Appendix A
Selected OMNI Scales

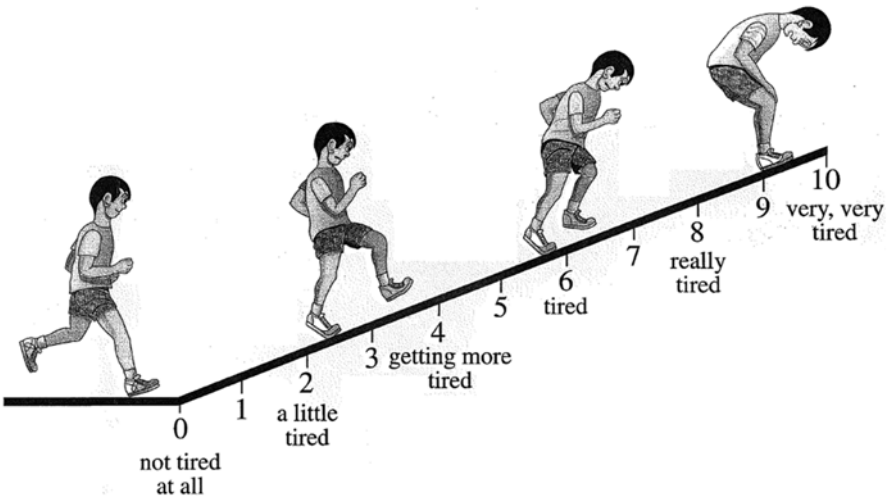

Fig. A.1 Children's OMNI-walk/run RPE scale (Robertson 2004)

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DOI 10.1007/978-1-4939-1917-8

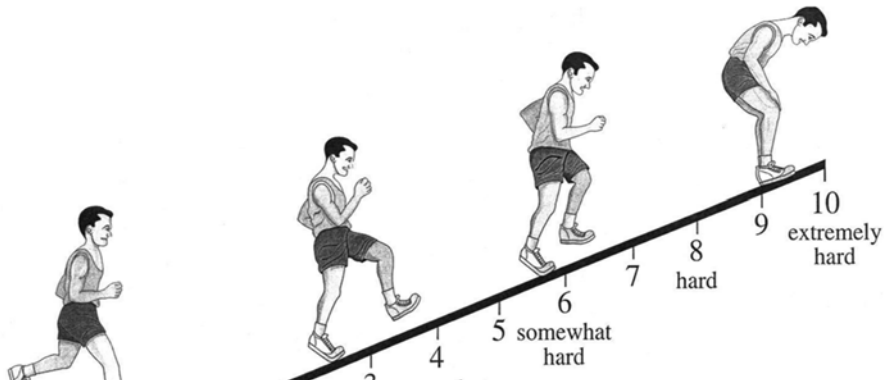

Fig. A.2 Adult OMNI-walk/run RPE scale (Robertson 2004)

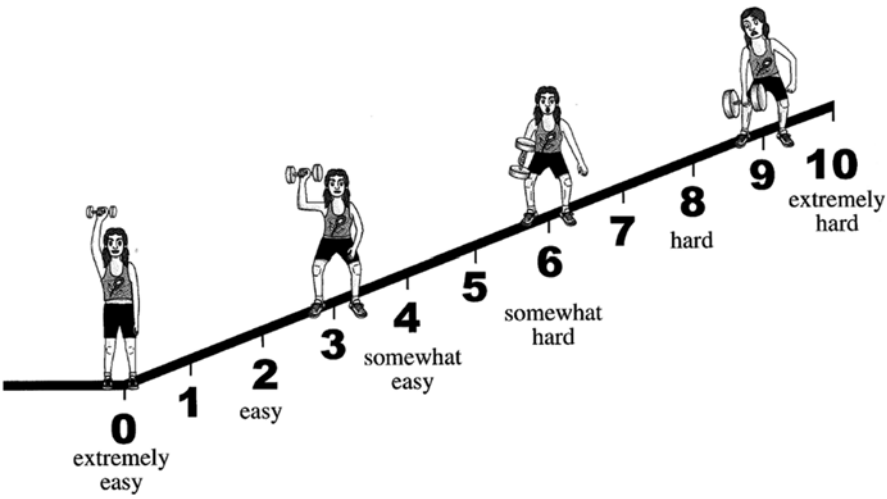

Fig. A.3 Children's OMNI-resistance exercise RPE scale, female (Robertson 2004)

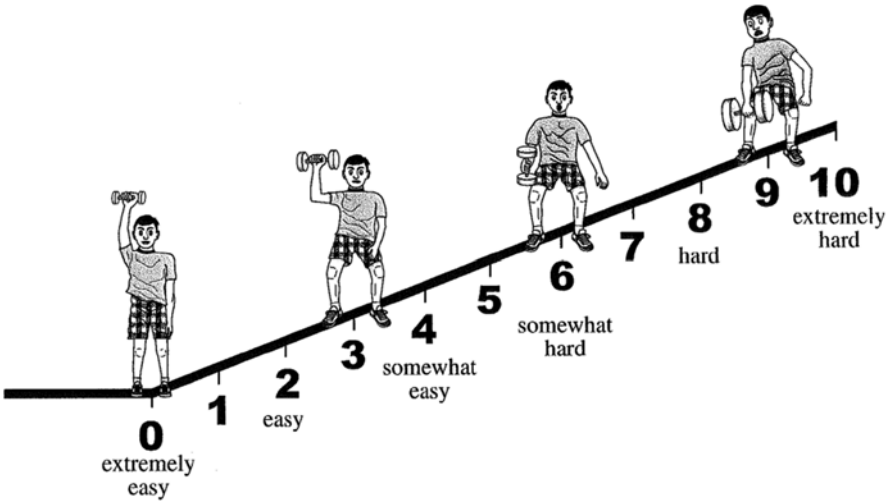

Fig. A.4 Children's OMNI-resistance exercise RPE scale, male (Robertson 2004)

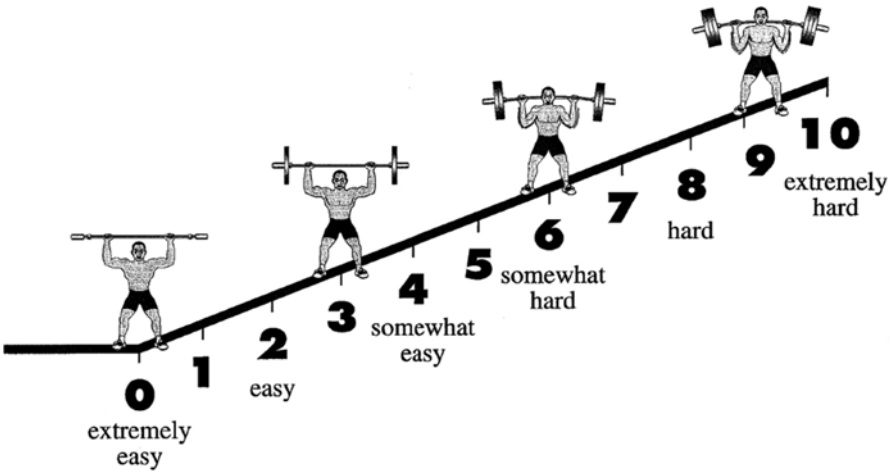

Fig. A.5 Adult OMNI-resistance exercise RPE scale, male (Robertson 2004)

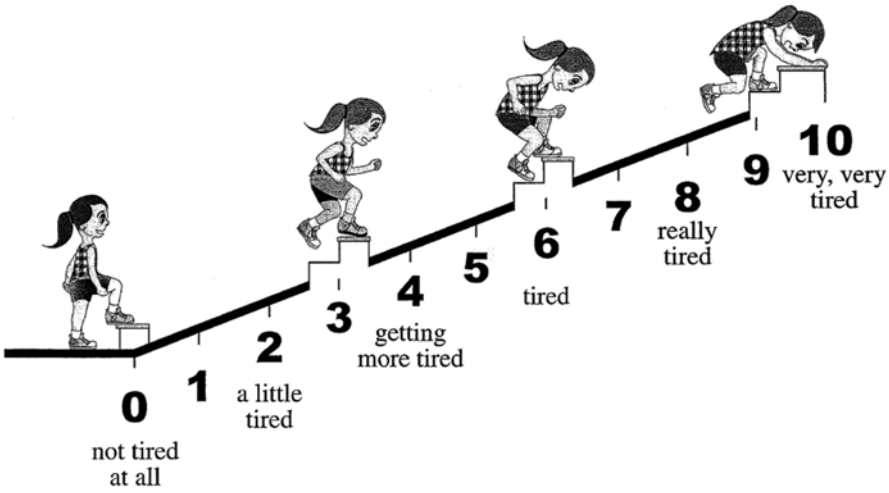

Fig. A.6 Children's OMNI-step RPE scale, female (Robertson 2004)

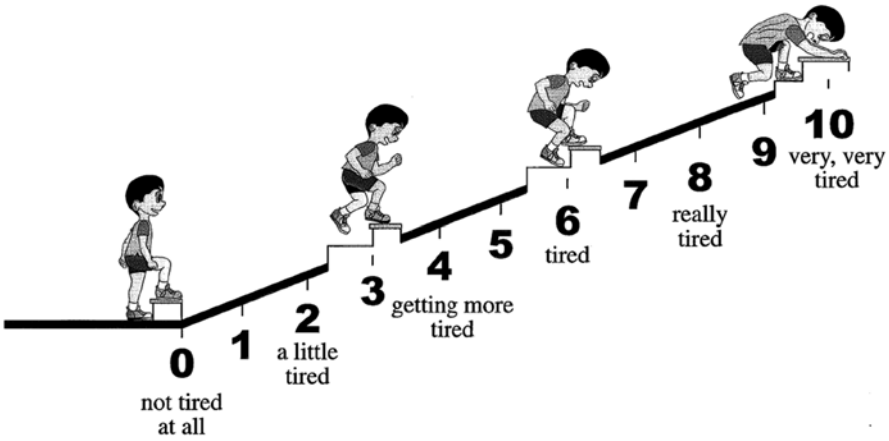

Fig. A.7 Children's OMNI-step RPE scale, male (Robertson 2004)

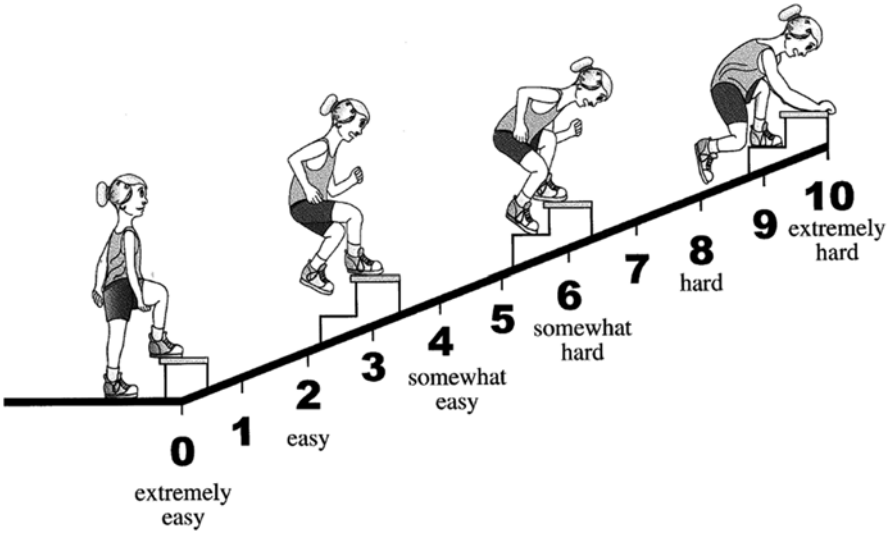

Fig. A.8 Adult OMNI-step RPE scale, female (Robertson 2004)

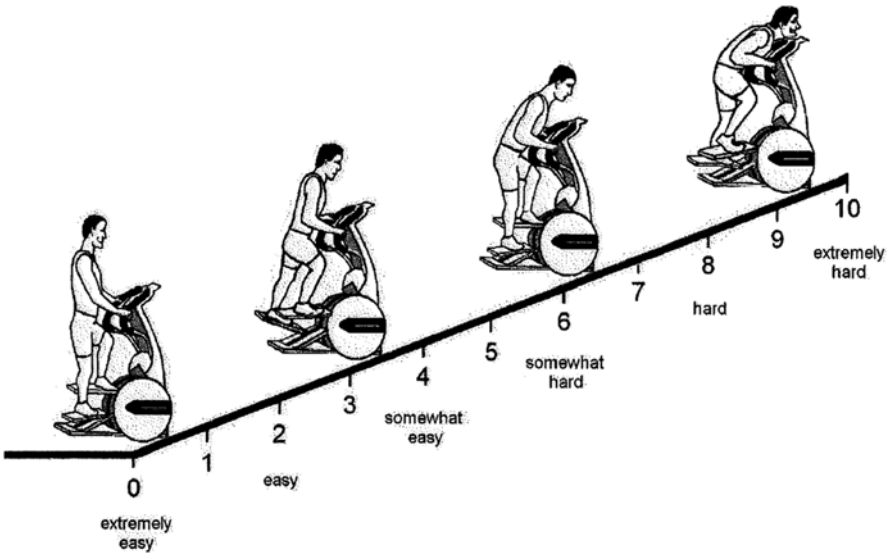

Fig. A.9 Adult OMNI-elliptical RPE scale (Mays et al. 2010)

Appendix B
RPE Scale Instructions

Adult OMNI-Walk/Run RPE Scale Instructions for RPE-O Only

This perceived exertion scale includes numerical categories from 0 to 10. You will use it to assess your perceptions of exertion while you exercise. The numbers on the scale represent a range of exertion levels from 0, "extremely easy," to 10, "extremely hard." To help you select a number that represents your level of exertion, consider the following. When the exercise exertion you are experiencing is "extremely easy," respond with a 0. Think about a time when you exercised and the level of exertion was "extremely easy" and most likely equivalent to a rating of 0. As an example, you should respond with a 0 when you are walking very slowly on the treadmill. When the exertion you are experiencing is "extremely hard," respond with a 10. Think about a time when you exercised and the perception of exertion was "extremely hard," likely attained at your maximal performance level. Most likely the exertional level would be equivalent to a rating of 10. As an example, you should respond with a 10 when you are running up a steep incline on the treadmill and you may not be able to exercise much longer owing to fatigue. Please rate your level of exertion for your overall body, taking into consideration the exertion experienced in your legs and your chest/breathing. When asked, use both the pictures and words to help you select one rating number that represents the level of exertion your body is experiencing. Each number response is called a rating of perceived exertion, or RPE. Please point to the number that best represents your RPE at the moment you are asked.

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DOI 10.1007/978-1-4939-1917-8

Adult OMNI-Walk/Run RPE Scale Instructions for Undifferentiated and Differentiated RPE

This perceived exertion scale includes numerical categories from 0 to 10. You will use it to assess your perceptions of exertion while you exercise. The numbers on the scale represent a range of exertion levels from 0, 'extremely easy,' to 10, 'extremely hard.' To help you select a number that represents your level of exertion, consider the following. When the exercise exertion you are experiencing is 'extremely easy,' respond with a 0. Think about a time when you exercised and the level of exertion was 'extremely easy' and most likely equivalent to a rating of 0. As an example, you should respond with a 0 when you are walking very slowly on the treadmill. When the exertion you are experiencing is 'extremely hard,' respond with a 10. Think about a time when you exercised and the perception of exertion was 'extremely hard,' likely attained at your maximal performance level. Most likely the exertional level would be equivalent to a rating of 10. As an example, you should respond with a 10 when you are running up a steep incline on the treadmill and you may not be able to exercise much longer owing to fatigue. You will be asked to rate your level of exertion for your overall body, your legs and your chest/breathing. When asked, use both the pictures and words to help you select one rating number that represents the level of exertion your overall body, legs, or chest/breathing are experiencing. Each number response is called a rating of perceived exertion, or RPE. Please point to the number that best represents your RPE at the moment you are asked.

Borg (6–20) Scale Instructions for RPE-O Only During Treadmill Exercise

This perceived exertion scale includes numerical categories from 6 to 20. You will use it to assess your perceptions of exertion while you exercise. The numbers on the scale represent a range of exertion levels from 6, "no exertion at all," to 20, "maximal exertion." To help you select a number that represents your level of exertion, consider the following. When the exercise exertion you are experiencing is "no exertion at all," respond with a 6. Think about a time when you exercised and the level of exertion was "no exertion at all" and most likely equivalent to a rating of 6. As an example, you should respond with a 6 when you are walking very slowly on the treadmill. When the exertion you are experiencing is "maximal exertion," respond with a 20. Think about a time when you exercised and the perception of exertion was "maximal exertion," likely attained at your maximal performance level. Most likely the exertional level would be equivalent to a rating of 20. As an example, you should respond with a 20 when you are running up a steep incline on the treadmill and you may not be able to exercise much longer owing to fatigue. Please rate your level of exertion for your overall body, taking into consideration the exertion experienced in your legs and your chest/breathing. When asked, use the

words to help you select one rating number that represents the level of exertion your body is experiencing. Each number response is called a rating of perceived exertion, or RPE. Please point to the number that best represents your RPE at the moment you are asked.

Adult OMNI-Cycle RPE Scale Instructions for RPE-L Only

This perceived exertion scale includes numerical categories from 0 to 10. You will use it to assess your perceptions of exertion while you exercise. The numbers on the scale represent a range of exertion levels from 0, "extremely easy," to 10, "extremely hard." To help you select a number that represents your level of exertion, consider the following. When the exercise exertion you are experiencing is "extremely easy," respond with a 0. Think about a time when you exercised and the level of exertion was "extremely easy" and most likely equivalent to a rating of 0. As an example, you should respond with a 0 when you are pedaling against no resistance on the cycle. When the exertion you are experiencing is "extremely hard," respond with a 10. Think about a time when you exercised and the perception of exertion was "extremely hard," likely attained at your maximal performance level. Most likely the exertional level would be equivalent to a rating of 10. As an example, you should respond with a 10 when you are pedaling against a very heavy resistance on the cycle and may not be able to exercise any longer owing to fatigue. You will be asked to rate the level of exertion of your legs only, not for your chest/breathing or your overall body. When asked, use both the pictures and words to help you select one rating number that represents the level of exertion your body is experiencing. Each number response is called a rating of perceived exertion, or RPE. Please point to the number that best represents your RPE at the moment you are asked.

Adult OMNI-Cycle RPE Scale Instructions for Undifferentiated and Differentiated RPE

This perceived exertion scale includes numerical categories from 0 to 10. You will use it to assess your perceptions of exertion while you exercise. The numbers on the scale represent a range of exertion levels from 0, "extremely easy," to 10, "extremely hard." To help you select a number that represents your level of exertion, consider the following. When the exercise exertion you are experiencing is "extremely easy," respond with a 0. Think about a time when you exercised and the level of exertion was "extremely easy" and most likely equivalent to a rating of 0. As an example, you should respond with a 0 when you are pedaling against no resistance on the cycle. When the exertion you are experiencing is "extremely hard," respond with a 10. Think about a time when you exercised and the perception of exertion was "extremely hard," likely attained at your maximal performance level.

Most likely the exertional level would be equivalent to a rating of 10. As an example, you should respond with a 10 when you are pedaling against a very heavy resistance on the cycle and may not be able to exercise any longer owing to fatigue. You will be asked to rate your level of exertion for your overall body, your legs and your chest/breathing. When asked, use both the pictures and words to help you select one rating number that represents the level of exertion your overall body, legs, or chest/breathing are experiencing. Each number response is called a rating of perceived exertion, or RPE. Please point to the number that best represents your RPE at the moment you are asked.

Borg (6–20) Scale Instructions for RPE-L Only During Cycle Exercise

This perceived exertion scale includes numerical categories from 6 to 20. You will use it to assess your perceptions of exertion while you exercise. The numbers on the scale represent a range of exertion levels from 6, "no exertion at all," to 20, "maximal exertion." To help you select a number that represents your level of exertion, consider the following. When the exercise exertion you are experiencing is "no exertion at all," respond with a 6. Think about a time when you exercised and the level of exertion was "no exertion at all" and most likely equivalent to a rating of 6. As an example, you should respond with a 6 when you are pedaling against no resistance on the cycle. When the exertion you are experiencing is "maximal exertion," respond with a 20. Think about a time when you exercised and the perception of exertion was "maximal exertion," likely attained at your maximal performance level. Most likely the exertional level would be equivalent to a rating of 20. As an example, you should respond with a 20 when you are pedaling against a very heavy resistance on the cycle and may not be able to exercise any longer owing to fatigue. Please rate your level of exertion for your legs only, not for your chest/breathing or your overall body. When asked, use the words to help you select one rating number that represents the level of exertion your legs are experiencing. Each number response is called a rating of perceived exertion, or RPE. Please point to the number that best represents your RPE at the moment you are asked.

Adult OMNI-Resistance Exercise RPE Scale for RPE-AM Only

This perceived exertion scale includes numerical categories from 0 to 10. You will use it to assess your perceptions of exertion while you perform resistance exercise. The numbers on the scale represent a range of exertion levels from 0, "extremely easy," to 10, "extremely hard." To help you select a number that represents your

level of exertion, consider the following. When the resistance exercise exertion you are experiencing is “extremely easy,” respond with a 0. Think about a time when you exercised and the level of exertion was “extremely easy” and most likely equivalent to a rating of 0. As an example, you should respond with a 0 when you are lifting a very light weight that is extremely easy to lift. When the exertion you are experiencing is “extremely hard,” respond with a 10. Think about a time when you performed resistance exercise and the perception of exertion was “extremely hard,” likely attained at your maximal performance level. Most likely the exertional level would be equivalent to a rating of 10. As an example, you should respond with a 10 when you are lifting the heaviest weight you can lift and may not be able to lift for one more repetition owing to fatigue. You will be asked to rate the level of exertion of your active muscles only, not for your chest/breathing or your overall body. When asked, use both the pictures and words to help you select one rating number that represents the level of exertion your active muscles are experiencing. Each number response is called a rating of perceived exertion, or RPE. Please point to the number that best represents your RPE at the moment you are asked.

Adult OMNI-Resistance Exercise RPE Scale for Undifferentiated and Differentiated RPE

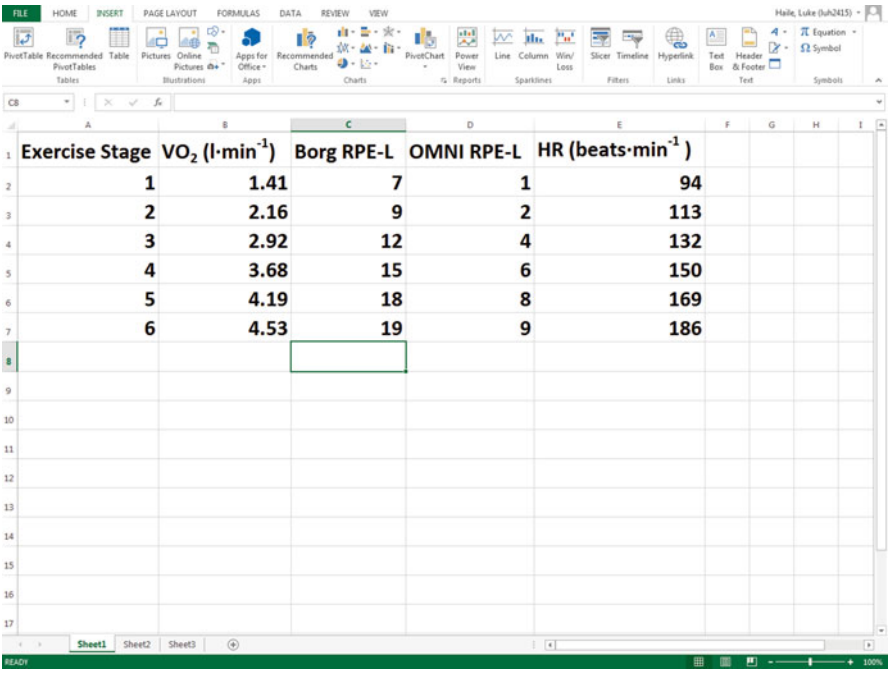
This perceived exertion scale includes numerical categories from 0 to 10. You will use it to assess your perceptions of exertion while you perform resistance exercise. The numbers on the scale represent a range of exertion levels from 0, “extremely easy,” to 10, “extremely hard.” To help you select a number that represents your level of exertion, consider the following. When the resistance exercise exertion you are experiencing is “extremely easy,” respond with a 0. Think about a time when you exercised and the level of exertion was “extremely easy” and most likely equivalent to a rating of 0. As an example, you should respond with a 0 when you are lifting a very light weight that is extremely easy to lift. When the exertion you are experiencing is “extremely hard,” respond with a 10. Think about a time when you performed resistance exercise and the perception of exertion was “extremely hard,” likely attained at your maximal performance level. Most likely the exertional level would be equivalent to a rating of 10. As an example, you should respond with a 10 when you are lifting the heaviest weight you can lift and may not be able to lift for one more repetition owing to fatigue. You will be asked to rate your level of exertion for your overall body, your active muscles and your chest/breathing. When asked, use both the pictures and words to help you select one rating number that represents the level of exertion your overall body, active muscles, or chest/breathing are experiencing. Each number response is called a rating of perceived exertion, or RPE. Please point to the number that best represents your RPE at the moment you are asked.

Borg (6–20) Scale Instructions for RPE-AM Only During Resistance Exercise

This perceived exertion scale includes numerical categories from 6 to 20. You will use it to assess your perceptions of exertion while you perform resistance exercise. The numbers on the scale represent a range of exertion levels from 6, "no exertion at all," to 20, "maximal exertion." To help you select a number that represents your level of exertion, consider the following. When the resistance exercise exertion you are experiencing is "no exertion at all," respond with a 6. Think about a time when you exercised and the level of exertion was "no exertion at all" and most likely equivalent to a rating of 6. As an example, you should respond with a 6 when you are lifting a very light weight that is extremely easy to lift. When the exertion you are experiencing is "maximal exertion," respond with a 20. Think about a time when you performed resistance exercise and the perception of exertion was "maximal exertion," likely attained at your maximal performance level. Most likely the exertional level would be equivalent to a rating of 20. As an example, you should respond with a 20 when you are lifting the heaviest weight you can lift and may not be able to lift for one more repetition owing to fatigue. You will be asked to rate the level of exertion of your active muscles only, not for your chest/breathing or your overall body. When asked, use the words to help you select one rating number that represents the level of exertion your active muscles are experiencing. Each number response is called a rating of perceived exertion, or RPE. Please point to the number that best represents your RPE at the moment you are asked.

Appendix C
Determination of Validity Coefficients: An Example Using Cycle Ergometry Graded Exercise Test Results

1. In a Microsoft Excel spreadsheet, label columns of data as shown in Fig. A.10.
   (a) For resistance exercise, Exercise Stage may be replaced with %1RM and Weight Lifted may take the place of physiological variables such as VO_2 and HR.
   (b) For treadmill exercise, VO_2 may be expressed in $ml \cdot kg \cdot min^{-1}$.
   (c) RPE-O and other differentiated RPE's such as RPE-C or RPE-AM may be used in your experiment.



Exercise Stage	VO_2 ($l \cdot min^{-1}$)	Borg RPE-L	OMNI RPE-L	HR ($beats \cdot min^{-1}$)
1	1.41	7	1	94
2	2.16	9	2	113
3	2.92	12	4	132
4	3.68	15	6	150
5	4.19	18	8	169
6	4.53	19	9	186

Fig. A.10 ∎

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DOI 10.1007/978-1-4939-1917-8

2. Plot of VO_2 and Borg RPE-L for determination of concurrent validity:

   (a) Click on the **INSERT** tab and in the **CHARTS** section click on **SCATTER**. Select the first available chart option. A blank or example scatter plot will appear on your screen (Fig. A.11).

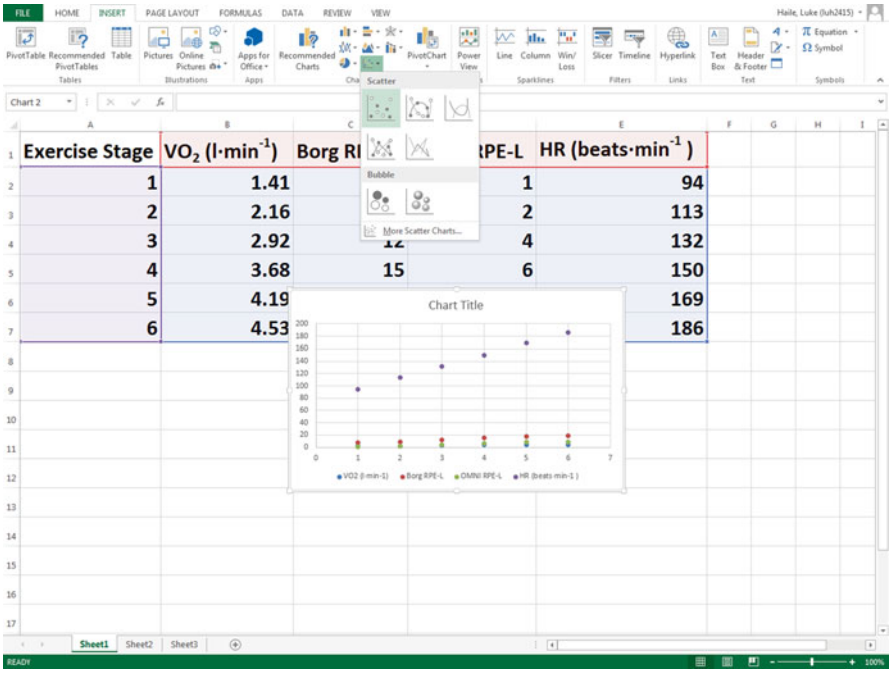


Fig. A.11 ∎

   (b) Click on the **SELECT DATA** tab (Fig. A.12).

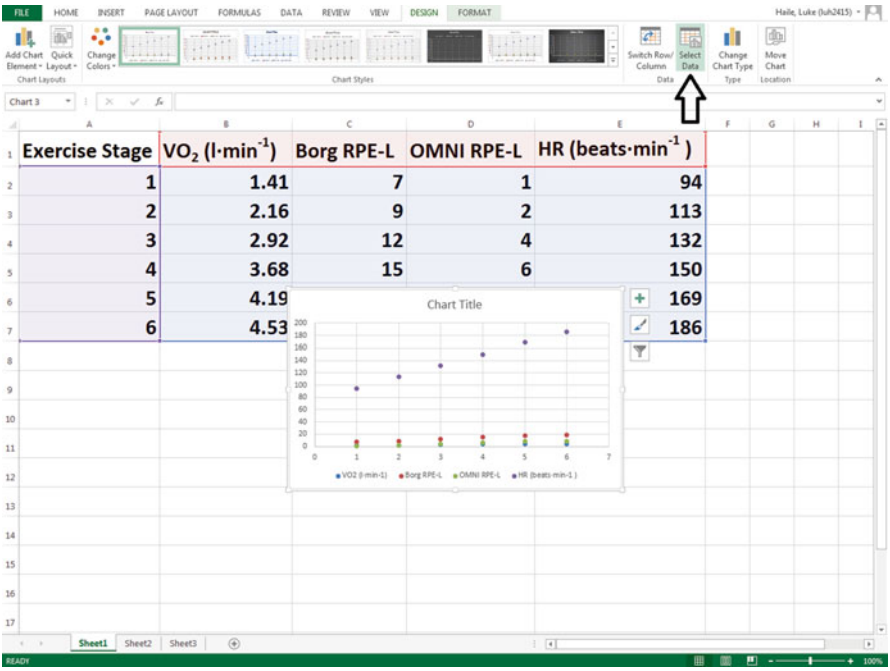


Fig. A.12 ∎

(c) Remove any entries found in the **LEGEND ENTRIES** text box then click **ADD** (Figs. A.13 and A.14).

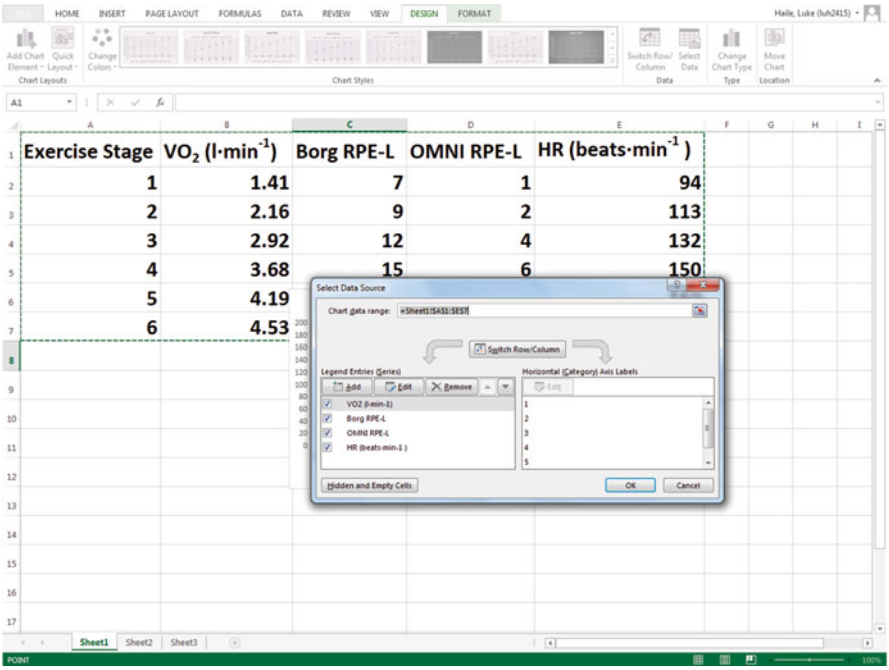


Fig. A.13 ∎

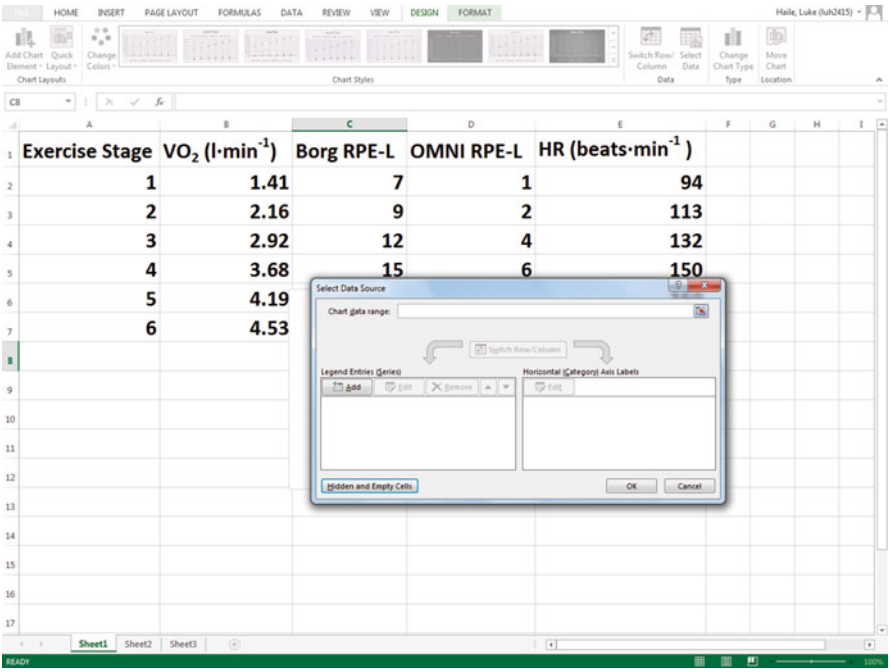


Fig. A.14 ∎

(d) Under **SERIES NAME**, enter VO_2 and Borg RPE-L. Then click on the icon to the right of the **SERIES X VALUES** text box and highlight the VO_2 values. After the values are highlighted click the icon on the box that appeared (Fig. A.15).

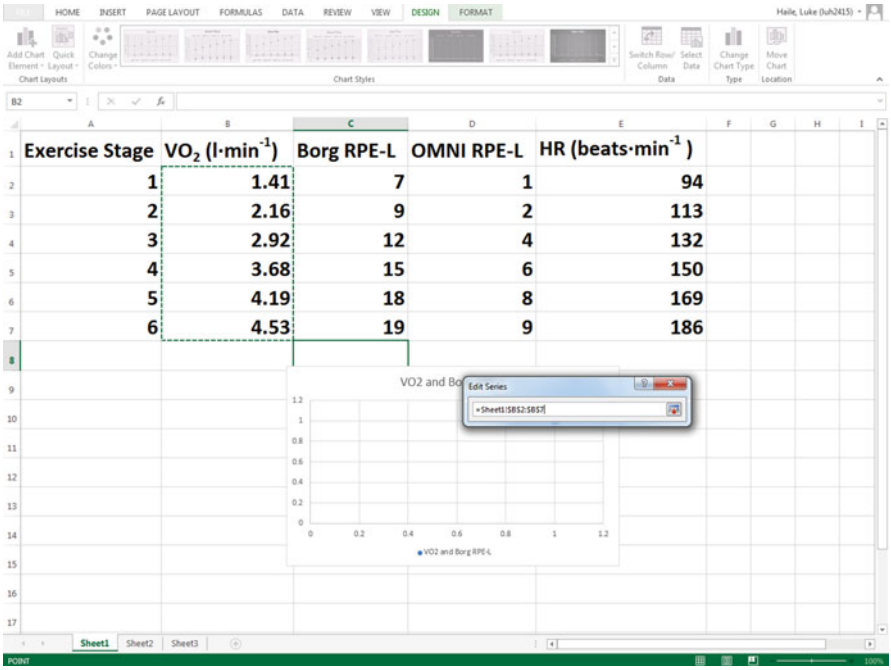
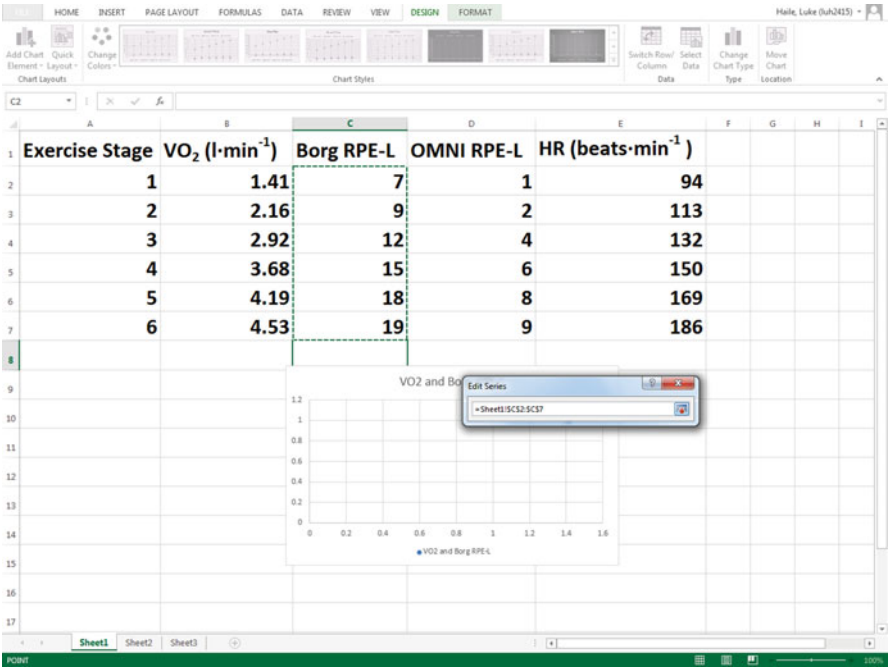


Fig. A.15 ∎

(e) Then click on the icon to the right of the **SERIES Y VALUES** text box and highlight the Borg RPE-L values. After the values are highlighted click the icon on the box that appeared (Fig. A.16).



Exercise Stage	VO_2 ($l \cdot min^{-1}$)	Borg RPE-L	OMNI RPE-L	HR ($beats \cdot min^{-1}$)
1	1.41	7	1	94
2	2.16	9	2	113
3	2.92	12	4	132
4	3.68	15	6	150
5	4.19	18	8	169
6	4.53	19	9	186

Fig. A.16 ∎

(f) Click **OK** on the next two screens. You should now have a scatter plot with Borg RPE-L on the *y*-axis and VO_2 on the *x*-axis (Fig. A.17).

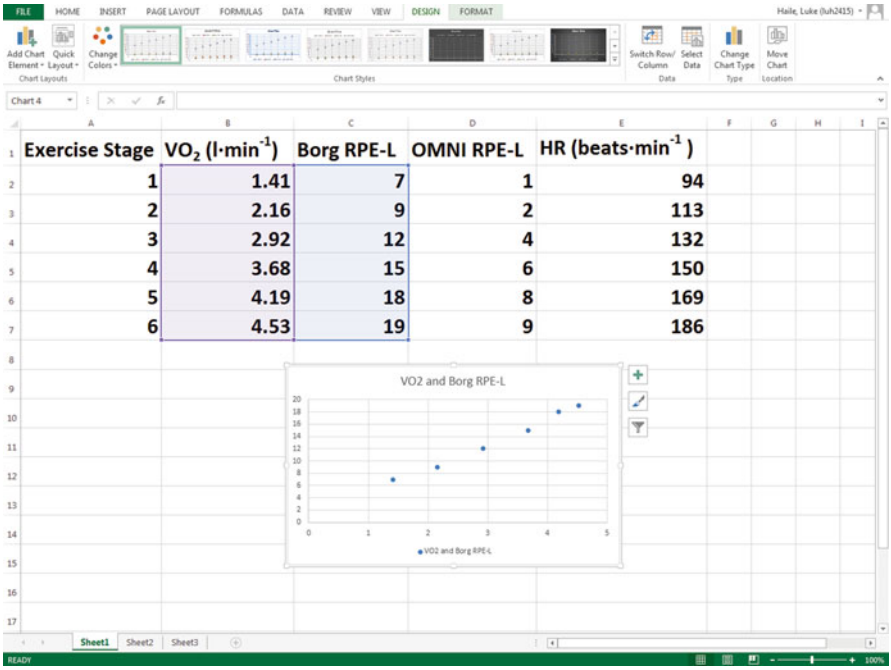


Fig. A.17 ∎

(g) Create a title for the plot and enter the appropriate axis labels and units of measure (Fig. A.18).

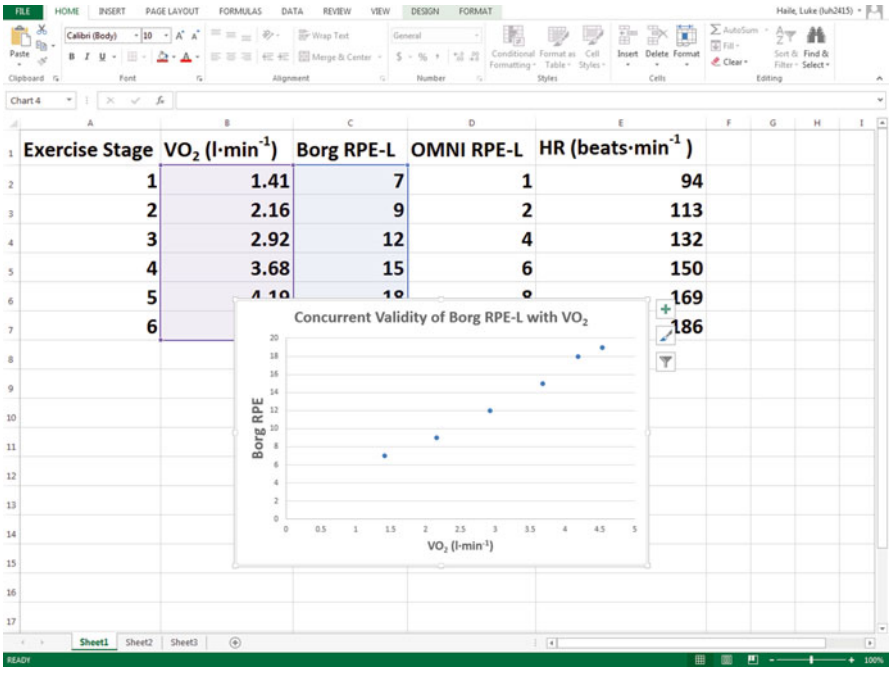


Fig. A.18 ∎

(h) To determine the validity coefficient, click on one of the data points to highlight the entire data series. Right click on one of the data points and a menu will appear. Click **ADD TRENDLINE** and the **FORMAT TRENDLINE** menu will appear. Select **LINEAR**, **DISPLAY EQUATION ON CHART**, and **DISPLAY R-SQUARED VALUE ON CHART** then click **CLOSE**. The trendline and equation will be displayed on the chart. Take the square root of the R^2 value to determine the Pearson correlation coefficient (Fig. A.19).

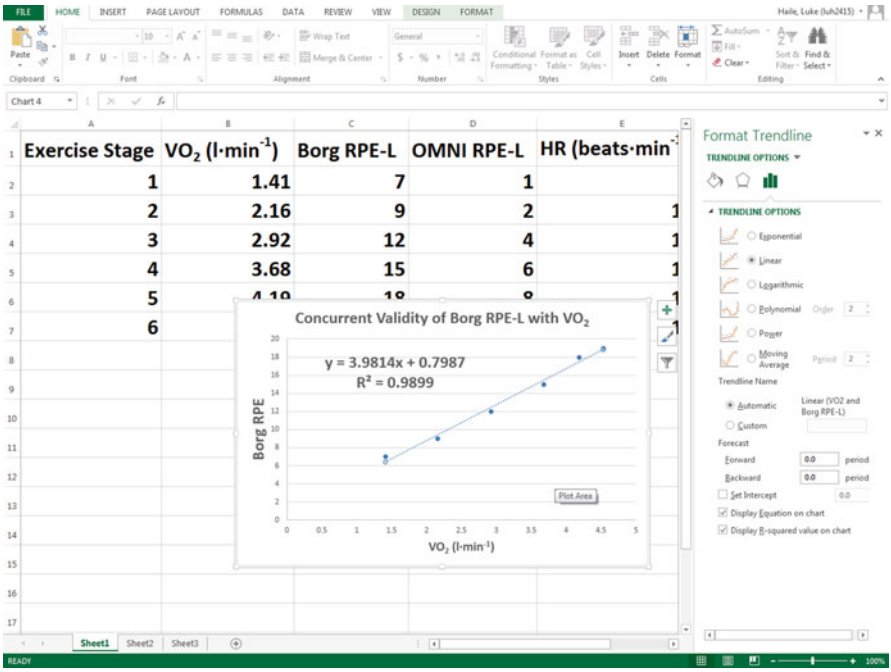
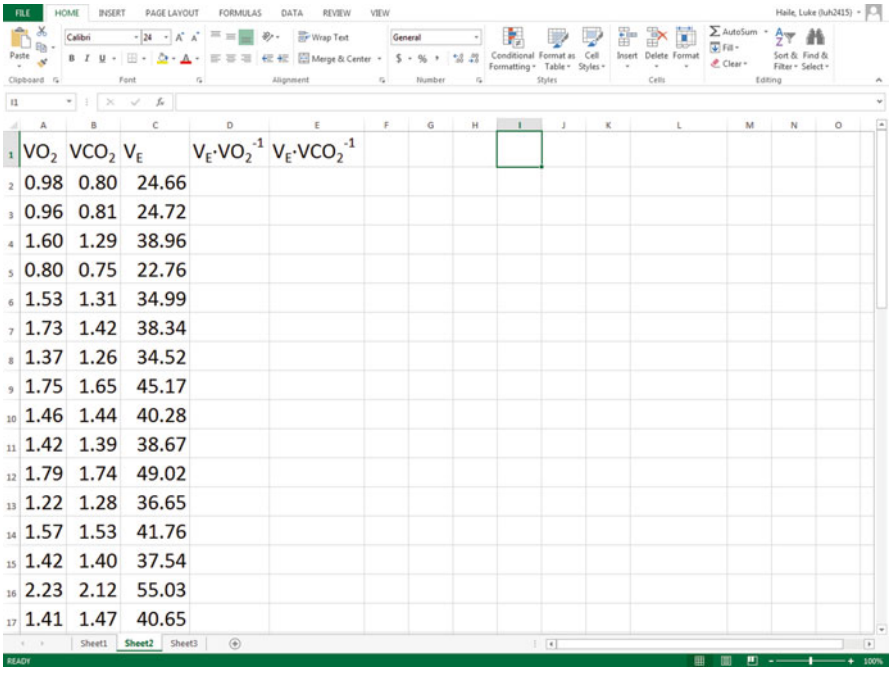


Fig. A.19 ∎

Appendix D
Determination of VT and RPE-VT

Calculation of $V_E \cdot VO_2^{-1}$ and $V_E \cdot VCO_2^{-1}$

1. Obtain a printout containing the 15-s exercise VO_2, VCO_2, and V_E values in $l \cdot min^{-1}$ from the respiratory-metabolic measurement system. In a Microsoft Excel spreadsheet, label columns for VO_2, VCO_2, V_E (each in $l \cdot min^{-1}$), $V_E \cdot VO_2^{-1}$ and $V_E \cdot VCO_2^{-1}$.
2. In the columns for VO_2, VCO_2, and V_E, enter each 15-s value measured during exercise as listed in the printout (Fig. A.20).



	A	B	C	D	E
1	VO_2	VCO_2	V_E	$V_E \cdot VO_2^{-1}$	$V_E \cdot VCO_2^{-1}$
2	0.98	0.80	24.66		
3	0.96	0.81	24.72		
4	1.60	1.29	38.96		
5	0.80	0.75	22.76		
6	1.53	1.31	34.99		
7	1.73	1.42	38.34		
8	1.37	1.26	34.52		
9	1.75	1.65	45.17		
10	1.46	1.44	40.28		
11	1.42	1.39	38.67		
12	1.79	1.74	49.02		
13	1.22	1.28	36.65		
14	1.57	1.53	41.76		
15	1.42	1.40	37.54		
16	2.23	2.12	55.03		
17	1.41	1.47	40.65		

Fig. A.20 ∎

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DOI 10.1007/978-1-4939-1917-8

3. Calculate $V_E \cdot VO_2^{-1}$ by dividing V_E ($l \cdot min^{-1}$) by VO_2 ($l \cdot min^{-1}$) for each row and enter the value in the appropriate cell. This can be completed by typing the equation seen in Fig. A.21 in the first cell available under $V_E \cdot VO_2^{-1}$ then hitting the **ENTER** key on the keyboard. This equation can be copied into the remaining cells below $V_E \cdot VO_2^{-1}$ to complete the calculation for each 15-s interval.

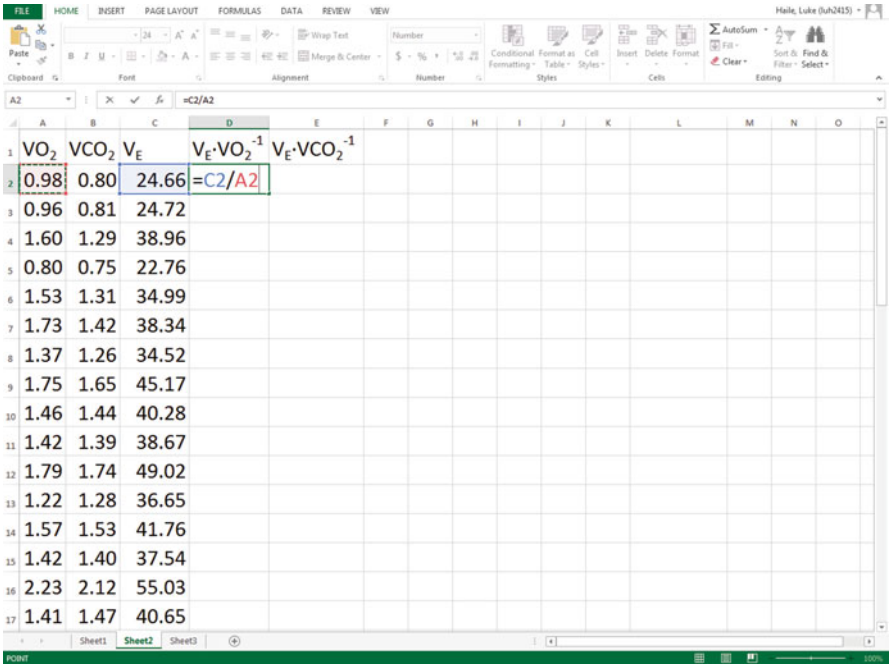
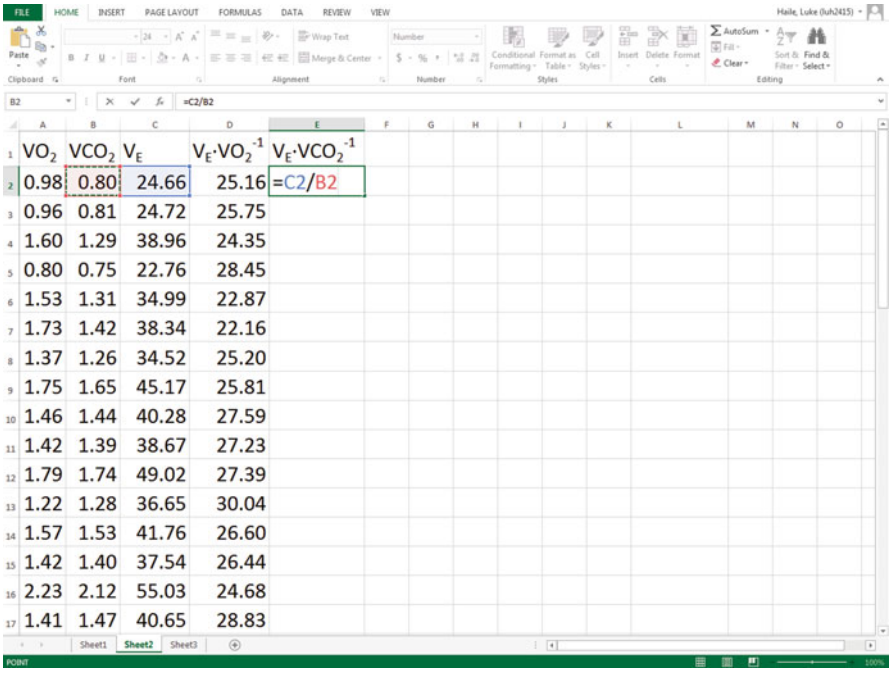


Fig. A.21 ∎

4. Calculate $V_E \cdot VCO_2^{-1}$ by dividing V_E ($l \cdot min^{-1}$) by VCO_2 ($l \cdot min^{-1}$) for each row and enter the value in the appropriate cell. This can be completed by typing the equation seen in Fig. A.22 in the first cell available under $V_E \cdot VO_2^{-1}$ then hitting the **ENTER** key on the keyboard. This equation can be copied into the remaining cells below $V_E \cdot VCO_2^{-1}$ to complete the calculation for each 15-s interval.

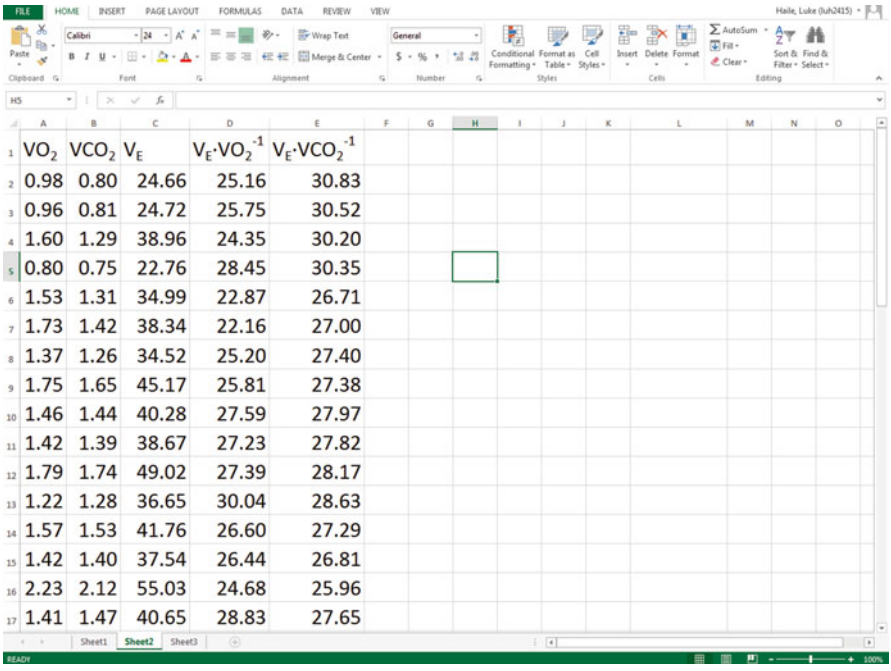


	A	B	C	D	E
1	VO_2	VCO_2	V_E	$V_E \cdot VO_2^{-1}$	$V_E \cdot VCO_2^{-1}$
2	0.98	0.80	24.66	25.16	=C2/B2
3	0.96	0.81	24.72	25.75	
4	1.60	1.29	38.96	24.35	
5	0.80	0.75	22.76	28.45	
6	1.53	1.31	34.99	22.87	
7	1.73	1.42	38.34	22.16	
8	1.37	1.26	34.52	25.20	
9	1.75	1.65	45.17	25.81	
10	1.46	1.44	40.28	27.59	
11	1.42	1.39	38.67	27.23	
12	1.79	1.74	49.02	27.39	
13	1.22	1.28	36.65	30.04	
14	1.57	1.53	41.76	26.60	
15	1.42	1.40	37.54	26.44	
16	2.23	2.12	55.03	24.68	
17	1.41	1.47	40.65	28.83	

Fig. A.22 ■

Plot of $V_E \cdot VO_2^{-1}$ and $V_E \cdot VCO_2^{-1}$ for Determination of VT

1. Obtain a printout from the respiratory-metabolic measurement system containing the 15-s exercise values of VO_2 ($l \cdot min^{-1}$) and the ventilatory equivalents ($V_E \cdot VO_2^{-1}$ and $V_E \cdot VCO_2^{-1}$). These variables have no units of measure because they are a ratio between two variables with the same units of measure.
2. In a Microsoft Excel spreadsheet, label columns for VO_2 ($l \cdot min^{-1}$), $V_E \cdot VO_2^{-1}$ and $V_E \cdot VCO_2^{-1}$. Enter each 15-s value measured during exercise as listed in the printout. If $V_E \cdot VO_2^{-1}$ and $V_E \cdot VCO_2^{-1}$ were calculated using a Microsoft Excel spreadsheet as described above, you may continue to use that spreadsheet (Fig. A.23).

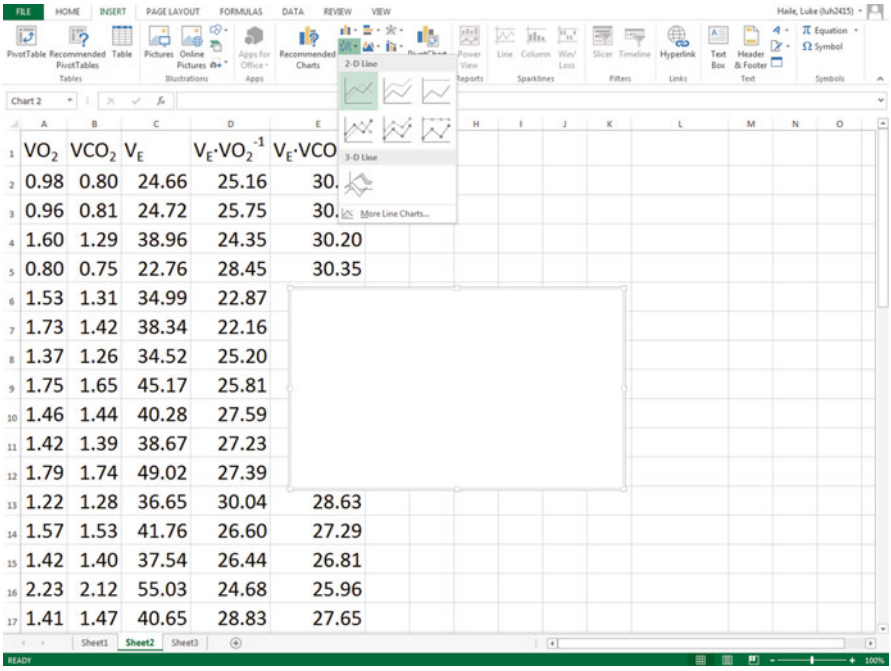


	A	B	C	D	E
1	VO_2	VCO_2	V_E	$V_E \cdot VO_2^{-1}$	$V_E \cdot VCO_2^{-1}$
2	0.98	0.80	24.66	25.16	30.83
3	0.96	0.81	24.72	25.75	30.52
4	1.60	1.29	38.96	24.35	30.20
5	0.80	0.75	22.76	28.45	30.35
6	1.53	1.31	34.99	22.87	26.71
7	1.73	1.42	38.34	22.16	27.00
8	1.37	1.26	34.52	25.20	27.40
9	1.75	1.65	45.17	25.81	27.38
10	1.46	1.44	40.28	27.59	27.97
11	1.42	1.39	38.67	27.23	27.82
12	1.79	1.74	49.02	27.39	28.17
13	1.22	1.28	36.65	30.04	28.63
14	1.57	1.53	41.76	26.60	27.29
15	1.42	1.40	37.54	26.44	26.81
16	2.23	2.12	55.03	24.68	25.96
17	1.41	1.47	40.65	28.83	27.65

Fig. A.23 ∎

3. Create a line graph with $V_E \cdot VO_2^{-1}$ and $V_E \cdot VCO_2^{-1}$ on the *y*-axis and VO_2 ($l \cdot min^{-1}$) on the *x*-axis.

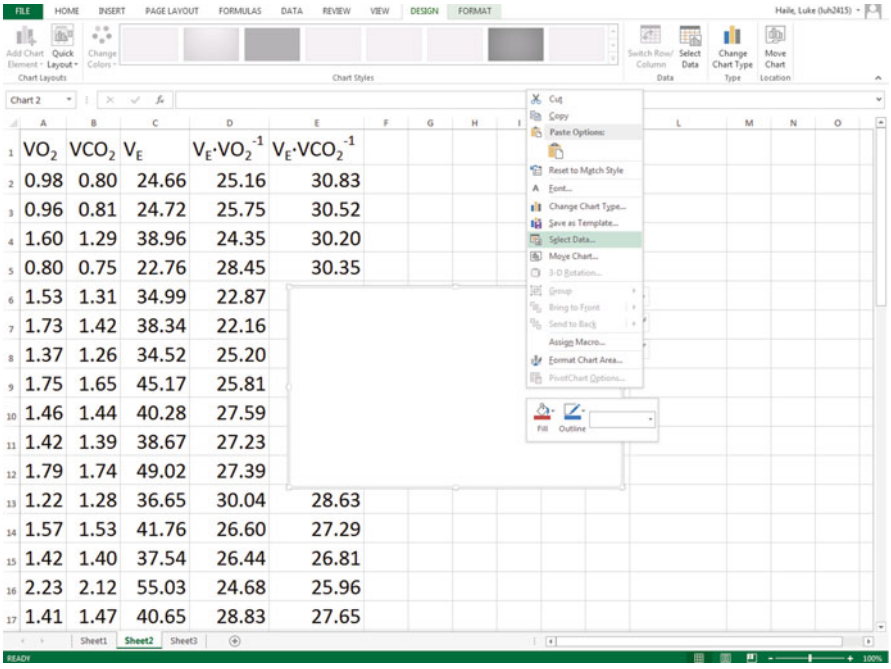
   (a) Click on the **INSERT** tab then click on the **INSERT LINE CHART** icon. Select the first option for a basic 2D line chart (Fig. A.24).



	A	B	C	D	E
1	VO_2	VCO_2	V_E	$V_E \cdot VO_2^{-1}$	$V_E \cdot VCO$
2	0.98	0.80	24.66	25.16	30.
3	0.96	0.81	24.72	25.75	30.
4	1.60	1.29	38.96	24.35	30.20
5	0.80	0.75	22.76	28.45	30.35
6	1.53	1.31	34.99	22.87	
7	1.73	1.42	38.34	22.16	
8	1.37	1.26	34.52	25.20	
9	1.75	1.65	45.17	25.81	
10	1.46	1.44	40.28	27.59	
11	1.42	1.39	38.67	27.23	
12	1.79	1.74	49.02	27.39	
13	1.22	1.28	36.65	30.04	28.63
14	1.57	1.53	41.76	26.60	27.29
15	1.42	1.40	37.54	26.44	26.81
16	2.23	2.12	55.03	24.68	25.96
17	1.41	1.47	40.65	28.83	27.65

Fig. A.24 ∎

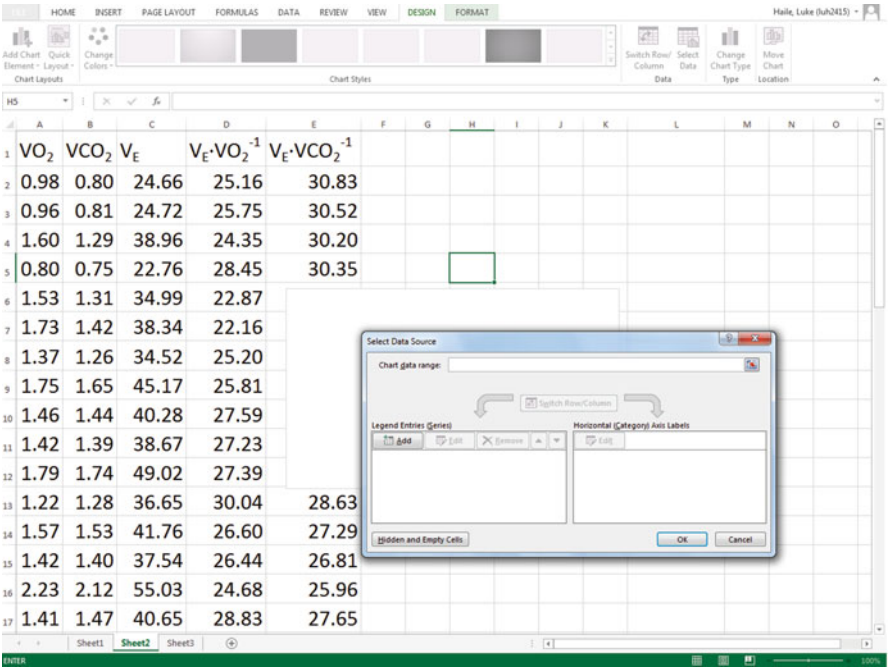
(b) A blank chart will appear on the spreadsheet. Right click on the chart and click **SELECT DATA** (Fig. A.25).



	A	B	C	D	E
1	VO_2	VCO_2	V_E	$V_E \cdot VO_2^{-1}$	$V_E \cdot VCO_2^{-1}$
2	0.98	0.80	24.66	25.16	30.83
3	0.96	0.81	24.72	25.75	30.52
4	1.60	1.29	38.96	24.35	30.20
5	0.80	0.75	22.76	28.45	30.35
6	1.53	1.31	34.99	22.87	
7	1.73	1.42	38.34	22.16	
8	1.37	1.26	34.52	25.20	
9	1.75	1.65	45.17	25.81	
10	1.46	1.44	40.28	27.59	
11	1.42	1.39	38.67	27.23	
12	1.79	1.74	49.02	27.39	
13	1.22	1.28	36.65	30.04	28.63
14	1.57	1.53	41.76	26.60	27.29
15	1.42	1.40	37.54	26.44	26.81
16	2.23	2.12	55.03	24.68	25.96
17	1.41	1.47	40.65	28.83	27.65

Fig. A.25 ∎

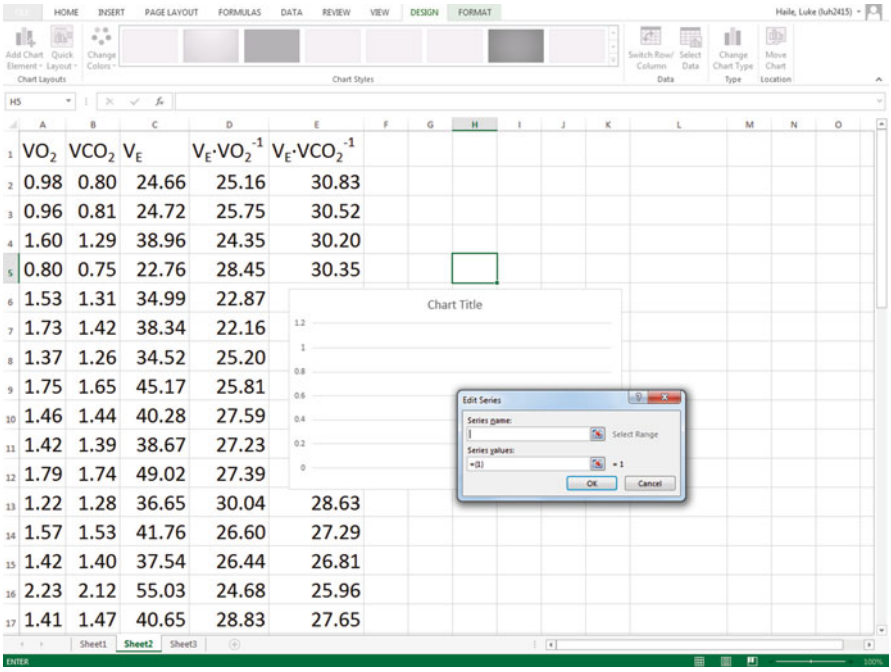
(c) The **SELECT DATA SOURCE** box will appear (Fig. A.26).



	A	B	C	D	E
1	VO_2	VCO_2	V_E	$V_E \cdot VO_2^{-1}$	$V_E \cdot VCO_2^{-1}$
2	0.98	0.80	24.66	25.16	30.83
3	0.96	0.81	24.72	25.75	30.52
4	1.60	1.29	38.96	24.35	30.20
5	0.80	0.75	22.76	28.45	30.35
6	1.53	1.31	34.99	22.87	
7	1.73	1.42	38.34	22.16	
8	1.37	1.26	34.52	25.20	
9	1.75	1.65	45.17	25.81	
10	1.46	1.44	40.28	27.59	
11	1.42	1.39	38.67	27.23	
12	1.79	1.74	49.02	27.39	
13	1.22	1.28	36.65	30.04	28.63
14	1.57	1.53	41.76	26.60	27.29
15	1.42	1.40	37.54	26.44	26.81
16	2.23	2.12	55.03	24.68	25.96
17	1.41	1.47	40.65	28.83	27.65

Fig. A.26 ∎

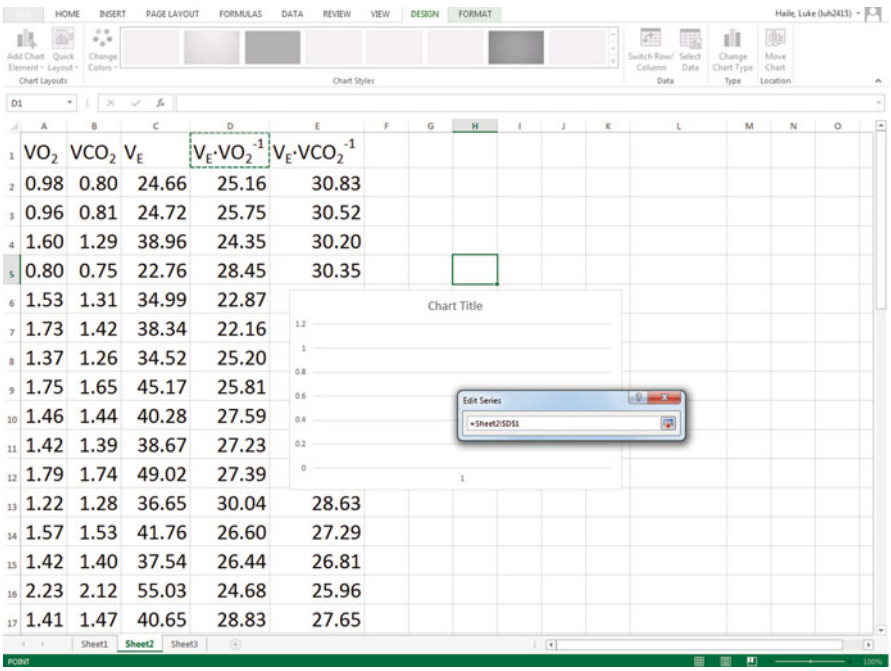
(d) Click **ADD** under **LEGEND ENTRIES** and the **EDIT SERIES** box will appear (Fig. A.27).



	A	B	C	D	E
1	VO_2	VCO_2	V_E	$V_E \cdot VO_2^{-1}$	$V_E \cdot VCO_2^{-1}$
2	0.98	0.80	24.66	25.16	30.83
3	0.96	0.81	24.72	25.75	30.52
4	1.60	1.29	38.96	24.35	30.20
5	0.80	0.75	22.76	28.45	30.35
6	1.53	1.31	34.99	22.87	
7	1.73	1.42	38.34	22.16	
8	1.37	1.26	34.52	25.20	
9	1.75	1.65	45.17	25.81	
10	1.46	1.44	40.28	27.59	
11	1.42	1.39	38.67	27.23	
12	1.79	1.74	49.02	27.39	
13	1.22	1.28	36.65	30.04	28.63
14	1.57	1.53	41.76	26.60	27.29
15	1.42	1.40	37.54	26.44	26.81
16	2.23	2.12	55.03	24.68	25.96
17	1.41	1.47	40.65	28.83	27.65

Fig. A.27 ∎

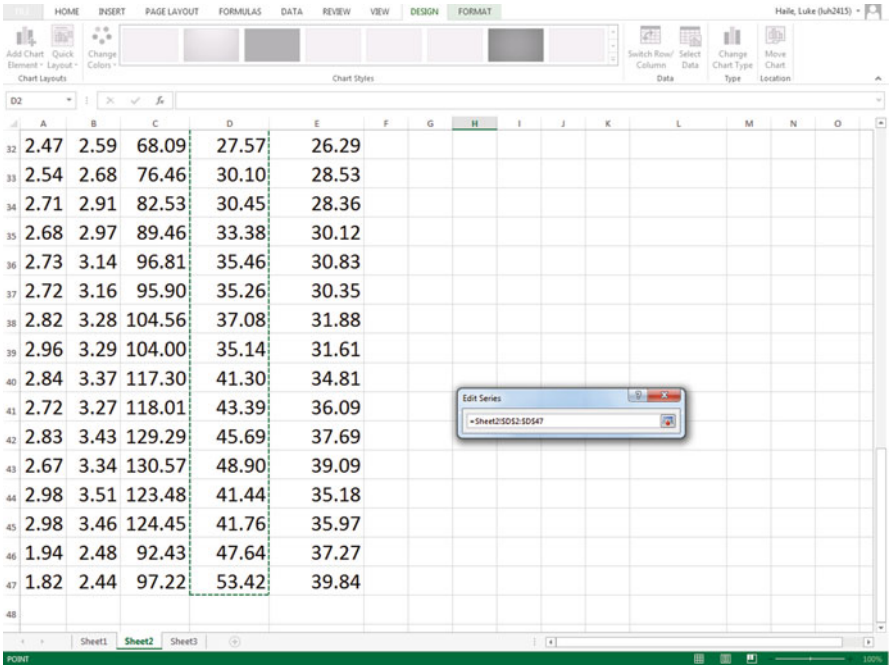
(e) Click on the icon to the right of the **SERIES NAME** text box then click on the cell in the spreadsheet containing $V_E \cdot VO_2^{-1}$. Click the icon on the right side of the box that appeared to return to the **EDIT SERIES** box (Fig. A.28).



VO_2	VCO_2	V_E	$V_E \cdot VO_2^{-1}$	$V_E \cdot VCO_2^{-1}$
0.98	0.80	24.66	25.16	30.83
0.96	0.81	24.72	25.75	30.52
1.60	1.29	38.96	24.35	30.20
0.80	0.75	22.76	28.45	30.35
1.53	1.31	34.99	22.87	
1.73	1.42	38.34	22.16	
1.37	1.26	34.52	25.20	
1.75	1.65	45.17	25.81	
1.46	1.44	40.28	27.59	
1.42	1.39	38.67	27.23	
1.79	1.74	49.02	27.39	
1.22	1.28	36.65	30.04	28.63
1.57	1.53	41.76	26.60	27.29
1.42	1.40	37.54	26.44	26.81
2.23	2.12	55.03	24.68	25.96
1.41	1.47	40.65	28.83	27.65

Fig. A.28 ∎

(f) Click on the icon to the right of the **SERIES VALUES** text box then highlight all the cells in the spreadsheet containing data under $V_E \cdot VO_2^{-1}$. Click the icon on the right side of the box that appeared to return to the **EDIT SERIES** box. Click **OK** to return to the **SELECT DATA SOURCE BOX** (Fig. A.29).



	A	B	C	D	E
32	2.47	2.59	68.09	27.57	26.29
33	2.54	2.68	76.46	30.10	28.53
34	2.71	2.91	82.53	30.45	28.36
35	2.68	2.97	89.46	33.38	30.12
36	2.73	3.14	96.81	35.46	30.83
37	2.72	3.16	95.90	35.26	30.35
38	2.82	3.28	104.56	37.08	31.88
39	2.96	3.29	104.00	35.14	31.61
40	2.84	3.37	117.30	41.30	34.81
41	2.72	3.27	118.01	43.39	36.09
42	2.83	3.43	129.29	45.69	37.69
43	2.67	3.34	130.57	48.90	39.09
44	2.98	3.51	123.48	41.44	35.18
45	2.98	3.46	124.45	41.76	35.97
46	1.94	2.48	92.43	47.64	37.27
47	1.82	2.44	97.22	53.42	39.84
48					

Fig. A.29 ∎

(g) Click **ADD** under **LEGEND ENTRIES** and the **EDIT SERIES** box will appear.
(h) Click on the icon to the right of the **SERIES NAME** text box then click on the cell in the spreadsheet containing $V_E \cdot VCO_2^{-1}$. Click the icon on the right side of the box that appeared to return to the **EDIT SERIES** box.
(i) Click on the icon to the right of the **SERIES VALUES** text box then highlight all the cells in the spreadsheet containing data under $V_E \cdot VCO_2^{-1}$. Click the icon on the right side of the box that appeared to return to the **EDIT SERIES** box. Click **OK** to return to the **SELECT DATA SOURCE BOX**.
(j) Click **EDIT** under **HORIZONTAL (CATEGORY) AXIS LABELS** (Fig. A.30).

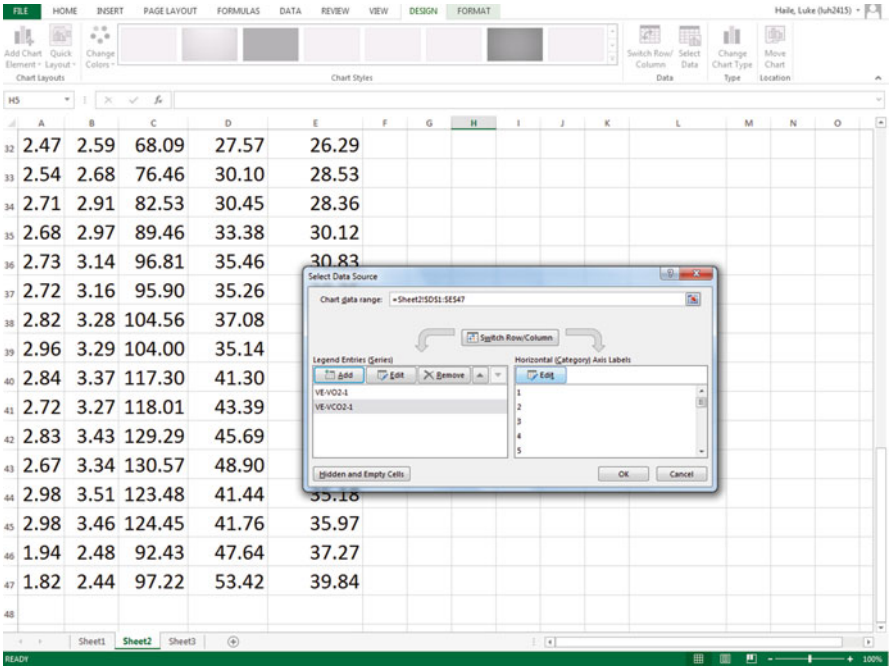
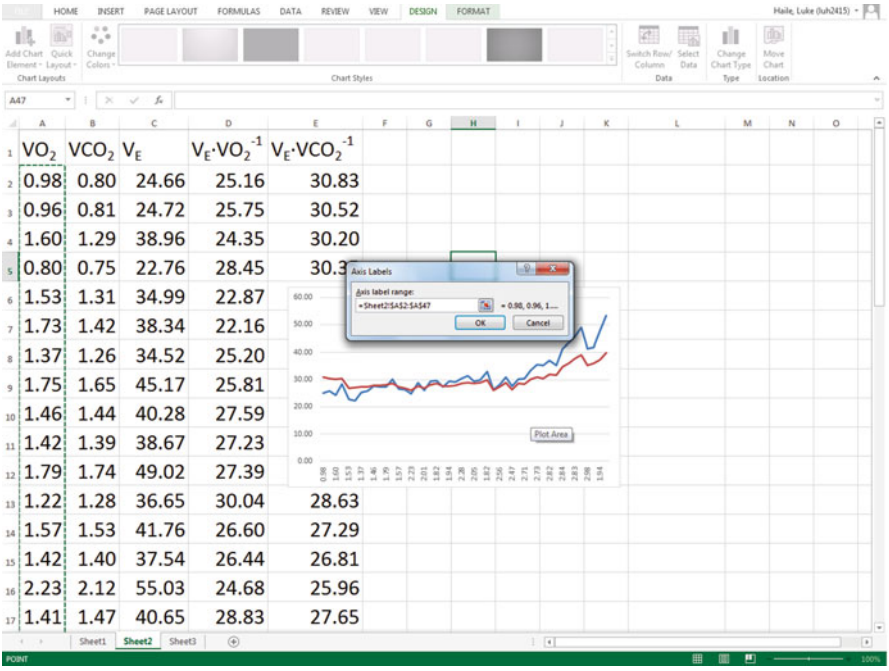


Fig. A.30 ∎

(k) Highlight all the cells containing data under VO_2 then click **OK** (Fig. A.31).



	A	B	C	D	E
1	VO_2	VCO_2	V_E	$V_E \cdot VO_2^{-1}$	$V_E \cdot VCO_2^{-1}$
2	0.98	0.80	24.66	25.16	30.83
3	0.96	0.81	24.72	25.75	30.52
4	1.60	1.29	38.96	24.35	30.20
5	0.80	0.75	22.76	28.45	30.3
6	1.53	1.31	34.99	22.87	
7	1.73	1.42	38.34	22.16	
8	1.37	1.26	34.52	25.20	
9	1.75	1.65	45.17	25.81	
10	1.46	1.44	40.28	27.59	
11	1.42	1.39	38.67	27.23	
12	1.79	1.74	49.02	27.39	
13	1.22	1.28	36.65	30.04	28.63
14	1.57	1.53	41.76	26.60	27.29
15	1.42	1.40	37.54	26.44	26.81
16	2.23	2.12	55.03	24.68	25.96
17	1.41	1.47	40.65	28.83	27.65

Fig. A.31 ∎

(l) Click **OK** on the **SELECT DATA SOURCE** box and the plot will appear. It may be beneficial to enlarge the plot so the labels on the *x*-axis are easily viewable. Locate the point on the graph where $V_E \cdot VO_2^{-1}$ begins to increase without an increase in $V_E \cdot VCO_2^{-1}$. Draw a vertical line from that point down to the *x*-axis and identify the VO_2 equivalent to this divergent point. Convert the units of this VO_2 value from $l \cdot min^{-1}$ to $\%VO_2$max/peak (Fig. A.32).

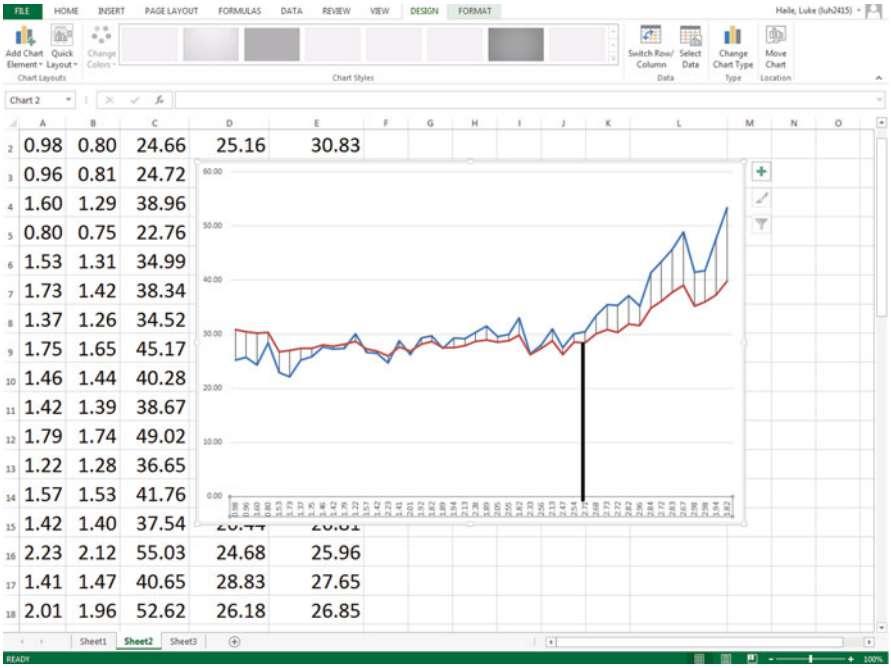


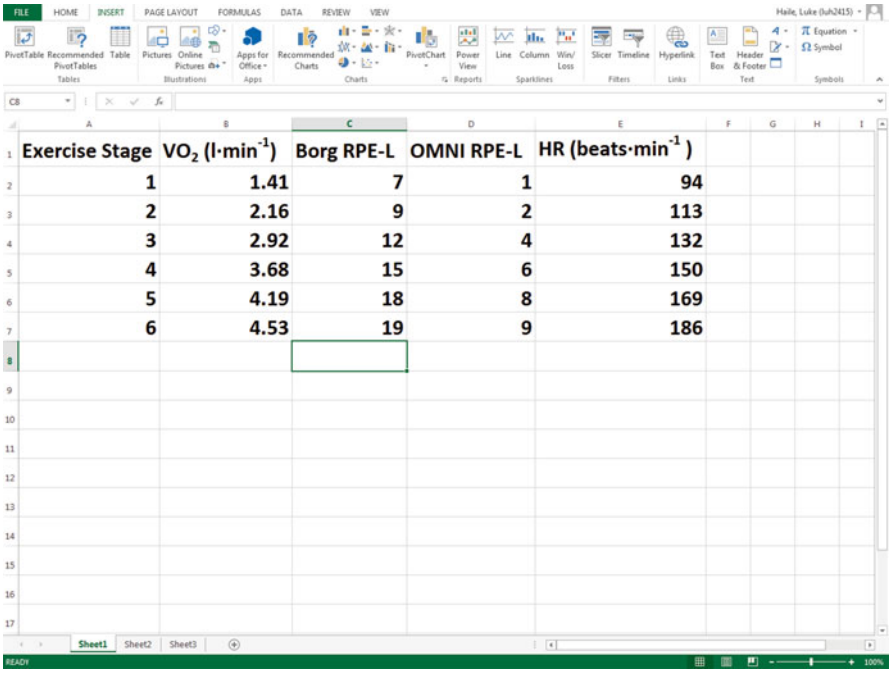
Fig. A.32 ∎

Adjustment of Automatic VT Calculation in a Respiratory Metabolic Measurement System

1. Focus your attention on the figure showing $V_E \cdot VO_2^{-1}$ and $V_E \cdot VCO_2^{-1}$ on the *y*-axis and Time on the *x*-axis. There will be a vertical line indicating the position of the VT on this figure.
2. If the vertical line is not located over the point where $V_E \cdot VO_2^{-1}$ begins to increase without an increase in $V_E \cdot VCO_2^{-1}$, adjust the vertical line until it is located directly over this point.
3. If the vertical line is located over the point where $V_E \cdot VO_2^{-1}$ begins to increase without an increase in $V_E \cdot VCO_2^{-1}$, do not adjust it.
4. The computer program will automatically provide the VO_2 value ($l \cdot min^{-1}$) and $\%VO_2max$/peak associated with the VT.

Determination of RPE-VT: An Example Using Cycle Ergometry Graded Exercise Test Results

1. In a Microsoft Excel spreadsheet, label columns of data as shown in Fig. A.33.



Exercise Stage	VO_2 ($l \cdot min^{-1}$)	Borg RPE-L	OMNI RPE-L	HR ($beats \cdot min^{-1}$)
1	1.41	7	1	94
2	2.16	9	2	113
3	2.92	12	4	132
4	3.68	15	6	150
5	4.19	18	8	169
6	4.53	19	9	186

Fig. A.33 ∎

(a) For treadmill exercise, VO_2 may be expressed in $ml \cdot kg \cdot min^{-1}$.
(b) RPE-O and differentiated RPE such as RPE-C may be used in your experiment.

2. Plot of VO_2 as a function of Borg RPE-L for determination of RPE-VT.

(a) Click on the **INSERT** tab and in the **CHARTS** section click on **SCATTER**. Select the first available chart option. A blank or example scatter plot will appear on your screen (Fig. A.34).

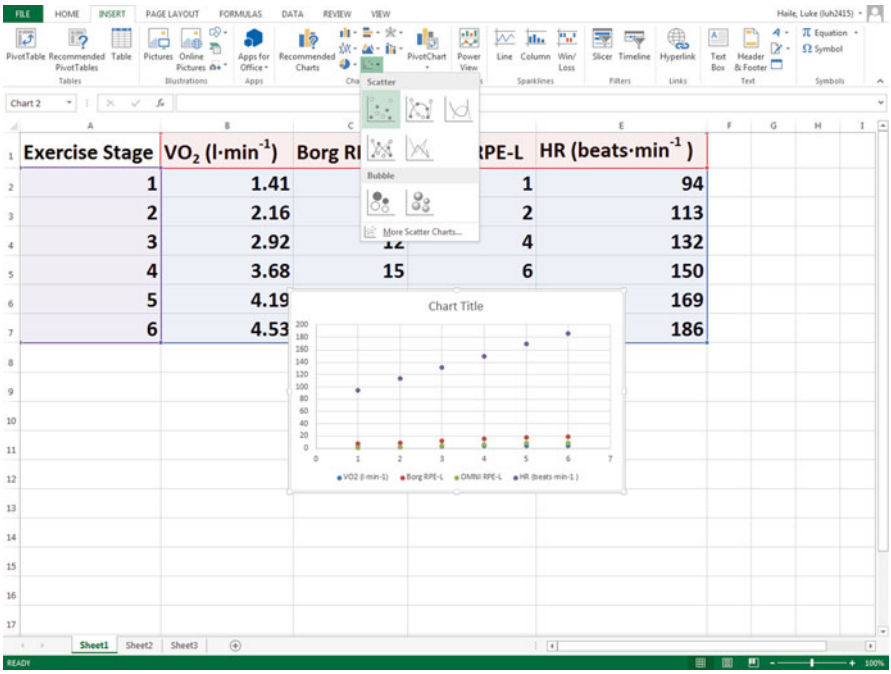


Fig. A.34 ∎

(b) Click on the **SELECT DATA** tab (Fig. A.35).

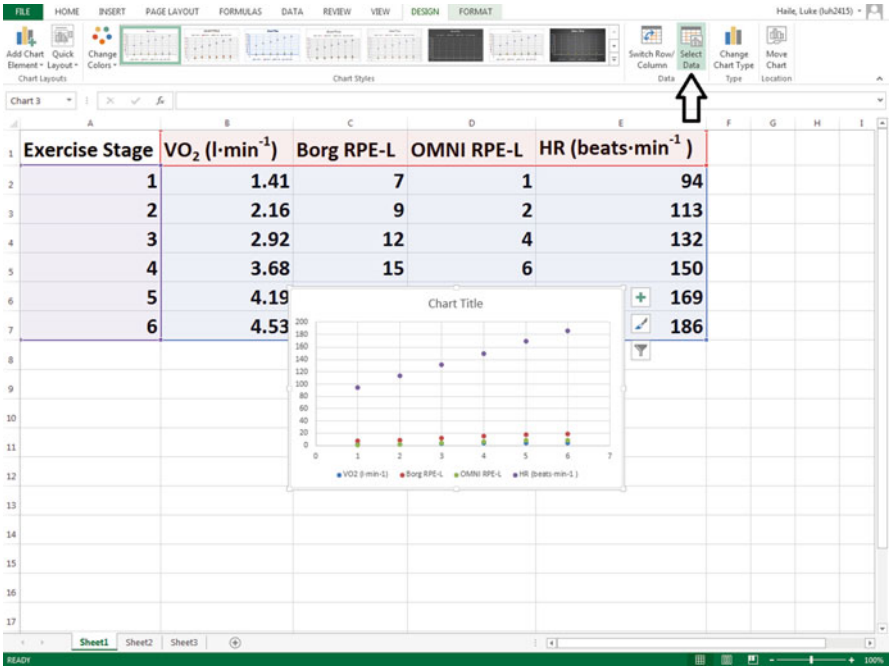


Fig. A.35 ∎

(c) Remove any entries found in the **LEGEND ENTRIES** text box then click **ADD** (Fig. A.36).

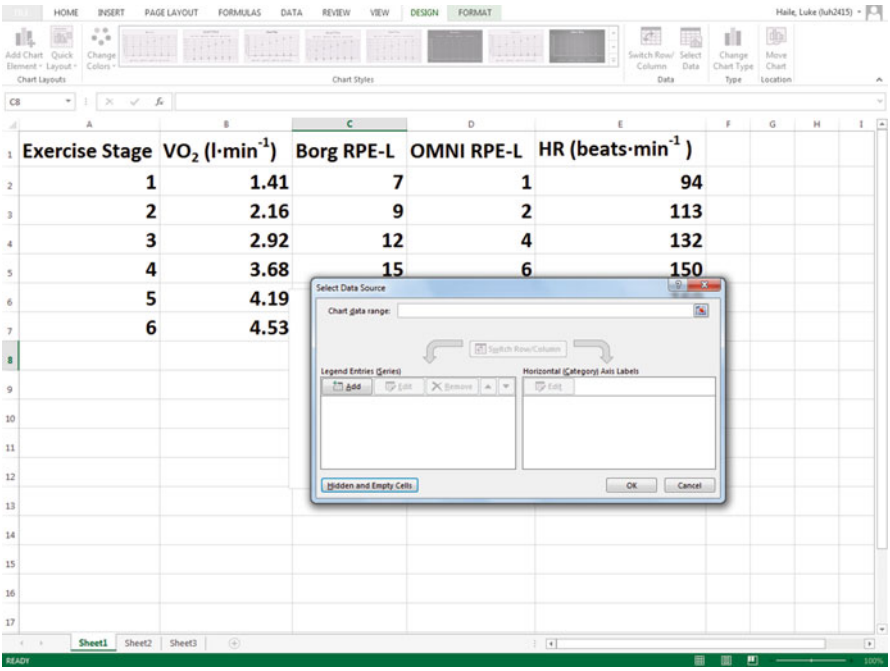
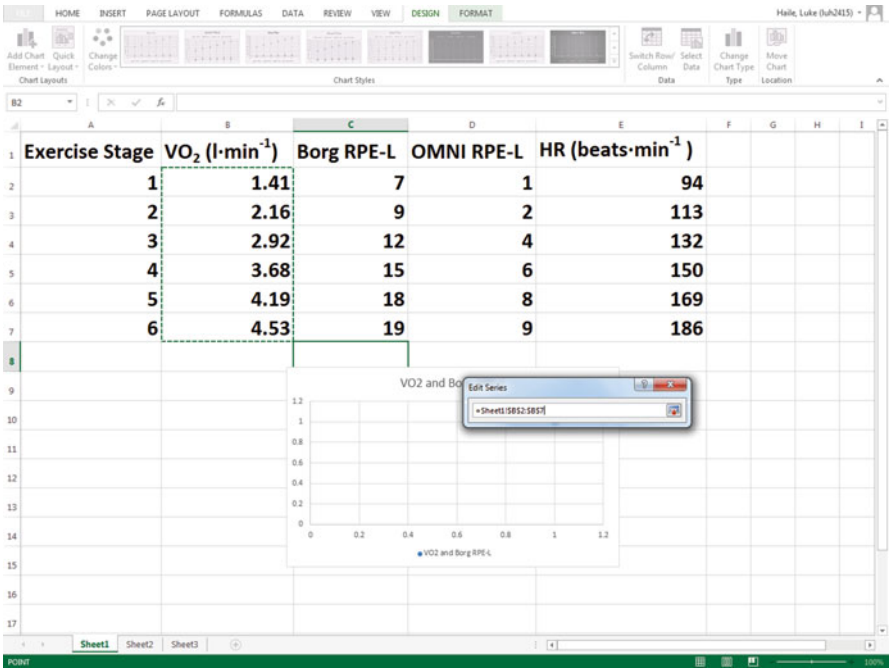


Fig. A.36 ∎

(d) Under **SERIES NAME**, enter VO_2 and Borg RPE-L. Then click on the icon to the right of the **SERIES X VALUES** text box and highlight the VO_2 values. After the values are highlighted click the icon on the box that appeared (Fig. A.37).



Exercise Stage	VO_2 (l·min^{-1})	Borg RPE-L	OMNI RPE-L	HR (beats·min^{-1})
1	1.41	7	1	94
2	2.16	9	2	113
3	2.92	12	4	132
4	3.68	15	6	150
5	4.19	18	8	169
6	4.53	19	9	186

Fig. A.37 ∎

(e) Then click on the icon to the right of the **SERIES Y VALUES** text box and highlight the Borg RPE-L values. After the values are highlighted click the icon on the box that appeared (Fig. A.38).

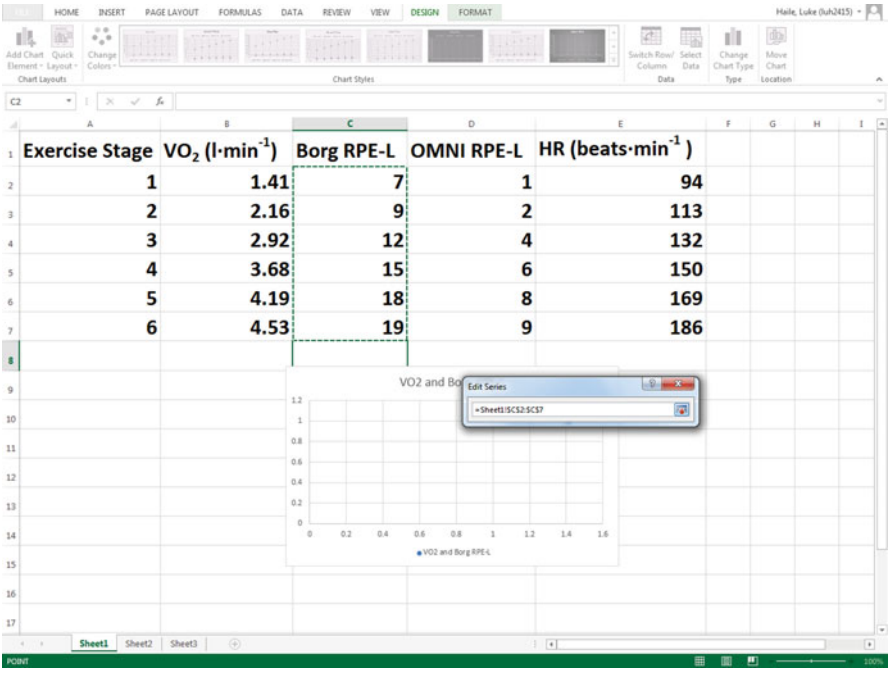


Fig. A.38 ∎

(f) Click **OK** on the next two screens. You should now have a scatter plot with Borg RPE-L on the *y*-axis and VO_2 on the *x*-axis (Fig. A.39).

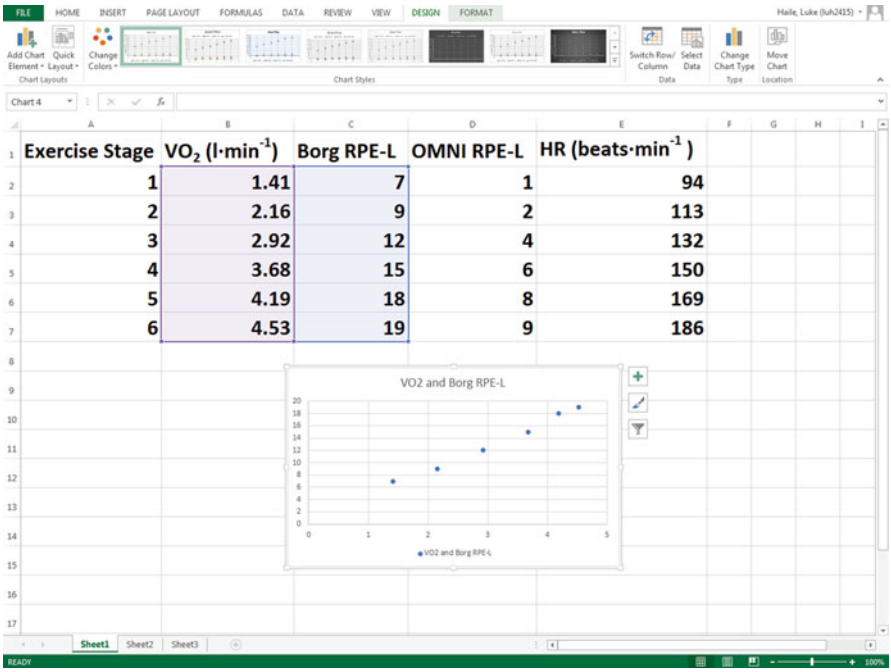


Fig. A.39 ∎

(g) To determine the Borg RPE-VT, click on one of the data points to highlight the entire data series. Right click on one of the data points and a menu will appear. Click **ADD TRENDLINE** and the **FORMAT TRENDLINE** menu will appear. Select **LINEAR** and **DISPLAY EQUATION ON CHART** then click **CLOSE**. The trendline and its linear equation will be displayed on the chart. Use this linear equation to calculate RPE-VT. Use VO_2 ($l \cdot min^{-1}$) corresponding to the VT as the "x" value in the equation and solve for "y." The calculated "y" value is the Borg RPE-VT (Fig. A.40).

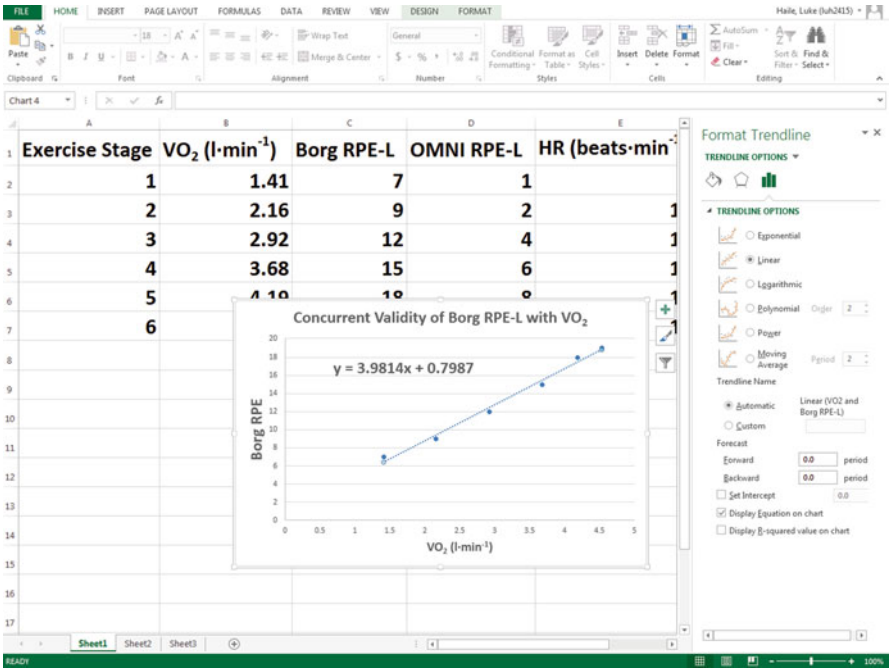


Fig. A.40 ∎

Appendix E
Prediction of VO_2peak: An Example Using Cycle Ergometry Graded Exercise Test Results

1. In a Microsoft Excel spreadsheet, label columns of data as shown in Fig. A.41.
   (a) For treadmill exercise, VO_2 may be expressed in $ml \cdot kg \cdot min^{-1}$.
   (b) RPE-O and differentiated RPE such as RPE-C may be used in your experiment.

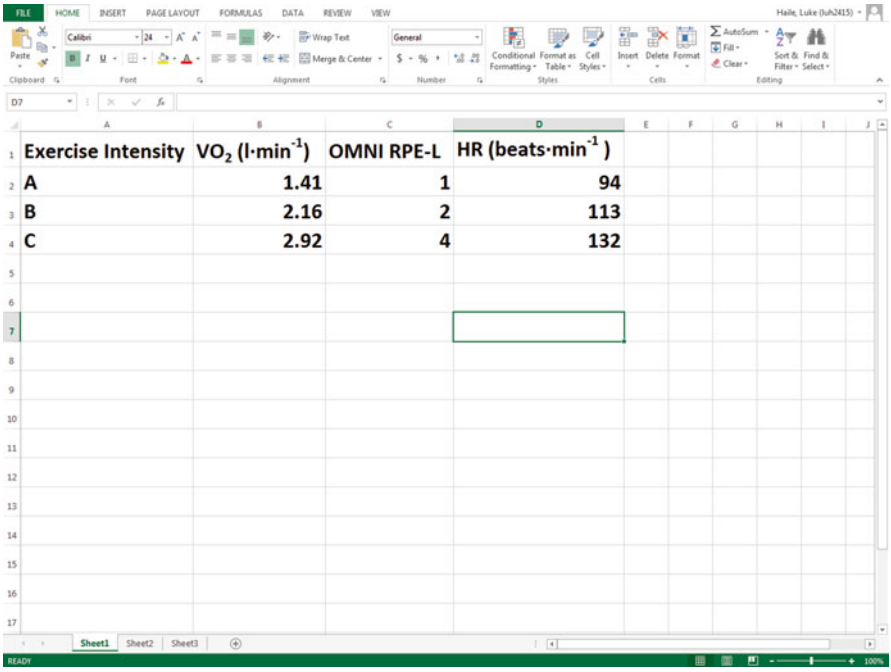


Fig. A.41 ∎

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2. Plot of VO_2 and OMNI RPE-L for prediction of VO_2peak.

   (a) Click on the **INSERT** tab and in the **CHARTS** section click on **SCATTER**. Select the first available chart option. A blank or example scatter plot will appear on your screen (Fig. A.42).

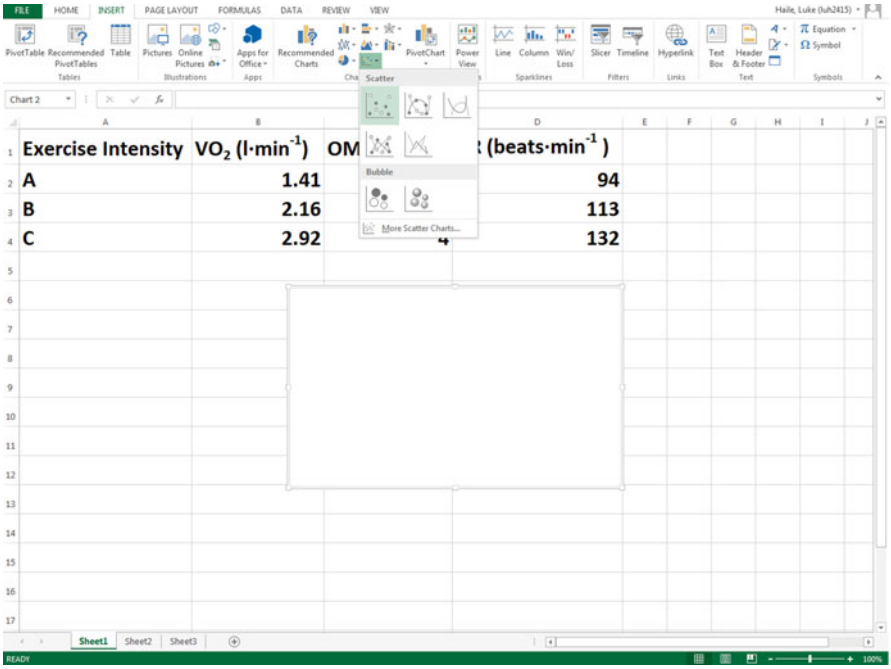

Fig. A.42 ∎

(b) Click on the **SELECT DATA** tab (Fig. A.43).

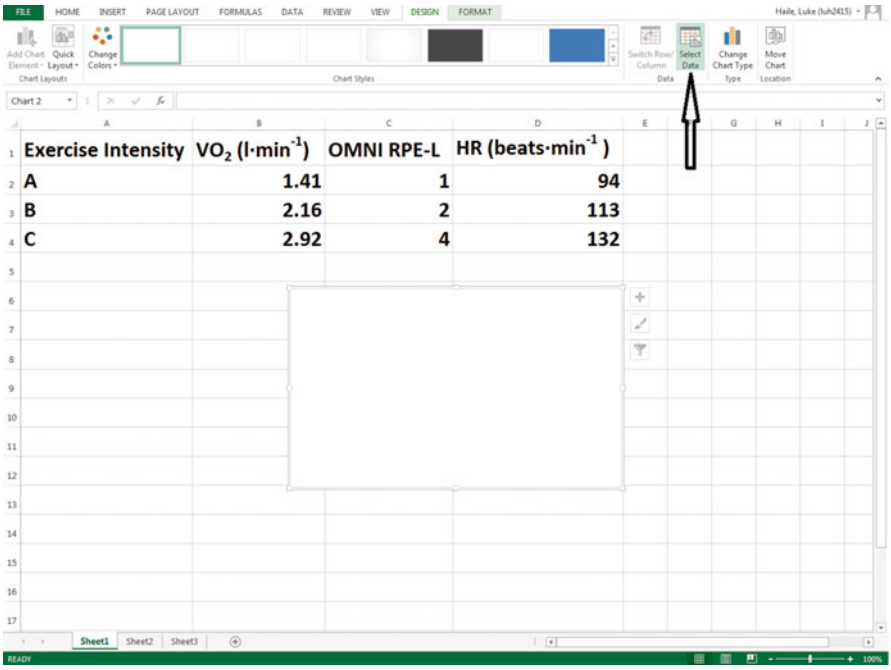

Fig. A.43 ∎

(c) Remove any entries found in the **LEGEND ENTRIES** text box then click **ADD** (Fig. A.44).

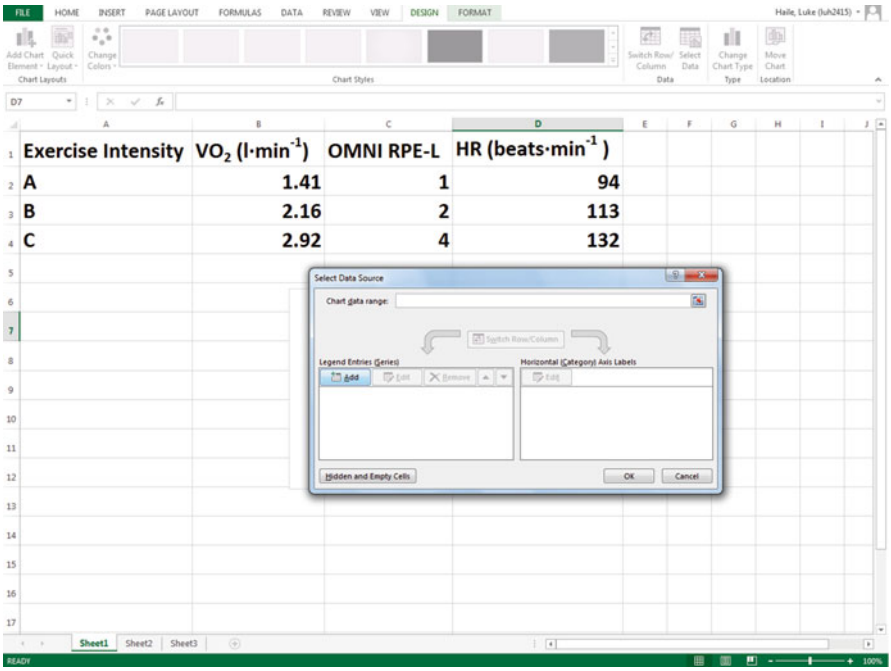

Fig. A.44 ∎

(d) Under **SERIES NAME**, enter VO_2 and OMNI RPE-L. Then click on the icon to the right of the **SERIES X VALUES** text box and highlight the OMNI RPE-L values. After the values are highlighted click the icon on the box that appeared (Fig. A.45).

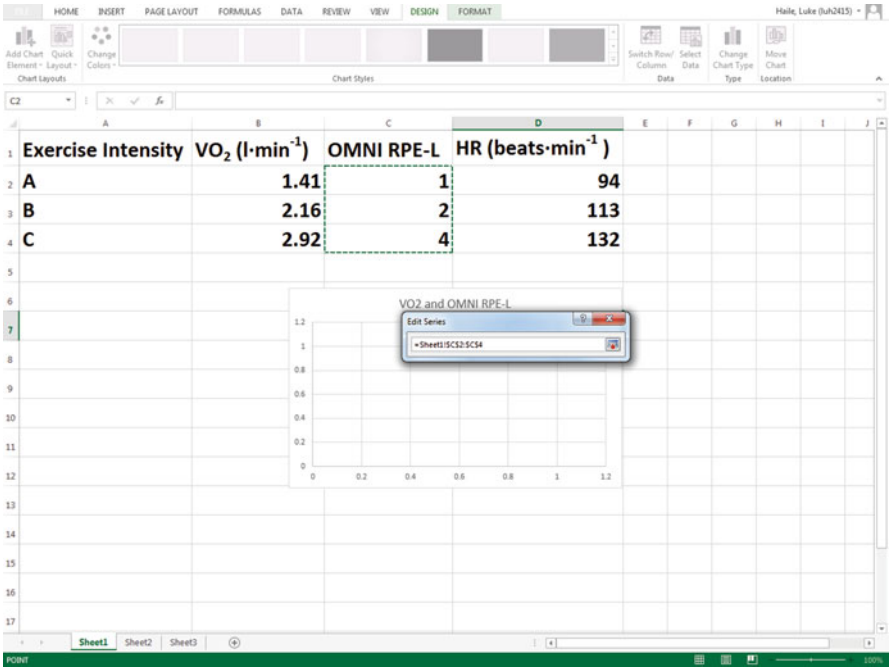

Fig. A.45 ∎

(e) Then click on the icon to the right of the **SERIES Y VALUES** text box and highlight the VO_2 values. After the values are highlighted click the icon on the box that appeared (Fig. A.46).

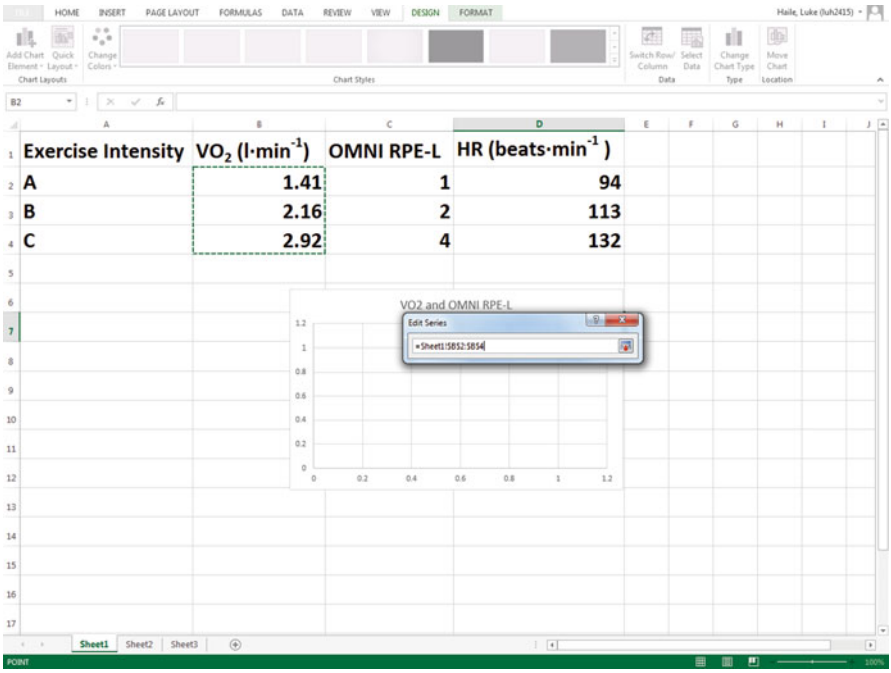

Fig. A.46 ∎

(f) Click **OK** on the next two screens. You should now have a scatter plot with VO_2 on the *y*-axis and OMNI RPE-L on the *x*-axis (Fig. A.47).

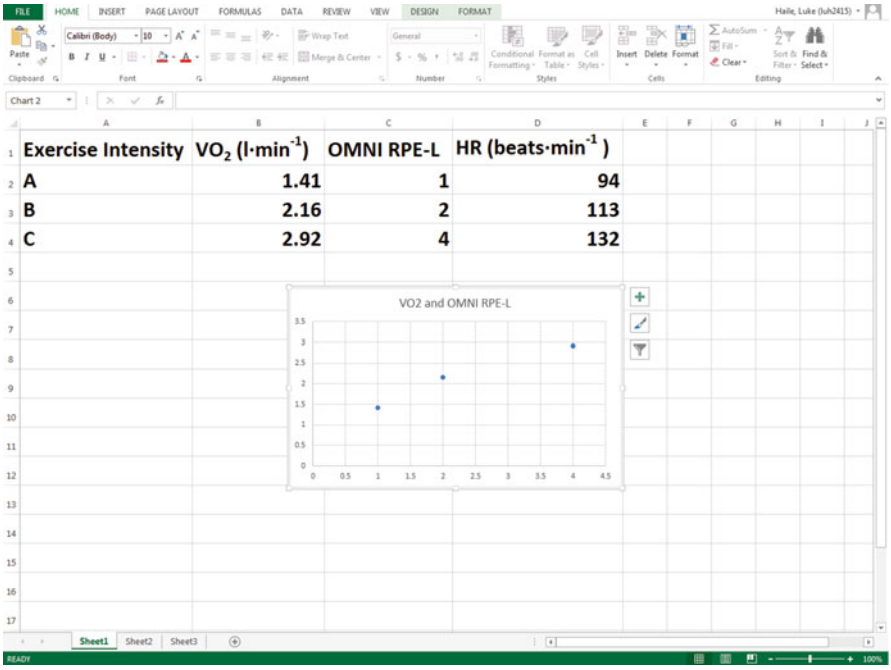

Fig. A.47 ∎

(g) To determine the equation from which VO_2peak will be predicted, click on one of the data points to highlight the entire data series. Right click on one of the data points and a menu will appear. Click **ADD TRENDLINE** and the **FORMAT TRENDLINE** menu will appear. Select **LINEAR** and **DISPLAY EQUATION ON CHART** then click **CLOSE**. The trendline and its linear equation will be displayed on the chart. Use this linear equation to calculate RPE-VT. Use VO_2 ($l \cdot min^{-1}$) corresponding to the VT as the "x" value in the equation and solve for "y." The calculated "y" value is the Borg RPE-VT (Fig. A.48).

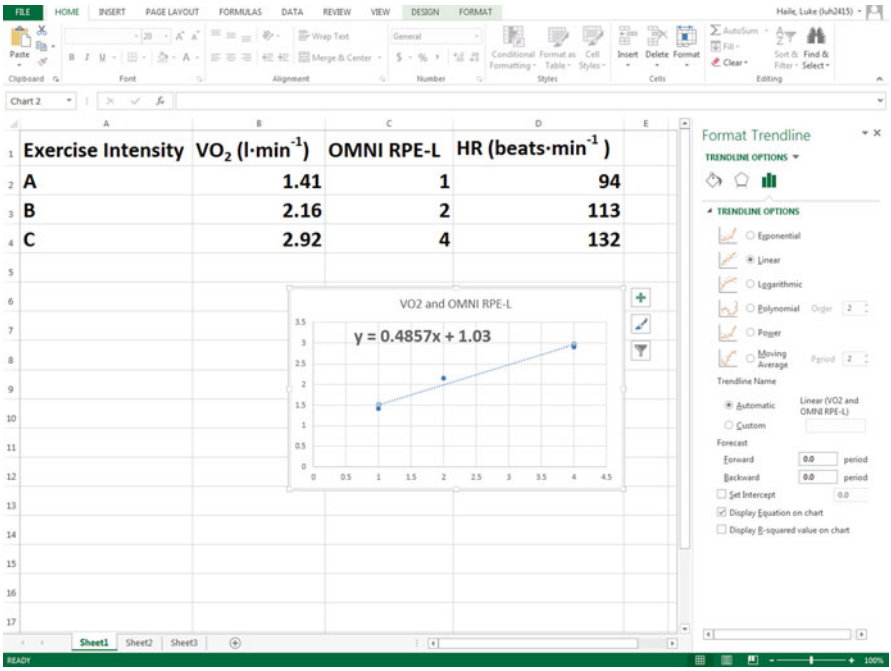

Fig. A.48 ∎

Appendix F
Advanced Perceived Exertion Scaling Procedure for Use Prior to an RPE-Based, Interval Exercise Program

For cycle exercise, the low intensity bout begins with unloaded pedaling and subsequently increases in power output every 15 or 30 s. The client provides RPE just prior to each power output increase until moderate intensity is reached, identified by a rating of 5–6 on the OMNI Scale or 11–13 on the Borg Scale. If the client shows physiological signs of moderate to high intensity exercise, such as increased rate of breathing or heart rate, yet continues to rate exertion levels as low, further discussion about the link between RPE and physiological intensity may be necessary. Then, to further test the subject's understanding, he/she is asked to produce a specific level of perceived exertion on the cycle. The test administrator decides on a specific target RPE, from two to four on the OMNI Scale, and then instructs the client to adjust the power output until the intensity of cycling produces an exertion level equal to that specific RPE. The subject should be allowed to adjust the intensity for 1 or 2 min before the power output is checked for accuracy. If the intensity chosen does not match the intensity at which the client previously rated that particular RPE, additional practice and feedback may be necessary. However, if the intensity chosen matches the intensity at which the client previously reported that particular RPE, provide him/her with positive reinforcement and continue with the next phase.

For the moderate intensity phase, begin the load-incremented bout at the low intensity that the client previously produced and increase power output every 15 or 30 s. The client provides RPE just prior to each power output increase until high intensity is reached, identified by a rating of 8 on the OMNI Scale or 17–18 on the Borg Scale. If the client terminates exercise due to fatigue yet rates exertion levels as moderate, further discussion about RPE and maximal physiological intensity may be necessary. For some clients, especially those who may not have performed maximal exercise previously, the experience of maximal exercise facilitates their ability to rate exertion levels at moderate intensities of exercise. For the production bout at moderate intensity, RPE's from 5 to 7 on the OMNI Scale are appropriate. This bout is important to determine if additional practice and feedback may be necessary to rate exertion accurately at moderate exercise intensity.

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For the high/maximal intensity phase, begin the load-incremented bout at the intensity the client previously produced in the moderate phase and subsequently increase power output every 15 or 30 s until volitional termination owing to fatigue. Similar to the standard exercise anchoring procedure, instruct the subject to assign a maximal RPE value (10 on the OMNI Scale, 20 on the Borg Scale) to that intensity. Minimal rest (approximately 2 min) is necessary between phases and between load-incremented and production bouts within phases. However, ample rest sufficient for complete or near complete recovery is advised between advanced exercise anchoring and subsequent administration of aerobic fitness testing. For unfit and/or sedentary individuals, advanced exercise anchoring and aerobic fitness testing may need to be performed on separate days.

Glossary

Cardiorespiratory fitness The ability to perform dynamic exercise of a moderate to vigorous intensity using large muscle groups for a prolonged period; this fitness measurement is dependent upon the functional capacity of the cardiovascular and respiratory systems and the oxidative capacity of skeletal muscle.

Differentiated RPE RPE used to estimate the level of exertion for a specific anatomical region of the body, such as the chest/breathing (RPE-C), arms (RPE-A), legs (RPE-L), or active muscle mass (RPE-AM).

Estimation–production paradigm A perceptually based exercise prescription procedure whereby both the estimation and production test protocols are used to prescribe and self-regulate exercise intensity according to a target RPE or RPE zone.

Estimation protocol A research procedure used in perceived exertion scale validation studies involving a graded exercise test during which RPE and physiological responses are measured for each progressive exercise test stage, with intensity ranging from very low through maximal.

Exercise anchoring A procedure whereby the individual links the perception of exertion experienced while actually performing a very low exercise intensity and when performing a very high exercise intensity with the low and high anchor points on the perceived exertion scale, respectively.

Exercise intensity self-regulation error When an individual is not accurately self-regulating exercise intensity at a target RPE such that the physiological responses (VO_2, HR) during the production trial are different from those that were observed at the same target RPE during the estimation trial.

Exertional recall An estimate of the RPE for a bout of exercise or physical activity performed at least 1 week prior; may be included as part of a physical activity questionnaire.

Group-normalized perceptual response A range of RPE's that corresponds to a target physiological outcome during exercise and that is common to a specified group of individuals.

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Imposed exercise intensity When an individual performs a prescribed exercise intensity based on physical units (W), ergometer settings (speed/grade, intensity settings) or physiological measures (HR, VO_2) which has been determined by the health-fitness professional or exercise test administrator.

Intensity discrimination The ability to perceptually differentiate between separate target RPE's such that physiological responses are different between different self-regulated conditions.

Just noticeable difference in perceived exertion (perceived exertion JND) The smallest amount of change in a stimulus (exercise intensity), expressed in physiological (VO_2) or physical (PO) units, necessary to elicit a change in sensation (perception of physical exertion).

Maximal Aerobic Power (VO_2max/peak) The maximum amount of oxygen that can be consumed while breathing ambient air during load-incremented aerobic exercise at sea level; the terms maximal aerobic power and maximal or peak oxygen uptake (VO_2max/peak) can be used interchangeably.

Memory anchoring A procedure used to acquaint the user with the level of exertion perceived at the low and high anchor points of a category RPE scale.

Momentary RPE The acute level of perceived exertion rated at the moment the individual is asked during exercise or PA; also referred to as in-task or on-stimulus RPE.

Muscular strength, dynamic The ability of a muscle or muscle group to exert force using concentric or eccentric muscular action resulting in the movement of a resistance.

One-repetition maximum (1RM) The maximal amount of force that can be produced during a single contraction of a muscle or muscle group through the full range of motion.

Pacing Strategy The self-selected exercise pace or tactic that an athlete adopts, usually at the beginning of an event or competition, to ensure optimal metabolic requirements and performance outcomes.

Perceived exertion The subjective intensity of effort, strain, discomfort, and/or fatigue that is experienced during exercise and physical activity.

Perceptual augmenter A perceptual outlier who provides RPE values greater than what is appropriate based on a given physiological and/or physical marker of exercise intensity and may assign a maximal or near-maximal RPE to submaximal exercise intensity.

Perceptual outlier An individual who provides inappropriate RPE values that do not conform to the predictions of Borg's Range Model.

Perceptual reducer A perceptual outlier who provides RPE values less than what is appropriate based on a given physiological and/or physical marker of exercise intensity and may assign a submaximal RPE to maximal exercise intensity.

Prescription congruence When physiological responses (VO_2, HR) corresponding to a specific target RPE are similar between the estimation trial and production trial at a given submaximal intensity.

Predicted RPE A global estimate of the expected RPE for an entire bout of exercise or PA rated prior to performance of that activity.

Production protocol An exercise bout during which an individual self-regulates exercise intensity to produce a specific target RPE.

RPE warning zone A range of RPE's that indicate impending graded exercise test termination and, as such, the initiation of preliminary procedures to safely end the exercise test.

Segmented session RPE A global estimate of the average RPE experienced for a specific segment (time-period) of a bout of exercise or PA but rated after performance of that activity.

Self-selected exercise intensity When an individual performs exercise at a preferred intensity during which self-adjustment of ergometer settings are allowed.

Session RPE A global estimate of the average RPE experienced for an entire bout of exercise or PA but rated after performance of that activity.

Target RPE or target RPE range One RPE or a range of RPE's that indicate the level(s) of exertion to be achieved by self-regulating exercise intensity using a production perceptual protocol.

Teleoanticipation A sensory nervous system comprised of both feed-forward and feedback perceptual-cognitive information regarding muscle fiber recruitment and firing frequency during exercise performance; in this system the magnitude and frequency of efferent (i.e., descending) motor signals associated with previous exercise performance are stored in the sensory cortex; this information is further augmented by afferent signals reflecting the metabolic and biomechanical limits of muscular performance; subsequently, the stored perceptual-cognitive information is recalled to shape the upper limits of exercise performance as set by peak tolerable perceptual limits of heavy muscular exercise.

Undifferentiated RPE RPE used to estimate the level of exertion for the overall body, often referred to as RPE-O.

Validity The degree to which a test or test item measures the construct it is intended to measure.

Validity, concurrent (general definition) The extent to which test scores are associated with those of other accepted tests when both measures are obtained along a common stimulus range.

Validity, concurrent, of a perceived exertion scale The extent to which RPE are associated with accepted physical and physiological markers of exercise intensity across an individual's full physiological range.

Validity, construct (general definition) The ability of a test to represent the underlying construct.

Validity, construct, of a perceived exertion scale The extent to which RPE from a newly developed perceived exertion scale are associated with RPE derived from a perceived exertion scale for which concurrent validity has been previously established.

Ventilatory threshold (VT) Also known as the ventilatory breakpoint, can be defined as the point during exercise of increasing intensity when pulmonary ventilation begins to increase at a rate disproportionately faster than that of oxygen consumption; the respiratory analog to the lactate threshold (both commonly called the anaerobic threshold).

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