<u>Analysis Report</u>

This report is structured as follows.

<u>Contents</u>

Sample Characteristics

The current study examined the sprint times over different lengths, specifically 30 meters, 60 meters, and 80 meters, across various weeks and under different conditions of loading and exercise participation. Data were collected from a sample comprising 46 participants, with an average age of 14.83 years. The gender distribution within the sample consisted of 28 males and 18 females.

Across six weeks, sprint times showed variability. For the 30-meter sprint, the fastest average time recorded was 4.392 seconds in week 6, with the slowest being 5.239 seconds in week 5. The 60-meter sprints followed a similar pattern, where the quickest mean time was 8.048 seconds in week 6, and the slowest was 9.265 seconds in week 5. The 80-meter sprint times also varied, with the fastest average of 11.071 seconds occurring in week 6 and the slowest average of 12.351 seconds in week 5.

Variable	Week	Mean	SEM	SD
30m	1	4.568	0.078	0.526
	2	4.762	0.080	0.540
	3	5.157	0.093	0.633
	4	4.786	0.079	0.533
	5	5.239	0.095	0.647
	6	4.392	0.067	0.457
60m	1	8.377	0.114	0.770
	2	8.593	0.122	0.826
	3	9.157	0.141	0.959
	4	8.640	0.121	0.822
	5	9.265	0.144	0.974
	6	8.048	0.098	0.665
80m	1	11.223	0.212	1.439
	2	11.391	0.200	1.359
	3	12.238	0.216	1.466
	4	11.443	0.199	1.352
	5	12.351	0.218	1.481
	6	11.071	0.200	1.353

Analysis of the impact of loading on sprint performance indicated that increasing loading weights corresponded with slower sprint times. For the 30-meter sprint, times increased from an average of 4.480 seconds with no load to 5.198 seconds with a 200 kg load. Similarly, for the 60-meter and 80-meter sprints, times increased from 8.213 seconds and 11.147 seconds with no load to 9.211 seconds and 12.294 seconds with a 200 kg load, respectively.

Variable	Loading	Mean	SEM	SD
30m	0	4.480	0.052	0.498
	100	4.774	0.056	0.534
	200	5.198	0.067	0.638
60m	0	8.213	0.077	0.734
	100	8.617	0.085	0.820
	200	9.211	0.100	0.963
80m	0	11.147	0.145	1.391
	100	11.417	0.141	1.348
	200	12.294	0.153	1.467

The participation in exercises also influenced sprint times. Participants who engaged in exercises recorded slightly slower times across all distances. For instance, in the 30-meter sprint, the average time for participants who did not engage in exercises was 4.689 seconds, compared to 4.946 seconds for those who did. This trend was consistent for the 60-meter and 80-meter sprints, with exercised participants recording times of 8.844 seconds and 11.777 seconds, respectively, compared to 8.516 seconds and 11.462 seconds for non-exercised participants.

Variable	Exercises	Mean	SEM	SD
30m	No	4.689	0.048	0.558
	Yes	4.946	0.057	0.674
60m	No	8.516	0.072	0.847
	Yes	8.844	0.085	0.994
80m	No	11.462	0.120	1.414
	Yes	11.777	0.131	1.535

For the 30-meter sprints, results indicate a range of performances, with Candidate 1 starting the first week at 3.945 seconds, decreasing over time to 3.800 seconds by week 6. Conversely, Candidate 18 exhibited an increasing trend from 5.475 seconds in week 1 to 6.140 seconds by week 6, showing a substantial divergence in performance trajectories among participants. Notably, Candidate 23 marked a steady increase from 5.310 seconds to 5.785 seconds across the weeks.

Candidate	Week					
	1	2	3	4	5	6
1	3.945	4.465	4.625	4.485	4.650	3.800
2	4.230	4.125	4.315	4.145	4.390	4.255
3	3.960	4.485	4.770	4.505	4.870	3.700
4	3.920	4.205	4.535	4.230	4.620	3.760
5	4.335	4.165	4.530	4.200	4.615	4.285
6	4.465	4.600	4.920	4.630	4.995	4.390
7	4.145	4.750	5.285	4.790	5.375	4.015
8	4.160	4.370	4.725	4.395	4.815	4.065
9	4.210	4.430	4.820	4.450	4.940	4.000
10	4.025	4.555	5.015	4.595	5.090	3.995
11	4.220	4.090	4.525	4.115	4.605	4.200
12	4.075	4.420	5.020	4.445	5.125	4.030
13	4.545	4.200	4.565	4.220	4.650	4.195
14	4.325	4.810	5.310	4.820	5.400	4.095
15	4.940	4.680	5.135	4.705	5.195	4.730
16	5.310	5.130	5.525	5.150	5.595	4.990
17	5.410	5.570	5.870	5.590	5.960	4.855
18	5.475	5.650	6.050	5.670	6.140	5.020
19	4.830	5.780	6.230	5.810	6.315	4.755
20	5.115	4.965	5.230	4.990	5.290	5.060
21	5.165	5.385	5.870	5.405	5.935	4.990
22	4.945	5.405	6.040	5.425	6.150	4.850
23	5.310	5.280	5.695	5.300	5.785	4.975

In the 60-meter category, Candidate 1 improved from 7.140 seconds to 7.090 seconds, while Candidate 19's performance peaked at 10.280 seconds in week 5, from an initial 8.940 seconds. This variance underscores significant differences in sprint performance dynamics among the participants over the weeks.

Candidate	Week					
	1	2	3	4	5	6
1	7.140	7.735	8.030	7.765	8.160	7.090
2	7.500	7.380	7.735	7.420	7.815	7.500
3	7.040	7.825	8.080	7.870	8.195	6.990
4	7.035	7.375	7.780	7.435	7.910	7.005
5	7.920	7.330	7.870	7.400	7.955	7.875
6	8.145	8.210	8.750	8.230	8.835	8.020
7	8.250	8.500	9.215	8.520	9.300	7.705
8	8.235	8.335	8.690	8.355	8.775	7.670
9	8.345	8.295	8.765	8.325	8.825	7.885
10	7.565	8.570	9.285	8.640	9.360	7.260
11	7.815	7.720	8.190	7.740	8.305	7.580
12	8.380	8.060	8.810	8.095	8.910	7.700
13	8.895	8.685	9.105	8.745	9.200	8.205
14	8.105	9.290	9.930	9.350	10.035	7.965
15	8.865	8.500	9.485	8.560	9.595	8.225
16	8.965	9.165	10.030	9.235	10.155	8.550
17	8.960	9.315	9.840	9.375	10.005	8.665
18	9.215	9.300	9.905	9.370	10.045	8.965
19	8.940	9.610	10.125	9.680	10.280	8.540

20	9.320	9.235	9.710	9.265	9.840	8.585
21	9.465	9.720	10.420	9.760	10.530	9.250
22	9.045	9.935	10.585	9.980	10.705	8.670
23	9.525	9.560	10.265	9.600	10.360	9.205

The 80-meter sprint times further exemplified this variability, with Candidate 1 recording a time reduction from 9.485 seconds to 9.470 seconds across the six weeks. In contrast, Candidate 23 demonstrated a significant performance increase from 14.120 seconds to 14.690 seconds.

Candidate	Week					
	1	2	3	4	5	6
1	9.485	10.180	10.840	10.235	10.930	9.470
2	9.940	9.835	10.470	9.860	10.535	9.865
3	9.785	10.320	10.775	10.380	10.865	9.500
4	9.170	10.005	10.790	10.040	10.935	9.150
5	10.100	9.650	10.530	9.705	10.680	10.220
6	10.845	10.470	11.270	10.505	11.405	10.575
7	10.185	11.120	11.845	11.190	11.955	10.065
8	10.405	10.560	11.240	10.605	11.355	10.390
9	10.925	10.750	11.415	10.815	11.525	10.745
10	9.915	11.140	11.985	11.190	12.080	10.005
11	9.975	10.080	10.920	10.105	10.975	9.995
12	10.595	10.340	11.395	10.415	11.470	10.485
13	11.015	11.105	11.920	11.170	12.030	10.840
14	10.980	11.605	12.485	11.670	12.625	10.735
15	11.515	11.240	12.015	11.305	12.110	11.295
16	11.845	11.725	12.720	11.795	12.875	11.630
17	12.055	12.090	13.320	12.160	13.455	11.790
18	12.595	12.415	13.450	12.490	13.550	12.250
19	12.030	13.000	13.840	13.070	13.960	11.950
20	13.595	12.535	13.760	12.570	13.900	13.150
21	13.910	13.960	14.920	13.985	15.045	13.745
22	13.140	14.320	14.995	14.350	15.125	13.000
23	14.120	13.555	14.570	13.590	14.690	13.790

In the case of the 30-meter sprint, participants not subjected to exercise maintained relatively stable times, with a minimal peak towards the middle of the study period. Specifically, times started at 4.530 seconds, peaked slightly at 4.960 seconds around the midpoint, and decreased to 4.395 seconds by the study's end. Conversely, those undergoing exercise regimens exhibited more variability: beginning at 4.605 seconds, peaking at 5.519 seconds, and reducing sharply to 4.388 seconds by the final wave, indicating potential temporary fatigue followed by recovery.

Variable	Exercises	Wave	Mean	SEM	SD
30m	No	1	4.530	0.112	0.538
	No	2	4.647	0.106	0.510
	No	3	4.901	0.122	0.587
	No	4	4.699	0.106	0.508

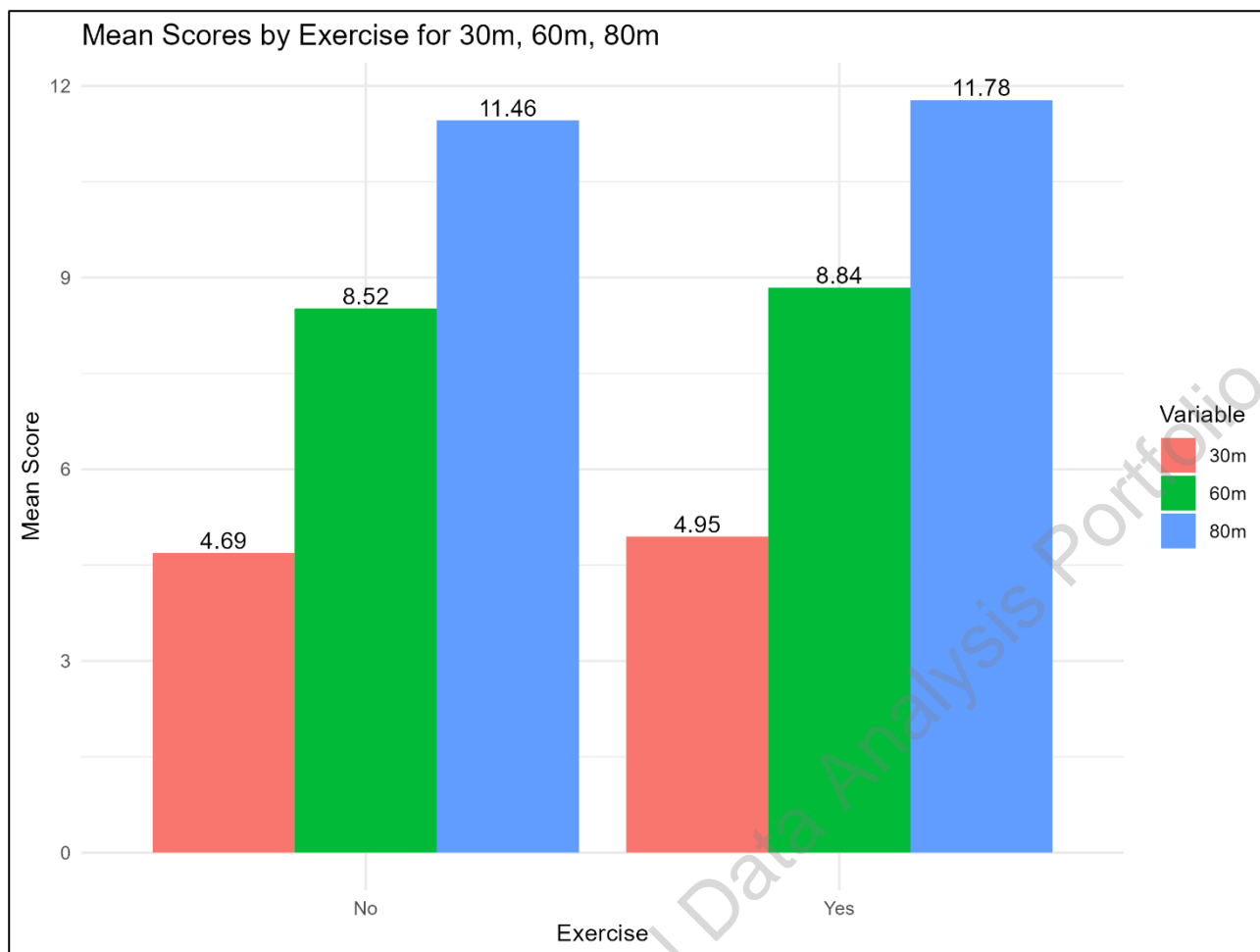|					
	No	5	4.960	0.120	0.574
	No	6	4.395	0.097	0.465
	Yes	1	4.605	0.109	0.523
	Yes	2	4.877	0.116	0.555
	Yes	3	5.412	0.121	0.582
	Yes	4	4.872	0.116	0.555
	Yes	5	5.519	0.126	0.603
	Yes	6	4.388	0.096	0.459
	No	1	8.333	0.162	0.776
	No	2	8.418	0.163	0.781
	No	3	8.851	0.184	0.881
	No	4	8.510	0.165	0.790
	No	5	8.941	0.186	0.892
	No	6	8.041	0.143	0.686
60m	Yes	1	8.421	0.162	0.779
	Yes	2	8.769	0.177	0.849
	Yes	3	9.462	0.199	0.953
	Yes	4	8.770	0.177	0.850
	Yes	5	9.589	0.201	0.963
	Yes	6	8.055	0.137	0.659
	No	1	11.180	0.304	1.456
	No	2	11.197	0.276	1.322
	No	3	11.970	0.290	1.392
	No	4	11.292	0.275	1.321
	No	5	12.064	0.292	1.401
	No	6	11.068	0.290	1.390
80m	Yes	1	11.266	0.303	1.454
	Yes	2	11.585	0.291	1.397
	Yes	3	12.505	0.317	1.519
	Yes	4	11.595	0.291	1.394
	Yes	5	12.638	0.320	1.534
	Yes	6	11.075	0.281	1.346

Similar patterns were observed in the 60-meter sprints, where non-exercised conditions showed a steady increase from 8.333 seconds to 8.941 seconds over the first five waves, ending with a slight decrease to 8.041 seconds. Exercised conditions reflected an increase from 8.421 seconds to a high of 9.589 seconds, followed by a decrease to 8.055 seconds, which paralleled the 30-meter sprint trends.
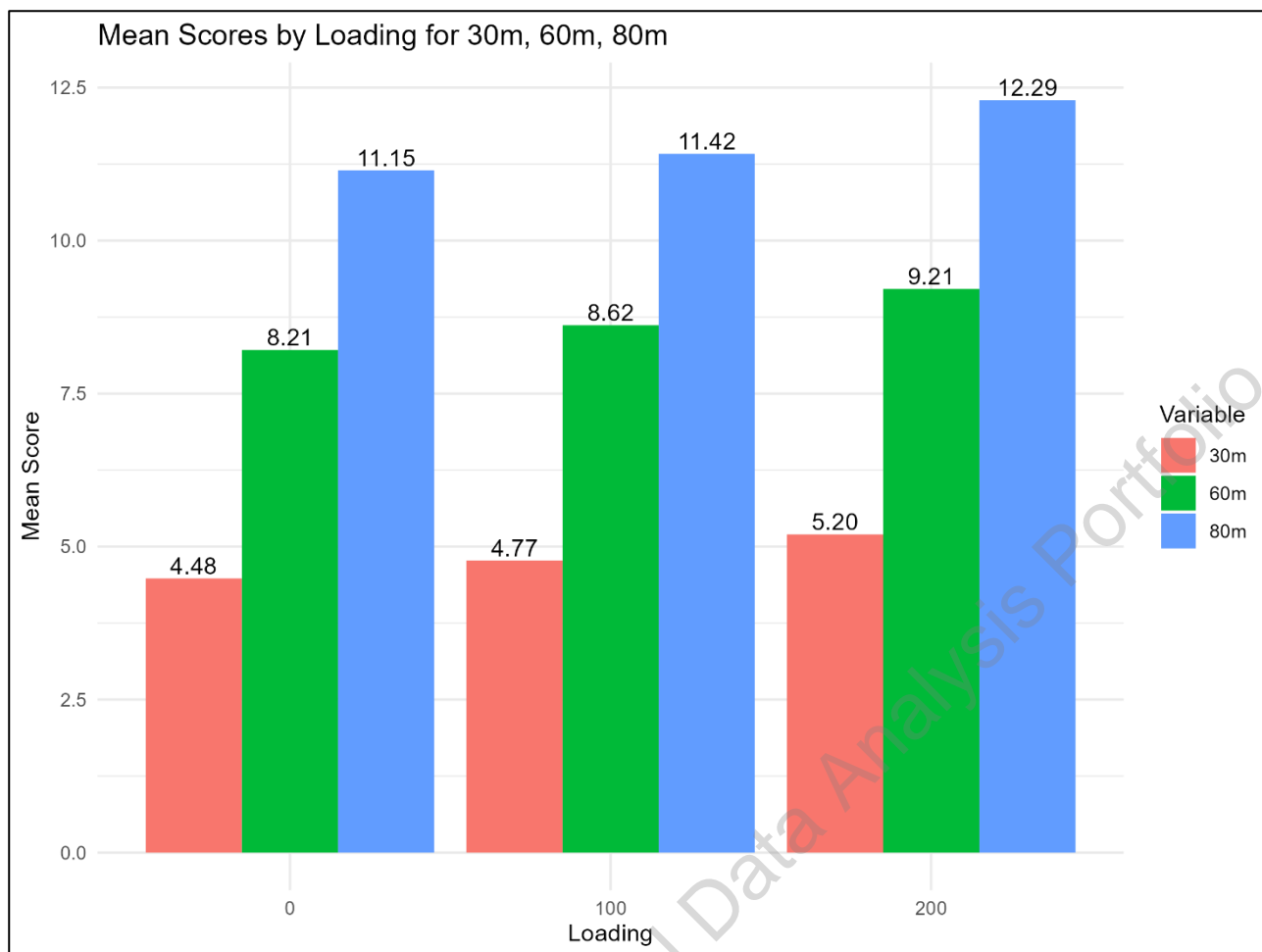
The 80-meter sprints further corroborated these findings. Non-exercised participants saw their times rise from 11.180 seconds to 12.064 seconds by the fifth wave, with a minor reduction to 11.068 seconds in the last wave. Exercised participants experienced a rise from 11.266 seconds to 12.638 seconds, decreasing to 11.075 seconds by wave six.
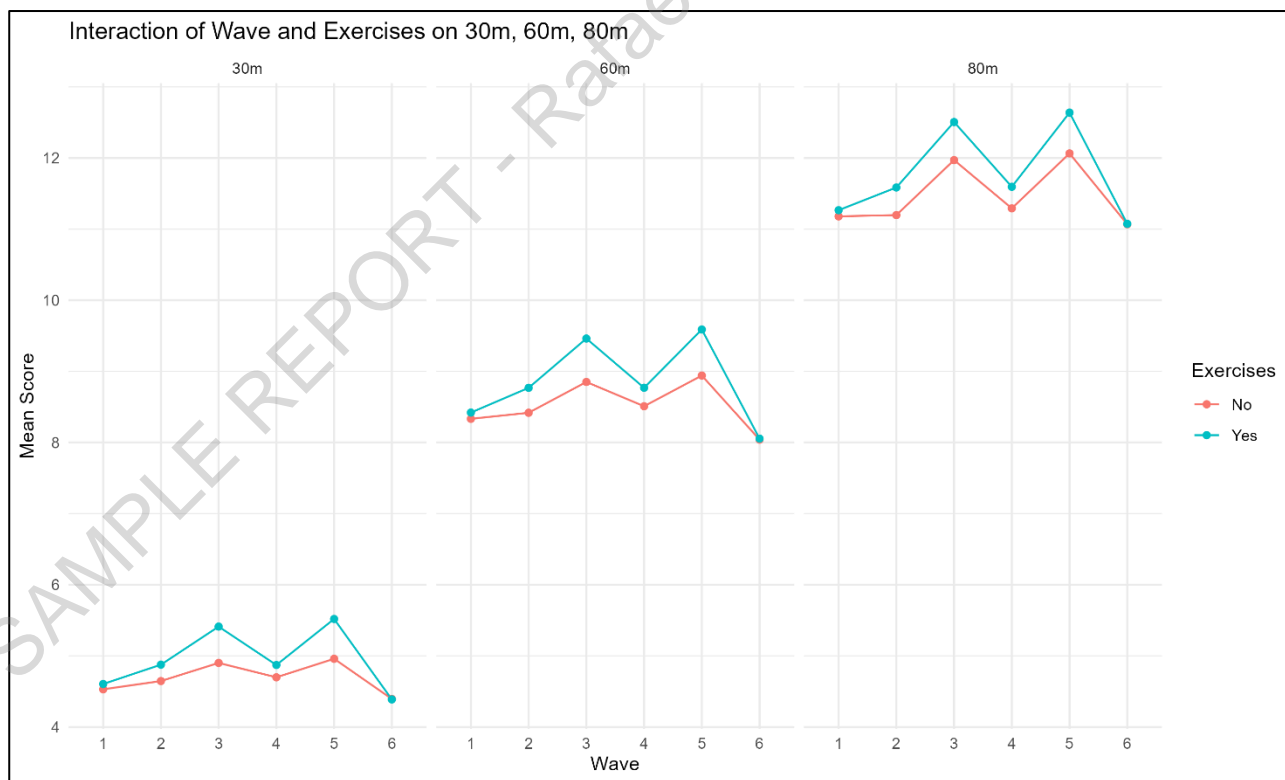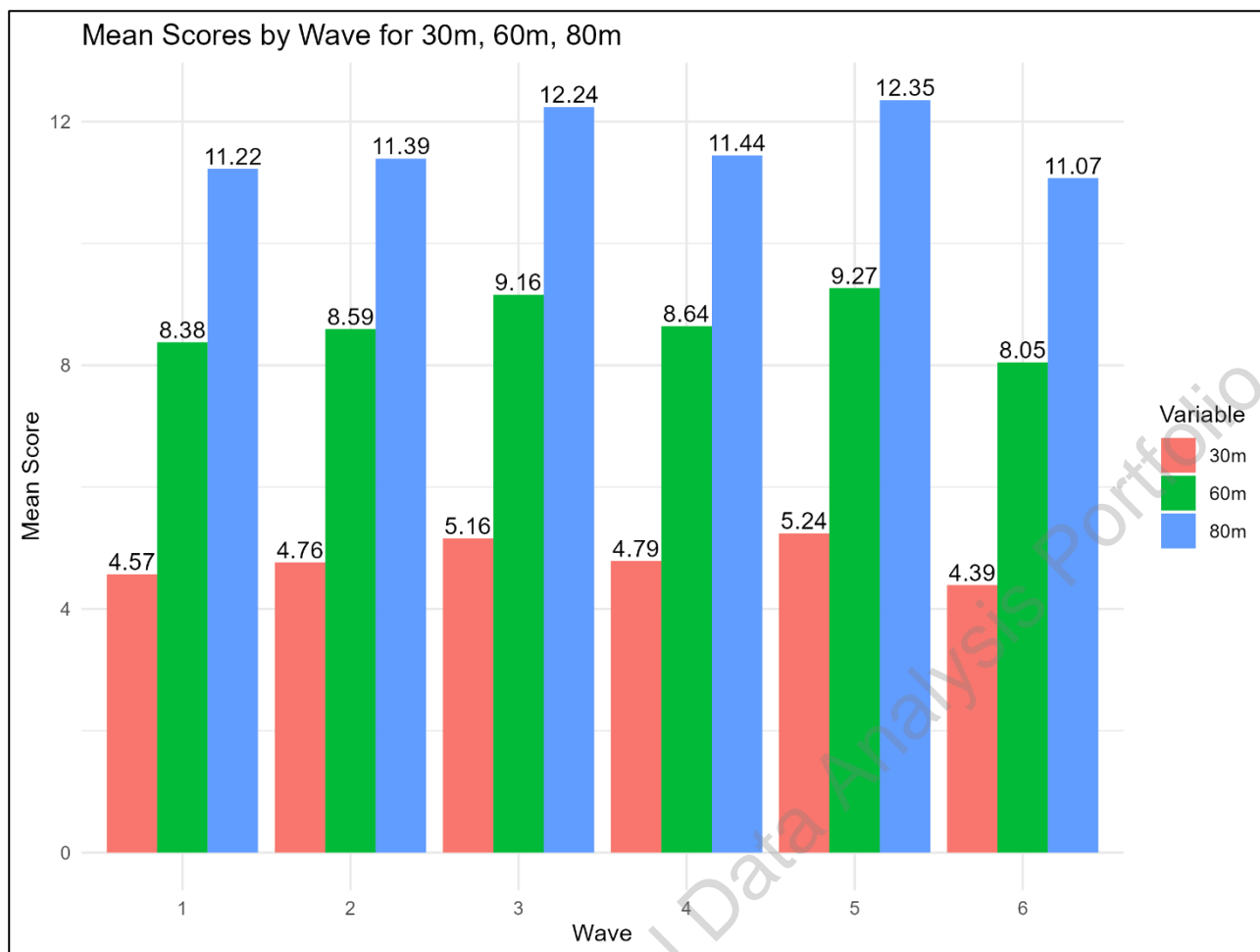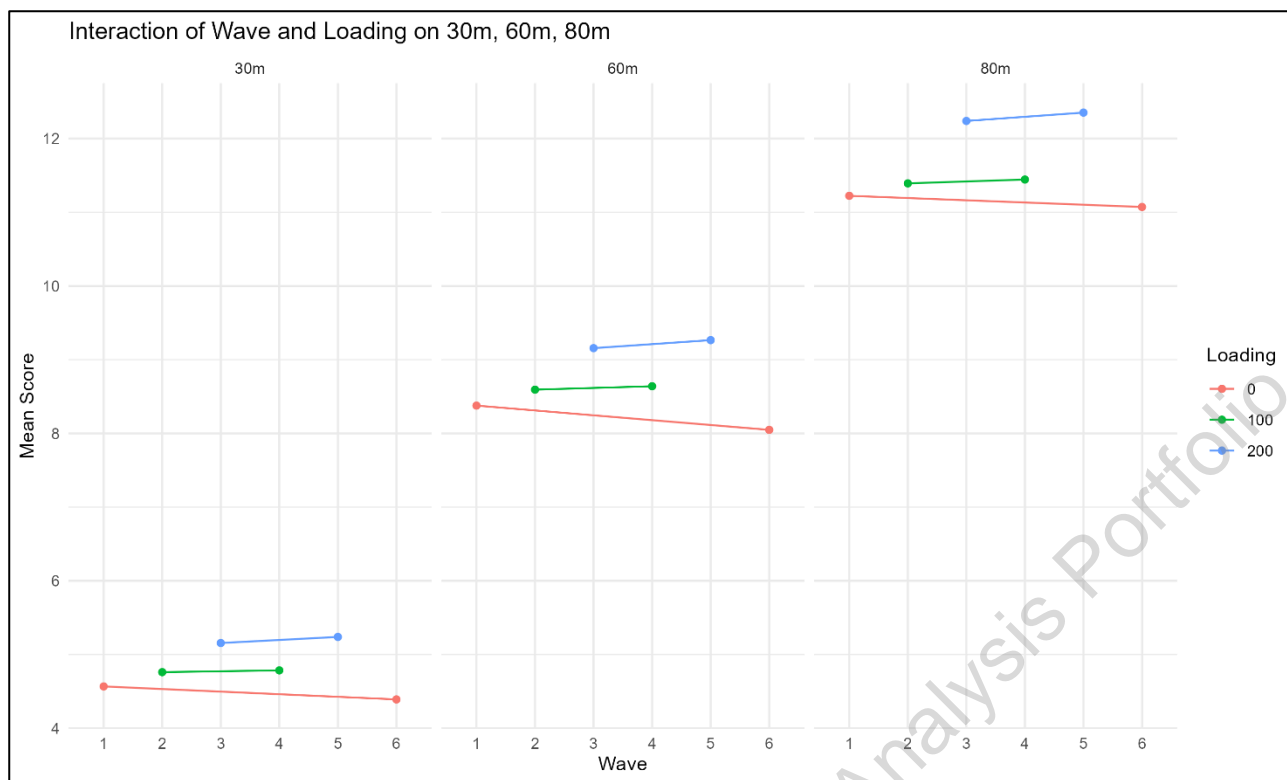
Chart Visualizations

The charts below illustrate the mean differences across different factors.

Mean Scores by Exercise for 30m, 60m, 80m

Mean Scores by Wave for 30m, 60m, 80m

Interaction of Wave and Exercises on 30m, 60m, 80m

Interaction of Wave and Loading on 30m, 60m, 80m

Mixed Models

In the analysis of sprint performance across various distances, mixed models have been employed to adequately account for both fixed and random effects within the dataset. This methodology is particularly apt given the study's structure, where repeated measurements from the same candidates are taken under varying conditions of exercise and loading. The inherent correlation within these repeated measures from individual subjects necessitates a modeling approach that can handle such dependencies explicitly.

Mixed models are integral to this study because they allow for the inclusion of both fixed effects, which assess the influence of controlled experimental factors like repetitive measurements in weeks, exercises, loading, age, and gender, and random effects, which account for variations at the candidate level that are not explained by the fixed effects. The random effects component is crucial as it captures the random variability among candidates, acknowledging that each individual might have a unique baseline ability or response to training that could affect their sprint times.

30m

For the 30-meter sprint, the model illustrates significant effects from several variables. Wave progression negatively impacted performance slightly (-0.020 seconds per wave), which was statistically significant, indicating a marginal increase in speed over time. Exercise participation increased sprint times significantly (0.257 seconds), as did incremental loading, with 100g and 200g loads adding approximately 0.284 seconds and 0.728 seconds to the sprint times, respectively. Notably, gender showed a significant effect, with males sprinting faster by 0.925 seconds on average compared to females. Age showed no significant effect on the 30m sprint times.

effect	term	estimate	std.error	statistic	df	p.value
Fixed Effect	(Intercept)	5.153	0.586	8.798	20.167	0.000
Fixed Effect	Wave	-0.020	0.008	-2.424	249.000	0.016
Fixed Effect	Exercises1	0.257	0.028	9.289	249.000	0.000
Fixed Effect	Loading100	0.284	0.034	8.313	249.000	0.000
Fixed Effect	Loading200	0.728	0.034	21.343	249.000	0.000
Fixed Effect	Age	-0.011	0.040	-0.286	20.000	0.778
Fixed Effect	GenderM	-0.925	0.091	-10.110	20.000	0.000
		vcov	**sdcor**			
Random Variance	Candidate. (Intercept)	0.041	0.202			
Random Variance	Residual	0.053	0.230			

60m

The wave effect (weekly measurements) was more pronounced than in the 30m sprints, with each wave decreasing sprint times by 0.040 seconds. Exercises significantly increased sprint times by 0.328 seconds. Loading impacts were also significant, with 100g and 200g increasing times by 0.384 seconds and 1.018 seconds, respectively. Gender differences were substantial, with males performing significantly faster by 1.312 seconds. Age again showed no significant impact.

effect	term	estimate	std.error	statistic	df	p.value
Fixed Effect	(Intercept)	9.238	1.255	7.362	20.060	0.000
Fixed Effect	Wave	-0.040	0.011	-3.762	249.000	0.000
Fixed Effect	Exercises1	0.328	0.036	9.206	249.000	0.000
Fixed Effect	Loading100	0.384	0.044	8.723	249.000	0.000
Fixed Effect	Loading200	1.018	0.044	23.143	249.000	0.000
Fixed Effect	Age	-0.017	0.085	-0.198	20.000	0.845
Fixed Effect	GenderM	-1.312	0.196	-6.687	20.000	0.000
			vcov	sdcor		
Random Variance	Candidate.		0.201	0.448		
Random Variance	Residual		0.088	0.296		

80m

In the 80-meter sprint model, wave progression did not significantly impact performance, with a minor and non-significant decrease of 0.013 seconds per wave. Exercise exerted a significant upward pressure on sprint times (0.315 seconds), similar to the shorter distances. Loading was particularly impactful; 100g and 200g loads increased sprint times by 0.264 seconds and 1.154 seconds, respectively. Gender differences were the most pronounced at this distance, with males sprinting significantly faster by 2.414 seconds. Age did not significantly affect the 80m sprint times.

effect	term	estimate	std.error	statistic	df	p.value
Fixed Effect	(Intercept)	10.861	1.976	5.496	20.031	0.000
Fixed Effect	Wave	-0.013	0.012	-1.065	249.000	0.288
Fixed Effect	Exercises1	0.315	0.040	7.830	249.000	0.000
Fixed Effect	Loading100	0.264	0.050	5.309	249.000	0.000
Fixed Effect	Loading200	1.154	0.050	23.216	249.000	0.000
Fixed Effect	Age	0.111	0.134	0.829	20.000	0.417
Fixed Effect	GenderM	-2.414	0.309	-7.808	20.000	0.000
			vcov	sdcor		
Random Variance	Candidate.		0.508	0.713		
Random Variance	Residual		0.112	0.335		

Residual assumptions were tested for the three models using QQ and dispersion plots. These suggested that residuals are homoscedastic, linear and normally distributed.