Analysis Report

This report is structured as follows.

Contents

Descriptive Statistics

A two-way Analysis of Covariance was conducted to test if there are significant main effects of time (pre/post comparison) and group (group 1 and group 2) on five different measures, while controlling for the effects of height and age (covariates). The table below shows the descriptive statistics of each measure for each analysed group.

Descriptive Statistics

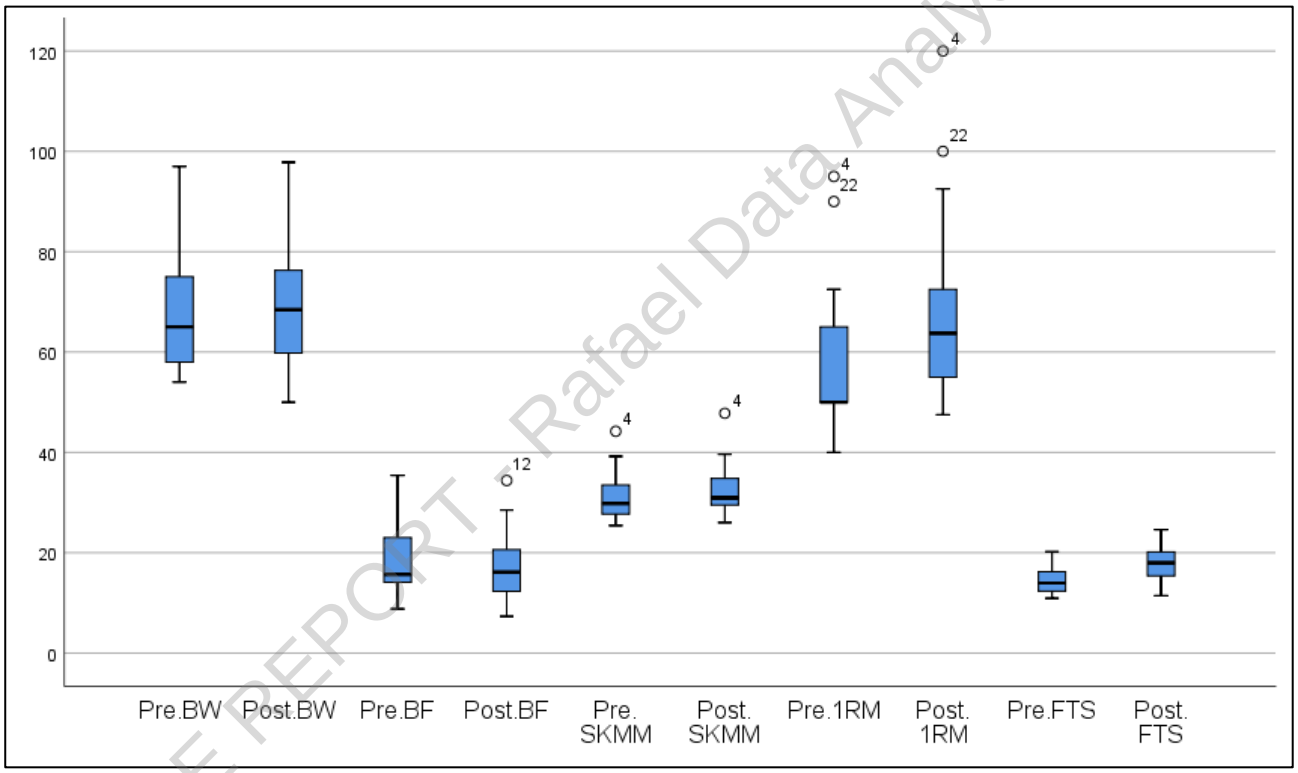
Group		Mean	Std. Deviation	N
Pre.BW	1	68.270	12.586	11
	2	67.090	10.242	11
	Total	67.680	11.214	22
Post.BW	1	68.700	13.37	11
	2	68.518	10.66	11
	Total	68.609	11.80	22
Pre.BF	1	19.327	7.6634	11
	2	17.518	7.0767	11
	Total	18.423	7.2574	22
Post.BF	1	17.727	7.2427	11
	2	16.582	7.1309	11
	Total	17.155	7.0382	22
Pre.SKMM	1	30.900	4.3704	11
	2	31.127	4.8753	11
	Total	31.014	4.5196	22
Post.SKMM	1	31.864	4.0751	11
	2	32.373	5.7632	11
	Total	32.118	4.8777	22
Pre.1RM	1	57.273	14.3376	11
	2	56.591	15.5834	11
	Total	56.932	14.6168	22
Post.1RM	1	67.727	14.4246	11
	2	67.500	21.3014	11
	Total	67.614	17.7529	22
Pre.FTS	1	14.770	2.114	11
	2	14.216	2.789	11
	Total	14.493	2.431	22
Post.FTS	1	18.419	3.451	11
	2	17.558	3.188	11
	Total	17.989	3.272	22

Two-way ANCOVA

There are three main assumptions present in the two-way ANCOVA method: lack of extreme outliers, homogeneity of intercorrelations and equality of variances.

The existence of outliers was examined using box plots. Box plots are graphical representations of the distribution of values in a particular variable. The graph literally box

in observations that are around the median (horizontal line in the middle of the box). The box edges represent the interquartile range of values. That is, the 25th percentile (lowest edge) and the 75th percentile (highest edge). 50% of values lie inside the box. The whiskers (lines protruding from the box) represent the minimum and maximum values observed among the cases. Outliers (participants of which values surpass 1.5 times the interquartile range) are presented as dots outside the whiskers, extreme outliers (more than 3 times this range) are represented as stars. The figure is shown below. There are no extreme outliers in the sample.



The other assumptions require that for all levels of the between-subjects factor (in this case, the different groups), variances and intercorrelations of the pre and post-op scores must be homogeneous. Homogeneity of intercorrelations is tested using Box M's test, of which results should not be significant under the 1% significance level (Pallant, 2010). The execution of the test indicated the assumption was not violated, Box's M (55) = 137.346, p =.304. Homogeneity of variances, on its turn, is tested with Levene's test (Levene, 1961)

and the results should not be significant as well. Results were non-significant for all measures (p > .05) (table below).

Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
Pre.BW	0.004	1	20	0.948
Post.BW	0.256	1	20	0.619
Pre.BF	0.058	1	20	0.812
Post.BF	0.001	1	20	0.971
Pre.SKMM	0.648	1	20	0.430
Post.SKMM	0.027	1	20	0.870
Pre.1RM	1.105	1	20	0.306
Post.1RM	0.251	1	20	0.622
Pre.FTS	0.316	1	20	0.580
Post.FTS	1.781	1	20	0.197

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a. Design: Intercept + Age + Height + Group
Within Subjects Design: Pre_Post

The multivariate effect of Group, Pre/Post, Age and Height

The first analysis tested the multivariate effect. That is, does belonging to group 1 or group 2 produce a significant effect on all indicators together (BW, BF, SKMM, 1RM and FTS)? The table below suggests that Height, Pre/Post and 'Pre/Post * Height' have a significant effect on all physical indicators (p < .05). That is, different heights produce different scores on the physical indicators, as well as time (Pre/Post). There is a significant difference on all indicators together between pre and post scores. 'Pre/Post * Height' refers to the interaction effect. That is, the effect of time (pre/post) is significantly different between different heights (table below). The statistical significance (p-value) is shown in the column "sig.". The effect size (partial eta squared - η_p^2) has the following thresholds (Cohen, 1988):

- 0.01: small effect;
- 0.06: medium effect;
- 0.138: large effect.

Thus, all the significant effects that were found were large effects.

Multivariate Tests[a]

Effect			Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Between Subjects	Intercept	Pillai's Trace	0.792	10,684[b]	5.000	14.000	0.000	0.792
		Wilks' Lambda	0.208	10,684[b]	5.000	14.000	0.000	0.792
		Hotelling's Trace	3.816	10,684[b]	5.000	14.000	0.000	0.792
		Roy's Largest Root	3.816	10,684[b]	5.000	14.000	0.000	0.792
	Age	Pillai's Trace	0.191	0,661[b]	5.000	14.000	0.659	0.191
		Wilks' Lambda	0.809	0,661[b]	5.000	14.000	0.659	0.191
		Hotelling's Trace	0.236	0,661[b]	5.000	14.000	0.659	0.191
		Roy's Largest Root	0.236	0,661[b]	5.000	14.000	0.659	0.191
	Height	Pillai's Trace	0.782	10,069[b]	5.000	14.000	0.000	0.782
		Wilks' Lambda	0.218	10,069[b]	5.000	14.000	0.000	0.782
		Hotelling's Trace	3.596	10,069[b]	5.000	14.000	0.000	0.782
		Roy's Largest Root	3.596	10,069[b]	5.000	14.000	0.000	0.782
	Group	Pillai's Trace	0.214	0,764[b]	5.000	14.000	0.591	0.214
		Wilks' Lambda	0.786	0,764[b]	5.000	14.000	0.591	0.214
		Hotelling's Trace	0.273	0,764[b]	5.000	14.000	0.591	0.214
		Roy's Largest Root	0.273	0,764[b]	5.000	14.000	0.591	0.214
Within Subjects	Pre_Post	Pillai's Trace	0.530	3,161[b]	5.000	14.000	0.041	0.530
		Wilks' Lambda	0.470	3,161[b]	5.000	14.000	0.041	0.530
		Hotelling's Trace	1.129	3,161[b]	5.000	14.000	0.041	0.530
		Roy's Largest Root	1.129	3,161[b]	5.000	14.000	0.041	0.530
	Pre_Post * Age	Pillai's Trace	0.325	1,348[b]	5.000	14.000	0.301	0.325
		Wilks' Lambda	0.675	1,348[b]	5.000	14.000	0.301	0.325
		Hotelling's Trace	0.481	1,348[b]	5.000	14.000	0.301	0.325
		Roy's Largest Root	0.481	1,348[b]	5.000	14.000	0.301	0.325
	Pre_Post * Height	Pillai's Trace	0.643	5,041[b]	5.000	14.000	0.008	0.643
		Wilks' Lambda	0.357	5,041[b]	5.000	14.000	0.008	0.643
		Hotelling's Trace	1.800	5,041[b]	5.000	14.000	0.008	0.643
		Roy's Largest Root	1.800	5,041[b]	5.000	14.000	0.008	0.643
	Pre_Post * Group	Pillai's Trace	0.177	0,601[b]	5.000	14.000	0.700	0.177
		Wilks' Lambda	0.823	0,601[b]	5.000	14.000	0.700	0.177

Hotelling's Trace	0.215	0,601[b]	5.000	14.000	0.700	0.177
Roy's Largest Root	0.215	0,601[b]	5.000	14.000	0.700	0.177

a. Design: Intercept + Age + Height + Group
Within Subjects Design: Pre_Post
b. Exact statistic

The univariate effect of time (Pre/Post) on the physical measures

The table below shows the main effects of the intervention over time (difference in Pre/Post scores) for each studied indicator, while controlling for Age and Height. The Pre/Post effect was significant only for RM, $F(1, 22) = 14.986$, $p = .001$, $\eta_p^2 = .454$. This indicates that the scores of RM are significantly different from Pre to Post times, while controlling for age and height. This effect, nevertheless, is significantly different depending on the height of the participant ($p < .05$). The 'Pre_Post * Group' line of the table indicates that there is no interaction effect between time and group for any measure. That is, the effect of the intervention (Pre/Post) is not significantly different between the groups ($p > .05$).

Tests of Within-Subjects Contrasts

Source			Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Pre_Post	BW	Linear	0.909	1	0.909	0.396	0.537	0.022
	BF	Linear	0.006	1	0.006	0.002	0.963	0.000
	SKMM	Linear	0.312	1	0.312	0.594	0.451	0.032
	RM	Linear	196.293	1	196.293	14.986	0.001	0.454
	FTS	Linear	4.131	1	4.131	1.464	0.242	0.075
Pre_Post * Age	BW	Linear	0.648	1	0.648	0.282	0.602	0.015
	BF	Linear	0.491	1	0.491	0.200	0.660	0.011
	SKMM	Linear	1.548	1	1.548	2.948	0.103	0.141
	RM	Linear	3.086	1	3.086	0.236	0.633	0.013
	FTS	Linear	10.043	1	10.043	3.559	0.075	0.165
Pre_Post * Height	BW	Linear	0.280	1	0.280	0.122	0.731	0.007
	BF	Linear	0.076	1	0.076	0.031	0.862	0.002
	SKMM	Linear	0.022	1	0.022	0.041	0.842	0.002
	RM	Linear	267.888	1	267.888	20.452	0.000	0.532
	FTS	Linear	0.068	1	0.068	0.024	0.878	0.001
Pre_Post * Group	BW	Linear	1.986	1	1.986	0.864	0.365	0.046
	BF	Linear	1.602	1	1.602	0.654	0.429	0.035
	SKMM	Linear	0.003	1	0.003	0.005	0.942	0.000
	RM	Linear	19.822	1	19.822	1.513	0.234	0.078
	FTS	Linear	0.220	1	0.220	0.078	0.783	0.004
Error (Pre_Post)	BW	Linear	41.384	18	2.299			

BF	Linear	44.086	18	2.449
SKMM	Linear	9.450	18	0.525
RM	Linear	235.775	18	13.099
FTS	Linear	50.793	18	2.822

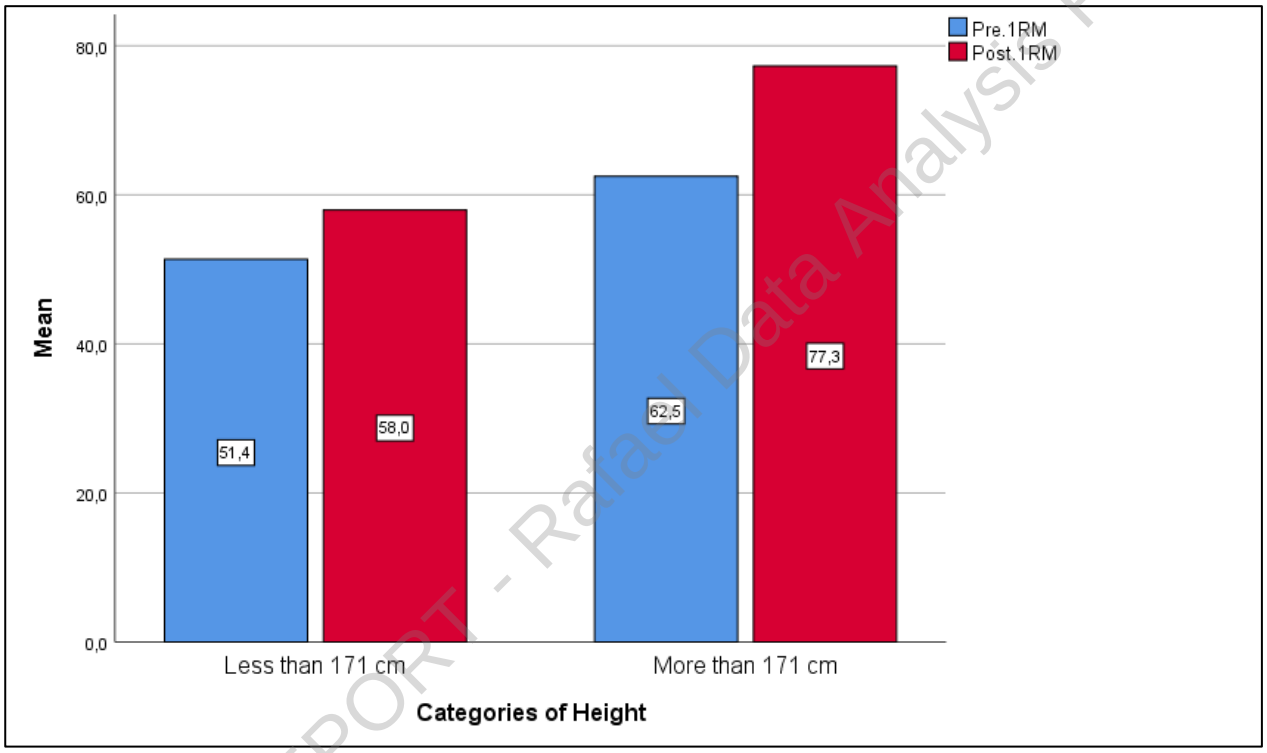
The univariate effect of groups

The table below shows that there are no significant main effects of belonging to a specific group on any of the measures ($p > .05$). Height is a significant covariate in for SKMM and RM ($p < .01$), which means that height significantly influences the scores of SKMM and RM.

Tests of Between-Subjects Effects

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	BW	860.324	1	860.324	3.972	0.062	0.181
	BF	172.260	1	172.260	1.597	0.223	0.081
	SKMM	342.581	1	342.581	17.169	0.001	0.488
	RM	3861.150	1	3861.150	12.989	0.002	0.419
	FTS	28.482	1	28.482	1.873	0.188	0.094
Age	BW	157.500	1	157.500	0.727	0.405	0.039
	BF	1.743	1	1.743	0.016	0.900	0.001
	SKMM	44.003	1	44.003	2.205	0.155	0.109
	RM	1028.443	1	1028.443	3.460	0.079	0.161
	FTS	0.089	1	0.089	0.006	0.940	0.000
Height	BW	1087.742	1	1087.742	5.022	0.038	0.218
	BF	130.314	1	130.314	1.208	0.286	0.063
	SKMM	391.578	1	391.578	19.625	0.000	0.522
	RM	2804.768	1	2804.768	9.435	0.007	0.344
	FTS	6.941	1	6.941	0.456	0.508	0.025
Group	BW	0.973	1	0.973	0.004	0.947	0.000
	BF	51.325	1	51.325	0.476	0.499	0.026
	SKMM	10.363	1	10.363	0.519	0.480	0.028
	RM	0.044	1	0.044	0.000	0.990	0.000
	FTS	6.785	1	6.785	0.446	0.513	0.024
Error	BW	3899.021	18	216.612			
	BF	1942.078	18	107.893			
	SKMM	359.159	18	19.953			
	RM	5350.707	18	297.261			
	FTS	273.773	18	15.210			

In order to better visualize where the differences are present in terms of the RM scores and different heights, the following graph was plot. The variable ‘Height’ was categorizes into tho with less than 171cm and those with more than 171cm. The graph shows that the pre/post difference in the scores of “1RM” is substantially higher for those taller than 171cm. While the first group increases the mean score from 51.4 to 58, the taller group increases the scores from 62.5 to 77.3.



Summary of the tests of hypotheses

The table below summarizes the results of the study hypotheses.

Hypothesis	Result
H1: There is a significant difference in BW measurements from pre to post periods.	Rejected
H2: There is a significant difference in BF measurements from pre to post periods.	Rejected
H3: There is a significant difference in SKMM measurements from pre to post periods.	Rejected

H4: There is a significant difference in 1RM measurements from pre to post periods.	Confirmed
H5: There is a significant difference in FTS measurements from pre to post periods.	Rejected
H6: There is a significant difference in BW measurements between groups 1 and 2.	Rejected
H7: There is a significant difference in BF measurements between groups 1 and 2.	Rejected
H8: There is a significant difference in SKMM measurements between groups 1 and 2.	Rejected
H9: There is a significant difference in 1RM measurements between groups 1 and 2.	Rejected
H10: There is a significant difference in FTS measurements between groups 1 and 2.	Rejected
H11: The difference between pre and post scores of 1RM is significantly different between different height groups.	Confirmed

BMI as control variable

This section displays the same analyses conducted before, but this time controlling for BMI instead of Age and Height.

Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
Pre.BW	0.004	1	20	0.951
Post.BW	0.216	1	20	0.647
Pre.BF	0.772	1	20	0.390
Post.BF	0.155	1	20	0.698
Pre.SKMM	0.075	1	20	0.787
Post.SKMM	1.237	1	20	0.279
Pre.1RM	0.062	1	20	0.807
Post.1RM	0.804	1	20	0.380
Pre.FTS	0.966	1	20	0.337
Post.FTS	0.385	1	20	0.542

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + BMI + Group
Within Subjects Design: Pre_Post

The multivariate effect of Group, Pre/Post, Age and Height

Multivariate Tests[a]

Effect			Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Between Subjects	Intercept	Pillai's Trace	0.827	14,299[b]	5.000	15.000	0.000	0.827
		Wilks' Lambda	0.173	14,299[b]	5.000	15.000	0.000	0.827
		Hotelling's Trace	4.766	14,299[b]	5.000	15.000	0.000	0.827
		Roy's Largest Root	4.766	14,299[b]	5.000	15.000	0.000	0.827
	BMI	Pillai's Trace	0.842	15,961[b]	5.000	15.000	0.000	0.842
		Wilks' Lambda	0.158	15,961[b]	5.000	15.000	0.000	0.842
		Hotelling's Trace	5.320	15,961[b]	5.000	15.000	0.000	0.842
		Roy's Largest Root	5.320	15,961[b]	5.000	15.000	0.000	0.842
	Group	Pillai's Trace	0.362	1,700[b]	5.000	15.000	0.195	0.362
		Wilks' Lambda	0.638	1,700[b]	5.000	15.000	0.195	0.362
		Hotelling's Trace	0.567	1,700[b]	5.000	15.000	0.195	0.362
		Roy's Largest Root	0.567	1,700[b]	5.000	15.000	0.195	0.362
Within Subjects	Pre_Post	Pillai's Trace	0.105	0,352[b]	5.000	15.000	0.873	0.105
		Wilks' Lambda	0.895	0,352[b]	5.000	15.000	0.873	0.105
		Hotelling's Trace	0.117	0,352[b]	5.000	15.000	0.873	0.105
		Roy's Largest Root	0.117	0,352[b]	5.000	15.000	0.873	0.105
	Pre_Post * BMI	Pillai's Trace	0.167	0,599[b]	5.000	15.000	0.701	0.167
		Wilks' Lambda	0.833	0,599[b]	5.000	15.000	0.701	0.167
		Hotelling's Trace	0.200	0,599[b]	5.000	15.000	0.701	0.167
		Roy's Largest Root	0.200	0,599[b]	5.000	15.000	0.701	0.167
	Pre_Post * Group	Pillai's Trace	0.113	0,382[b]	5.000	15.000	0.854	0.113
		Wilks' Lambda	0.887	0,382[b]	5.000	15.000	0.854	0.113
		Hotelling's Trace	0.127	0,382[b]	5.000	15.000	0.854	0.113
		Roy's Largest Root	0.127	0,382[b]	5.000	15.000	0.854	0.113

a. Design: Intercept + BMI + Group
Within Subjects Design: Pre_Post
b. Exact statistic

The univariate effect of time (Pre/Post) on the physical measures

The table below shows the main effects of the intervention over time (difference in Pre/Post scores) for each studied indicator, while controlling for Age and Height. The Pre/Post effect was significant only for RM, $F(1, 22) = 14.986$, $p = .001$, $\eta_p^2 = .454$. This indicates that the scores of RM are significantly different from Pre to Post times, while controlling for age and height. This effect, nevertheless, is significantly different depending on the height of the participant ($p < .05$). The 'Pre_Post * Group' line of the table indicates that there is no interaction effect between time and group for any measure. That is, the effect of the intervention (Pre/Post) is not significantly different between the groups ($p > .05$).

Tests of Within-Subjects Contrasts

Source			Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Pre_Post	BW	Linear	0.179	1	0.179	0.080	0.780	0.004
	BF	Linear	2.200	1	2.200	1.048	0.319	0.052
	SKMM	Linear	0.072	1	0.072	0.133	0.720	0.007
	RM	Linear	32.405	1	32.405	1.200	0.287	0.059
	FTS	Linear	0.384	1	0.384	0.122	0.731	0.006
Pre_Post * BMI	BW	Linear	0.004	1	0.004	0.002	0.969	0.000
	BF	Linear	4.708	1	4.708	2.243	0.151	0.106
	SKMM	Linear	0.728	1	0.728	1.341	0.261	0.066
	RM	Linear	0.019	1	0.019	0.001	0.979	0.000
	FTS	Linear	1.473	1	1.473	0.468	0.502	0.024
Pre_Post * Group	BW	Linear	2.488	1	2.488	1.108	0.306	0.055
	BF	Linear	2.747	1	2.747	1.309	0.267	0.064
	SKMM	Linear	0.046	1	0.046	0.084	0.775	0.004
	RM	Linear	0.581	1	0.581	0.022	0.885	0.001
	FTS	Linear	0.681	1	0.681	0.216	0.647	0.011
Error(Pre_Post)	BW	Linear	42.658	19	2.245			
	BF	Linear	39.874	19	2.099			
	SKMM	Linear	10.318	19	0.543			
	RM	Linear	513.049	19	27.003			
	FTS	Linear	59.821	19	3.148			

The univariate effect of groups

The table below shows that there are no significant main effects of belonging to a specific group on any of the measures ($p > .05$). Height is a significant covariate in for SKMM and RM ($p < .01$), which means that height significantly influences the scores of SKMM and RM.

Tests of Between-Subjects Effects

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	BW	52.872	1	52.872	0.736	0.402	0.037
	BF	87.569	1	87.569	1.299	0.269	0.064
	SKMM	210.505	1	210.505	7.000	0.016	0.269
	RM	1743.161	1	1743.161	3.297	0.085	0.148
	FTS	275.598	1	275.598	18.579	0.000	0.494
BMI	BW	4150.165	1	4150.165	57.791	0.000	0.753
	BF	796.007	1	796.007	11.811	0.003	0.383
	SKMM	344.504	1	344.504	11.457	0.003	0.376
	RM	543.987	1	543.987	1.029	0.323	0.051
	FTS	0.089	1	0.089	0.006	0.939	0.000
Group	BW	399.044	1	399.044	5.557	0.029	0.226
	BF	156.388	1	156.388	2.320	0.144	0.109
	SKMM	15.647	1	15.647	0.520	0.479	0.027
	RM	62.319	1	62.319	0.118	0.735	0.006
	FTS	5.462	1	5.462	0.368	0.551	0.019
Error	BW	1364.461	19	71.814			
	BF	1280.546	19	67.397			
	SKMM	571.339	19	30.070			
	RM	10045.217	19	528.696			
	FTS	281.835	19	14.833			

In order to better visualize where the differences are present in terms of the RM scores and different heights, the following graph was plot. The variable ‘Height’ was categorizes into tho with less than 171cm and those with more than 171cm. The graph shows that the pre/post difference in the scores of “1RM” is substantially higher for those taller than 171cm. While the first group increases the mean score from 51.4 to 58, the taller group increases the scores from 62.5 to 77.3.

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