

Analysis Report

This report presents the results of a mixed-design ANOVA, which was conducted to examine the pre/post intervention difference in four measures of performance across three different groups. The report is structured as follows.

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Descriptives

This section presents descriptive statistics and graphs of the variables of interest. The table below shows the minimum and maximum values, along with the mean, standard deviation, skewness and kurtosis for each variable. A total of 48 subjects were included in the study.

Descriptive Statistics

Variable	N	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
1RM% - Pre	48	28.000	85.000	58.135	13.127	-0.077	-0.496
1RM% - Post	48	35.000	98.000	63.313	14.029	0.281	-0.546
Throwing velocity - Pre (TV)	48	20.620	34.020	26.846	3.290	0.349	-0.492
Throwing velocity - Post (TV)	48	22.440	34.220	28.747	3.150	-0.056	-0.818
Seated ball throw - Pre (SBT)	48	2.700	5.800	4.077	0.629	0.250	0.398
Seated ball throw - Post (SBT)	48	3.000	5.800	4.308	0.687	0.219	-0.830
Muscle mass - Pre (MMS)	48	20.900	39.000	31.110	4.227	0.011	-0.573
Muscle mass - Post (MMS)	48	20.900	39.000	31.638	4.293	-0.136	-0.452
Valid N (listwise)	48						

All the values of skewness and kurtosis are within the range of -1 to +1, which suggest no substantial deviation from a normal distribution (Hair et al., 2014). In order to confirm this assumption, a statistical test for normality was conducted and is presented in next section.

Normality

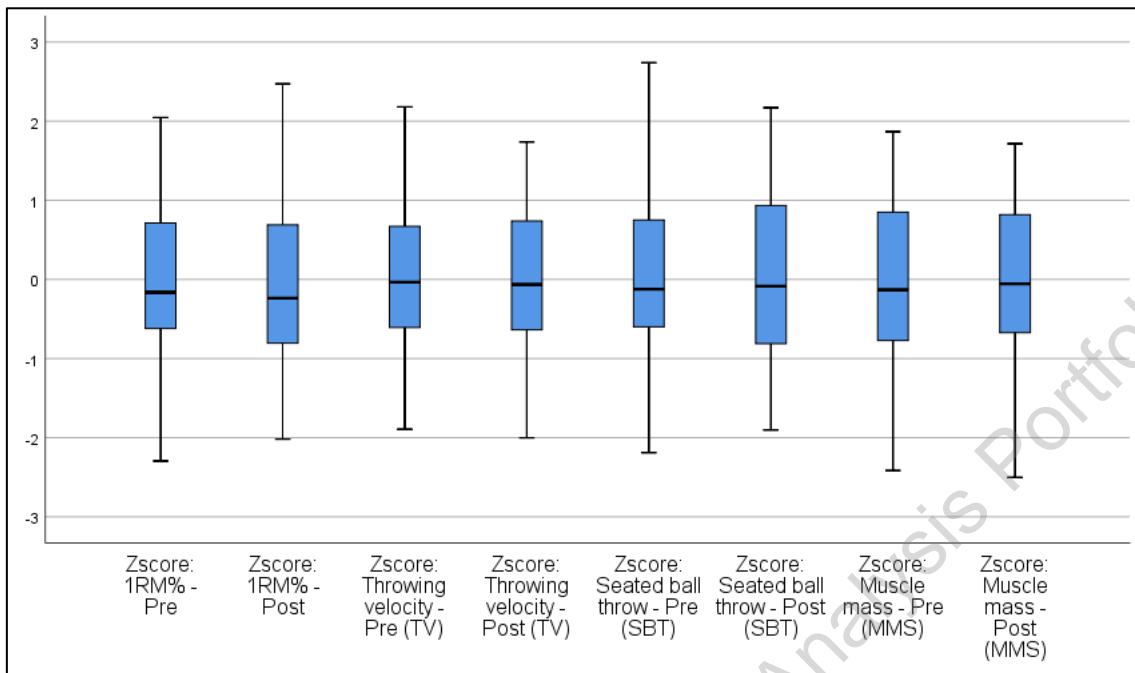
Besides looking at skewness and kurtosis, statistical tests can also be used to assess normality, namely, the Kolmogorov-Smirnov or the Shapiro-Wilk's tests. A non-significance in these tests ($p > 0.05$) means data are normally distributed. The figure below shows the results of a Shapiro-Wilk's test.

<i>Tests of Normality</i>			
Variable	Shapiro-Wilk		
	Statistic	df	Sig.
1RM% - Pre	0.981	48	0.611
1RM% - Post	0.973	48	0.341
Throwing velocity - Pre (TV)	0.971	48	0.279
Throwing velocity - Post (TV)	0.975	48	0.393
Seated ball throw - Pre (SBT)	0.974	48	0.354
Seated ball throw - Post (SBT)	0.971	48	0.287
Muscle mass - Pre (MMS)	0.979	48	0.530
Muscle mass - Post (MMS)	0.978	48	0.496

All variables under study are normally distributed ($p > .05$).

Outliers

The existence of outliers can distort the results of ANOVA, so these need to be examined carefully. A first assessment was done 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. The scores of the interval variables were standardized (Z-scores) and the box plots of these scores are shown in the figure below. Values above 4 should be deleted according to Hair et al. (2014).



The graph shows that the highest absolute scores were below 3 or above -3, so no significant outliers exist, and the complete dataset was used for the mixed ANOVA analysis, which is presented next.

Mixed Between-Within-Subjects ANOVA

A mixed between-within-subjects ANOVA was conducted. This factorial design is appropriate when one or more IVs are measured between subjects, whereas other IVs are measured within subjects (Tabachnick and Fidell, 2014).

Assumptions

In addition to normality and absence of outliers, one additional assumption is present in the mixed ANOVA method: equality of variances. That is, for both levels of the between-subjects factor (in this case, the groups), variances of the dependent variables scores must be homogeneous. The results of the Levene's test is shown in the table below.

The results show that all variances are homogeneous ($p > .05$), which indicates no violation of this assumption.

Levene's Test of Equality of Error Variances^a

	Levene Statistic	df1	df2	Sig.
1RM% - Pre	1.209	2	45	0.308
1RM% - Post	0.965	2	45	0.389
Throwing velocity - Pre (TV)	0.448	2	45	0.642
Throwing velocity - Post (TV)	1.169	2	45	0.320
Seated ball throw - Pre (SBT)	0.652	2	45	0.526
Seated ball throw - Post (SBT)	0.740	2	45	0.483
Muscle mass - Pre (MMS)	0.550	2	45	0.581
Muscle mass - Post (MMS)	0.435	2	45	0.650

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

a. Design: Intercept + GroupID

Within Subjects Design: Time_Pre_Post

Multivariate Effects

The first test was to measure if there are significant effects of the intervention and belonging to specific groups on all the indicators together (multivariate analysis).

The between-subjects line of the following table shows that there is a significant effect of Group, $F(8) = 2.154$, $p = .039$, on the performance indicators, which means that the performances are significantly different across the groups.

The effect of the intervention is also significant for all measures considered together $F(4) = 69.453$, $p < .001$, as well as the interaction effect, $F(8) = 10.159$, $p < .001$. The significant interaction effect means that the effect of the intervention is not constant across the groups.

Multivariate Tests^a

Effect	Value	F	Hypothesis df	Sig.	Partial Eta Squared
Between Subjects	Intercept	0.993	1439.085	4.000	0.000
	GroupID	0.334	2.154	8.000	0.039

Within Subjects	Time_Pre_Post	0.869	69.453	4.000	0.000	0.869
	Time_Pre_Post * GroupID	0.972	10.159	8.000	0.000	0.486

a. Design: Intercept + GroupID

Within Subjects Design: Time_Pre_Post

The partial eta squared column indicates the effect sizes, which can be interpreted as the following:

- 0.01: small
- 0.06: medium
- 0.138: large (Cohen, 1988)

Within-Subjects and Interaction Effects

This section looks at univariate results, separately for each performance indicator. The effect of the intervention is significant for all four measures ($p < .001$), with large effect sizes. Interaction effects are present for all measures too ($p < .001$), meaning that the pre/post differences are significantly different across groups.

Tests of Within-Subjects Contrasts

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Time_Pre_Post	RM	643.253	1	643.253	147.245	0.000	0.766
	TV	86.678	1	86.678	48.461	0.000	0.519
	SBT	1.283	1	1.283	31.351	0.000	0.411
	MMS	6.668	1	6.668	29.785	0.000	0.398
Time_Pre_Post * Group	RM	365.786	2	182.893	41.866	0.000	0.650
	TV	68.209	2	34.104	19.067	0.000	0.459
	SBT	1.419	2	0.710	17.336	0.000	0.435
	MMS	6.654	2	3.327	14.862	0.000	0.398
Error(Time_Pre_Post)	RM	196.586	45	4.369			
	TV	80.488	45	1.789			
	SBT	1.842	45	0.041			
	MMS	10.073	45	0.224			

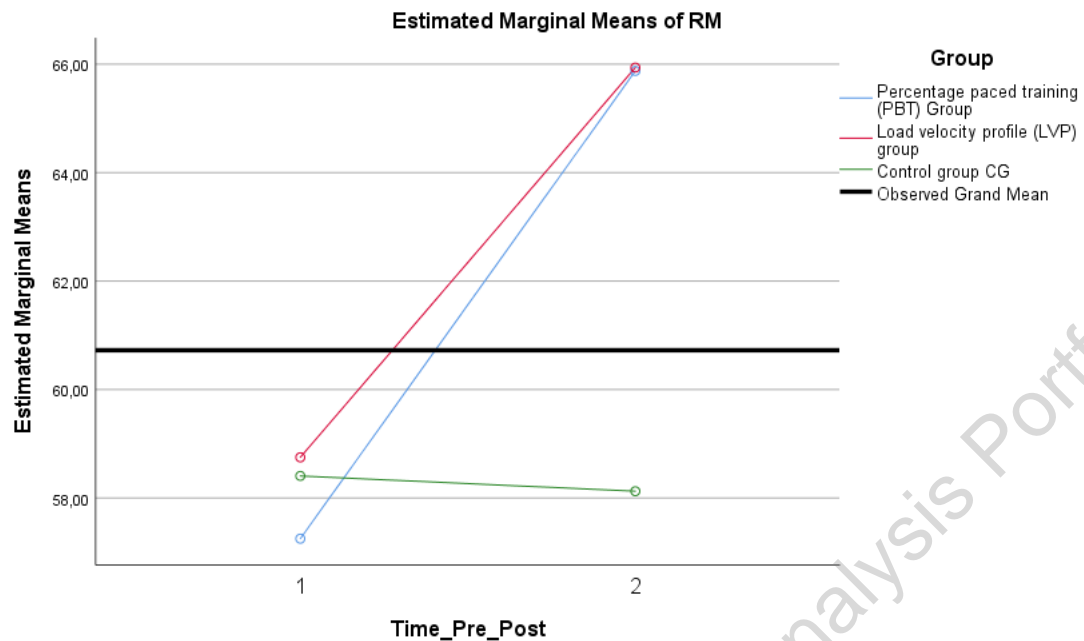
Between-Subjects Effects

In terms of the effect of 'Group' alone, it is non-significant for all four measures ($p > .05$), which means that there is no difference on the scores of RM, TV, SBT and MMS between groups, without considering pre and post periods, but the scores for the whole period instead.

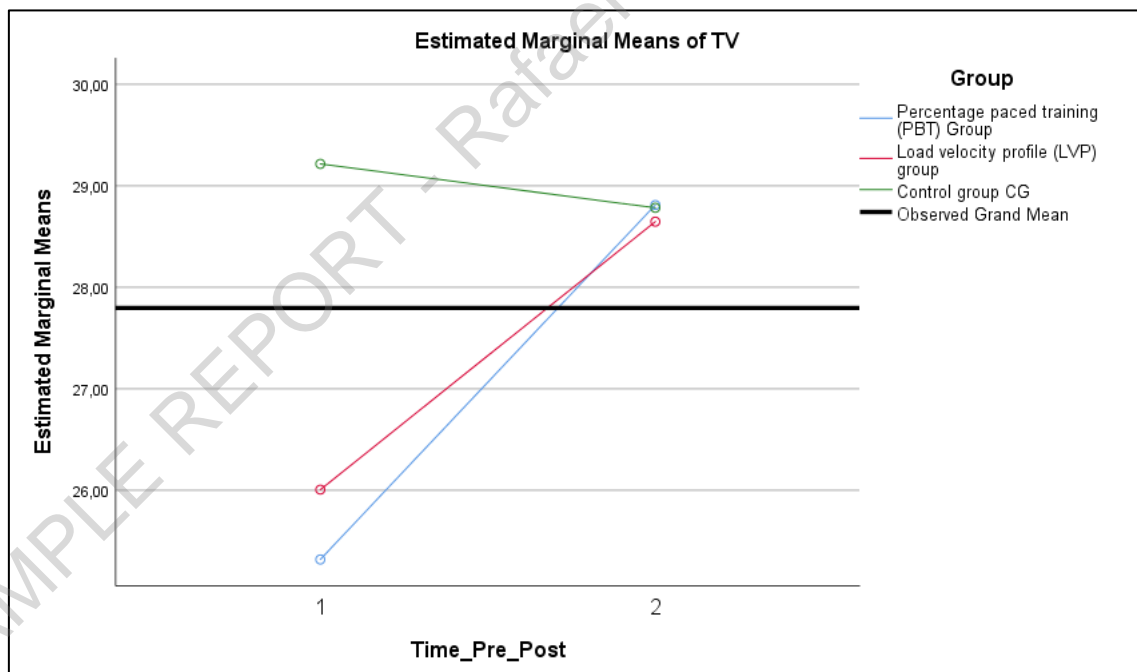
Tests of Between-Subjects Effects

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	RM	353990.315	1	353990.315	966.162	0.000	0.955
	TV	74174.849	1	74174.849	4415.995	0.000	0.990
	SBT	1687.565	1	1687.565	2306.314	0.000	0.981
	MMS	94495.225	1	94495.225	2662.282	0.000	0.983
Groups	RM	299.849	2	149.924	0.409	0.667	0.018
	TV	70.530	2	35.265	2.099	0.134	0.085
	SBT	4.613	2	2.306	3.152	0.052	0.123
	MMS	91.956	2	45.978	1.295	0.284	0.054
Error	RM	16487.461	45	366.388			
	TV	755.859	45	16.797			
	SBT	32.927	45	0.732			
	MMS	1597.233	45	35.494			

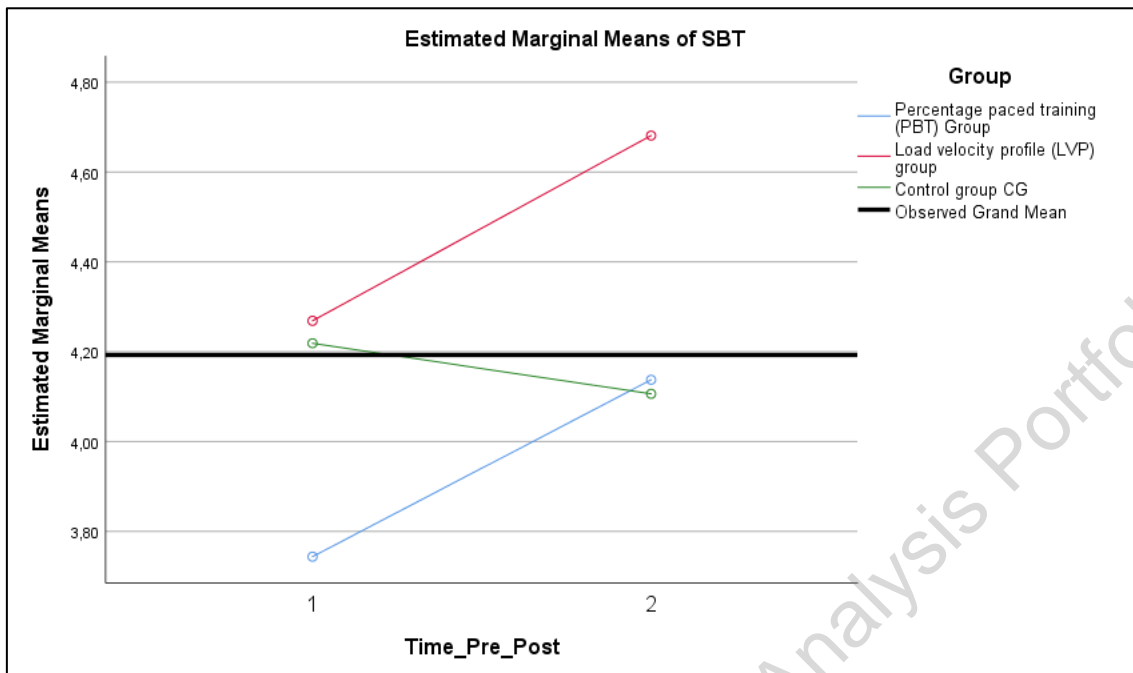
To visualize the results and see how the groups differed in terms of pre and post scores of RM, TV, SBT and MMS, the following line graphs were created. They show how the mean scores vary across the performance measures (pre and post intervention) for the three groups. The first figure is for RM. While the scores for the control group remained fairly constant, the scores for the other two groups increased substantially.



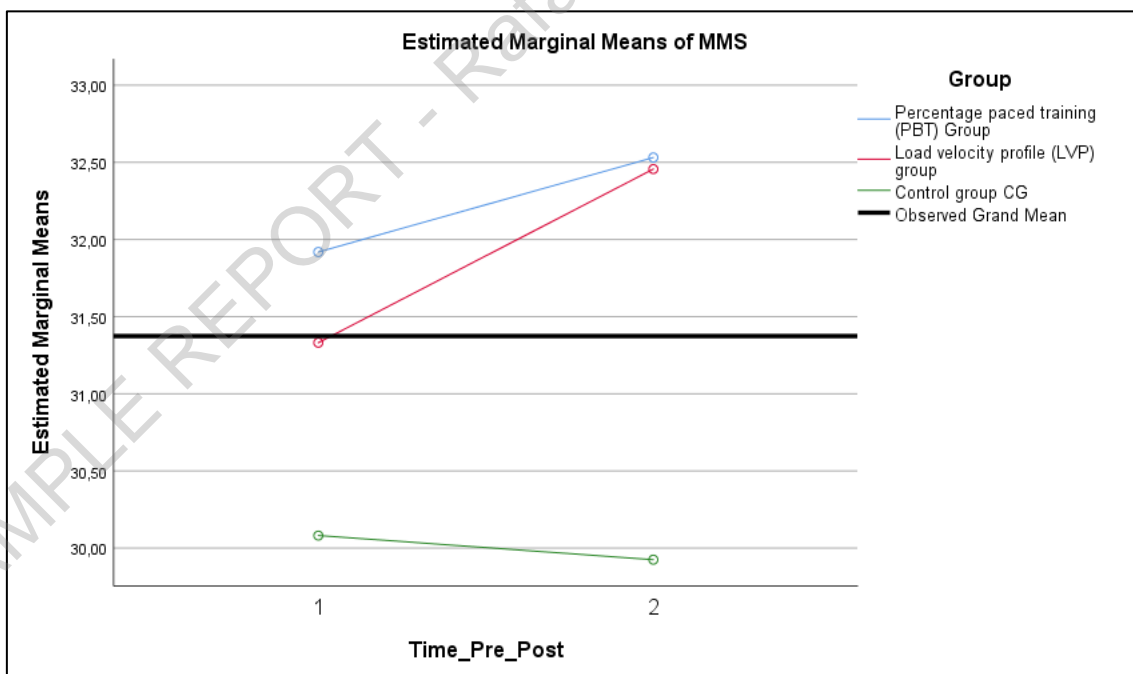
For TV (figure below), the scores for the control group decreased slightly, while for the two treatment groups, they increased substantially.



A similar pattern is shown for SBT scores. While the control group has a slight decrease from pre to post, the other two groups show increasing scores.



For the MMS measure, the pattern is also similar, but this time the Load Velocity Group shows a higher increase compared to the percentage paced training.



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