components: endomorphy, representing relative adiposity; mesomorphy, reflecting musculoskeletal robustness; and ectomorphy, representing relative linearity. Forwards generally demonstrate greater endomorphic and mesomorphic characteristics than backs, consistent with their greater body mass and the strength and contact requirements associated with their positional activities. In contrast, backs generally demonstrate somatotype profiles characterised by lower relative endomorphy than forwards. For example, Holway and Garavaglia (2009) reported marked positional variation among Group 1 Argentine rugby union players, with front-row forwards demonstrating particularly high mesomorphy ratings. However, somatotype assessment has been reported less frequently in academy populations than traditional anthropometric measures such as stature, body mass, and skinfold thickness. This limits comparisons between cohorts and conclusions regarding how physique may differ according to age, playing position, or competitive level.

As playing level increases, greater height, body mass, and fat-free mass are generally observed, suggesting that physical characteristics may influence both selection and progression within rugby development systems. Till et al. (2017) reported that players progressing towards higher levels of competition consistently demonstrated greater body mass, muscularity, and strength characteristics than lower-level players, while body composition and strength were identified as important contributors to attaining professional status. These findings suggest that anthropometric and physical qualities may play an important role in both talent identification and athlete

development pathways. However, it remains unclear whether these differences primarily result from training adaptations within academy environments or whether players with favourable anthropometric characteristics are more likely to be selected into high-performance programmes at earlier stages. Additionally, methodological differences between studies, including variation in body composition assessment techniques and positional classification criteria, make direct comparisons between populations challenging.

Despite the growing body of research examining anthropometric characteristics in rugby players, no studies identified in the present review directly compared academy populations from Argentina and New Zealand. Differences in player development pathways, competitive structures, and population characteristics may be associated with variation in anthropometric profiles; however, comparative data obtained using consistent assessment methods are currently unavailable. Furthermore, limited research has characterised positional groups during the period between school or club rugby and potential progression to senior competition. Therefore, the direct comparison of the anthropometric characteristics of academy rugby players from Argentina and New Zealand represents a novel contribution of the present study and may provide useful reference data for talent identification and physical preparation practices.

2.4 Maximal strength

High levels of maximal strength are required to effectively perform key actions in rugby union, including tackling, scrummaging, ruck involvement, and ball carrying (Duthie et al., 2003). Strength qualities contribute to a player's ability to generate force during contact situations and tolerate repeated collisions throughout match play. The most commonly reported measures of maximal strength within the literature are one-repetition maximum (1RM) or multiple-repetition maximum tests, typically assessed using compound resistance exercises such as the back squat and bench press to evaluate lower- and upper-body strength, respectively (Crewther et al., 2009). In applied academy settings, submaximal strength assessments such as three-repetition maximum (3RM) testing are frequently used due to time efficiency and reduced injury risk, while still providing reliable estimations of maximal strength (Weakley et al., 2017). These testing approaches allow practitioners to monitor strength development during late adolescence, a critical period where increases in maximal strength are associated with improved readiness for senior competition (Till et al., 2017; Casserly et al., 2020).

Differences in maximal strength between positional groups have been consistently reported across rugby populations. Forwards generally demonstrate greater absolute strength than backs due to the higher physical demands associated with scrummaging, mauling, and repeated collision involvement (Quarrie et al., 1996; Till et al., 2014). However, the interpretation of strength performance in rugby is complicated by substantial differences in body mass between positional groups. Larger athletes are inherently capable of producing greater

absolute force outputs, meaning that comparisons based solely on absolute strength values may overestimate the influence of training adaptations and underestimate the role of body size (Crewther et al., 2009).

To account for differences in body size, strength performance is often expressed relative to body mass. For example, in a sample of American collegiate rugby athletes, (La Monica, M. B., et al. 2016) observed that forwards demonstrated greater absolute bench press (effect size = 1.17) and squat strength (effect size = 1.42) than backs. However, these differences were substantially reduced when strength was expressed relative to body mass, with effect sizes of 0.40 (unclear effect) and 0.85, respectively. These findings highlight the importance of considering body size when interpreting strength performance in rugby players.

Traditional ratio scaling methods, whereby strength is divided by body mass, have been criticised because they assume a linear relationship between body size and performance and may favour lighter athletes while penalising heavier individuals (Crewther et al., 2009). Consequently, allometric scaling has been proposed as a more appropriate approach for normalising strength performance. This method adjusts strength relative to body mass raised to a power exponent and has been shown to reduce the confounding influence of body size when comparing rugby players of different positions (Crewther et al., 2009). Using elite rugby union players, Crewther et al. (2009) demonstrated that positional differences observed in absolute strength measures were substantially reduced following allometric scaling, suggesting that body mass contributes considerably to the differences often observed between forwards and backs.

The importance of considering both absolute and relative strength has also been demonstrated across different levels of rugby participation. Argus et al. (2012) reported that higher-level rugby union players displayed greater absolute strength than lower-level players; however, these differences were reduced when performance was normalised for body mass. Similarly, Loturco et al. (2020) reported that relative strength measures may provide additional insight into athletic performance beyond absolute strength alone, particularly when comparing athletes of different body sizes. Collectively, these findings highlight the importance of evaluating both absolute and relative strength characteristics when assessing physical performance and progression within rugby development pathways.

Strength levels have also been shown to increase with playing level, with academy players typically demonstrating lower maximal strength values than senior professional players, reflecting ongoing physical development and training exposure (Jones et al., 2018; Till et al., 2017). Given the continued physical development occurring during the academy years, monitoring both absolute and relative strength characteristics may provide valuable information regarding athlete progression, positional suitability, and readiness for professional competition.

While maximal strength remains a fundamental physical quality underpinning rugby performance, the ability to express force rapidly may be of greater importance for distinguishing higher levels of competition. Argus et al. (2012) reported that although both strength and power differentiated playing standards, power measures appeared to provide greater discrimination between professional and semi-professional rugby union players. Indeed, the authors suggested that the ability to produce high levels of power may be a better determinant of playing ability than maximal strength alone at higher levels of competition. These findings suggest that once an adequate strength base has been established, further improvements in playing performance may be more closely associated with the ability to generate force quickly rather than increases in maximal strength alone. Consequently, both strength and power characteristics should be considered when evaluating athlete development and readiness for higher levels of competition.

2.5 Upper and lower body power

Muscular power represents the ability to produce force rapidly and contributes to explosive actions relevant to rugby match play, including jumping, sprinting, changing direction, tackling, and engaging in contact situations (Duthie et al., 2003). Both upper- and lower-body power may therefore provide important information regarding a player's physical capacity. Although maximal strength contributes to power production, strength and power represent related but distinct physical qualities, and improvements in one may not necessarily result in equivalent improvements in the other, particularly among highly trained athletes.

Argus et al. (2012) examined upper- and lower-body power using the bench throw and jump squat, respectively, alongside assessments of bench press and box squat strength. Professional players generally demonstrated greater absolute and relative strength and power than players competing at lower levels. However, bench press and box squat strength did not clearly distinguish professional from semi-professional players, whereas power measures provided greater differentiation between these groups. The authors consequently proposed that the capacity to produce high levels of power may be a better determinant of playing ability than maximal strength alone when comparing professional and semi-professional rugby players. These findings demonstrate the value of assessing both upper- and lower-body power and suggest that power measures provide relevant information beyond that obtained from assessments of maximal strength.

The countermovement jump (CMJ) is one of the most widely used assessments of explosive lower-body performance due to its practicality, reliability, and sensitivity to changes in neuromuscular status (Cormack et al., 2008; Gathercole et al., 2015). The CMJ evaluates an athlete's ability to utilise the stretch-shortening cycle and rapidly produce force. Consequently, it is commonly employed within academy and professional rugby environments to evaluate training adaptations, monitor neuromuscular fatigue, and inform assessments of readiness throughout the competitive season.

Positional differences in CMJ performance have consistently been reported, with backs generally demonstrating greater jump heights than forwards. For example, Till et al. (2014) reported CMJ values of approximately 46–48 cm in outside backs compared with 40–44 cm in forwards across elite youth rugby cohorts. Positional differences in explosive lower-body performance have also been observed in academy and professional rugby populations, although the magnitude of these differences varies between studies (Owen et al., 2020). Greater CMJ performance among backs may reflect their lower body mass, greater relative force-production capabilities, and the positional demands associated with high-speed running and explosive open-field movements.

Lower-body power contributes to sprint performance; however, its relative importance may differ across the phases of a sprint. Performance over the initial 5–10 m is typically more closely associated with the capacity to produce force relative to body mass due to the comparatively long ground-contact times during the initial strides. As sprint velocity increases and ground-contact times become shorter, the ability to produce force rapidly may assume greater importance. Therefore, CMJ performance should not be interpreted as the sole determinant of initial acceleration but as one component of the broader neuromuscular qualities contributing to sprint performance.

Methodological variation must also be considered when comparing CMJ results between studies. Testing protocols may differ in relation to the equipment used, movement execution, and the method employed to calculate jump height. Recent evidence suggests that flight-time methods may systematically overestimate jump height compared with force-platform-derived impulse–momentum calculations because flight-time estimates can be influenced by differences between take-off and landing positions and the associated displacement of the centre of mass (Xu et al., 2023). Therefore, caution is required when comparing CMJ values obtained using different measurement and calculation methods.

No studies identified in the present review directly compared the upper or lower body power characteristics of academy rugby players from Argentina and New Zealand using consistent assessment methods. Differences in training exposure, competition demands and player-development systems may contribute to variation between these populations. Consequently, the present study provides a novel comparison of lower body explosive performance between Argentine and New Zealand academy rugby players while also examining differences between positional groups.

2.6 Speed

Speed is an important physical quality in rugby union, contributing to line breaks, defensive recoveries, support play, and the successful execution of attacking actions. Given the intermittent, high-intensity nature of the sport,

sprint performance over short distances is commonly assessed within player-profiling protocols. Linear sprint tests over distances such as 10 m, 20 m, and 30 m are frequently used to evaluate different components of sprint performance relevant to match play (Owen et al., 2020). The initial 5–10 m primarily reflects acceleration capacity, whereas maximal velocity makes a progressively greater contribution as sprint distance increases. In academy populations, improvements in sprint performance during late adolescence have been associated with neuromuscular development and increased exposure to structured strength and conditioning programmes (Till et al., 2017).

Differences in sprint performance between positional groups have been widely reported. Backs generally demonstrate faster sprint times than forwards, reflecting the greater requirement for high-speed running and open-field play associated with backline positions (Deutsch et al., 2007). Positional differences have been observed across multiple sprint distances and may become more pronounced over longer distances as maximal velocity makes a greater contribution to overall performance (Darrall-Jones et al., 2016). Initial acceleration is influenced by an athlete's capacity to apply force relative to body mass during the comparatively long ground-contact periods of the first strides. Consequently, the greater body mass of forwards may increase the inertia that must be overcome during acceleration, particularly when this additional mass is not accompanied by proportionally greater force-production capacity (Jones et al., 2018). At higher running velocities, shorter ground-contact times increase the importance of producing force rapidly. Sprint performance should therefore be interpreted in relation to body mass, relative strength, rapid force production, and the specific distance assessed.

Sprint performance has also been associated with playing standard and the execution of important match behaviours. Smart et al. (2013) reported that international rugby players demonstrated faster 20 m sprint times than Super Rugby players, with differences of 1.9% among forwards and 2.2% among backs. In a separate investigation, Smart et al. (2014) combined fitness-test data from 510 rugby union players with game statistics obtained across 296 matches and reported relationships between sprint performance and key game behaviours, including line breaks, metres advanced, tackle breaks, and tries scored. The authors concluded that physical conditioning programmes should reflect the importance of speed, repeated-sprint ability, and body composition in the performance of key behaviours during competition. Collectively, these findings indicate that sprint capacity may contribute both to differentiation between playing standards and to the successful execution of relevant match actions.

Reliable measurement of sprint performance is essential for monitoring physical development within academy environments. Electronic timing gates are commonly used because they reduce the human error associated with manual timing methods (Earp & Newton, 2012). Sprint testing in adolescent rugby players has demonstrated acceptable reliability, with coefficients of variation of approximately 2–3% reported across distances between 10 m and 30 m (Darrall-Jones et al., 2016). Dual-beam timing gates may further improve measurement accuracy by

reducing false triggering caused by the movement of an athlete's limbs through the timing gate (Earp & Newton, 2012).

The starting procedure must also be considered when interpreting and comparing sprint times. Differences in starting position, the distance between the athlete and the first timing gate, and the use of self-initiated or externally signalled starts can influence recorded performance, particularly over shorter distances. For example, positioning an athlete further behind the first timing gate provides additional space to accelerate before timing begins and may result in faster recorded times. Similarly, variations in body position and initial movement may trigger timing systems inconsistently. Standardising the starting position, the distance behind the first timing gate, and the method of sprint initiation is therefore necessary to improve within- and between-participant comparability. These considerations informed the use of a consistent starting procedure and electronic timing system in the present study.

Comparisons across studies may nevertheless be limited by methodological variation, including differences in sprint distances, timing-gate configuration, starting positions, initiation procedures, and the placement of the first timing gate. Participant age, biological maturation, positional classification, and playing standard may also influence the sprint performances reported across rugby populations. These methodological and participant-related factors should therefore be considered when interpreting differences between studies.

No studies identified in the present review directly compared sprint characteristics between academy rugby players from Argentina and New Zealand using consistent testing procedures. Differences in training exposure, competition demands, physical-development practices and player-selection systems may contribute to variation between these populations. Therefore, the present investigation provides a novel comparison of 10 m and 30 m sprint performance between Argentine and New Zealand academy rugby players while also examining differences between forwards and backs.

2.7 Aerobic capacity

Although rugby union is characterised by intermittent high-intensity activity, aerobic capacity plays an important role in supporting repeated efforts, recovery between phases of play, and the ability to maintain performance throughout match duration (Duthie et al., 2003). Players are required to perform repeated bouts of sprinting, accelerations, and collisions interspersed with periods of lower intensity activity, placing significant demands on both aerobic and anaerobic energy systems (Deutsch et al., 2007). Within academy environments, aerobic fitness is considered important for tolerating increased training volumes and facilitating recovery between high-intensity efforts, particularly as players transition from school or club rugby into structured high-performance programmes.

Several field-based tests have been used to assess aerobic capacity in rugby players due to their practicality and ecological validity. Shuttle-based assessments such as the Yo-Yo Intermittent Recovery Test Level 1 (Yo-Yo IR1) are commonly used to evaluate an athlete's ability to repeatedly perform high-intensity exercise with short recovery periods (Bangsbo et al., 2008). In academy players, Yo-Yo test performance has been shown to differentiate between playing levels, with higher level athletes demonstrating greater aerobic capacity and improved ability to sustain repeated high-intensity efforts (Owen et al., 2020).

Alternative shuttle-based protocols such as the Bronco test have increasingly been used within rugby environments due to their simplicity and minimal equipment requirements. The Bronco test, consisting of repeated 20 m, 40 m, and 60 m shuttle runs, has been investigated as a practical measure of aerobic fitness and running performance in rugby players (Deuchrass et al., 2019). Research has demonstrated good reliability for shuttle-based aerobic tests in youth rugby players, with coefficients of variation reported at approximately 2–3%, indicating consistency in repeated assessments (Deuchrass et al., 2019). The Bronco test has also been used as a practical field-based indicator of aerobic fitness in applied rugby settings.

Differences in aerobic capacity have been observed between positional groups, with backs typically demonstrating greater aerobic fitness compared to forwards due to higher running demands during match play (Deutsch et al., 2007). However, positional differences may be influenced by variations in body mass and match activity profiles, as forwards are involved in greater frequency of collisions and static exertions (Duthie et al., 2005). Improvements in aerobic fitness have also been reported across playing levels, with academy and professional players generally demonstrating greater aerobic capacity than sub-elite cohorts, likely reflecting increased exposure to structured conditioning programmes (Owen et al., 2020).

Despite the widespread use of shuttle-based aerobic tests within rugby environments, variability in testing protocols and limited research involving academy players from different national development systems makes comparisons between populations difficult. Differences in competition structure, training methodology, and physical preparation practices may influence the development of aerobic capacity across countries. Furthermore, limited research has directly compared aerobic fitness characteristics of academy rugby players from Argentina and New Zealand. Therefore, further investigation is required to better understand how aerobic capacity develops within different performance pathways and how these differences may influence progression towards elite rugby participation.

2.8 Conclusions

In conclusion the existing literature highlights the importance of anthropometric characteristics, maximal strength, power, speed, and aerobic capacity as key determinants of performance in rugby union. Research consistently demonstrates positional differences between forwards and backs, as well as progressive improvements in physical qualities as players transition from school and club environments into structured high-performance pathways. These physical attributes are commonly assessed using standardised field and laboratory-based testing protocols, allowing practitioners to monitor development and inform training practices. However, limited research has directly compared academy players across Tier 1 national development systems. Furthermore, methodological differences between studies, including variations in testing protocols, maturation status considerations, and positional classifications, make direct comparisons between populations challenging.

While anthropometric characteristics have been relatively well documented in Argentine rugby players, considerably less research has examined physical performance qualities such as strength, power, speed, and aerobic capacity within academy populations. In contrast, countries such as New Zealand have established long-term athlete development structures that regularly monitor physical qualities as part of player progression towards professional competition. Differences in training exposure, competition structures, and physical preparation practices may therefore influence the development of physical characteristics across national pathways. Additionally, the transition from school or club rugby into academy environments represents a critical stage in player development, where increased training loads and performance expectations may accelerate physical adaptations required for elite competition.

Despite the recognised importance of physical profiling in talent identification and player monitoring, limited research has directly compared multiple physical qualities within academy rugby players from different countries. Understanding whether differences exist between development pathways may provide valuable insight into how physical characteristics evolve in response to training environments and competitive demands. Therefore, further investigation is required to examine the anthropometric and physical qualities of academy rugby players within different national contexts. Such research may contribute to a better understanding of how physical development aligns with the evolving demands of modern rugby union and may provide practitioners with information to support evidence-based decision making in athlete development pathways.

Chapter 3: Methods and Results

3.1 Preface

As discussed in Chapter 2, anthropometric characteristics and physical qualities such as strength, power, speed, and aerobic capacity contribute to rugby union performance (Duthie et al., 2003; Owen et al., 2020). Differences in these characteristics have consistently been reported between playing positions, reflecting the distinct physical and match demands of forwards and backs (Till et al., 2015; Jones et al., 2018). Monitoring these characteristics during the academy phase is therefore important for evaluating physical development and establishing performance benchmarks within rugby union development pathways (Owen et al., 2020).

Previous research involving academy rugby union players has predominantly examined differences between age groups and positional groups within individual national development systems. Darrall-Jones et al. (2015) compared English academy players across the under-16, under-18, and under-21 age categories, while Durandt et al. (2006) examined differences between 16- and 18-year-old South African players. Furthermore, Owen et al. (2020) reviewed studies that primarily compared physical qualities across age and positional groups. However, no studies identified in the present review directly compared the anthropometric and physical performance characteristics of male academy rugby union players from Argentina and New Zealand using consistent testing protocols.

Therefore, the primary aim of this chapter was to examine country and position-related differences in the anthropometric and physical performance characteristics of male academy rugby union players from Argentina and New Zealand. Both cohorts were assessed during the preseason phase using the same standardised testing protocols.

3.2 Methods

3.2.1 Experimental approach to the problem

The research employed a cross-sectional comparative design to investigate positional and between-country differences in the anthropometric and physical performance characteristics of male academy rugby union players. Physical performance testing was conducted during the pre-season period using a testing battery commonly implemented within high-performance rugby environments. Efforts were made to standardise testing procedures between cohorts, although some operational and procedural differences remained between the two academy environments.

Anthropometric assessments included height, body mass, and the sum of six skinfolds. Physical performance assessments included maximal strength tests (3RM back squat, 3RM bench press, and 1RM weighted chin-up),

lower-body power assessment using the countermovement jump (CMJ), linear sprint performance over 10 m and 30 m, and aerobic-running performance using the Bronco test. Absolute and allometrically scaled strength outcomes were subsequently examined to account for differences in body size. These tests were selected because they are commonly used within high-performance rugby union environments to assess physical qualities relevant to match performance (Duthie et al., 2003; Owen et al., 2020).

Comparisons were primarily conducted between countries (Argentina and New Zealand) and broad positional groups (forwards and backs) to examine differences in anthropometric and physical performance characteristics during the academy phase. To provide additional positional context, a secondary exploratory descriptive analysis was undertaken using more specific positional categories, including front five, back row, halves, midfielders, and outside backs. These exploratory analyses were intended to further characterise positional trends within each academy system but were not subjected to inferential statistical analysis because of the small sample sizes within several positional subgroups.

3.2.2 Participants

A total of 67 male academy rugby union players aged between 18 and 20 years participated in this study. Participants were recruited from high-performance academy programmes in Argentina ($n = 34$) and New Zealand ($n = 33$) during the pre-season phase of their competitive season. All participants were actively engaged in structured strength and conditioning programmes and regular rugby training as part of their academy development pathway.

Players were categorised according to playing position as forwards or backs, based on their primary positional role within their respective teams. The inclusion criteria required participants to be currently registered academy rugby union players, regularly participating in structured training and competition, and free from injury at the time of testing that would prevent maximal physical performance.

Anthropometric and physical performance testing was conducted as part of routine performance monitoring procedures within each academy environment. Participants were informed of the purpose and procedures of testing prior to participation. Data collection was conducted during the pre-season period to ensure consistency in training phase and minimise the influence of accumulated fatigue associated with in-season competition. The study was approved by the Auckland University of Technology Ethics Committee (AUTEC); reference number 25/339. Local ethics clearance was also obtained via the New Zealand Rugby Union (NZRU), the New Zealand Medical & Science Advisory Panel (MSAP) and the Union Argentina de Rugby (UAR).

3.3.3 Testing protocol

Data collection was conducted within the high-performance training facilities of each academy using procedures commonly implemented as part of routine physical monitoring. Due to logistical and operational differences between the two academy environments, the testing schedule was adapted to align with the organisational structure and regular training practices of each country. Efforts were made to maintain consistency in the type and order of assessments performed.

In Argentina, testing was conducted across two separate days. Anthropometric measurements were collected before the physical performance assessments by the academy nutritionist, who was certified as an International Society for the Advancement of Kinanthropometry (ISAK) Level 2 practitioner. Following the anthropometric assessments, participants completed the field-based tests during the first session, including linear sprint testing and the Bronco test, both of which were conducted on a natural-grass field at the academy training facility. During the second session, participants completed the gym-based assessments at the academy gym. The testing order was CMJ, 3RM back squat, 3RM bench press, and 1RM weighted chin-up.

In New Zealand, testing was conducted in two sessions within a single day, separated by a scheduled lunch break, in accordance with the academy's standard testing procedures. Anthropometric measurements were completed before the physical assessments by a separate ISAK-accredited practitioner. Linear sprint testing was conducted on artificial turf, whereas the Bronco test was performed on a natural-grass field. The gym-based assessments were completed after the field-testing session, following the same order as that used for the Argentinian cohort: CMJ, 3RM back squat, 3RM bench press, and 1RM weighted chin-up.

Although both assessors were ISAK-accredited and followed the same anatomical-site identification and measurement procedures, skinfold measurements were conducted by a different assessor within each country. Inter-tester reliability was not formally assessed because the same participants were not independently measured by both assessors. This should be considered when interpreting between-country differences in the sum of six skinfolds.

All participants completed a standardised dynamic warm-up before testing. Specific warm-up protocols were also completed before the field-based and gym-based assessments to ensure that participants were adequately prepared for maximal performance (see Sections 3.3.3.1 and 3.3.3.2). Overall, efforts were made to maintain consistency in testing procedures, equipment, and test order between countries while accommodating the practical constraints of each high-performance environment.

3.2.3.1 Field assessments

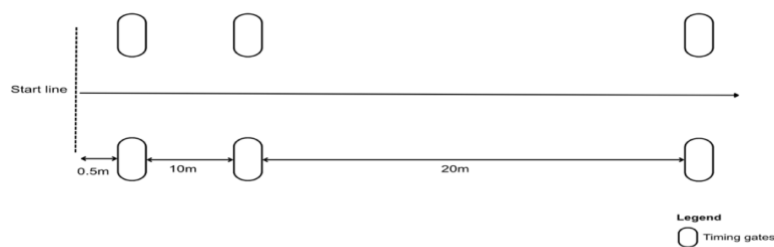
The field assessment consisted of two main components: linear sprint performance (10 m and 30 m) and the Bronco test.

Sprint performance was assessed using a SmartSpeed Plus timing system (VALD Performance, Brisbane, Australia). Timing gates were positioned at a height of approximately 1 m, corresponding to the participants' estimated centre of mass. Timing data were recorded to the nearest 0.001 s and reported to the nearest 0.01 s for the purpose of analysis.

Participants completed 10 m and 30 m linear sprint times within the same sprint effort. The timing gate setup for the linear sprint assessment is illustrated in Figure 1. Participants began each sprint using a two-point staggered stance, with the front foot positioned on the starting line located 0.5 m behind the first timing gate to prevent early triggering of the timing system. Participants were instructed to sprint maximally through the final timing gate positioned at 30 m. Two maximal sprint trials were completed, separated by 5 minutes of passive recovery. The fastest 30 m sprint time was used for analysis, with the 10 m split time extracted from the first timing gate interval. Both sprint variables were analysed in seconds (s).

Figure 1.

10m and 30m linear sprint setup



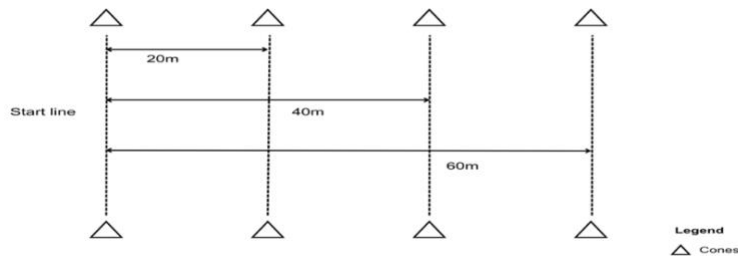
Following the sprint assessment, participants were provided with a 10 minutes passive recovery period with access to water before completing the Bronco test. Testing order was standardised, with backs completing the Bronco test first, followed by forwards.

The Bronco test consisted of repeated shuttle runs over distances of 20 m, 40 m, and 60 m, performed continuously in the following sequence: 20 m out and back, 40 m out and back, and 60 m out and back. This sequence was repeated five times, resulting in a total running distance of 1,200 m. Cones were positioned at 20 m, 40 m, and 60 m from the starting line, as illustrated in Figure 2.

Performance in the Bronco test was measured as the total time required to complete the full 1200 m distance, with faster completion times indicating greater intermittent running capacity.

Figure 2.

Bronco Test setup



3.2.3.2 Gym assessments

The gym assessment consisted of two main components: countermovement jump (CMJ) performance and maximal strength testing. The CMJ assessment was conducted prior to the strength assessments to minimise the influence of neuromuscular fatigue on jump performance.

CMJ performance was assessed using dual force platforms (ForceDecks, VALD Performance, Brisbane, Australia), which recorded vertical ground reaction force data throughout the movement. Ground reaction force data were collected at a sampling frequency of 1,000 Hz. CMJ height was selected as the primary performance variable due to its relevance as an indicator of lower-body explosive power in rugby union players (Thomas et al., 2017).

Prior to the maximal test, participants completed two standardised warm-up jumps to ensure familiarisation with the movement and to progressively prepare for maximal effort. The first warm-up jump was performed at approximately 50% of perceived maximal effort, followed by a second warm-up jump at approximately 75% of perceived maximal effort. A 1 minute passive recovery period was provided between warm-up attempts.

Following the warm-up trials, participants completed one maximal-effort set consisting of three consecutive CMJs. Participants were instructed to keep their hands on their hips throughout the movement to minimise the contribution of arm swing and ensure consistency between trials. Participants performed a rapid downward movement to a self-selected depth before immediately jumping vertically as high as possible (Thomas et al., 2017). CMJ height (cm) was calculated using the impulse–momentum method, whereby take-off velocity was derived from net vertical impulse and subsequently used to estimate jump height (Linthorne, 2001) and the highest jump from three attempts was retained for subsequent statistical analysis.

Maximal strength performance was assessed using the barbell back squat, barbell bench press, and weighted chin-up. In accordance with recommendations from the New Zealand Rugby Medical & Science Advisory Panel (MSAP), maximal strength for the back squat and bench press was assessed using a three-repetition maximum (3RM) protocol. The use of 3RM testing is commonly implemented within academy and high-performance environments due to the reduced injury risk compared with one-repetition maximum (1RM) testing, while still providing a valid measure of maximal strength capacity. For the weighted chin-up exercise, maximal strength was assessed using a 1RM protocol.

All resistance exercises were performed using standard Olympic barbells (20 kg, 220 cm) and Olympic weight plates. Participants completed progressive warm-up sets with increasing loads prior to each maximal strength attempt to ensure adequate preparation and reduce injury risk. Load increments were determined by the supervising strength and conditioning staff based on the participant's perceived capability and previous training experience.

For the barbell back squat assessment, participants performed a 3RM lift using their preferred stance width. The use of a weightlifting belt and knee sleeves was permitted in accordance with typical high-performance training practices. Participants were allowed to perform the lift either barefoot or wearing training shoes. Squat depth required the participant's hip crease to descend below the top of the knee to ensure a consistent range of motion between trials. The use of heel elevation (e.g., weight plates placed under the heels) was not permitted.

For the barbell bench press assessment, participants performed a 3RM lift while maintaining contact between the shoulders and hips with the bench throughout the movement. Feet were required to remain in contact with the floor at all times, and the barbell was lowered in a controlled manner until it lightly touched the chest before being pressed vertically to full elbow extension. Participants were instructed to maintain control of the bar throughout the movement, and bouncing the bar off the chest was not permitted.

As maximal strength for the back squat and bench press was assessed using a 3RM protocol, one-repetition maximum (1RM) values were estimated using the Epley equation (Epley, 1985), which is commonly applied in strength and conditioning research to predict maximal strength from submaximal loads. The use of predictive equations allows for comparison with existing literature that typically reports maximal strength as 1RM values, while reducing the potential injury risk associated with direct 1RM testing in academy athletes.

The equation applied was: $1RM = Load \times (1 + 0.0333 \times repetitions)$

Estimated 1RM values derived from the 3RM back squat and bench press assessments were used for subsequent statistical analyses. For all strength assessments, the highest successfully completed load was recorded as the

participant's maximal performance score. Adequate rest intervals were provided between attempts to minimise the influence of fatigue and ensure valid and reliable measures of maximal strength.

Weighted chin-up strength was assessed using a 1RM protocol. Participants performed the exercise using either an underhand (supinated) or neutral grip according to their preference (as per the standard academy protocols). Each repetition began from a dead hang position with full elbow extension. Participants were required to pull until the collarbone reached the bar, ensuring full range of motion, followed by a controlled eccentric phase until returning to the dead hang position.

Allometrically scaled strength variables were calculated using the procedures described by Crewther et al. (2009), whereby strength values were normalised to body mass raised to the power of 0.67. This approach was selected in preference to simple ratio scaling because it reduces the confounding influence of body size and permits more meaningful comparisons between athletes of different body masses.

The equation applied was: *Allometrically scaled* = $1RM \div \text{body mass}^{0.67}$

The fixed exponent of 0.67 was selected to provide a consistent scaling method across the back squat, bench press, and weighted chin-up assessments and to facilitate comparison with the proposed allometric approach examined by Crewther et al. (2009). Crewther et al. also calculated exercise-specific exponents derived from the characteristics of their sample. However, these derived exponents were specific to the participants and exercises assessed, which included the box squat and bench press, and no exercise-specific exponent was provided for the weighted chin-up. Consequently, the fixed exponent of 0.67 was applied consistently across all three strength assessments in the present study. It is acknowledged that a fixed exponent may not completely remove the influence of body mass and may be less specific than exponents individually derived for each exercise and sample.

Allometrically scaled squat, bench press, and weighted chin-up strength variables were subsequently calculated and included in the statistical analyses alongside the corresponding absolute strength measures to facilitate comparisons between athletes of different body sizes.

3.2.3.3 Anthropometric assessments

Anthropometric assessments were conducted by the academy nutritionist, who was certified at Level 2 by the International Society for the Advancement of Kinanthropometry (ISAK). The assessor routinely monitored players on a monthly basis, ensuring consistency and reliability in measurement procedures.

Body mass and height were measured with participants barefoot and wearing minimal clothing to reduce measurement error. Body mass was recorded to the nearest 0.1 kg using calibrated digital scales, while height was measured to the nearest 0.1 cm using a stadiometer.

Skinfold thickness was assessed using calibrated skinfold callipers following standardised ISAK procedures. In New Zealand, an eight-site skinfold protocol was used, whereas in Argentina a six-site protocol was applied, reflecting the standard athlete monitoring practices within each academy environment. To facilitate direct comparison between cohorts, only the six skinfold sites common to both protocols were included in the analysis. These sites were subscapular, triceps, supraspinale, abdominal, medial thigh, and calf, and were summed to provide a six-site skinfold score. The use of a six-site sum is consistent with previous rugby union research and provides a practical measure of subcutaneous adiposity for athlete monitoring (Holway & Garavaglia, 2009).

All measurements were taken on the right side of the body in accordance with ISAK guidelines and were recorded by the same trained assessor within each testing location to minimise inter-tester variability.

3.3 Statistical analysis

All statistical analyses were conducted using JASP statistical software (Version 0.19.3; JASP Team, 2025). Descriptive statistics were calculated for all variables and are presented as mean $\pm$ standard deviation (SD). Descriptive analyses were used to summarise the anthropometric characteristics and physical performance profiles of male rugby academy players from Argentina and New Zealand.

To address the study aims and examine the effects of country and playing position on anthropometric and physical performance characteristics, two-way analyses of variance (ANOVA) were performed. Country (Argentina and New Zealand) and playing position (forwards and backs) were included as fixed factors in all analyses. Main effects of country and position, as well as country $\times$ position interaction effects, were examined to determine whether anthropometric and physical performance characteristics differed between countries, playing positions, or a combination of both factors.

In addition to the primary analyses comparing forwards and backs, descriptive statistics were presented for more specific positional groupings, including front five forwards (props, hookers, and locks), back row forwards (loose forwards), halves (scrum-halves and fly-halves), midfield backs (inside and outside centres), and outside backs (wings and fullbacks). These subgroup analyses were exploratory and descriptive in nature and were included to provide additional positional context. No inferential statistical comparisons were performed for these positional subgroups due to the limited sample sizes within individual positions.

Prior to analysis, assumptions of normality and homogeneity of variance were assessed. Normality of residuals was evaluated using Shapiro–Wilk tests, histograms, and Q–Q plots, while homogeneity of variance was assessed using Levene’s test. Statistical significance was set at $p \leq .05$.

Effect sizes were reported using partial eta squared (η^2p) for ANOVA models and Cohen’s d for post hoc pairwise comparisons. Partial eta squared values were interpreted as small (.01), medium (.06), and large (.14), while Cohen’s d values (Cohen, 1988) were interpreted as small (0.20), medium (0.50), and large (0.80). Where main effects or interaction effects were observed, Bonferroni-adjusted post hoc pairwise comparisons and estimated marginal means were examined to further investigate differences between countries and playing positions. Mean differences, 95% confidence intervals, effect sizes, and p -values were considered when interpreting the practical relevance of observed effects.

3.4 Results

Violations of homogeneity of variance were identified for five of the outcome variables assessed, including body mass ($p = .034$), sum of six skinfolds ($p < .001$), Bronco performance ($p = .010$), 10-m sprint performance ($p = .005$), and 30-m sprint performance ($p = .010$). However, group sizes were relatively balanced across the four comparison groups (ARG forwards, $n = 18$; ARG backs, $n = 16$; NZ forwards, $n = 18$; NZ backs, $n = 15$). Given the robustness of ANOVA to moderate departures from homogeneity when sample sizes are similar, analyses were retained and interpreted with appropriate caution.

Descriptive statistics for anthropometric and physical performance characteristics by country and playing position are presented in Table 1, with allometrically scaled strength variables presented alongside the corresponding absolute strength measures. In general, forwards displayed greater body size, skinfold thickness, and absolute strength characteristics than backs, whereas backs demonstrated superior countermovement jump, sprint, and Bronco performances. Argentinian forwards exhibited the largest anthropometric profiles and the greatest absolute squat strength values, while New Zealand backs achieved the highest countermovement jump performance. Argentinian backs recorded the fastest sprint and Bronco performances and also demonstrated the highest allometrically scaled upper-body strength values. Overall, anthropometric and physical performance characteristics were broadly similar between countries, with the most pronounced differences consistently observed between positional groups.

Table 1.

Descriptive statistics of anthropometric and physical performance characteristics by country and playing position.

	Arg Forwards		NZ Forwards		Arg Backs		NZ Backs	
	N	Mean $\pm$ SD	N	Mean $\pm$ SD	N	Mean $\pm$ SD	N	Mean $\pm$ SD
Height (cm)	17	188.1 $\pm$ 6.8	18	186.8 $\pm$ 8.0	14	178.1 $\pm$ 5.8	15	182.6 $\pm$ 5.7
Body mass (kg)	17	109.9 $\pm$ 15.4	18	106.8 $\pm$ 11.6	14	81.5 $\pm$ 7.0	15	93.7 $\pm$ 10.8
Sum of 6 skinfolds (mm)	17	92.5 $\pm$ 33.8	17	63.9 $\pm$ 15.6	14	44.1 $\pm$ 9.9	15	57.3 $\pm$ 14.8
1RM back squat (kg)	18	193 $\pm$ 22.5	18	171 $\pm$ 19.3	14	167 $\pm$ 19.2	15	170 $\pm$ 25.1
Allometrically scaled back squat (1RM/kg ^{0.67})	16	8.19 $\pm$ 0.91	18	7.51 $\pm$ 0.87	13	8.76 $\pm$ 0.94	14	8.14 $\pm$ 1.02
1RM bench press (kg)	19	136 $\pm$ 18.0	18	124 $\pm$ 14.2	14	120 $\pm$ 15.8	15	122 $\pm$ 15.5
Allometrically scaled bench press (1RM/kg ^{0.67})	17	5.90 $\pm$ 0.72	18	5.47 $\pm$ 0.68	14	6.20 $\pm$ 0.60	15	5.83 $\pm$ 0.59
1RM chin up (kg)	19	141 $\pm$ 12.5	16	130 $\pm$ 9.5	14	137 $\pm$ 12.0	15	125 $\pm$ 3.2
Allometrically scaled chin up (1RM/kg ^{0.67})	17	6.15 $\pm$ 0.66	16	5.81 $\pm$ 0.40	13	7.13 $\pm$ 0.37	15	6.01 $\pm$ 0.48
CMJ height (cm)	18	35.8 $\pm$ 5.0	18	43.2 $\pm$ 6.8	14	43.0 $\pm$ 6.8	15	48.3 $\pm$ 4.1
Bronco (s)	19	327.3 $\pm$ 28.1	17	316.3 $\pm$ 8.5	15	284.9 $\pm$ 8.5	14	297.6 $\pm$ 5.1
10 m sprint (s)	16	1.70 $\pm$ 0.10	18	1.76 $\pm$ 0.06	14	1.61 $\pm$ 0.05	15	1.70 $\pm$ 0.07
30 m sprint (s)	16	4.24 $\pm$ 0.20	18	4.17 $\pm$ 0.10	14	3.96 $\pm$ 0.10	15	4.02 $\pm$ 0.10

Note. Values are presented as mean $\pm$ standard deviation. Arg = Argentina; NZ = New Zealand; CMJ = countermovement jump; 1RM = one-repetition maximum; N = sample size.

Descriptive statistics for specific positional groups are presented in Tables 2 and 3. These secondary exploratory analyses were included to provide additional positional context within each academy and should be interpreted descriptively. Given the limited sample sizes within several positional subgroups, no inferential statistical comparisons were performed. Consequently, the primary interpretation of differences between countries and playing positions is based on the inferential analyses presented subsequently.

Table 2.

Exploratory descriptive statistics of anthropometric and physical performance characteristics by specific playing position in Argentinian academy rugby union players.

Argentina Players	Front Five		Back Row		Halves		Midfielders		Outside Backs	
	N	Mean $\pm$ SD	N	Mean $\pm$ SD	N	Mean $\pm$ SD	N	Mean $\pm$ SD	N	Mean $\pm$ SD
Height (cm)	12	187.4 $\pm$ 7.7	5	189.9 $\pm$ 3.9	6	174.2 $\pm$ 4.9	3	181.9 $\pm$ 2.7	5	180.4 $\pm$ 6.0
Body mass (kg)	12	117.3 $\pm$ 11.4	5	92.2 $\pm$ 5.6	6	77.2 $\pm$ 4.3	3	90.6 $\pm$ 5.7	5	81.4 $\pm$ 5.7
Sum of 6 skinfolds (mm)	12	110.7 $\pm$ 20.3	5	48.9 $\pm$ 7.9	6	45.0 $\pm$ 8.0	3	47.6 $\pm$ 4.1	5	40.9 $\pm$ 14.4
1RM back squat (kg)	13	199 $\pm$ 21.1	5	180 $\pm$ 22.0	6	160 $\pm$ 12.6	3	176 $\pm$ 25.1	5	171 $\pm$ 23.0
Allometrically scaled back squat (1RM/kg ^{0.67})	12	8.17 $\pm$ 1.04	4	8.25 $\pm$ 0.45	6	8.70 $\pm$ 0.65	3	8.65 $\pm$ 1.44	4	8.93 $\pm$ 1.17
1RM bench press (kg)	13	141 $\pm$ 18.7	6	124 $\pm$ 9.7	6	111 $\pm$ 6.8	3	123 $\pm$ 15.2	4	127 $\pm$ 21.6
Allometrically scaled bench press (1RM/kg ^{0.67})	12	5.82 $\pm$ 0.83	5	6.08 $\pm$ 0.38	6	6.01 $\pm$ 0.60	3	6.54 $\pm$ 0.95	4	5.26 $\pm$ 0.61
1RM chin up (kg)	13	142 $\pm$ 14.4	6	139 $\pm$ 8.0	6	126 $\pm$ 8.1	3	151 $\pm$ 5.7	5	140 $\pm$ 6.1
Allometrically scaled chin up (1RM/kg ^{0.67})	12	5.92 $\pm$ 0.62	5	6.71 $\pm$ 0.40	6	6.88 $\pm$ 0.31	3	7.42 $\pm$ 0.43	4	7.30 $\pm$ 0.14
CMJ height (cm)	13	33.5 $\pm$ 3.4	5	41.8 $\pm$ 3.1	6	40.9 $\pm$ 3.1	3	44.5 $\pm$ 6.1	5	44.6 $\pm$ 4.2
Bronco (s)	13	340.3 $\pm$ 23.7	6	299.3 $\pm$ 10.6	6	281.1 $\pm$ 5.0	3	291.3 $\pm$ 14.5	5	285.5 $\pm$ 7.2
10 m sprint (s)	10	1.75 $\pm$ 0.09	6	1.60 $\pm$ 0.04	6	1.63 $\pm$ 0.05	3	1.60 $\pm$ 0.04	5	1.61 $\pm$ 0.04
30 m sprint (s)	10	4.40 $\pm$ 0.10	6	3.98 $\pm$ 0.08	6	4.03 $\pm$ 0.10	3	3.96 $\pm$ 0.10	5	3.89 $\pm$ 0.10

Note. Values are presented as mean $\pm$ standard deviation. CMJ = countermovement jump; 1RM = one-repetition maximum; N = sample size.

Table 3.

Exploratory descriptive statistics of anthropometric and physical performance characteristics by specific playing position in New Zealand academy rugby union players.

New Zealand Players	Front Five		Back Row		Halves		Midfielders		Outside Backs	
	N	Mean $\pm$ SD	N	Mean $\pm$ SD	N	Mean $\pm$ SD	N	Mean $\pm$ SD	N	Mean $\pm$ SD
Height (cm)	9	185.9 $\pm$ 11.2	9	187.8 $\pm$ 3.0	5	179.2 $\pm$ 8.4	3	184.6 $\pm$ 2.3	7	184.1 $\pm$ 3.5
Body mass (kg)	9	112.0 $\pm$ 14.3	9	101.7 $\pm$ 11.6	5	84.7 $\pm$ 7.5	3	107.3 $\pm$ 9.9	7	94.4 $\pm$ 6.8
Sum of 6 skinfolds (mm)	8	71.1 $\pm$ 17.1	9	57.4 $\pm$ 7.9	5	51.7 $\pm$ 13.2	3	74.1 $\pm$ 17.9	7	54.2 $\pm$ 10.5
1RM back squat (kg)	9	171 $\pm$ 24.6	9	170 $\pm$ 13.8	5	166 $\pm$ 9.6	3	195 $\pm$ 35.0	7	162.8 $\pm$ 24.9
Allometrically scaled back squat (1RM/kg ^{0.67})	9	7.31 $\pm$ 1.07	9	7.70 $\pm$ 0.62	5	8.51 $\pm$ 0.82	3	8.52 $\pm$ 1.50	7	7.71 $\pm$ 0.90
1RM bench press (kg)	9	123 $\pm$ 11.9	9	125 $\pm$ 16.8	5	117 $\pm$ 11.7	3	131 $\pm$ 15.2	7	122 $\pm$ 18.1
Allometrically scaled bench press (1RM/kg ^{0.67})	9	5.26 $\pm$ 0.61	9	5.67 $\pm$ 0.72	5	6.00 $\pm$ 0.40	3	5.77 $\pm$ 0.86	7	5.76 $\pm$ 0.66
1RM chin up (kg)	7	129 $\pm$ 11.2	9	130 $\pm$ 8.6	5	119 $\pm$ 12.1	3	137 $\pm$ 11.4	7	125 $\pm$ 10.7
Allometrically scaled chin up (1RM/kg ^{0.67})	7	5.67 $\pm$ 0.28	9	5.92 $\pm$ 0.45	5	6.08 $\pm$ 0.52	3	6.01 $\pm$ 0.64	7	5.95 $\pm$ 0.46
CMJ height (cm)	9	40.2 $\pm$ 6.3	9	46.3 $\pm$ 6.2	5	43.0 $\pm$ 6.8	3	48.2 $\pm$ 5.8	7	49.1 $\pm$ 3.7
Bronco (s)	8	340.3 $\pm$ 27.9	9	295.0 $\pm$ 16.1	5	286.8 $\pm$ 5.5	2	316.0 $\pm$ 19.7	7	300.1 $\pm$ 22.4
10 m sprint (s)	9	1.78 $\pm$ 0.07	9	1.73 $\pm$ 0.06	5	1.71 $\pm$ 0.07	3	1.74 $\pm$ 0.10	7	1.68 $\pm$ 0.07
30 m sprint (s)	9	4.25 $\pm$ 0.10	9	4.10 $\pm$ 0.10	5	4.07 $\pm$ 0.10	3	4.11 $\pm$ 0.10	7	3.95 $\pm$ 0.09

Note. Values are presented as mean $\pm$ standard deviation. CMJ = countermovement jump; 1RM = one-repetition maximum; N = sample size.

Results of the two-way ANOVA examining the effects of country, playing position, and their interaction on anthropometric and physical performance characteristics are presented in Table 4. Country $\times$ position interaction effects were observed for body mass ($\eta^2p = .099$), sum of six skinfolds ($\eta^2p = .205$), and 1RM squat performance ($\eta^2p = .085$). Based on the predefined thresholds, the interaction effects for body mass and squat performance were of medium magnitude, whereas the interaction effect for skinfold thickness was large. No evidence of country $\times$ position interaction effects was observed for the remaining anthropometric and physical performance variables. Bonferroni-adjusted post hoc comparisons were conducted to further examine the observed interaction effects. New Zealand backs demonstrated greater body mass than Argentinian backs (MD = 12.2 kg, 95% CI [0.20, 24.20], $p = .044$, $d = 1.03$). Argentinian forwards demonstrated greater skinfold thickness than New Zealand forwards (MD = 28.6 mm, 95% CI [8.74, 48.49], $p = .001$, $d = 1.35$) and greater squat strength (MD = 22.9 kg, 95% CI [3.20, 42.69], $p = .014$, $d = 1.06$).

Table 4.

Results of two-way ANOVA examining country and playing position differences in anthropometric and physical performance characteristics.

	Country			Position			Country × Position			Bonferroni post hoc comparisons
	F	p	η^2p	F	p	η^2p	F	p	η^2p	
Height (cm)	0.877	.353	.014	17.798	< .001	.229	2.916	.093	.046	
Body mass (kg)	2.358	.130	.038	48.599	< .001	.448	6.596	.013	.099	ARG backs < NZ backs (p = .044)
Sum of 6 skinfolds (mm)	2.051	.157	.034	26.170	< .001	.307	15.209	< .001	.205	ARG forwards > NZ forwards (p < .001)
1RM back squat (kg)	3.440	.068	.053	6.200	.016	.092	5.651	.021	.085	ARG forwards > NZ forwards (p = .014)
Allometrically scaled back squat (1RM/kg ^{0.67})	7.463	.008	.114	6.352	0.14	.099	.020	.889	< .001	
1RM bench press (kg)	1.263	.265	.020	5.424	.023	.080	2.971	.090	.046	
Allometrically scaled bench press (1RM/kg ^{0.67})	5.746	.020	.089	4.011	.050	.064	.034	.854	< .001	
1RM chin up (kg)	14.450	< .001	.194	2.429	.124	.039	.004	.951	< .001	
Allometrically scaled chin up (1RM/kg ^{0.67})	32.262	< .001	.361	20.833	< .001	.268	9.114	.004	.138	ARG backs > NZ backs (p < .001)
CMJ height (cm)	23.090	< .001	.275	21.254	< .001	.258	.658	.420	.011	
Bronco (min)	.019	.890	< .001	25.125	< .001	.292	3.783	.056	.058	
10 m sprint (s)	13.900	< .001	.191	11.731	.001	.166	.437	.511	.007	
30 m sprint (s)	.005	.942	< .001	21.763	< .001	.269	1.870	.177	.031	

Note. F = F statistic; p = probability value; η^2p = partial eta squared. Significant Bonferroni-adjusted post hoc comparisons are reported where applicable.

3.5 Discussion

The primary aim of this study was to investigate and compare the anthropometric profiles and physical qualities of male academy rugby union players from Argentina and New Zealand. Overall, the findings provided strong support for the first hypothesis, as playing position was associated with consistent differences across most anthropometric and physical performance variables. The second hypothesis was not supported, as no significant overall country effects were observed for the anthropometric measures. The third hypothesis was partially supported, with country-related differences identified in selected physical performance measures rather than across all measures. The fourth hypothesis was also partially supported, with country × playing position interactions observed for body mass, the sum of six skinfolds, absolute squat strength, and allometrically scaled weighted chin-up strength.

Collectively, these findings indicate that several characteristics were comparable between the two national cohorts, while selected physical qualities differed between countries and some positional differences varied between the two academy pathways. The inclusion of allometrically scaled strength measures provided additional insight beyond absolute strength values by accounting for the influence of body size when comparing players.

Consistent with the first hypothesis, clear positional differences were observed in anthropometric profiles. Large positional effects were observed for height ($\eta^2p = .229$), body mass ($\eta^2p = .448$), and the sum of six skinfolds ($\eta^2p = .307$). Across both countries, forwards were taller and heavier and demonstrated a greater sum of six skinfolds than backs (Table 1). These findings are consistent with previous research involving academy rugby

populations, in which forwards have typically demonstrated greater body mass and skinfold measures than backs (Agar-Newman et al., 2015; Darrall-Jones et al., 2015; Till et al., 2015). Comparable positional differences have also been reported among senior rugby union players (Holway & Garavaglia, 2009; Quarrie et al., 1996).

The anthropometric differences observed between forwards and backs are consistent with the distinct match demands of these positional groups. Greater body mass may benefit forwards during scrums, mauls, tackles, and other contact situations by contributing to momentum and stability. In contrast, lower body mass and a lower sum of six skinfolds may benefit backs during acceleration, high-speed running, and open-field movement. Although the cross-sectional design of the present study does not permit identification of the mechanisms underlying these positional differences, the observed profiles may reflect a combination of player selection and long-term exposure to position-specific training and competition demands.

The second hypothesis, which proposed that anthropometric characteristics would differ between countries, was not supported by the country main effects, as no significant overall country differences were observed for height, body mass, or the sum of six skinfolds. However, consistent with the fourth hypothesis, significant country $\times$ playing position interactions for body mass and the sum of six skinfolds indicated that some positional differences varied between pathways (Table 1). Specifically, New Zealand backs were, on average, 12.2 kg heavier than Argentinian backs (95% CI [0.20, 24.20], $p = .044$, $d = 1.03$), whereas Argentinian forwards demonstrated a 28.6 mm greater sum of six skinfolds than New Zealand forwards (95% CI [8.74, 48.49], $p < .001$, $d = 1.35$). The interaction effect for the sum of six skinfolds was large ($\eta^2p = .205$), indicating substantial variation in this positional pattern between pathways.

Differences in talent-identification and selection criteria, nutritional practices, body-composition targets, maturation status, or long-term athlete-development strategies may have contributed to the observed interactions. However, these factors were not directly assessed and should therefore be regarded as possible explanations rather than established mechanisms. Notably, no significant difference in body mass was observed between Argentinian and New Zealand forwards, despite the greater sum of six skinfolds among Argentinian forwards. This finding may indicate differences in body composition between the forward groups; however, lean mass and fat mass were not directly assessed, preventing further interpretation. Height did not differ significantly between countries, suggesting that stature was more consistently associated with playing position than with national pathway.

Positional differences were also evident in measures of absolute maximal strength, further supporting the first hypothesis. Moderate positional effects were observed for absolute back squat ($\eta^2p = .092$), bench press ($\eta^2p = .080$), and weighted chin-up performance ($\eta^2p = .080$), with forwards demonstrating greater absolute strength than backs across both countries. These findings are consistent with previous research involving academy and

professional rugby union players, in which maximal strength has been recognised as an important physical quality for scrummaging, tackling, force production, and performance during contact situations (Casserly et al., 2020; Crewther et al., 2009).

Greater absolute strength among forwards is consistent with their repeated involvement in scrums, mauls, rucks, tackles, and close-quarter carries, which impose substantial force-production and force-absorption demands. Greater maximal strength may assist players in tolerating contact loads, maintaining body position during contact situations, and producing force during set-piece actions. Systematic reviews of age-grade rugby players have similarly identified strength as an important characteristic differentiating playing positions and competitive standards (Owen et al., 2020).

However, because forwards also possess substantially greater body mass than backs, absolute strength measures alone may overstate positional differences in strength relative to body size.

To account for the influence of body size, the present study also examined allometrically scaled back squat, bench press, and weighted chin-up strength. Significant positional effects remained for allometrically scaled squat ($p = .014$, $\eta^2p = .099$) and bench press performance ($p = .050$, $\eta^2p = .064$), although no significant positional effect was observed for allometrically scaled weighted chin-up strength ($p = .124$, $\eta^2p = .039$). These findings indicate that the positional differences in squat and bench press strength were not attributable solely to differences in body mass. The inclusion of both absolute and allometrically scaled measures therefore provided a more comprehensive interpretation of strength characteristics among players of different body sizes.

Country-related differences in strength provided partial support for the third hypothesis. Significant country effects were observed for allometrically scaled squat, bench press, and weighted chin-up performance, with Argentinian players demonstrating greater scaled strength than their New Zealand counterparts. In addition, Argentinian forwards demonstrated greater absolute squat strength than New Zealand forwards, with a mean difference of 22.9 kg (95% CI [3.20, 42.69], $p = .014$, $d = 1.06$) (Table 1). The moderate country $\times$ playing position interaction for absolute squat performance ($p = .021$, $\eta^2p = .085$) provided partial support for the fourth hypothesis, indicating that the difference in absolute squat strength between positions varied according to country.

A country $\times$ playing position interaction was also observed for allometrically scaled weighted chin-up performance ($p = .004$, $\eta^2p = .138$), representing a medium-to-large effect and providing further partial support for the fourth hypothesis. Bonferroni post hoc comparisons indicated that Argentinian backs demonstrated greater allometrically scaled weighted chin-up strength than New Zealand backs ($p < .001$). This finding may reflect differences in upper-body pulling-strength development, training emphasis, or athlete characteristics between the two pathways; however, it should be interpreted cautiously.

Unlike the back squat and bench press assessments, the execution criteria for the weighted chin-up differed between the participating academies. Specifically, the Argentinian protocol required athletes to raise their chin above the bar, whereas the New Zealand protocol required the collarbone to reach the bar, resulting in a greater range of motion and potentially reducing the maximal load achieved by the New Zealand players. Consequently, the weighted chin-up assessment was not fully standardised between pathways, and part of the observed country-related variation may reflect methodological differences in testing procedures rather than true physiological differences between the cohorts.

The present allometrically scaled strength findings contrast partly with those of Crewther et al. (2009), who reported no significant differences between forwards and backs in box squat or bench press performance after applying either the fixed exponent of 0.67 or exercise-specific derived exponents. In contrast, positional effects remained for allometrically scaled squat and bench press performance in the present study, alongside country effects for all three scaled strength measures and a country $\times$ playing position interaction for the weighted chin-up. Differences in testing procedures may have contributed to these contrasting findings, including Crewther et al.'s use of the box squat and directly assessed 1RM values, compared with the estimated 1RM back squat, bench press, and weighted chin-up values used in the present study. Furthermore, the persistence of group effects after scaling may reflect genuine variation in strength characteristics, incomplete removal of the influence of body mass by the fixed exponent of 0.67, or a combination of both factors.

Although the cross-sectional design does not permit identification of the mechanisms underlying these country-related strength differences, variations in strength and conditioning practices, resistance-training emphasis, athlete maturation, training age, or talent-identification and selection criteria may have contributed. The greater absolute back squat strength observed among Argentinian forwards, together with the greater allometrically scaled strength demonstrated by Argentinian players, may therefore reflect pathway-specific factors beyond differences in body size. However, these explanations remain speculative because training exposure, maturation status, selection processes, and pathway practices were not directly assessed.

The first hypothesis was further supported by positional differences in CMJ, sprint, and Bronco performance. Across both national cohorts, backs demonstrated greater CMJ height, faster 10 m and 30 m sprint times, and faster Bronco completion times than forwards. This positional pattern is consistent with the demands of backline play, which include frequent accelerations, repeated high-speed running efforts, defensive coverage, and open-field attacking actions (Duthie et al., 2003; Duthie et al., 2005). Although the cross-sectional design does not permit identification of the mechanisms underlying these differences, the contrasting match and training demands experienced by forwards and backs may contribute to the observed performance profiles.

The greater CMJ performance observed among backs may reflect greater explosive lower-body capability relative to forwards. CMJ performance has previously been recognised as an indicator of explosive athletic capability in rugby players (Cormack et al., 2008; McMahon et al., 2018), and the present findings are consistent with previous observations that backs typically demonstrate greater power-related characteristics than forwards (Owen et al., 2020). A large country effect was also observed for CMJ performance ($p < .001$, $\eta^2p = .275$), with New Zealand players demonstrating greater jump heights than Argentinian players. Differences in force-production characteristics, movement strategy, or task-specific training may have contributed to this country difference; however, these mechanisms were not directly assessed. Moreover, the relationship between maximal strength and CMJ performance was not examined through correlational analysis and therefore cannot be determined from the present findings.

Backs also recorded faster 10 m and 30 m sprint times than forwards. Faster 10 m performance indicates greater short-distance acceleration, whereas faster 30 m performance reflects sprint capability over a longer distance. These qualities may benefit line-breaking, evasive running, defensive coverage, and attacking support during match play. Previous reviews have similarly reported faster sprint times among backs in age-grade rugby populations (Owen et al., 2020; Read et al., 2018).

Importantly, a large country effect was observed for 10 m sprint performance ($p < .001$, $\eta^2p = .191$), with Argentinian players recording faster times than New Zealand players. In contrast, no country effect was identified for 30 m sprint performance ($p = .942$, $\eta^2p < .001$). This distinction suggests that the between-country difference was specific to initial acceleration rather than sprint performance over a longer distance. Initial acceleration is influenced by relative strength, force application, sprint technique, and the comparatively longer ground-contact times observed during the early stages of a sprint. However, these mechanisms were not directly assessed, and their contribution to the observed country difference therefore remains uncertain. The contrasting CMJ and 10 m sprint findings also demonstrate that greater performance in one explosive task does not necessarily correspond with greater performance in another, as jumping and sprint acceleration require different movement strategies and force-application characteristics.

Backs also recorded faster Bronco completion times than forwards, consistent with the greater running demands associated with backline positions. Better Bronco performance may reflect greater intermittent running capacity and may assist backs in performing repeated high-intensity efforts and maintaining running performance throughout match play. No significant country effect was observed for Bronco completion time ($p = .890$, $\eta^2p < .001$), indicating that aerobic running performance was comparable between the national cohorts based on this assessment.

Overall, playing position was associated with the most consistent variation in the anthropometric and physical performance characteristics examined, strongly supporting the first hypothesis. The second hypothesis was not supported by the absence of significant country main effects for the anthropometric measures. The third hypothesis was partially supported by country differences in selected physical performance measures, including allometrically scaled strength, CMJ height, and 10 m sprint performance. The fourth hypothesis was also partially supported by country $\times$ playing position interactions for body mass, the sum of six skinfolds, absolute squat strength, and allometrically scaled weighted chin-up strength. Thus, although no significant country differences were observed for several characteristics, the country effects and country $\times$ playing position interactions identified in selected measures indicate variation in physical performance and positional profiles between the Argentinian and New Zealand academy pathways.

Chapter 4: Conclusion, Practical Recommendations and Limitations & Future Research

4.1 Conclusion

The primary aim of this thesis was to investigate and compare the anthropometric profiles and physical qualities of male academy rugby union players from Argentina and New Zealand. Playing position was associated with the most consistent variation in the anthropometric and physical performance characteristics examined, whereas country-related differences were limited to selected measures. Accordingly, the first hypothesis was strongly supported, the second hypothesis was not supported, and the third and fourth hypotheses were partially supported.

Forwards demonstrated greater body size, a greater sum of six skinfolds, and greater absolute maximal strength, whereas backs achieved greater CMJ heights, faster sprint times, and faster Bronco completion times. The inclusion of allometrically scaled strength measures provided additional insight by accounting for the influence of body size and demonstrated that selected differences in strength persisted after scaling. Collectively, these findings reinforce the importance of considering positional demands, body size, and athlete morphology when interpreting physical performance in academy rugby players.

No significant overall country differences were observed for the anthropometric measures. However, country effects were identified for selected strength, CMJ, and 10 m sprint measures, while country $\times$ playing position interactions were observed for body mass, the sum of six skinfolds, absolute squat strength, and allometrically scaled weighted chin-up strength. New Zealand players demonstrated greater CMJ heights, whereas Argentinian players recorded faster 10 m sprint times. However, no significant country difference was observed for 30 m sprint performance, indicating that the difference between countries was specific to initial acceleration rather than sprint performance over a longer distance.

These findings demonstrate that the physical profiles of the two cohorts should not be characterised as either entirely comparable or consistently different. Instead, several characteristics were comparable between countries, while meaningful country effects and country $\times$ playing position interactions were identified for selected measures. The findings therefore emphasise the importance of interpreting academy-player profiles according to the specific physical quality, playing position, and national context examined.

This thesis contributes to the limited literature directly comparing international academy rugby union populations. To the author's knowledge, it represents the first study to directly compare male academy players from Argentina and New Zealand across a comprehensive range of anthropometric, strength, jump, sprint, and aerobic-running assessments. The findings provide contemporary reference data and identify areas that may inform athlete monitoring and physical preparation within academy rugby environments. Nevertheless, physical profiling should be considered as one component of a broader athlete-development process that also includes

technical skill, tactical understanding, decision-making, psychological characteristics, maturation, durability, and availability for training and competition.

4.2 Practical recommendations

The findings provide practically relevant information for coaches, strength and conditioning practitioners, sport scientists, nutrition practitioners, and talent-development personnel working within academy rugby union environments. The consistent positional differences observed across anthropometric and physical performance characteristics reinforce the importance of implementing position-specific and individually adjusted physical preparation programmes. However, the results should not be interpreted as universal selection thresholds or prescriptive standards because the sample represented specific academy cohorts assessed at one point in time.

The values presented in this study may serve as contextual reference benchmarks for comparing players of a similar age and academy level. Practitioners may use these data alongside repeated individual assessments to identify physical strengths, potential areas for development, and changes in performance over time. Such information may assist with training prescription and athlete monitoring, but should not be used independently to determine talent or readiness for higher levels of competition. Selection decisions should also account for maturation, training age, technical and tactical abilities, decision-making, psychological characteristics, injury history, and the specific requirements of the playing position.

Consistent testing protocols may also provide value beyond the collection of performance data. Regular exposure to force plates testing and nationally consistent assessment procedures may improve athlete familiarity, technical execution, and understanding of the physical qualities being monitored. This may assist not only academy players but also younger athletes aspiring to enter academy programmes by establishing consistent technical expectations and reference standards throughout the development pathway. Nevertheless, practitioners should recognise that greater familiarity with a testing procedure may also influence test performance and should therefore be documented when comparisons are made between programmes.

4.3 Limitations and future research

Although efforts were made to ensure consistency during data collection, testing was conducted within existing academy environments in Argentina and New Zealand. Standardised protocols were implemented and the researcher was present throughout data collection in both countries; however, minor variations in testing procedures, equipment setup, environmental conditions, and athlete preparation may have occurred between academies. Such variation is difficult to eliminate entirely in applied high-performance research and should be considered when interpreting the findings.

A specific procedural difference was identified in the weighted chin-up assessment. The Argentinian academy required athletes to raise the chin above the bar, whereas the New Zealand academy required the collarbone to reach the bar. The New Zealand protocol therefore involved a greater range of motion, which may have reduced the maximal load achieved. Consequently, the weighted chin-up assessment was not fully standardised between pathways, and some of the observed differences in absolute and allometrically scaled performance may reflect procedural variation rather than physiological differences. With greater methodological control, the same range of motion, technical criteria, equipment, familiarisation process, and assessor instructions would have been used across both cohorts.

Testing familiarity was another potential source of variation that was not formally quantified. Regular access to force plates may reinforce CMJ technique and reduce learning effects during testing, potentially contributing to more consistent or improved test performance. However, force plates exposure, test familiarity, and previous speed-training practices were not recorded, and their contribution to the observed country differences cannot be determined. Future research should document familiarisation history and recent training exposure or provide standardised familiarisation sessions before data collection.

The timing of data collection also represented a potential limitation. Testing was conducted according to the operational schedules of the participating academies rather than under a fully controlled research design. Consequently, players may have been assessed following different training loads, recovery periods, or preparation practices. Variations in accumulated fatigue, physical readiness, and recent training exposure may therefore have influenced individual results. Future investigations could improve control by standardising the period preceding testing, recording recent internal and external training loads, and assessing readiness or fatigue before physical testing.

The cross-sectional design provided a snapshot of athlete characteristics at a single point in time and did not allow changes in anthropometric or physical performance characteristics to be examined throughout the academy phase. Therefore, the findings cannot determine whether the observed profiles resulted from academy training, previous development experiences, selection practices, maturation, or other pathway-related influences. Longitudinal monitoring across multiple seasons would provide a more comprehensive understanding of how these characteristics change over time and whether they are associated with subsequent attainment of professional playing status.

Maturation status, relative age, resistance-training age, injury history, and previous exposure to structured physical preparation were not directly assessed. These factors may influence both inclusion in academy systems and physical-test performance. Their omission limits the ability to determine whether the observed country and

positional differences reflect training practices, biological development, selection or survival bias, or a combination of these factors. Future studies should integrate measures of maturation, birth date, training history, and selection status to provide a more complete interpretation of academy-player profiles.

The total sample was appropriate for the scope and access available to the present study but restricted the statistical power of more detailed subgroup analyses. Although secondary exploratory analyses were conducted using more specific positional categories, several subgroups contained relatively small numbers and were therefore interpreted descriptively. A larger sample established through an a priori power analysis would improve the precision of effect estimates, provide greater power to detect country $\times$ playing position interactions, and permit more detailed comparisons between specific positional groups.

International comparison could be expanded to include multiple academies within each country. This would help distinguish national pathway characteristics from practices specific to an individual academy. As an initial extension focused on Southern Hemisphere rugby systems, the inclusion of Australian and South African academies would provide a broader comparison across four established rugby nations. Subsequent research could incorporate Northern Hemisphere academies to examine whether similar positional and country-related patterns are evident across different competition structures and development systems.

Force plates testing could also have allowed the collection of more comprehensive neuromuscular data. The present study focused on CMJ height, but future investigations could examine more metrics. Additional assessments such as isometric mid-thigh pull or drop jump could provide information regarding maximal force, reactive strength, and force–velocity characteristics.

Future research should also integrate physical measures with technical, tactical, psychological, and contextual characteristics. This would provide a more holistic understanding of athlete development and avoid treating physical performance as the sole determinant of talent or future playing status. Linking multidimensional academy profiles with longitudinal selection, availability, injury, and professional-attainment outcomes may ultimately provide stronger evidence for talent identification and long-term athlete-development practices.

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Appendix A - Consent Form

Project title: **Argentina vs. New Zealand: A Comparison of Physical Qualities and Anthropometric Profiles in Male Rugby Academy Players**

Project Supervisor: **Dr. Adam Storey**

Researcher: **Juan Pablo Sahilices**

- ☐ I have read and understood the information provided about this research project in the Participant Information Sheet.
- ☐ I understand that participation in this research involves providing consent for the researcher to access and use data that are routinely collected during players' regular physical and performance assessments. All data will be handled confidentially and used solely for research purposes.
- ☐ I have had an opportunity to ask questions and to have them answered.
- ☐ I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time without being disadvantaged in any way.
- ☐ I understand that if I withdraw from the study then I will be offered the choice between having any data that is identifiable as belonging to me removed or allowing it to continue to be used. However, once the findings have been produced, removal of my data may not be possible.
- ☐ I am not suffering from heart disease, high blood pressure, any respiratory condition (mild asthma excluded), any illness or injury that impairs my physical performance, or any infection.
- ☐ I meet all the eligibility criteria as set out in the Participant Information Sheet: 1) a male rugby player currently enrolled in the academy high-performance program (aged 18-20 years) and 2) have a minimum of two years of continuous strength and conditioning training experience to ensure a consistent baseline of physical preparation.
- ☐ I agree to provide information related to my performance testing data (including countermovement jump, strength, sprint, aerobic, anthropometric measurements, and body composition), and I understand that all data will be de-identified and reported in a way that I cannot be personally identified.
- ☐ I agree to take part in this research.
- I wish to receive a copy of individual results (please tick one): Yes ☐ No ☐
- I wish to receive a summary of the research findings upon completion of the study (please tick one): Yes ☐ No ☐

Participant's Signature: _____

Date: _____

Participant's Name: _____

Participant's E-mail (if appropriate): _____

Approved by the Auckland University of Technology Ethics Committee on 31/10/2025 granted AUTEK Reference number 25/339.

Appendix B - Participant Information Sheet

Date Information Sheet Produced: 10/09/2025

Project Title: *Argentina vs. New Zealand: A Comparison of Physical Qualities and Anthropometric Profiles in Male Rugby Academy Players.*

An Invitation

Hi, my name is Juan Pablo Sahilices, and I am currently a master's student at AUT New Zealand University. I am inviting you to participate in the above-named study which is a research-based investigation conducted by Mr Juan Pablo Sahilices and supervised by Dr. Adam Storey. Participation in this study is completely voluntary and any decision to participate or not participate it is entirely your own decision. Your consent to participate in this research study will be indicated by you signing and dating the consent form. Signing the consent form indicates that you have read and understood this information sheet, freely given your consent to participate, and that there has been no coercion or inducement to participate by the researchers from AUT. Your participation, or lack of participation, will not advantage or disadvantage you in any way. The results of this research are intended for publication and will contribute to my master's degree and may be submitted to peer-reviewed journals for publication.

What is the purpose of this research?

This research aims to compare the physical qualities (i.e., strength, speed, and aerobic fitness) and body composition of rugby academy players. The findings will help coaches and sports staff identify key strengths and areas for improvement. It also adds to the limited available data on the physical profiles of academy players which will help to guide future strategies in youth athletic development.

As previously mentioned, this research is in fulfilment of my Masters of Sport, Exercise and Health at the Auckland University of Technology, and the information gathered in this study may be used for articles submitted for publication.

How was I identified and why am I being invited to participate in this research?

As this study is looking to make a comparison about the anthropometric and physical qualities of academy rugby union players mentioned above, you have been identified and invited to participate in this research. Your participation in this study would help to further our knowledge of this area. You are eligible to participate in this study if you are 1) a male rugby player currently enrolled in the academy high-performance program (aged 18-20 years) and 2) have a minimum of two years of continuous strength and conditioning training experience to ensure a consistent baseline of physical preparation.

Exclusion Criteria: Players currently injured or recovering from an injury that prevents full participation in physical testing were excluded from the study to maintain the safety of participants and the integrity of the data.

How do I agree to participate in this research?

If you agree to participate in this research study, you will be required to complete a Participant Consent Form which can be obtained from Juan Pablo Sahilices or Dr. Adam Storey. Your participation in this research is voluntary (it is your choice) and whether or not you choose to participate will neither advantage nor disadvantage you. You are able to withdraw from the study at any time. If you choose to withdraw from the study, then you will be offered the choice between having any data that is identifiable as belonging to you removed or allowing it to continue to be used. However, once the findings have been produced, removal of your data may not be possible.

What will happen in this research?

Players will be invited to provide their consent for the data obtained from their physical and performance assessments, which are routinely collected by the program's technical staff, to be shared with the researcher and used for research purposes. Players will not be asked to complete any additional tests beyond those that are already part of their regular assessment and training program. All collected information will be treated confidentially and presented only in aggregated form, without identifying individual players or specific academies.

Tests: Skinfold measurements, Countermovement jump (CMJ), 3 RM Back squat, 3RM Bench Press, 1RM Chin-ups, 10 m and 30 m sprints and Bronco test.

What are the discomforts and risks?

Players may experience mild discomfort knowing that their assessment data will be shared with the researcher for research purposes.

How will these discomforts and risks be alleviated?

To minimize this risk, all data will be treated confidentially, coded, and presented only in aggregated form, without identifying individual players or participating academies. If participants have any concerns regarding the use of their data, they are encouraged to contact the researcher to discuss these concerns and ensure they feel comfortable with their involvement in the study.

What are the benefits?

Participants will gain a personalised profile including their anthropometric measures, 1RM strength for upper and lower body, countermovement jump (CMJ) performance, speed, and Bronco test results. This will provide them with insight into their physical performance and development. New knowledge will be generated for researchers and practitioners as we explore the relationships between strength, power, speed, and aerobic capacity in elite rugby academy players. The wider sporting community will benefit from understanding how these measures can inform training and performance monitoring. The results of this research will contribute to my master's thesis and may be submitted to peer-reviewed journals for publication.

How will my privacy be protected?

Your privacy will be protected at all times. Before any data is shared with the research team, the academy will de-identify it by assigning coded numbers (e.g., "ID 432") to your data instead of using your name.

This means the researchers will not be able to directly identify you from the data. During the study, only the applicant and named researchers will have access to the collected data.

The results of the study may be used for further analysis, submitted to peer-reviewed journals, or presented at conferences. However, only group averages of descriptive characteristics (such as height, weight, etc.) will be reported, so individual participants cannot be identified from publications or presentations.

All data will be securely stored on password-protected computers or in locked files. Once data analysis is complete, your de-identified data will be stored by the AUT University SPRINZ research officer in the AUT University SPRINZ secure Ethics and Data facility at the AUT Millennium campus for six years. After this period, all hard copies will be shredded, and electronic files will be permanently deleted.

Your privacy and confidentiality are the primary concerns in handling all data collected.

What are the costs of participating in this research?

There will be no financial cost for you being involved with this study.

What opportunity do I have to consider this invitation?

It will be appreciated if you could let us know within two weeks whether you would like to or be available to take part in the study or not. After consideration you may withdraw your participation at any time.

Will I receive feedback on the results of this research?

Yes, participants will gain a personalised profile which will contain their anthropometric values, CMJ values, strength tests, 10 m and 30 m sprints and bronco timings. Also, participants will be offered a summary of the research findings upon completion of the study.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, Dr. Adam Storey, adam.storey@aut.ac.nz, +64212124200

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTECH, ethics@aut.ac.nz, (+649) 921 9999 ext 6038

Whom do I contact for further information about this research?

Please keep this Information Sheet and a copy of the Consent Form for your future reference. You are also able to contact the research team as follows:

Researcher Contact Details:

Juan Pablo Sahilices

AUT-Millennium, 17 Antares Place, Mairangi Bay

+6421491664

juanpablosahilices@gmail.com

Project Supervisor Contact Details:

Dr. Adam Storey

AUT-Millennium, 17 Antares Place, Mairangi Bay

+64212124200

adam.storey@aut.ac.nz

***Approved by the Auckland University of Technology Ethics Committee on 31/10/2025 granted AUTEC
Reference number 25/339.***

Note: The Participant should retain a copy of this form.

Appendix C – Ethics approval

Auckland University of Technology Ethics Committee (AUTEC)

31 October 2025

Adam Storey

Faculty of Health and Environmental Sciences

Dear Adam

Re Ethics Application: **25/339 Argentina vs. New Zealand: A Comparison of Physical Qualities and Anthropometrics Profiles in Male Rugby Academy Players**

Thank you for your responses to AUTEC's conditions.

Your ethics application has been approved for three years until 31 October 2028.

Non-Standard Conditions of Approval

1. Changes to the Information Sheet:
 - a. Replace all reference to Gym sessions (the research does not include any testing) and replace with the names of the tests that the data is being requested for;
 - b. Replace the risks associated with high-intensity exercise with potential data breach (only if the researcher considers there are any, as it is deidentified data that the researcher is receiving);
 - c. Remove the compensation paragraph as this research does not include physical testing, it is academy data that is being shared;
 - d. Revise the Privacy section to describe to the potential participant how the academy will deidentify data before sharing with the research team.

Non-standard conditions do not need to be submitted to or reviewed by AUTEC unless requested but must be completed before commencing your study.

Standard Conditions of Approval

1. The research is to be undertaken in accordance with the [Auckland University of Technology Code of Conduct for Research](#) and as approved by AUTEC.
2. All public facing documents must have the AUTEC approval number and be of a high standard of spelling and grammar. Dates on the Information Sheet(s) and Consent Form(s) must be consistent.
3. Any amendments to the project must be approved by AUTEC prior to being implemented.
4. A progress report is due annually on the anniversary of the approval date.
5. A final report is due at the expiration of the approval period, or, upon completion of project.
6. Any serious or adverse events must be reported to AUTEC, this includes unforeseen issues that might affect continued ethical acceptability of the project.
7. AUTEC grants ethical approval only. You are responsible for obtaining management permission for access from any institution or organisation at which your research is being conducted and you need to meet all ethical, legal, public health, and locality obligations or requirements for the jurisdictions in which the research is being undertaken.

The application number and title need to be referenced on all correspondence related to this project.

All forms are available online <http://www.aut.ac.nz/research/researchethics>

For any enquiries, please contact the Secretariat at ethics@aut.ac.nz
(This is a computer-generated letter for which no signature is required)

The AUTEC Secretariat

Auckland University of Technology Ethics Committee.

Appendix D – Data Sharing Agreement

This agreement is made between the Discloser and the Recipient (as those parties are identified in Schedule 1). The Discloser[s] and the Recipient[s] may be also referred to as the Parties and singularly as a “Party”.

Background

A-The Discloser is the custodian of Data defined below and the Data includes Personal Information.

B-The Recipient wishes to access and use the Data for the Purpose defined below, and acknowledges the importance of safeguarding Personal Information.

C-In consideration of and subject to compliance with the obligations on the part of the Recipient in this agreement, the Discloser is granting the Recipient a right to use and access the Data only for the Purpose.

The Parties agree as follows:

Definitions In this agreement, capitalised terms have the meaning given to them in context and/or as defined below:

Access Request means a request by an Individual for access to, or correction of, their personal information in accordance with Privacy Law.

Additional Security Requirements means those additional security requirements to prevent unauthorised access or disclosure of the Data required by Discloser set out in Schedule 1 (if any).

Affected Party is defined in clause **Error! Reference source not found.**.

Agreement means this data sharing agreement, including 0 and **Error! Reference source not found.** and any schedules that may be added from time to time.

Authorised Users means those individuals employed by or working with the Recipient identified Schedule 1, if any, who are authorised to access, use and Process the Data in accordance with the terms of this Agreement.

Business Day means any day of the week other than a Saturday, Sunday, public holiday in Auckland, New Zealand, or any day in the period commencing with 25 December in any year and ending with 15 January in the following year.

Data means the data shared between the Parties pursuant to this Agreement as described in 0.

Data Breach means actual, attempted or suspected unauthorised, unlawful or accidental access to, disclosure or Processing of, loss, destruction, alteration or damage of any Data; or an action that prevents the Recipient from accessing the Data on either a temporary or permanent basis.

Delivery means the approved method of delivery of the Data set out in Schedule 1.

Discloser means the Party disclosing Data under this Agreement as identified as such in Schedule 1.

Effective Date means the date this agreement has been signed by both Parties.

End Date means the intended date of expiry of this Agreement noted in Schedule 1.

Individual has the meaning given to it under Privacy Law.

Information Security Program is defined in clause **Error! Reference source not found..**

Notified Party is defined in clause **Error! Reference source not found..**

Personal Information has the meaning given to that term in the New Zealand Privacy Act 2020.

Privacy Laws means any applicable statute, regulation, bylaw, rule, order, or subordinate legislation in force from time to time and includes, without limitation, the New Zealand Privacy Act and the Health Information Privacy Code.

Process means any operation or set of operations which is performed on Data or on sets of Data, whether or not by automated means, such as collection, recording, organisation, structuring, storage, adaptation or alteration, retrieval, consultation, use, disclosure by transmission, dissemination or otherwise making available, alignment or combination, restriction, erasure or destruction.

Purpose means the purpose for which the Recipient may access and use the Data defined in Schedule 1.

Recipient means the Party receiving Data under this Agreement and identified as such in Schedule 1.

Regulator means any regulator and/or person entitled under Privacy Law to investigate the Processing of Personal Information, and includes the New Zealand Privacy Commissioner.

Special Terms means any special terms and conditions of this agreement set out in Part B Schedule 1 that either amend or additional to other terms in this agreement.

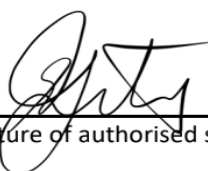
Term is defined in clause **Error! Reference source not found..**

Schedule 1 – Agreement Definitions & Special Terms

Part A - Agreement Definitions

ITEM No	DEFINITION USED IN THIS AGREEMENT	DESCRIPTION
1	Discloser	<i>NEW ZEALAND RUGBY (NZR) Level 3, 100 Molesworth Street, Wellington 6011, Box 2172, Wellington 6140, New Zealand</i>
2	Recipient	<i>AUCKLAND UNIVERSITY OF TECHNOLOGY (AUT) 55 Wellesley Street East, Auckland CBD, Auckland 1010, New Zealand</i>
3	Data	<i>DATA DICTIONARY</i>
4	Authorised Users	<i>Dr. ADAM STOREY (RESEARCH'S SUPERVISOR) JUAN PABLO SAHILICES (AUT RESEARCHER)</i>
5	Delivery Means	<i>BY PASSWORD-PROTECTED DOWNLOAD</i>
6	End Date	<i>FIVE (5) YEARS FROM EFFECTIVE DATE</i>
7	Purpose	<i>DATA ANALYSIS</i>
8	Additional Security Requirements	-
9	Fees	-
10	Local Data Laws	-

Signed by or on behalf of the Parties:



Signature of authorised signatory

The Discloser by:

Stephan van Gruting - NZ U20s S&C

Name of authorised signatory

The Recipient by:



Signature of authorised signatory

Dr. Adam Storey

Name of authorised signatory

Schedule 1 – Agreement Definitions & Special Terms

Part A - Agreement Definitions

ITEM No	DEFINITION USED IN THIS AGREEMENT	DESCRIPTION
1	Discloser	<i>UNION ARGENTINA DE RUGBY (UAR)</i> Dardo Rocha 2950, Martínez, B1640FTR, Buenos Aires; Argentina
2	Recipient	<i>AUCKLAND UNIVERSITY OF TECHNOLOGY (AUT)</i> 55 Wellesley Street East, Auckland CBD, Auckland 1010; New Zealand
3	Data	<i>DATA DICTIONARY</i>
4	Authorised Users	<i>Dr. ADAM STOREY (RESEARCH'S SUPERVISOR)</i> <i>JUAN PABLO SAHILICES (AUT RESEARCHER)</i>
5	Delivery Means	<i>BY PASSWORD-PROTECTED DOWNLOAD</i>
6	End Date	<i>FIVE (5) YEARS FROM EFFECTIVE DATE</i>
7	Purpose	<i>DATA ANALYSIS</i>
8	Additional Security Requirements	-
9	Fees	-
10	Local Data Laws	-

Signed by or on behalf of the Parties:

The Discloser by:

Signature of authorised signatory

Mr. Francisco Rubio

Name of authorised signatory

The Recipient by:



Signature of authorised signatory

Dr. Adam Storey

Name of authorised signatory

DATA DICTIONARY

Variable Name	Definition	Units	Data Type	Example
Player_ID	Unique identifier assigned to each participant	number	Integer	NZ-01
Country	Country of participant's academy	NZ / ARG	Categorical	NZ
Age	Age of participant at time of testing	Years	Numeric	18
Position	Player field position	Forward / Back	Categorical	Half back
Height	Standing height measured barefoot	centimetres (cm)	Numeric	170
Body_Mass	Body weight measured in light clothing	kilograms (kg)	Numeric	80
Sum_6_Skinfolds	Sum of six skinfolds	millimetres (mm)	Numeric	15
BenchPress_3RM	Maximum load lifted for three repetitions in bench press	kilograms (kg)	Numeric	90
ChinUp_1RM	Total maximal load lifted (body mass + external weight)	kilograms (kg)	Numeric	120
BackSquat_3RM	Maximum load lifted for three repetitions in back squat	kilograms (kg)	Numeric	130
CMJ_Height	Maximum jump height achieved in countermovement jump	centimetres (cm)	Numeric	41
CMJ_Contraction time	force generated during CMJ	milliseconds (ms)	Numeric	700
CMJ_Excentric speed	Rate of force development during CMJ	meters / seconds (m/s)	Numeric	1.34
Sprint_10m	Time to complete first 10 meters of sprint	seconds (s)	Numeric	1,80
Sprint_30m	Time to complete 30 meters of sprint	seconds (s)	Numeric	4,30
Bronco_Time	Total time to complete 1200 m Bronco test	seconds (s)	Numeric	280



Appendix E – New Zealand Rugby Medicine and Science Advisory Panel Approval



23rd October 2025

Juan Pablo Sahilices

By Email: juanpablosahilices@gmail.com

Medicine and Science Advisory Panel Decision Letter

Re. Principal Researcher: Juan Pablo Sahilices

Study Title: Argentina vs. New Zealand: A Comparison of Physical Qualities and Anthropometric Profiles in Male Rugby Academy Players

Dear Juan

I am pleased to inform you that the Medicine and Science Advisory Panel (MSAP) for New Zealand Rugby (NZR) has reviewed your proposal submitted and would like to provide its approval for the above proposed study.

At the conclusion of your study please provide MSAP with a report of your findings. This report will be passed along to relevant parties in NZR to ensure that this research is disseminated across the organisation.

If you require anything further or if we can be of assistance, please contact us via email msap@nzrugby.co.nz.

Kind regards,

Lauren Richardson

Medical Projects Lead

On behalf of the Medicine and Science Advisory Panel



Appendix F – Union Argentina Rugby approval

Buenos Aires, September 15th of 2025

To the AUT Ethics Committee,

This letter confirms that the Argentina Rugby Union (UAR) supports the Master's thesis research of Juan Pablo Sahilices, a postgraduate student at Auckland University of Technology (AUT).

The Academy is aware of the nature of this research project, which involves a comparison of physical capabilities and anthropometric measures between male academy rugby players.

The Argentina Rugby Union provides full permission for Juan Pablo Sahilices to conduct this research with Academy players as part of his thesis project, under the supervision of the Academy Manager and the Academy Lead Strength and Conditioning Coach.

Sincerely,



Mr. Francisco Rubio
High-Performance General Manager
Union Argentina de Rugby