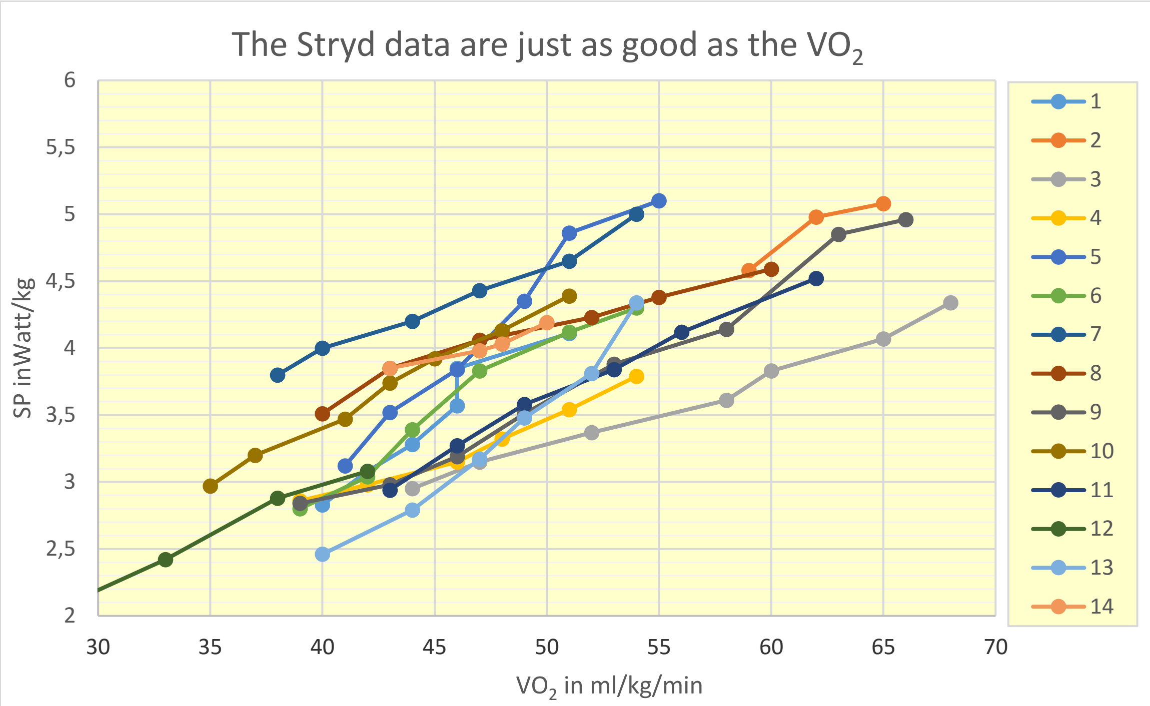
3. The running economy (RE) of 14 test persons

How good and reliable is the Stryd?

In a previous paper, 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:

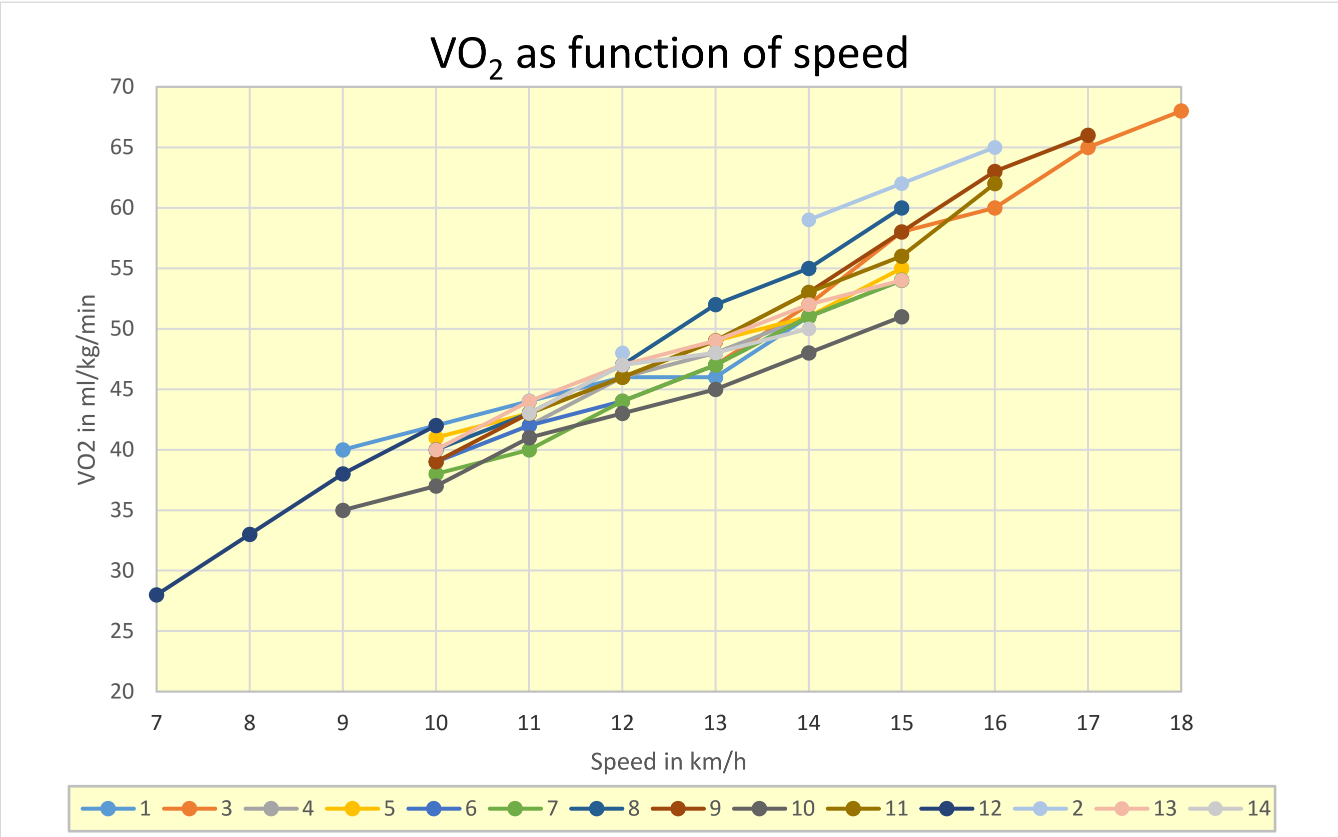
1. Differences in the VO_2 measurements and the running economy RE (the amount of oxygen a runner uses to run 1 km, the unit is ml O_2/kg/km). It is well-known that the RE of runners may vary, depending on running style and form.
2. Differences in the SP-measurements and the energy cost of running ECR (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 than fatty acids.

In three separate papers, we will analyze these 3 factors. This paper deals with the VO_2 measurements and the RE.

The VO_2 data

The VO_2 data of the 14 test runners are presented in the table and graph below.

VO_2 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												28		
8												33		
9	40									35		38		
10	42			39	41	39	38	40	39	37		42	40	
11	44			42	43	42	40	43	43	41	43		44	43
12	46	48	44	46	46	44	44	47	46	43	46		47	47
13	46		47	48	49	47	47	52	49	45	49		49	48
14	51	59	52	51	51	51	51	55	53	48	53		52	50
15		62	58	54	55	54	54	60	58	51	56		54	
16		65	60						63		62			
17			65						66					
18			68											



From the consistency of the data, we can conclude that outliers seem to be absent. This confirms that the VO_2 measurements are quite reliable and systematic measuring errors are small. Most likely, the differences in the data of the individual runners are caused by differences in RE and ME.

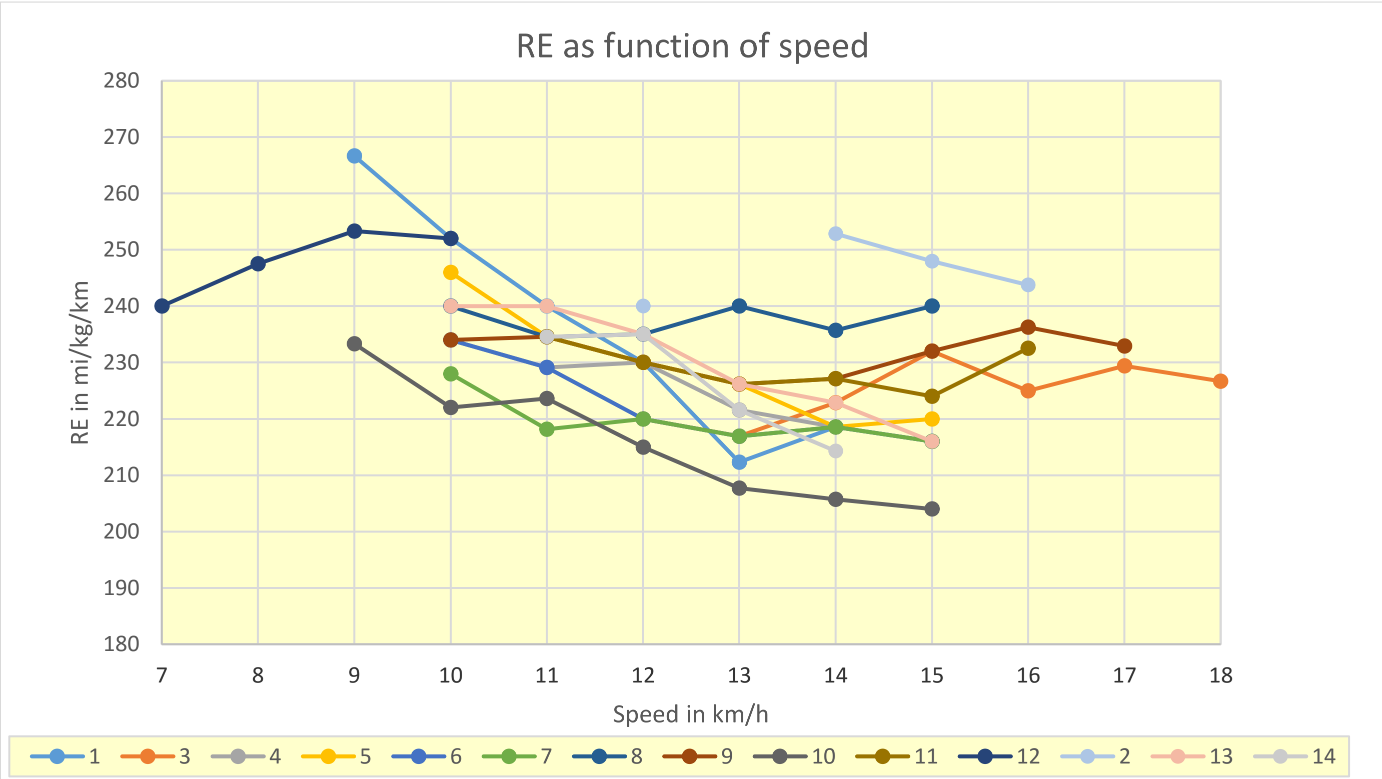
The RE

The RE can be calculated from the VO_2 data (in ml/kg/min) and the speed v (in km/min) by the following formula:

RE = VO_2/v

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

RE 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												240			240
8												248			248
9	267									233		253			251
10	252			234	246	234	228	240	234	222		252	240		238
11	240			229	235	229	218	235	235	224	235		240	235	232
12	230	240	220	230	230	220	220	235	230	215	230		235	235	228
13	212		217	222	226	217	217	240	226	208	226		226	222	222
14	219	253	223	219	219	219	219	236	227	206	227		223	214	223
15		248	232	216	220	216	216	240	232	204	224		216		224
16		244	225						236		233				234
17			229						233						231
18			227												227
Avg	237	**246**	225	225	229	222	220	238	231	218	229	**248**	230	226	233



From the table and the graph we conclude that the average RE of our 14 runners was 233 ml/kg/km (range 218-248). This is a rather high number, when we compare it to literature. In our book The Secret of Running (www.thesecretofrunning.com), we have shown that in literature on average a value of 201 ml/kg/km has been reported. Extremely economical Kenyan and Ethiopian runners, such as Wilson Kipsang, have been reported to have an RE as low as 180 ml/kg/km. Obviously, this means that our test runners needed almost 30% more oxygen to run at the same speed as Kipsang! So, 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 and 12 (indicated in bold) had a relatively high RE. We do not believe that these are caused by experimental errors as these data have been reproduced in other tests. Consequently, the explanation should be either a high ECR (meaning that the runner uses too much mechanical energy, e.g. due to excessive lateral and vertical movements) of a low ME (meaning that the runner's body is not very efficient is converting the metabolic energy stores into mechanical energy). In later papers we will discuss these explanations more in depth.

Discussion and conclusions

We determined the RE of 14 test runners from the VO_2 measurements during a treadmill test at a physiological laboratory. The average RE of the 14 runners was 233 ml/kg/km (range 218-248). This is rather high as compared to reported values in literature (average 210, as low as 180 for extremely economical elite runners). So, our (recreational) runners were NOT economical, as compared to elite runners. We do not believe that significant experimental errors occurred, so the explanation should be either a high ECR (meaning that the runner uses too much mechanical energy, e.g. due to excessive lateral and vertical movements) of a low ME (meaning that the runner's body is not very efficient is converting the metabolic energy stores into mechanical energy). In later papers we will discuss these explanations more in depth.

Hans van Dijk, Ron van Megen and Guido Vroemen

www.thesecretofrunning.com