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**Executive Summary:**

The South African Rugby Union (SARU) implemented regulations preventing underage players from playing in adult U20 and senior age-group rugby games.

The SARU regulations are aligned with World Rugby regulations and have been formulated to protect the players who may be vulnerable to serious injury because of a mismatch in size, experience, ability and physical development at this level of play.

The regulations were first implemented in 2010, with slight modifications made in 2011. No player in this vulnerable group has had a catastrophic injury since the regulations were implemented, at these levels.

These regulations have been perceived by some as being overly restrictive and several provincial rugby unions in the country have blamed a recent decrease in participation rates on these underage regulations. To address the concern raised, independent experts were tasked with the objective to re-evaluate the current regulations using a scientific method called the Delphi process.

Emanating from this analysis, a report, the age-based risk analysis for adult rugby (ABRAAR) report was generated. The findings of this report were circulated to all key stakeholders.

More specific to this document, one of the recommendations in this report was to assess the current normative data used at the elite U20 level and gauge whether these data were still valid.

The report below therefore investigates the previously reported normative data and follows an evidence-based approach to support and provide an adjustment to these data, where required. The summary of proposed new minimum requirements can be found at the end of this report.

**Methods:**

The rationale provided in this report uses percentile scores as the basis for reaching an adequate conditioning standard. Percentile scores may be calculated from the mean and standard deviations (SD) of a group. Once the mean and standard deviation (SD) of a given group outcome or score is known, one is able to compare a single outcome against this mean to rank the single outcome. In statistical terms, this is called a Z-Score, and it represents the distance between the observed score and the mean in units of the standard deviation.

The Z-score is calculated by taking the difference between the mean and the observed score and dividing this difference by the standard deviation. The Z-score is then used to calculate the percentile of the observed score (Table 1). We have chosen to evaluate individual percentile scores according to the classification system presented in Table 2. It is important to note that this calculation assumes that the data is normally distributed.

**Table 1: Z-score percentile for normal distribution**

Percentile	z-Score	Percentile	z-Score	Percentile	z-Score
1	-2.326	34	-0.412	67	0.44
2	-2.054	35	-0.385	68	0.468
3	-1.881	36	-0.358	69	0.496
4	-1.751	37	-0.332	70	0.524
5	-1.645	38	-0.305	71	0.553
6	-1.555	39	-0.279	72	0.583
7	-1.476	40	-0.253	73	0.613
8	-1.405	41	-0.228	74	0.643
9	-1.341	42	-0.202	75	0.674
10	-1.282	43	-0.176	76	0.706
11	-1.227	44	-0.151	77	0.739
12	-1.175	45	-0.126	78	0.772
13	-1.126	46	-0.1	79	0.806
14	-1.08	47	-0.075	80	0.842
15	-1.036	48	-0.05	81	0.878
16	-0.994	49	-0.025	82	0.915
17	-0.954	50	0	83	0.954
18	-0.915	51	0.025	84	0.994
19	-0.878	52	0.05	85	1.036
20	-0.842	53	0.075	86	1.08
21	-0.806	54	0.1	87	1.126
22	-0.772	55	0.126	88	1.175
23	-0.739	56	0.151	89	1.227
24	-0.706	57	0.176	90	1.282
25	-0.674	58	0.202	91	1.341
26	-0.643	59	0.228	92	1.405
27	-0.613	60	0.253	93	1.476
28	-0.583	61	0.279	94	1.555
29	-0.553	62	0.305	95	1.645
30	-0.524	63	0.332	96	1.751
31	-0.496	64	0.358	97	1.881
32	-0.468	65	0.385	98	2.054
33	-0.44	66	0.412	99	2.326

**Table 2: An evaluative description of Percentile scores**

Percentile	Description
0 – 20	low score
21 – 40	below average
41 – 60	average
61 – 80	above average
81 – 100	high Score

From: Tomkinson et al. *BJSM*, 2018;52:1445–1456

We have chosen the minimum required level for clearance to be set at greater than the 20<sup>th</sup> percentile (i.e. 21<sup>st</sup> Percentile or above).

Therefore, by the definitions given in Table 2, the minimum required level for clearance would be the category “below average” or above. This excludes players with values, which are defined as a “low score”, from being allowed to play at the applied for age category or level of play.

According to the equivalent Z score shown in Table 1, the player would require a Z score of equal to or greater than 0.806 of the SD *below* the average score (-0.806).

### **Absolute muscle strength Data Correction for 2020 and beyond:**

When all South African Rugby National U19 (during years 1997-2007) and U20 (during years 2008-2011) team testing data are combined, it was observed (Figure 1) that there is a linear trend for absolute muscle strength to increase. This was measured by a 1 Repetition Maximum (1RM) bench press and increases each year across the testing dataset from 1997 to 2011 within all playing positions.

From observing the data trend, there is no apparent plateau in these results, which one may have expected. However, since it is reasonable to assume that the data will eventually reach a plateau, we further evaluated these data against 2018 and 2019 known scores for each position. A comparison was made between current known data and pooled normative data of the last 3 years recorded in the current database, i.e. 2009, 2010 and 2011 (Circa 2010) across all the positional groups. Data from 2018 and 2019 national teams and provincial normative testing results shared with the South African Rugby Union are similar to the Circa 2010 results for the 1RM bench press. Therefore, it was concluded that the Circa 2010 results are still a valid measure of current strength based normative data in this group of players. Circa 2010 data were pooled to create a standard deviation representative of all the data collected (Table 3).

For a player to achieve an acceptable score (a Z-score of -0.806 or above), they need to achieve a score of no less than the 21<sup>st</sup> percentile. The score of the 20<sup>th</sup> percentile for absolute muscle strength (a Z-score of -0.842) or below, will score them a “low score” and therefore not at an acceptable level. The minimum required 1RM Bench Press scores for each positional category are shown in Table 3.

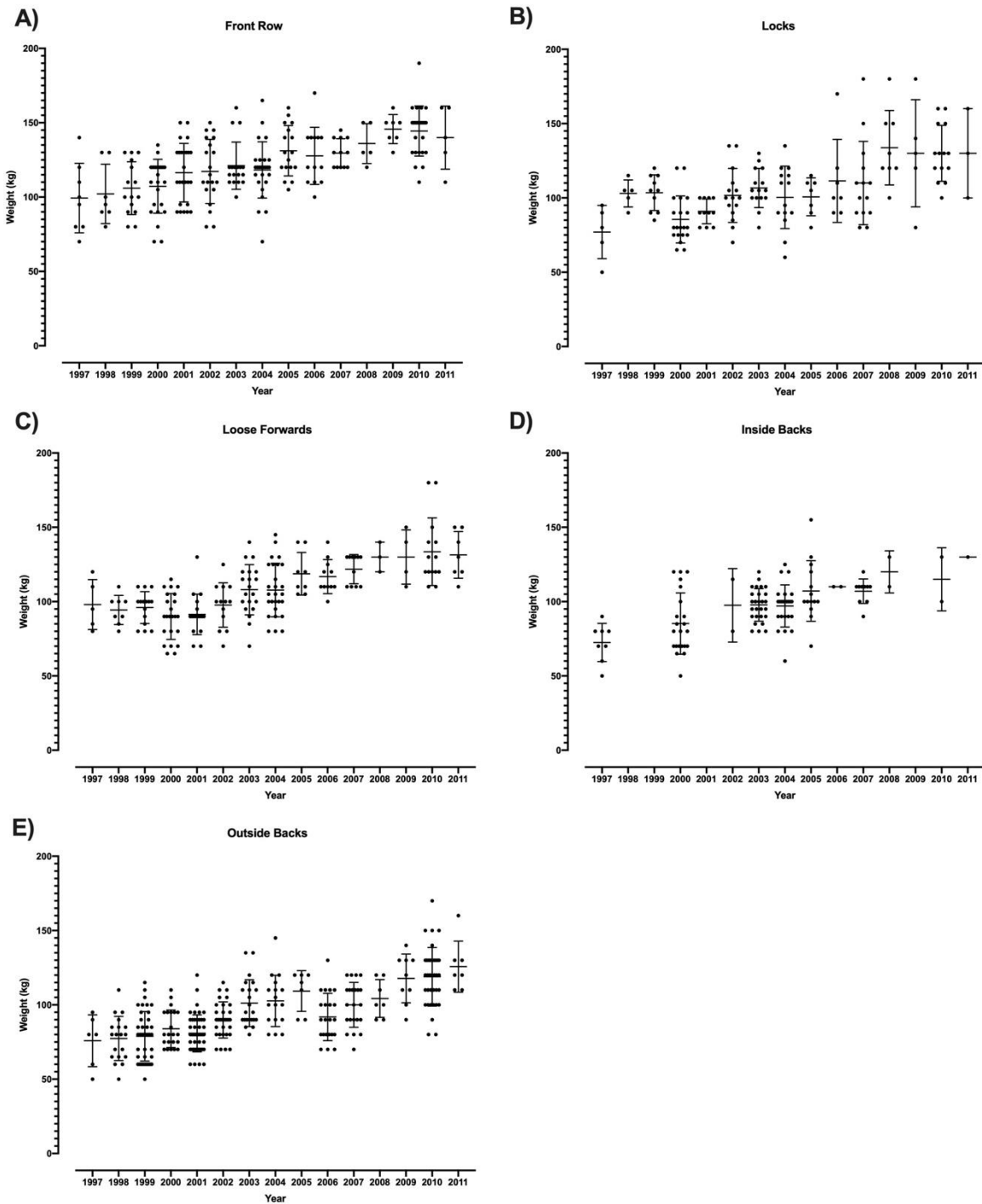


Figure 1: Secular trends in South African Rugby National U19 (during years 1997-2007) and U20 (during years 2008-2011) team testing data for the one repetition maximum bench press (measured in kg) for (A) Front Row players, (B) Locks, (C) Loose Forwards, (D) Inside backs, and (E) Outside backs.

Table 3: Current adjusted Normative data for the One repetition maximum Bench Press. Data shown as means and standard deviations (SD) across all the positional groups, with the new adjusted minimum required benchmark to reach the 21<sup>st</sup> percentile score.

	Normative Data*			Minimum Bench Press required to attain 21 <sup>st</sup> Percentile score
	Mean ± SD			
<b>Front Row</b>	144.1	±	16.1	131 kg
<b>Locks</b>	130.0	±	23.5	111 kg
<b>Loose Forwards</b>	132.4	±	19.6	117 kg
<b>Inside Backs</b>	120.0	±	17.3	106 kg
<b>Outside Backs</b>	119.6	±	18.7	104 kg

\*This data is calculated from the pooled data from 2009, 2010 and 2011

### Upper body muscular endurance Data Correction for 2020 and beyond:

When all South African Rugby National U19 (during years 1997-2007) and U20 (during years 2008-2011) team testing data are combined, it was observed (Figure 2) that there was an initial increase in upper body muscle endurance, as measured by the number of push ups completed in a minute, but from 2003 onwards there seems to be no further increases. It must however be noted that push ups were not recorded between 2006 and 2009. However, testing which was performed during 2010 showed that there were no further increases since 2003.

Based on the above observed trends for push up data, it was therefore proposed that current normative data would be equivalent to all pooled data collected between 2003 and 2010 (Table 4). The minimum requirements for Push Ups completed in one minute for each positional category is shown in Table 4.

Table 4: Current adjusted Normative data for Push ups in a minute. Data shown as means and standard deviations (SD) across all the positional groups, with the new adjusted minimum required benchmark to reach the 21<sup>st</sup> percentile score.

	Normative Data*			Minimum Push Ups required to attain 21 <sup>st</sup> Percentile score
	Mean ± SD			
<b>Front Row</b>	59.6	±	12.8	49
<b>Locks</b>	48.4	±	10.7	40
<b>Loose Forwards</b>	56.2	±	14.0	45
<b>Inside Backs</b>	59.3	±	10.5	51
<b>Outside Backs</b>	57.0	±	13.9	46

\*This data is calculated from the pooled data between 2003 and 2010.

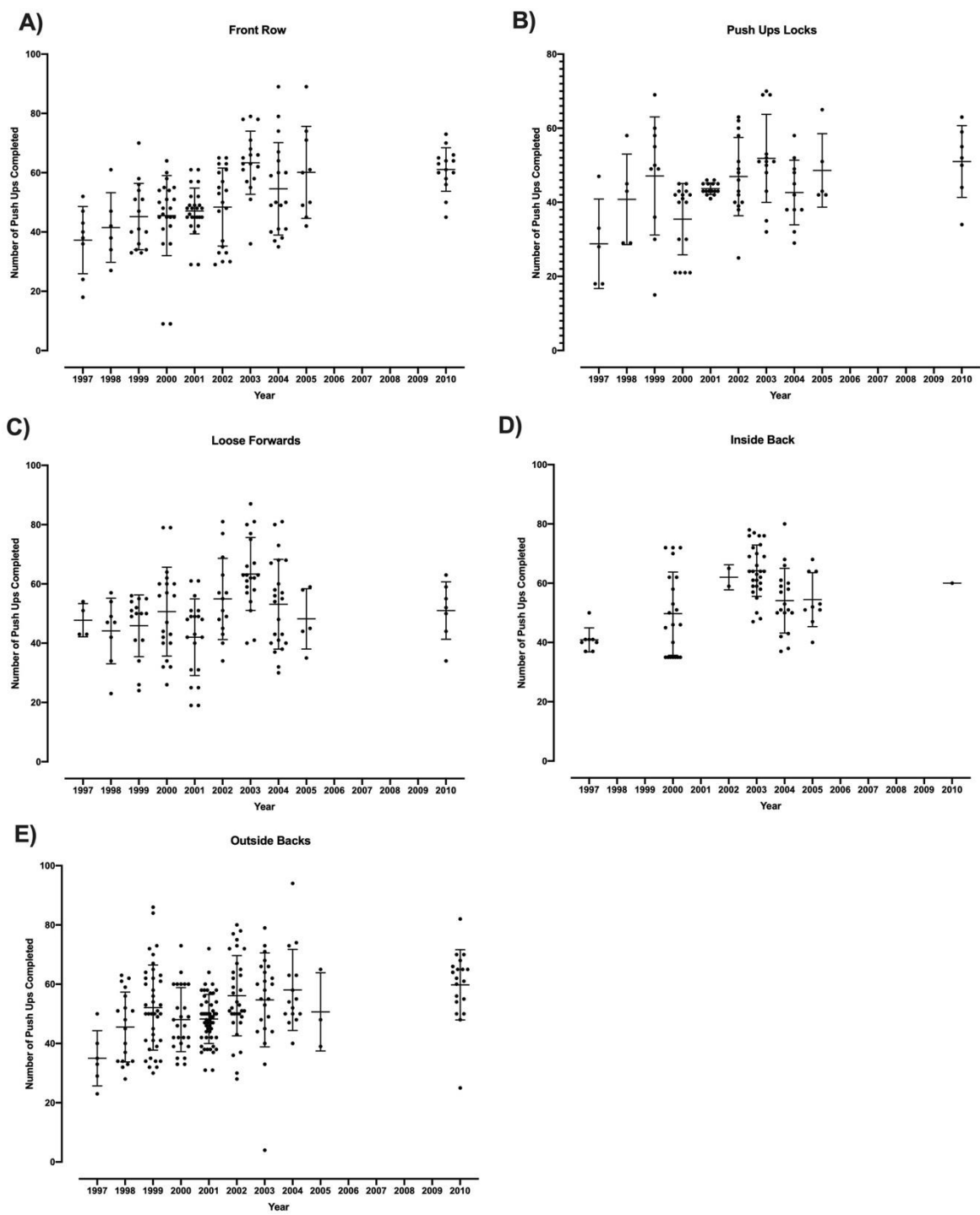


Figure 2: Secular trends in South African Rugby National U19 (during years 1997-2007) and U20 (during years 2008-2011) team testing data for the number of push ups completed in a minute for (A) Front Row players, (B) Locks, (C) Loose Forwards, (D) Inside backs, and (E) Outside backs.

## Aerobic Fitness Data Correction for 2020 and beyond:

When all South African rugby national U19 (during years 1997-2007) and U20 (during years 2008-2011) team testing data are combined, it was observed (Figure 3) that there has been very little increase in aerobic fitness data, as measured by the number of shuttles completed in the 20-meter multistage shuttle run test (bleep test).

For the bleep test data, it was therefore proposed that the pooled data from 1997 to 2011 still be used as current normative data (Table 5). The minimum requirements for the number of shuttles completed in a bleep test for each positional category are shown in Table 5

Table 5: Current adjusted Normative data for the Bleep Test (number of shuttles). Data shown as means and standard deviations (SD) across all the positional groups, with the new adjusted minimum required benchmark to reach the 21<sup>st</sup> percentile score.

	Normative Data			Minimum Bleep Test score required to attain 21 <sup>st</sup> Percentile score
	Mean ± SD			
<b>Front Row</b>	86.8	±	17.6	73
<b>Locks</b>	99.8	±	18.2	85
<b>Loose Forwards</b>	99.3	±	15.3	87
<b>Inside Backs</b>	108.5	±	12.4	99
<b>Outside Backs</b>	106.0	±	14.4	94

\*This data is calculated from the pooled data between 1997 and 2011.

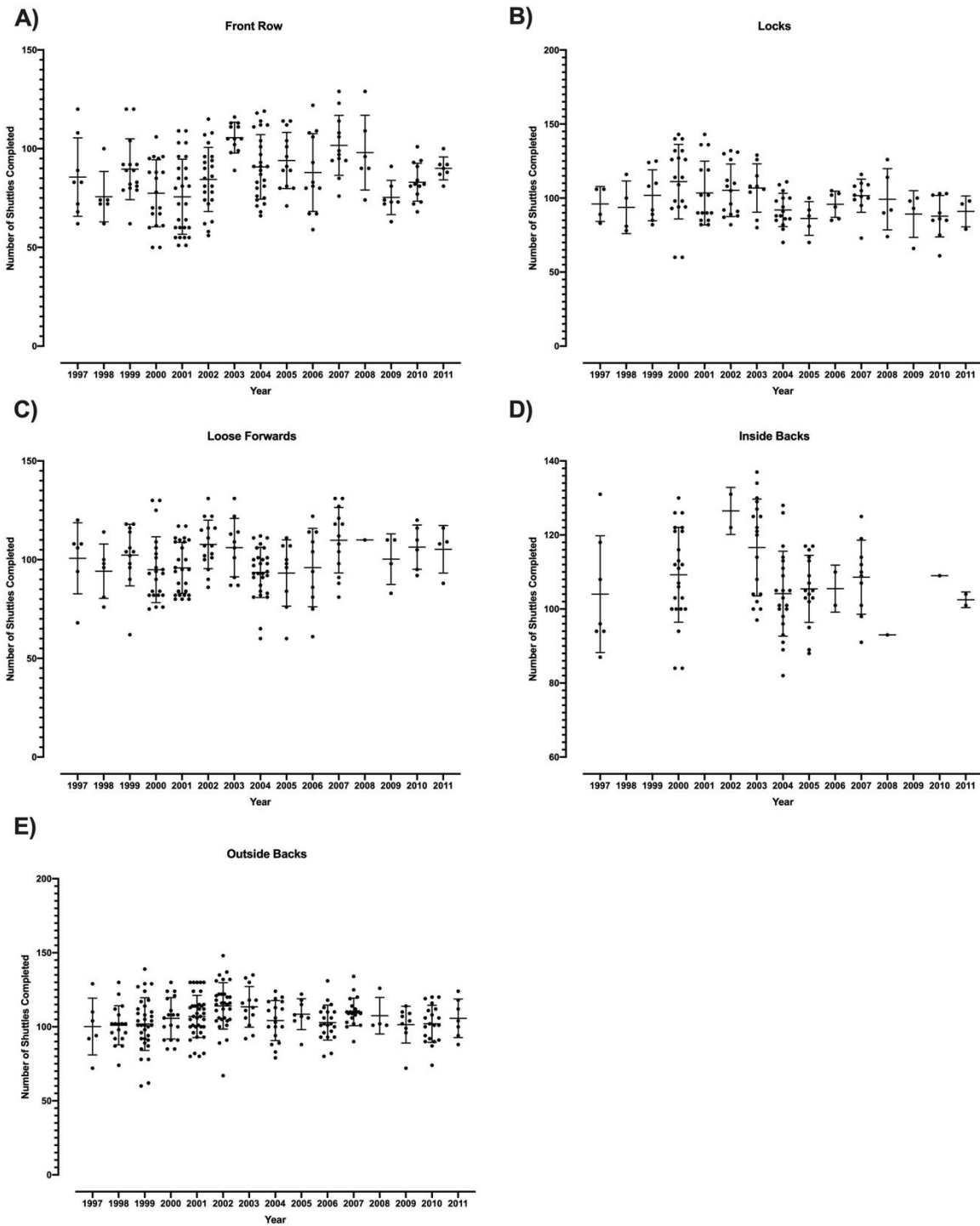


Figure 3: Secular trends in South African Rugby National U19 (during years 1997-2007) and U20 (during years 2008-2011) team testing data for the number of shuttles run during a bleep test for (A) Front Row players, (B) Locks, (C) Loose Forwards, (D) Inside backs, and (E) Outside backs.



## Anthropometric Data Correction for 2020 and beyond:

When all South African Rugby National U19 (during years 1997-2007) and U20 (during years 2008-2011) team weight (Figure 4), height (Figure 5) and sum of seven skinfolds (Figure 6) data are combined, there is an observed secular trend. As shown in Figure 6, players have become leaner across all positional categories within the 2009, 2010 and 2011 (Circa 2010) period, compared to previous years. Similar weight (Figure 4) and height (Figure 5) characteristics are also observed, with the Circa 2010 data demonstrating trends of players becoming heavier and taller than previous years. However, anthropometric data from 2018 and 2019 national and provincial normative testing results shared with the South African Rugby Union, show similar weight, height and body fatness within the positional categories. to the Circa 2010 data.

For all anthropometric data, it was therefore proposed that the Circa 2010 data be used as the current normative data. The minimum recommended requirements for Weight, Height and maximum recommended sum of seven skinfolds are shown in Table 6.

Table 6: Current adjusted Normative data for Weight (kg), Height (cm) and sum of seven skinfolds (mm). Data shown as means and standard deviations (SD) across all the positional groups, with the new adjusted minimum or maximum recommended benchmark to reach the 21<sup>st</sup> percentile score.

Body Weight	Normative Data		Minimum recommended Body Weight required to attain 21 <sup>st</sup> Percentile score
	Mean	± SD	
Front Row	111.4	± 8.0	105.0 kg
Locks	110.4	± 9.1	103.0 kg
Loose Forwards	100.5	± 4.5	96.8 kg
Inside Backs	87.7	± 7.0	82.1 kg
Outside Backs	88.6	± 6.7	83.2 kg
Body Height	Normative Data		Minimum recommended Body Height required to attain 21 <sup>st</sup> Percentile score
	Mean	± SD	
Front Row	182.1	± 5.2	177.9 cm
Locks	197.6	± 4.9	193.7 cm
Loose Forwards	187.2	± 3.8	184.1 cm
Inside Backs	178.5	± 5.6	173.9 cm
Outside Backs	182.9	± 5.2	178.7 cm
Sum of Seven Skinfolds	Normative Data		Maximum recommended Sum of Seven Skinfolds required to attain 21 <sup>st</sup> Percentile score
	Mean	± SD	
Front Row	55.9	± 12.2	65.7 mm
Locks	43.1	± 10.2	51.3 mm
Loose Forwards	35.9	± 6.5	41.2 mm
Inside Backs	31.4	± 8.3	38.1 mm
Outside Backs	29.6	± 3.9	32.7 mm

\*This data is calculated from the pooled data from 2009, 2010 and 2011.

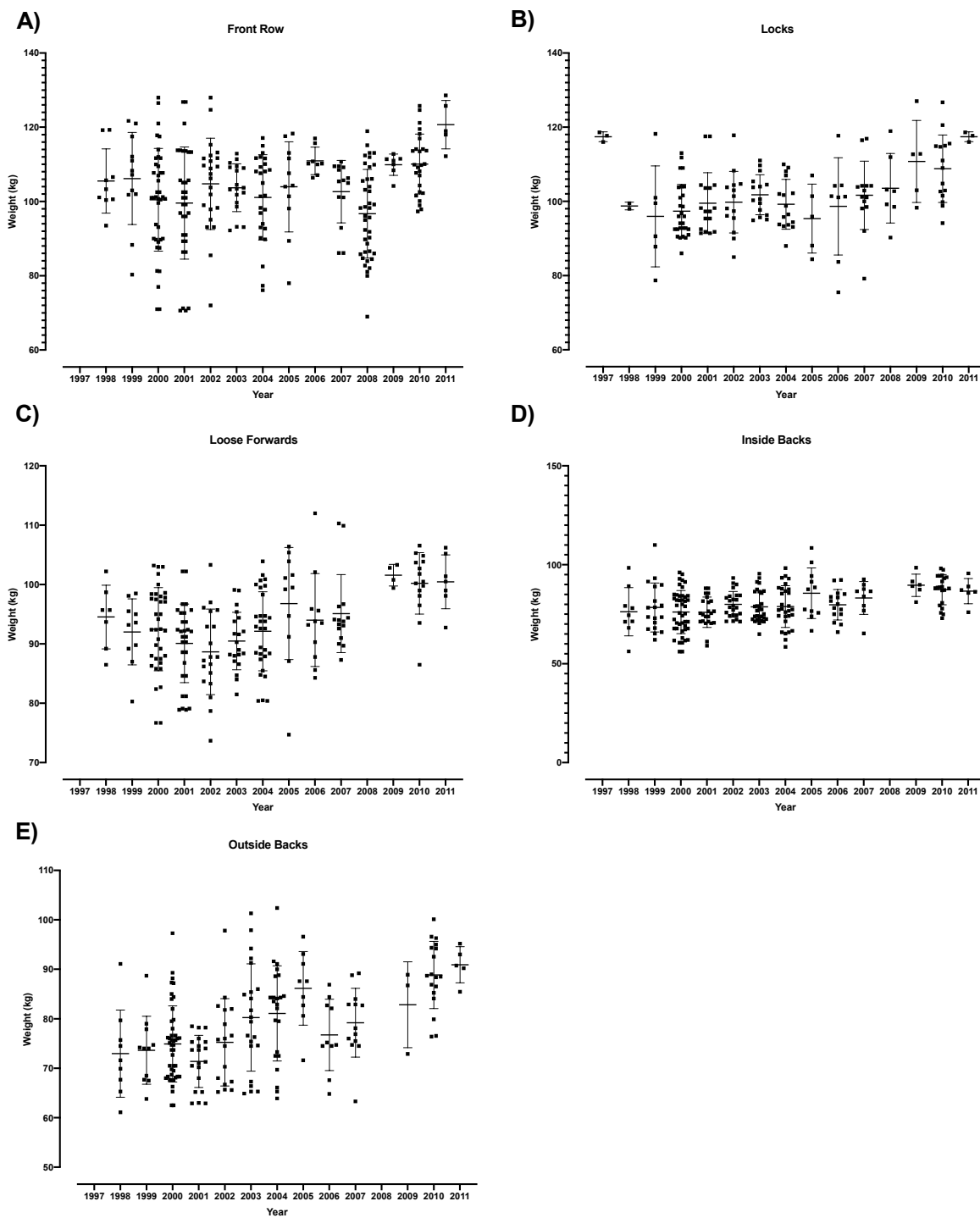


Figure 4: Secular trends in South African Rugby National U19 (during years 1997-2007) and U20 (during years 2008-2011) team testing data for body weight among; (A) Front Row players, (B) Locks, (C) Loose Forwards, (D) Inside backs, and (E) Outside backs.

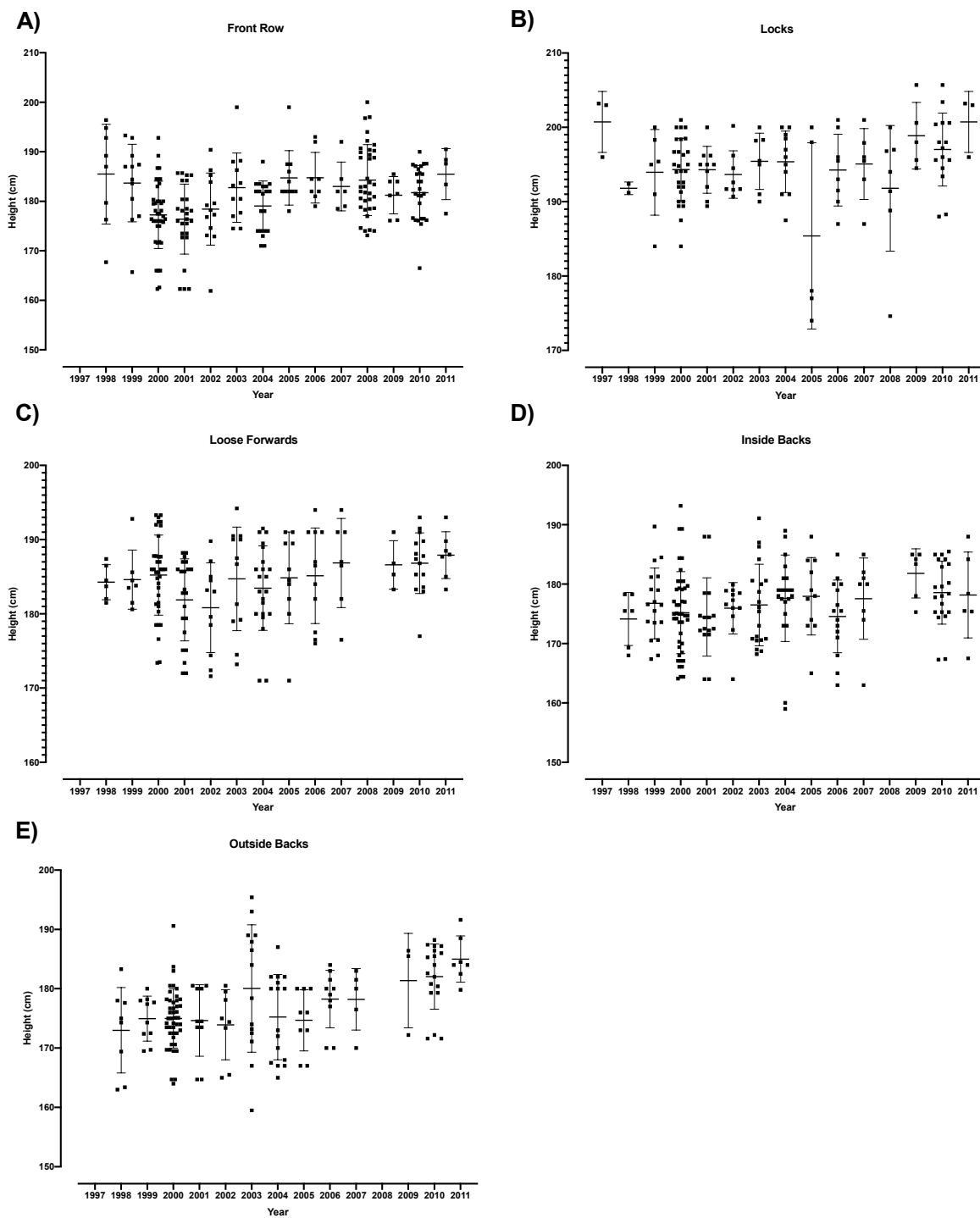


Figure 5: Secular trends in South African Rugby National U19 (during years 1997-2007) and U20 (during years 2008-2011) team testing data for body height among; (A) Front Row players, (B) Locks, (C) Loose Forwards, (D) Inside backs, and (E) Outside backs.

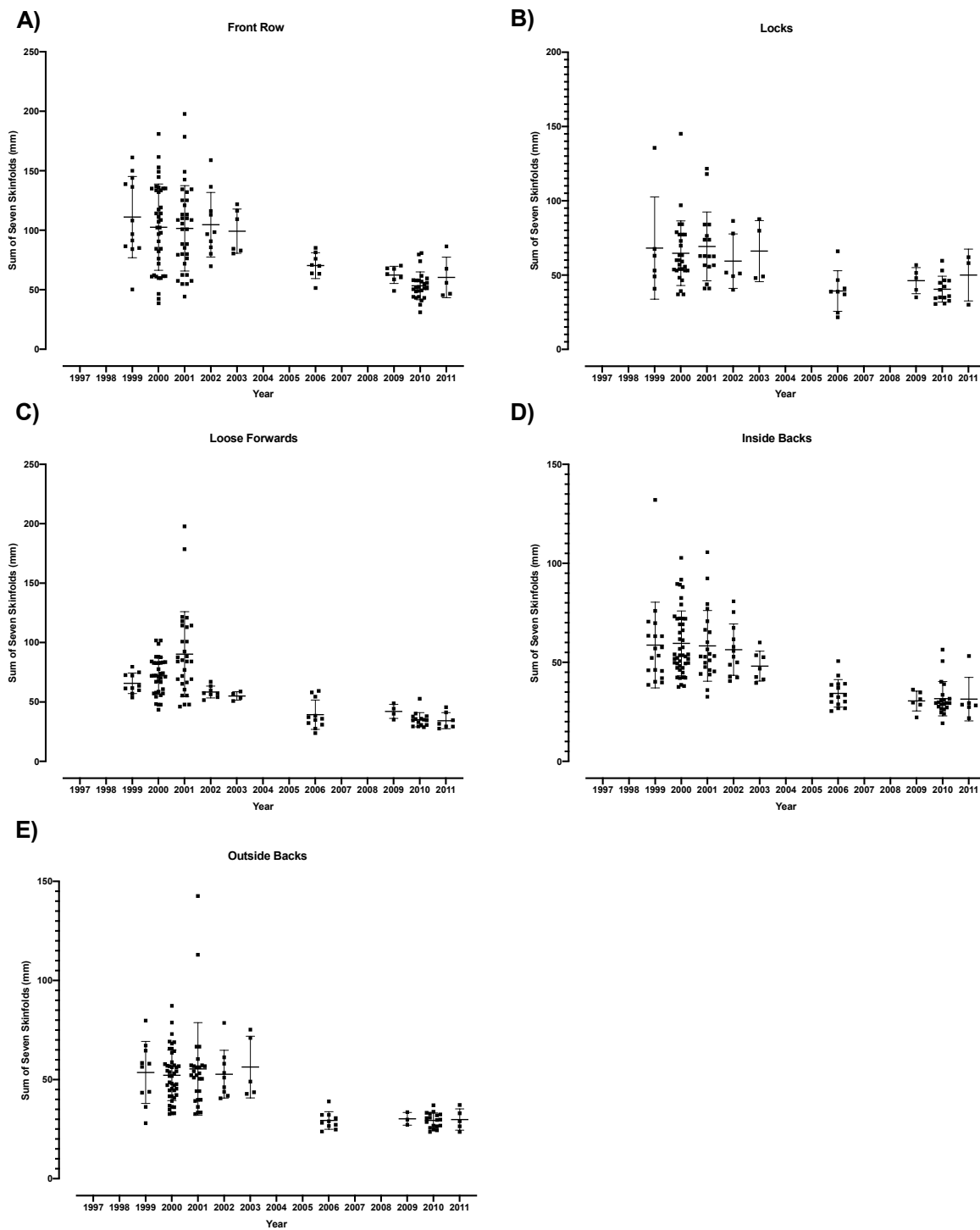


Figure 6: Secular trends in South African Rugby National U19 (during years 1997-2007) and U20 (during years 2008-2011) team testing data for the sum of seven skinfolds among; (A) Front Row players, (B) Locks, (C) Loose Forwards, (D) Inside backs, and (E) Outside backs.

## Summary of Adjusted Requirements:

	Minimum 1 RM Bench Press
Front Row	131 kg
Locks	111 kg
Loose Forwards	117 kg
Inside Backs	106 kg
Outside Backs	104 kg

	Minimum Push Ups in a minute
Front Row	49
Locks	40
Loose Forwards	45
Inside Backs	51
Outside Backs	46

	Minimum Bleep Test score
Front Row	73
Locks	85
Loose Forwards	87
Inside Backs	99
Outside Backs	94

	Minimum recommended Body Weight
<b>Body Weight</b>	
Front Row	105.0 kg
Locks	103.0 kg
Loose Forwards	96.8 kg
Inside Backs	82.1 kg
Outside Backs	83.2 kg
	Minimum recommended Height
<b>Body Height</b>	
Front Row	177.9 cm
Locks	193.7 cm
Loose Forwards	184.1 cm
Inside Backs	173.9 cm
Outside Backs	178.7 cm
	Maximum recommended Sum of Seven Skinfolts
<b>Sum of Seven Skinfolts</b>	
Front Row	65.7 mm
Locks	51.3 mm
Loose Forwards	41.2 mm
Inside Backs	38.1 mm
Outside Backs	32.7 mm