The Trend of Physical Performance and Its Predictive Power on Indoor Obstacle Course Test

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INTRODUCTION

3 graduating classes (2012, 2013, 2014) consist of college students from the United States Military Academy (also known as West Point or USMA) with a total of 3186 students (Male = 2691, Female = 488). The students performed a physical fitness test every semester, for a total of 8 semesters over their 4 years in college: twice per year, once in the Fall semester (August/September), and once in the Spring semester (March/April). During each test, the students has to do as many Push-Ups as possible in 2 minutes, as many Sit-Ups as possible in 2 minutes, and finally as fast as they can in a 2-miles run test. At the end of their college life, they have to go through an Indoor Obstacle Course Test (IOCT) and are timed on their completion time as a measure of their grades. They will fail the test if the male take more than 210 seconds to do the test, or the female take more than 329 seconds to do the same test. However, each student can take the test repeatedly until they are satisfied with their result.

PURPOSE

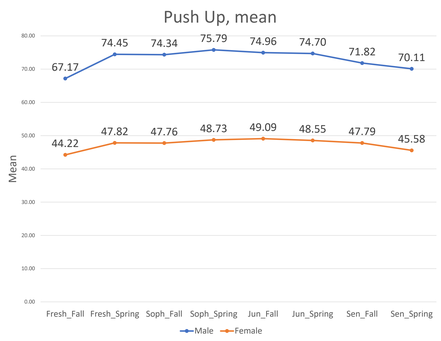
My study aims to explore the trend of students' physical performances over their 4-years period in college and analyze whether performances on physical activities throughout college could predict students' final result, the IOCT completion time.

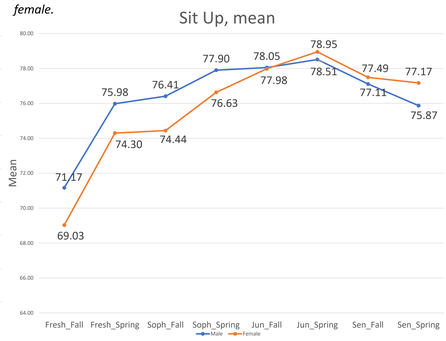
METHOD

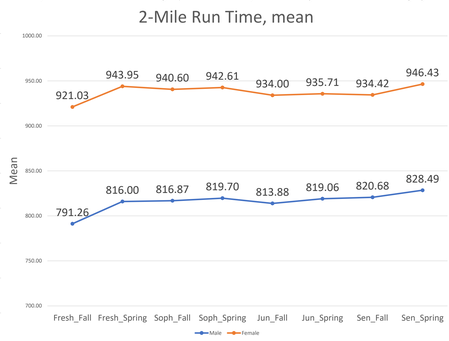
- There are 4 main variables: IOCT completion time, Push Up, Sit Up, and 2-mile run time. An additional variable time is provided to show the semester in relation to other variables in some circumstances, with time=1 as Freshman Fall semester, time=2 as Freshman Spring semester, ..., time=8 as Senior Spring semester, respectively.
- In Figure 1, I visualized the trend of the mean of each activities over each semester for male and female separately. In addition, I also have the quadratic regression to tell the trend more specifically. The visualization will show the change of male and female students' physical performances on each activities and how they trend over the course of 4 years in college.
- To analyze how physical activities affect IOCT over each semester, I ran 16 regressions, covering 8 semesters and 2 genders, with IOCT time as the dependent variable and 3 activities as independent variables, then compiled whether each activity is statistically significant in Table 1, and the R2-adjusted value of each regression over time in Figure 2.
- For further analysis on the predictive power of each activity on IOCT in overall, I ran multiple regressions separately for male and female with IOCT as the dependent variable showed in Table 2.
- Figure 3 works as extra histograms that show the distribution of IOCT score for male and female.

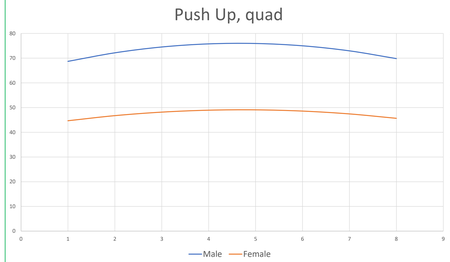
PERFORMANCE TREND ANALYSIS

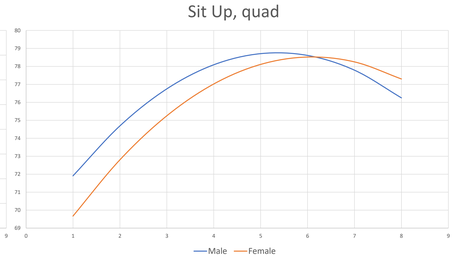
Figure 1. Each of the 3 higher graphs represents the trend of mean value of each activity over each semester, while the 3 lower graphs represent the quadratic best-fit line taken the whole dataset into account. The time variable, which is the 8 semesters, is on the x-axis. Each graph has 2 lines, with blue for male and orange for female.

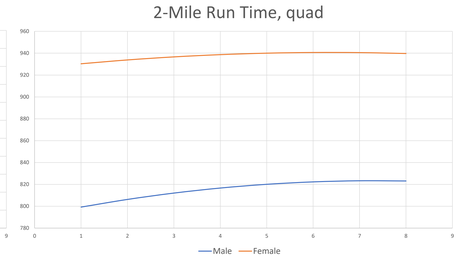












- Overall, male students do more Push-Ups than their female counterparts across all semesters.
- All students' performances improved at first, then peak at their junior year, and later worsened in their senior year.

- Both male and female students improved their performances at first, then peak at their junior year, and later fall off in senior year.
- Male students performed Sit-Ups better than female students up until junior year; after that, female students surpassed male and have better result.

- Different from the other 2 activities, we see a decrease in performance of both male and female students in 2-mile run time.
- The performance fluctuates and improved a little bit in junior year according to the mean time graph, then fall off right afterward.
- Generally, the female students take more time to run than male students

PERFORMANCE TREND PREDICTIVE POWER

	Freshman						Sophomore						Junior						Senior					
	Fall			Spring			Fall			Spring			Fall			Spring			Fall			Spring		
	PU	SU	R	PU	SU	R	PU	SU	R	PU	SU	R	PU	SU	R	PU	SU	R	PU	SU	R	PU	SU	R
Male Significance																								
Female Significance																								

Table 1. Significance of each activity on each semester over IOCT. The yellow squares inform the regression result for the corresponding variable is significant, while the white squares denote that the test was not significant.

- Most physical activities over semesters and genders significantly predict the IOCT completion time.
- Sit-Up is the only activity that has weak predictive power. The regression result for Sit-Up most of the time denote insignificance, especially for female.

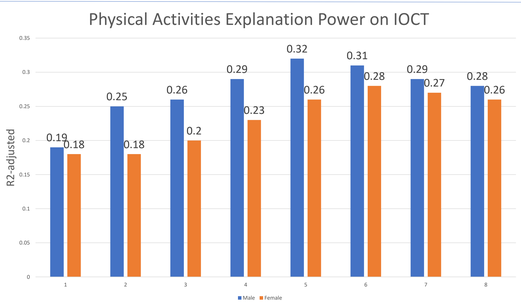


Figure 2. R^2-adjusted value of each semester's physical activities predicting on IOCT completion time for male and female.

- The adjusted R2 values for male and female both go up and down, with the highest value in the junior year.
- The gap between male and female is small at first, then increase until the end of junior year that it become small again.

REGRESSION

	Model 1		Model 2		Model 3		Model 4	
VARIABLES	IOCT_sec	IOCT_sec	IOCT_sec	IOCT_sec	IOCT_sec	IOCT_sec	IOCT_sec	IOCT_sec
	Male	Female	Male	Female	Male	Female	Male	Female
Push Up	-0.344***	-0.721***	-0.954***	-1.950*	-0.234***	-0.547***	-0.240***	-0.491***
	(0.0338)	(0.216)	(0.278)	(1.166)	(0.00966)	(0.0556)	(0.0195)	(0.112)
Push Up x Push Up			0.00410**	0.0117				
			(0.00190)	(0.0111)				
Push Up x Time							0.00130	-0.0133
							(0.00415)	(0.0237)
Sit Up	-0.114***	-0.394**	-0.295	-1.195	-0.0986***	-0.252***	-0.0206	-0.140
	(0.0418)	(0.177)	(0.468)	(1.638)	(0.0120)	(0.0512)	(0.0249)	(0.106)
Sit Up x Sit Up			0.00109	0.00533				
			(0.00306)	(0.0106)				
Sit Up x Time							-0.0184***	-0.0243
							(0.00506)	(0.0214)
Run	0.115***	0.171***	0.0807	-0.0710	0.0935***	0.140***	0.0923***	0.122***
	(0.00491)	(0.0204)	(0.0912)	(0.301)	(0.00160)	(0.00633)	(0.00334)	(0.0131)
Run x Run			2.15e-05	0.000129				
			(5.55e-05)	(0.000159)				
Run x Time							0.000115	0.00390
							(0.000673)	(0.00266)
Time					-0.240***	0.203	0.956	-1.027
					(0.0423)	(0.220)	(0.766)	(3.354)
Constant	118.6***	168.1***	162.2***	341.8**	128.3***	177.6***	123.9***	183.4***
	(6.062)	(26.86)	(39.07)	(152.2)	-1.823	-8.094	(3.640)	(16.43)
Observations	2,698	488	2,698	488	21,436	3,874	21,436	3,874
R-squared	0.357	0.301	0.359	0.305	0.276	0.234	0.277	0.236

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2. Multiple Regression Analysis of IOCT completion time on different activities and their relations with other factors.

- The 3 main variables are Push Up, Sit Up, and Run. Time works as an additional variable representing time in the last model, with time=1 as Freshman Fall semester to time=8 as Senior Spring semester, respectively.
- Model 2 and 4 are non-linear regressions with keynote:
  - Model 2 has the predictive power of activities change with its own value. PUxPU, SUxSU, RxR are variables represent the relation of each activity with itself.
  - Model 4 has the predictive power of activities change with the semester they are in. PUxT, SUxT, RxT are variables represent the relation of each activity with time.

- In Model 1, when we control all three activities, they are significant for both male and female, with an exception that female's Sit-Up is "less significant" than the other two.
- The coefficient of Push-Up is significantly higher than that of the other two activities.

- In Model 2, when we control for the corresponding value of every activity, only Push-Up is significant. The significant level of Push-Up for male is higher than that for female.

- In Model 3, when we control for the time, everything is statistically significant except for the time variable for female.

- In Model 4, when we control for the time and its relations to other activities, only Push-Up and 2-Mile Run Time are significant for both male and female. The time variable, however, is not significant, for both the time variable itself in its relations with other activities

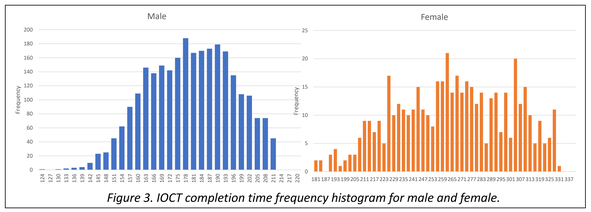


Figure 3. IOCT completion time frequency histogram for male and female.

DISCUSSION

Performance Trend

- As we can see in Figure 1, both male and female experienced the general decreasing trend for Push-Up and Sit-Up over their time in college.
- Their performance for Push-Up and Sit-Up is highest in Junior Year, with Freshman Year having the highest improvement.
- In general, male perform better than female; however, female surpass male in Sit-Up performance in their junior and senior year.
- For 2-Mile Run Time, data showed that students have worse performance over time in general. However, the decrement in performance started to decrease (student performance increased) during students' Sophomore Year and reached its lowest (student performance increases the most) in students' Junior Year. After that, students' performance become worsened again.

Predictive Power

- Table 1 shows that for both male and female, most activities are statistically significant except for Sit-Up which is the only activity shows insignificance, especially for female that it is not statistically significant most of the time.
- Figure 2 has R^2-adjusted value over 8 semesters for male and female both went up, peak at Junior Year and then went down.
- In Table 2, the R2 value is not so high, but quite consistent between Model 1 – Model 2, and Model 3 – Model 4. Push-Up is statistically significant in every model.

CONCLUSION

- In general, students' physical performances reach its highest in student's Junior Year, then drop in Senior Year, with Freshman Year having the highest improvement. This can be due to the reason that in Senior Year, students have other concerns for their next move in life, such as finding a job, applying for Grad School, etc. that they shift their focus away from physical performance.
- Female students' data is not very consistent and is not statistically significant sometimes, especially for Sit-Up activity. This can be due to the large variation and small population (N=488) of female data. In addition, female data may experience bias as there's a social norm that not many female attend military school, so the female in study could be the already exceptional ones (for example, specialized in sit-up). Further study is needed for this problem.
- The best activity for prediction on IOCT result is Push-Up, with it being statistically significant most of the time and seems to be more reliable than the other 2 activities.
- The best time for prediction on IOCT is the Junior Year, as students are at their best with the R-squared explanation factor being highest. However, the predictive power of Junior Year seems to be correlated with overall trend in performance, so there is no specific semester that training more intensively can pay off more than the others.
- The dataset may not correctly reflect the predictive power of physical performance on IOCT outcome because a cadet can take the IOCT test repeatedly until he or she meets the requirement to pass (male 210s & female 329s), and the dataset itself contains only data from cadets who passed the test, hence it is skewed to the left, concentrated near the right-end point, and truncated at the right end point. (refer to **Figure 3**).

References

Hoang, Long & Pham, Minh. (2019) *Predicting the Indoor Obstacle Course Test Completion Time with Physical Activities over Each Semester of Male and Female College Students*