

## NYACK College

### *Roswell Rodriguez*

#### *Heart Rate, Cardiovascular Fitness and the Scientific Method*

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##### **Goals of this Lab Activity**

- Correlate the fitness level of individuals with gender, age, exercise, smoking and body mass index (BMI)
- Accurately measure the human heart rate
- Determine the effect of body position and exercise on heart rate
- Analyze experimental data to test various hypotheses
- Collect data and summarize it in tables and graphs.
- Interpret experimental data and discuss the validity of these interpretations and conclusions

##### **Introduction**

**Cardiovascular fitness** (also known as **aerobic fitness**) is one of the most important components of physical fitness. Cardiovascular fitness is measured as the amount of oxygen transported in the blood and pumped by the heart to the working muscles and as the efficiency of the muscles to use that oxygen. Increasing cardiovascular fitness means increasing the capability of the heart and the rest of the cardiovascular system in their most important task, to supply oxygen and energy to your body.

Having good cardiovascular fitness has many health benefits—It decreases your risk of cardiovascular diseases, stroke, high blood pressure, diabetes and other diseases.

Cardiovascular fitness is best improved by activities that use large muscle groups. Such activities include walking, jogging, running, swimming, skating, cycling, stair climbing and cross-country skiing. The heart is like any other muscle—it becomes stronger and more efficient after practice. **Heart rate** is a quantitative measure of a heart's work. At rest the heart of an average healthy individual beats approximately **70 to 75 beats per minute** (bpm). A **conditioned heart** beats much less at rest, only **40 to 50 bpm** or even less—the heart of Tour de France champion, Lance Armstrong beats at 32-35 bpm! Heart rate variability is a quality measure of heart's work. The lower the resting heart rate the higher the heart rate variability, and thus the better the quality of heart's functions.

Cardiovascular fitness is related to age, gender, exercise habits, heredity and cardiovascular clinical status. **Maximum cardiovascular fitness occurs between ages 15 and 30 years, decreasing progressively with age.** At the age of 60, the mean maximal aerobic power in men is approximately three fourths of that at the age of 20. With sedentary lifestyle, there is a 10 % reduction in the mean maximal aerobic power per decade, the reduction with an active lifestyle being less than 5 %.

**Why is cardiovascular Fitness Important?** Cardiovascular fitness is related to health. In the United States, over 800,000 people die each year from **coronary artery disease** (CAD), the number one killer in the United States. The risk factors for CAD include: Inactivity, high

cholesterol levels, smoking, overweight, high blood pressure and diabetes. Numerous studies have shown that ***inactivity is the most important factor responsible for CAD***. It is twice as important as high cholesterol levels, and four times more important than high blood pressure. Consequently, exercise reduces the risk of dying from a heart attack and it is an effective method of rehabilitation in people who have suffered from a heart attack.

A simple ***method for determining cardiovascular fitness (aerobic fitness)*** involves the measurement of heart rate. The ability to perform aerobic work depends upon the delivery of oxygen to the muscles. Oxygen is delivered by the circulatory system and each heart beat indicates a quantity of blood pumped by the heart. ***Heart rate (HR) is a good measure of the severity of exercise and cardiovascular fitness***. Young people can increase their HR to high levels and deliver large amounts of oxygen to the muscles which is a major reason why their aerobic fitness is better than that of older people. The low maximal HR in old people is the major cause of their reduced aerobic fitness. Other age-related causes of decreased aerobic fitness include a reduction in muscle mass and an increase in body fat.

Training results in an increase in the efficiency of oxygen transport within the body. ***By lowering the resting HR, and heart rates at sub maximal loads, the heart pumps more blood with every heart beat***. This, and other physiological changes, increases the oxygen transport capability. When an individual is tested before and after training while performing exercise at the same load, a lower HR is shown after training because more blood (thus, oxygen) is delivered in each heart beat. Such HR differences during exercise can be used to predict aerobic fitness—***a fit person has a lower HR than an unfit person when exercising at the same load*** (same oxygen uptake). At least 3-5 minutes of exercise has to be performed because it takes several minutes for the HR to level off to the point where it represents the correct level of effort.

### ***Assessing your fitness level***

In this experiment, cardiovascular fitness will be determined by using rating system to “score” fitness during a variety of situations:

- Standing resting heart rate
- Heart rate while reclined on a table with knees bent
- Heart rate immediately upon going from reclined to standing position
- Heart rate immediately after 4 minutes of exercise (step test)

### ***Materials and Methods***

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#### **Materials**

Stop watch or timer

Table

Stepping platform (stairs)

#### **Measurement of the Standing Resting Heart Rate**

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Each time the heart beats, blood is pumped into the body's arteries. As the blood surges into the arteries during a heartbeat, each artery stretches and expands. This brief expansion of

the artery is called a pulse. You will be measuring heart rate by counting the number of pulses in the artery in the wrist in a **30 second interval**.

To feel the pulse, find the artery in your partner's wrist. Place the tips of the first two fingers of one hand on the palm side of your partner's wrist, over toward the thumb side of his or her wrist. You may need to press firmly in order to feel the pulse of blood which each heart beat sends through the artery. Don't use your thumb to feel the pulse in the wrist, because your thumb has a pulse of its own.

Pulse measurement  
in the wrist



To measure heart rate, count the **number of pulses in 30 seconds**. **Multiply that number by 2, and you will have the number of heart beats per minute.**

After you have practiced taking heart rate, it is important to check the accuracy of your heart rate measurements.

- (1) Choose one person in your group to be the subject, one person to measure the pulse count in the left arm, and one person to measure the pulse count in the right arm. Use the stop watch to time a **30 second interval**.
- (2) Both people who are measuring pulse count should write down the number of beats for the 30 second interval before saying the number out loud.

Pulse count in 30 seconds A) 25 B) 32

SUBJECT ONE WAS MY MOM, SHE HAS TYPE 2 DIABETES. SHE IS 39 YEAR OLD.

I'M A 19 YEAR OLD, AND I'M A CYCLIST. I RIDE BIKE EVERY DAY.

DID NOT HAVE NO 3 SUBJECT THREE, MY DAD IS OUT FOR WORK AND WO'NT BE BAKE IN A FEW DAYS.

Next, compare the results found by the two different people who were measuring pulse counts. Did you both count about the same number of pulses in the 30 second interval? If you got different results, can you figure out why? **We figured out that my mom started counting before I hit the start button on the timer.**

- (3) Try to improve your technique, and repeat step 2 until both people who are measuring pulse counts get the same number of pulses in the 30 second interval (or within 1 or 2 of the same number). **After second round we both counted the same amount of heart rate.**
- (4) Once you have accurate readings, use the final, accurate set of measurements to calculate the heart rate for this subject in bpm (beats per minute).

Heart rate = **72bpm**

- (5) After this, you should switch roles. The people who were measuring pulse counts should now be the subject and the timer, and the people who were the subject and the timer should now measure pulse counts. Repeat steps 2-3 until the heart rate measurements are accurate—**record the heart rate in bpm for each test subject in Table 5 on the report sheet.**
- (6) Compare each test subject's standing heart rate to the values in Table 1, below. Assign fitness points based on Table 1 and **record the points in Table 5 on the report sheet.**

Table 1. Fitness Points for Standing Heart Rate			
Beats/min	Fitness Points	Beats/min	Fitness Points
<60	12	86 - 90	6
60 – 65	11	91 - 95	5
66 – 70	10	96 - 100	4
71 - 75	9	101 - 105	3
76 - 80	8	106 - 110	2
81 - 85	7	> 110	1

Measurement of the Resting Heart Rate while Reclined (work in a team of 2)

- (7) Instruct the subject to recline on a *clean* table with their feet on the table and knees bent. After 2 minutes of being in the reclined position, **measure the subject's pulse for 30 seconds, convert to bpm by multiplying by 3 and record this value in Table 5 on the Report Sheet.** The subject should remain reclined until step 9.
- (8) Compare the *subject's reclining heart rate* to the values in Table 2. Assign fitness points based on Table 2 and **record the points in Table 5.**

Table 2. Fitness Points for Reclining Heart Rate			
Beats/min	Fitness Points	Beats/min	Fitness Points
< 50	13	71 - 75	8
50 - 54	12	76 - 85	6
55 - 60	11	86 - 95	4
61 - 65	10	> 95	2
66 - 70	9		

**Caution!!**

- Do not attempt the reclining to standing and the step test on the next page if physical exertion will aggravate a health problem.
- Inform the instructor of any possible health problems that might be affected if you participate in the reclining to standing and/or the step test.

**Measurement of the Heart Rate Change from Reclining to Standing**

- (9) Instruct the test subject to quickly stand up next to the lab table and remain still. **Upon standing immediately record the pulse for 20 seconds, convert to bpm, and record this value in Table 5.**
- (10) Find how much the heart rate increased after standing by subtracting the reclining rate value in Step 7 from the standing value in step 9. Locate the row corresponding to the reclining heart rate in Table 3 and use the heart rate increase value to obtain fitness points. **In Table 5, record the fitness points.**

Table 3. Fitness Points for Reclining to Standing							
Ave. Reclining rate (bpm)	Heart Rate Increase after Standing						
	0 - 5	6 - 10	11 - 15	16 - 20	21 - 25	26 - 30	> 30
< 50	12	11	10	9	8	7	6
50 - 55	11	10	9	8	7	6	5
56 - 60	10	9	8	7	6	5	4
61 - 65	9	8	7	6	5	4	3
66 - 70	8	7	6	5	4	3	2
71 - 75	7	6	5	4	3	2	1
76 - 85	6	5	4	3	2	1	0
86 - 95	5	4	3	2	1	0	0
> 95	4	3	2	1	0	0	0

**Step Test**

Carefully read the following procedure before starting the step test.

The step test should be performed for 4 minutes at a rate of 24 stepping cycles per minute. Try to maintain a constant step rate. The subject should make one-foot movement for each beat of the metronome: 4 foot movements/stepping cycle) x (24 stepping cycles/min) = 96 steps per minute. The test subject will step up and down on a low platform about 8 to 10 inches from the ground as follows:

- i. Place the right foot on the top step of the platform.
- ii. Place the left foot completely on the top step of the platform next to the right foot.
- iii. Place the right foot back on the floor.
- iv. Place the left foot back on the floor.
- v. Repeat the above stepping cycle for 4 minutes

(11) Carry out the step test for 4 minutes as outlined above. At the end of the step test ***immediately record the pulse for 20 seconds, convert to bpm, and record this value in Table 5.***

(12) Find how much the heart rate increased after the step test by subtracting the standing resting heart rate (step 5) from heart rate after exercise (step 11). Locate the row corresponding to the reclining heart rate in Table 4 and use the heart rate increase value to obtain fitness points. ***In Table 5, record the fitness points.***

<b>Table 4. Fitness Points for the Step Test</b>							
<b>Standing Resting Heart Rate (bpm)</b>	<b>Heart Rate Increase after Exercise</b>						
	<b>0 - 5</b>	<b>6 - 10</b>	<b>11 - 15</b>	<b>16 - 20</b>	<b>21 - 25</b>	<b>26 - 30</b>	<b>&gt; 30</b>
<b>&lt; 60</b>	12	11	10	9	8	7	6
<b>60 - 65</b>	11	10	9	8	7	6	5
<b>66 - 70</b>	10	9	8	7	6	5	4
<b>71 - 75</b>	9	8	7	6	5	4	3
<b>76 - 80</b>	8	7	6	5	4	3	2
<b>81 - 85</b>	7	6	5	4	3	2	1
<b>86 - 90</b>	6	5	4	3	2	1	0
<b>91 - 95</b>	5	4	3	2	1	0	0
<b>96 - 100</b>	4	3	2	1	0	0	0
<b>101 - 105</b>	3	2	1	0	0	0	0
<b>&gt; 105</b>	2	1	0	0	0	0	0

***Personal Data***

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(13) Enter in **Table 5** the following “personal data” for each test subject in your team: gender, age, if the test subject “exercises regularly” and if the subject is a “smoker” or nonsmoker.

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Table 5

Condition	HR of subject #			Fitness points for subject		
	1	2	3	1	2	3
Standing HR	72	62		9	12	
Reclining HR	74	64		8	10	
Standing 2nd	78	72		6		
Change	5 more beats	8 more beats		6	7	
Step test	76 before test (96 after test)	64 before test( 83 after)				
Change	20	19		1	4	
personal data	Hight 59 inches Weight : 158 pounds	Hight: 72 Inches Weight : 175				

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## Is Your BMI and is it affecting your health and cardiovascular fitness?

**Body Mass Index (BMI)** is one of the most accurate ways to determine when extra pounds translate into health risks. BMI is a measure that takes into account a person's weight and height to gauge total body fat in **adults**. Guidelines on the identification, evaluation, and treatment of overweight and obesity in adults released by the National Heart, Lung, and Blood Institute (NHLBI), in cooperation with the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), use the following definitions:

- A BMI of less than 18.5 is considered underweight.
- A BMI of 18.5 to 24.9 is considered healthy.
- A BMI of 25 to 29.9 is considered overweight.
- A BMI of 30 or more is considered obese.

Heart disease, diabetes and high blood pressure are all linked to being overweight. A BMI of 30 and over may increase the risk of death from any cause by 50 to 150 percent. According to health experts, people who are overweight but have no other health risk factors (such as high cholesterol or high blood pressure) should eat healthier and exercise to keep from gaining additional weight. For people who are overweight and also have health risks, they recommend trying to actively lose weight. Be sure to consult your doctor or other health professional before beginning any exercise or weight-loss program.

**What is your BMI? According I'm normal, with height of 72 inches and body weight of 175 pounds.**

(14) Use one of the two formulas below to determine your BMI **and record this value in Table 5.**

- a) Use the chart below to determine your BMI. To use the Chart, find your appropriate height in the left-hand column. Move across to a given weight. The number at the top of the column is the BMI for that height and weight. Pounds have been rounded off

Body Mass Index Table																																																						
	Normal					Overweight					Obese					Extreme Obesity																																						
BMI	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54																		
Height (inches)	Body Weight (pounds)																																																					
58	91	96	100	105	110	115	119	124	129	134	138	143	148	153	158	162	167	172	177	181	186	191	196	201	205	210	215	220	224	229	234	239	244	248	253	258																		
59	94	99	104	109	114	119	124	128	133	138	143	148	153	158	163	168	173	178	183	188	193	198	203	208	212	217	222	227	232	237	242	247	252	257	262	267																		
60	97	102	107	112	118	123	128	133	138	143	148	153	158	163	168	174	179	184	189	194	199	204	209	215	220	225	230	235	240	245	250	255	261	266	271	276																		
61	100	106	111	116	122	127	132	137	143	148	153	158	164	169	174	180	185	190	195	201	206	211	217	222	227	232	238	243	248	254	259	264	269	275	280	285																		
62	104	109	115	120	126	131	136	142	147	153	158	164	169	175	180	186	191	196	202	207	213	218	224	229	235	240	246	251	256	262	267	273	278	284	289	295																		
63	107	113	118	124	130	135	141	146	152	158	163	169	175	180	186	191	197	203	208	214	220	225	231	237	242	248	254	259	265	270	278	282	287	293	299	304																		
64	110	116	122	128	134	140	145	151	157	163	169	174	180	186	192	197	204	209	215	221	227	232	238	244	250	256	262	267	273	279	285	291	296	302	308	314																		
65	114	120	126	132	138	144	150	156	162	168	174	180	186	192	198	204	210	216	222	228	234	240	246	252	258	264	270	276	282	288	294	300	306	312	318	324																		
66	118	124	130	136	142	148	155	161	167	173	179	186	192	198	204	210	216	223	229	235	241	247	253	260	266	272	278	284	291	297	303	309	315	322	328	334																		
67	121	127	134	140	146	153	159	166	172	178	185	191	198	204	211	217	223	230	236	242	249	255	261	268	274	280	287	293	299	306	312	319	325	331	338	344																		
68	125	131	138	144	151	158	164	171	177	184	190	197	203	210	216	223	230	236	243	249	256	262	269	276	282	289	295	302	308	315	322	328	335	341	348	354																		
69	128	135	142	149	155	162	169	176	182	189	196	203	209	216	223	230	236	243	250	257	263	270	277	284	291	297	304	311	318	324	331	338	345	351	358	365																		
70	132	139	146	153	160	167	174	181	188	195	202	209	216	222	229	236	243	250	257	264	271	278	285	292	299	306	313	320	327	334	341	348	355	362	369	376																		
71	136	143	150	157	165	172	179	186	193	200	208	215	222	229	236	243	250	257	265	272	279	286	293	301	308	315	322	329	336	343	351	358	365	372	379	386																		
72	140	147	154	162	169	177	184	191	199	206	213	221	228	235	242	250	258	265	272	279	287	294	302	309	316	324	331	338	346	353	361	368	375	383	390	397																		
73	144	151	159	166	174	182	189	197	204	212	219	227	235	242	250	257	265	272	280	288	295	302	310	318	325	333	340	348	355	363	371	378	386	393	401	408																		
74	148	155	163	171	179	186	194	202	210	218	225	233	241	249	256	264	272	280	287	295	303	311	319	326	334	342	350	358	365	373	381	389	396	404	412	420																		
75	152	160	168	176	184	192	200	208	216	224	232	240	248	256	264	272	279	287	295	303	311	319	327	335	343	351	359	367	375	383	391	399	407	415	423	431																		
76	156	164	172	180	189	197	205	213	221	230	238	246	254	263	271	279	287	295	304	312	320	328	336	344	353	361	369	377	385	394	402	410	418	426	435	443																		

Source: Adapted from Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults: The Evidence Report.