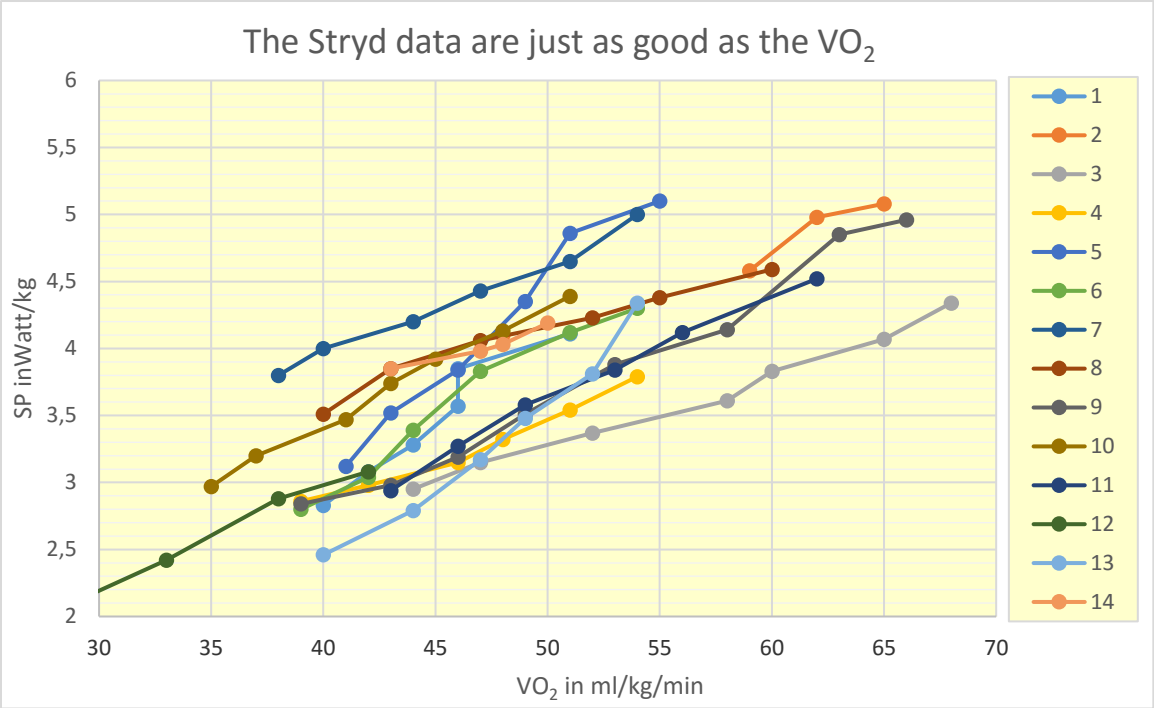
4. The energy cost of running (ECR) of 14 test persons

How good and reliable is the Stryd?

In previous papers , we have described our treadmill research in the physiological laboratory of the Dutch Sports Medical Center SMA Midden Nederland. In the test 14 runners (including authors Hans and Ron) were tested in a standard exercise stress test on a treadmill. The test started at a relatively low speed, which was stepwise increased every 3 minutes. Using breathing gas analysis we measured the VO_2 (in ml O_2/kg/min) as function of the treadmill speed. Simultaneously, with the Stryd Pioneer, we measured the specific power (SP, in Watt/kg) as a function of the treadmill speed. The picture shows author Hans and the measuring equipment with Guido Vroemen behind the monitors.

The results were quite convincing, as we found that the both data sets (the SP and the VO_2) were quite comparable. We found that an increase of the treadmill speed resulted in a consistent and similar increase of both the SP (in Watt/kg) and the VO_2 (in ml O_2/kg/min). The results of our measurements are presented in the graph below.



Based on the comparable results, we concluded that in general the Stryd data are just as good as the VO_2. This means that runners can now use their daily power data as an alternative to the once-a-year laboratory measurement of their VO_2.

However, the graph also shows notable differences between the results of individual runners. These differences may be caused by a combination of the following factors:

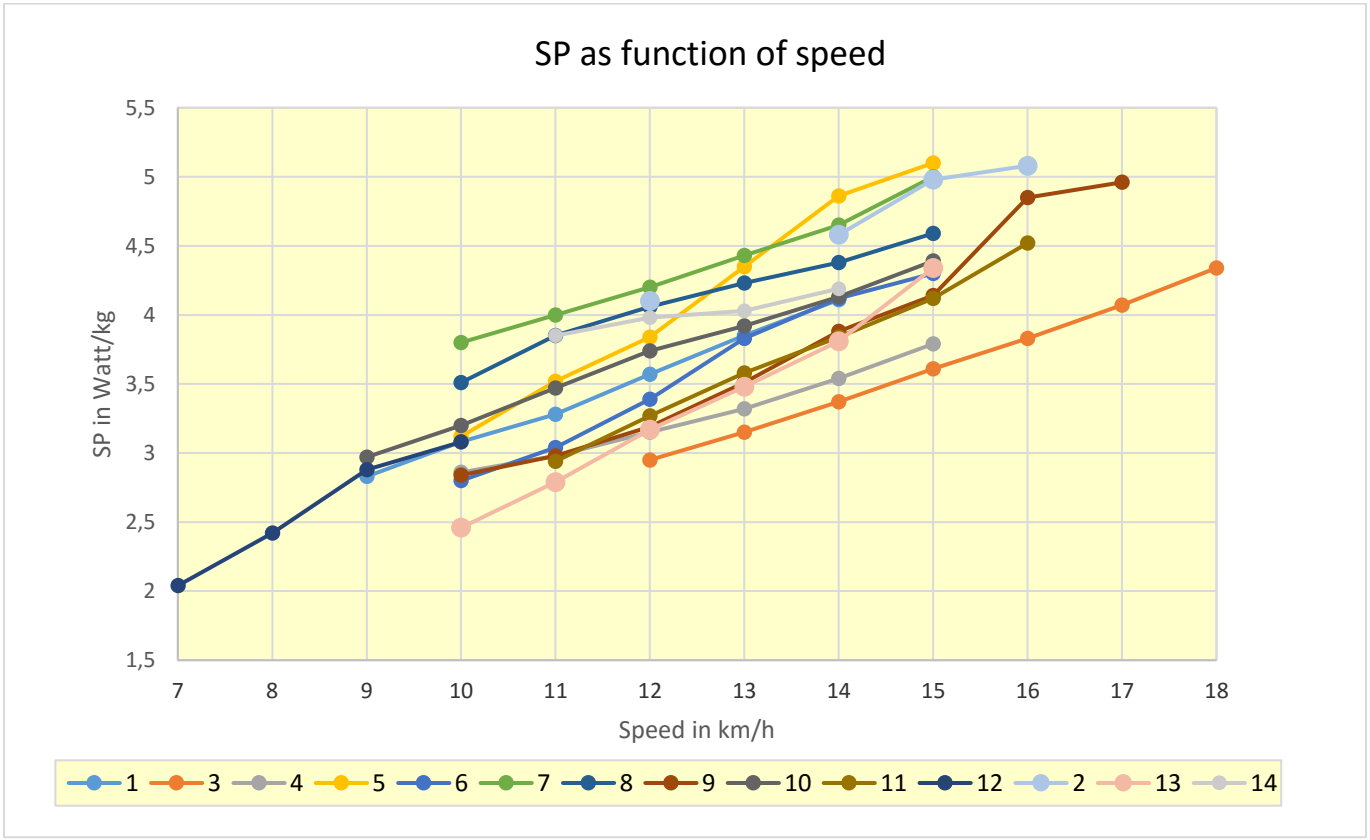
1. Differences in the VO_2 measurements and the running economy RE (the amount of oxygen a runner uses to run 1 km, the unit is ml O_2/kg/km). It is well-known that the RE of runners may vary, depending on running style and form.
2. Differences in the SP-measurements and the energy cost of running ECR (the amount of mechanical energy a runner uses to run 1 km, the unit is kJ/kg/km). Just like the RE, also the ECR of runners may vary, depending on running style and form.
3. Differences in the metabolic efficiency ME (the efficiency of the runner to convert his metabolic energy stores into mechanical energy). Differences in the fuel mix in the muscles will also have an impact. At higher speed, the muscles will depend more on glycogen which produces more energy that fatty acids.

In three separate papers, we will analyze these 3 factors. This paper deals with the SP-data and the ECR.

The SP data

From the Stryd power measurements and the body weight of the runners, the specific power (SP, in Watt/kg) was calculated. The SP data of the 14 test runners are presented in the table and graph below.

SP as function of speed														
v	1	2	3	4	5	6	7	8	9	10	11	12	13	14
km/h	65 kg	50 kg	59 kg	85 kg	81 kg	69 kg	69 kg	71 kg	57 kg	104kg	83 kg	78 kg	58 kg	80 kg
7												2.04		
8												2.42		
9	2.83									2.97		2.88		
10	3.08			2.86	3.12	2.80	3.80	3.51	2.84	3.20		3.08	2.46	
11	3.28			2.98	3.52	3.04	4.00	3.85	2.98	3.47	2.94		2.79	3.85
12	3.57	4.10	2.95	3.15	3.84	3.39	4.20	4.06	3.19	3.74	3.27		3.17	3.98
13	3.85		3.15	3.32	4.35	3.83	4.43	4.23	3.51	3.92	3.58		3.48	4.03
14	4.11	4.58	3.37	3.54	4.86	4.12	4.65	4.38	3.88	4.13	3.84		3.81	4.19
15		4.98	3.61	3.79	5.10	4.30	5.00	4.59	4.14	4.39	4.12		4.34	
16		5.08	3.83						4.85		4.52			
17			4.07						4.96					
18			4.34											



In general the data seem consistent and logical, as the SP increases linearly with speed in all runners. However, the differences between individuals seem a bit larger than for the VO_2 measurements (see previous paper). This will be discussed more in detail in the section on the Energy Cost of Running (ERC) below.

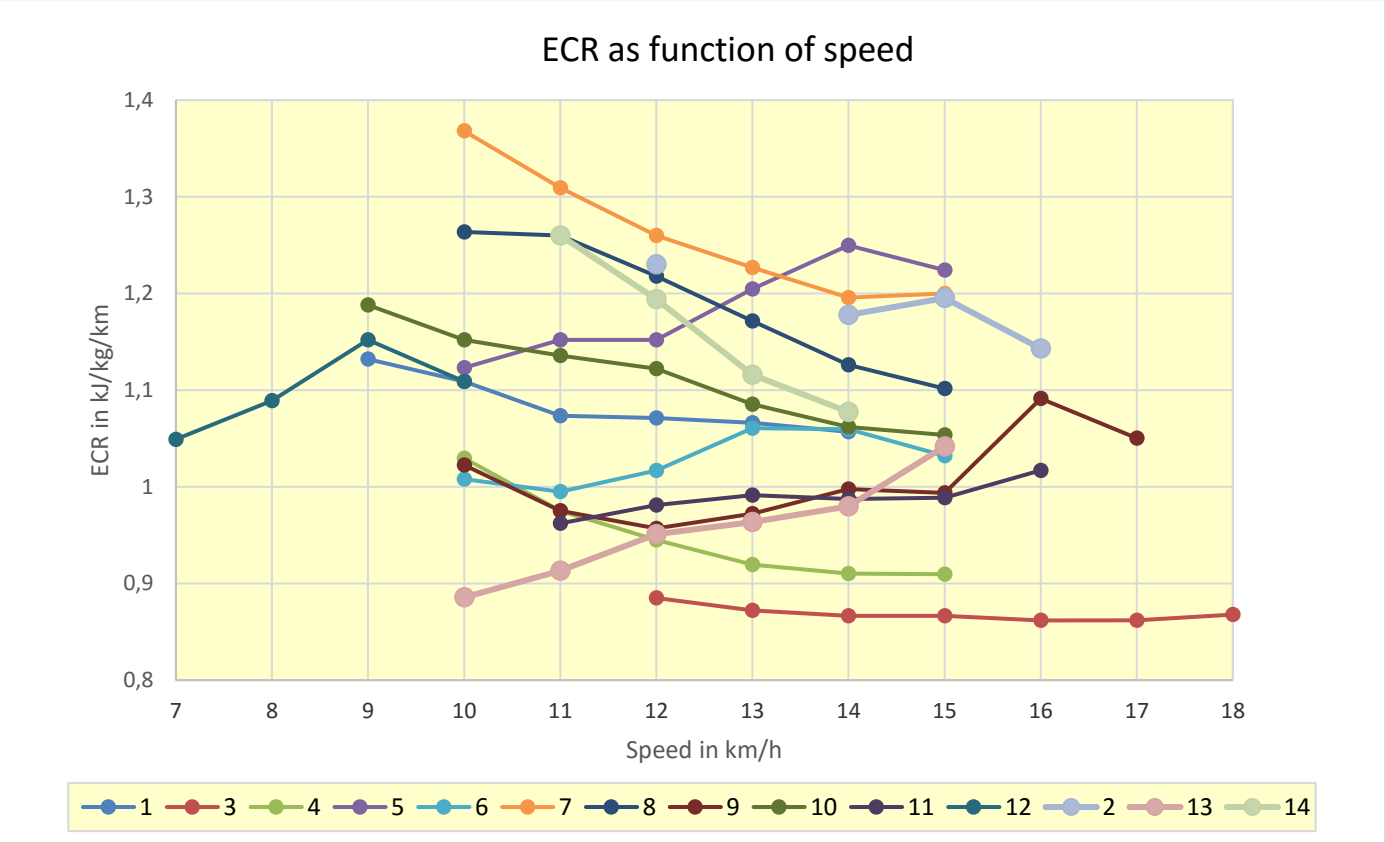
The ECR

The ECR can be calculated from the SP data (in Watt/kg) and the speed v (in m/s) by the following formula:

ECR = SP/v

The ECR of the 14 test runners are presented in the table and graph below.

ECR as function of speed															
v	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Avg
km/h	65 kg	50 kg	59 kg	85 kg	81 kg	69 kg	69 kg	71 kg	57 kg	104kg	83 kg	78 kg	58 kg	80 kg	
7												1.05			1.05
8												1.09			1.09
9	1.13									1.19		1.15			1.16
10	1.11			1.03	1.12	1.01	1.37	1.26	1.02	1.15		1.11	0.89		1.11
11	1.07			0.98	1.15	0.99	1.31	1.26	0.98	1.14	0.96		0.91	1.26	1.09
12	1.07	1.23	0.89	0.95	1.15	1.02	1.26	1.22	0.96	1.12	0.98		0.95	1.19	1.08
13	1.07		0.87	0.92	1.20	1.06	1.23	1.17	0.97	1.09	0.99		0.96	1.12	1.05
14	1.06	1.18	0.87	0.91	1.25	1.06	1.20	1.13	1.00	1.06	0.99		0.98	1.08	1.06
15		1.20	0.87	0.91	1.22	1.03	1.20	1.10	0.99	1.05	0.99		1.04		1.06
16		1.14	0.86						1.09		1.02				1.03
17			0.86						1.05						0.96
18			0.87												0.87
Avg	1.08	**1.19**	0.87	0.95	**1.18**	1.03	**1.26**	**1.19**	1.01	1.11	0.99	1.10	0.96	1.16	**1.05**



From the table and the graph we conclude that the average ECR of our 14 runners was 1.05 kJ/kg/km (range 0.87-1.26). Just like the RE this is higher than reported in literature for elite runners. In our book The Secret of Running (www.thesecretofrunning.com), we have shown that the average literature value is 0.98 kJ/kg/km. Extremely economical Kenyan and Ethiopian runners, such as Wilson Kipsang, may have an RE as low as 0.80 ml/kg/km. So, once again, we have to conclude that our test runners did NOT run very economically. This makes sense as our test persons were not elite runners.

Looking more closely at the data, we see that in particular runners 2, 5, 7 and 8 have a high ECR (indicated in bold). For runner 2 this seems logical, as this runner also has a high RE (see previous paper). For the other 3 runners, we cannot rule out a measuring error. This might have been caused by the well-known impact of a too low position of the Stryd chest-band. Many runners have experienced this impact which will probably be caused by the chest movement during breathing. These 3 runners had the highest ECR of 1.18, 1.26 en 1.19. When we exclude these suspicious results, the average ECR of our runners was 1.04 (range between 0.87 and 1.16). This ECR is 6% higher than the average literature value of elite runners.
Consequently, it would be a challenge for our runners to try to improve their running style and reduce their ECR; if they could achieve this, they might run up to 6% faster.

Discussion and conclusions

We determined the ECR of 14 test runners from the SP measurements during a treadmill test at a physiological laboratory. The average ECR of the 14 runners was 1.05 kJ/kg/km (range 0.87-1.26). This is rather high as compared to reported values in literature (average 0.98 kJ/kg/km). So, our (recreational) runners were NOT economical, as compared to elite runners. We feel that the high ECR data of 3 runners may have been influenced by a measuring error, due to a too low position of the Stryd chest band. When we exclude these suspicious results, the average ECR of our runners was 1.04 (range between 0.87 and 1.16). This ECR is 6% higher than the average literature value of elite runners.
Consequently, it would be a challenge for our runners to try to improve their running style and reduce their ECR; if they could achieve this, they might run up to 6% faster.

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www.thesecretofrunning.com