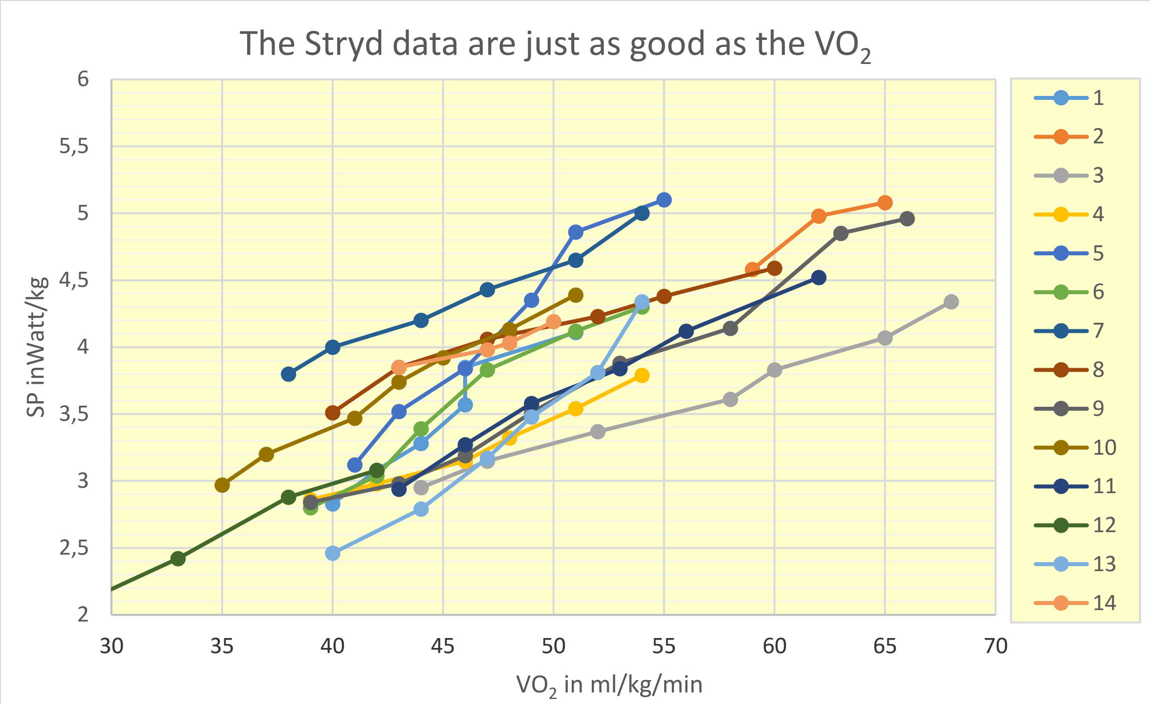
5. The metabolic efficiency (ME) of 14 test persons

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 K, 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 ME-data.

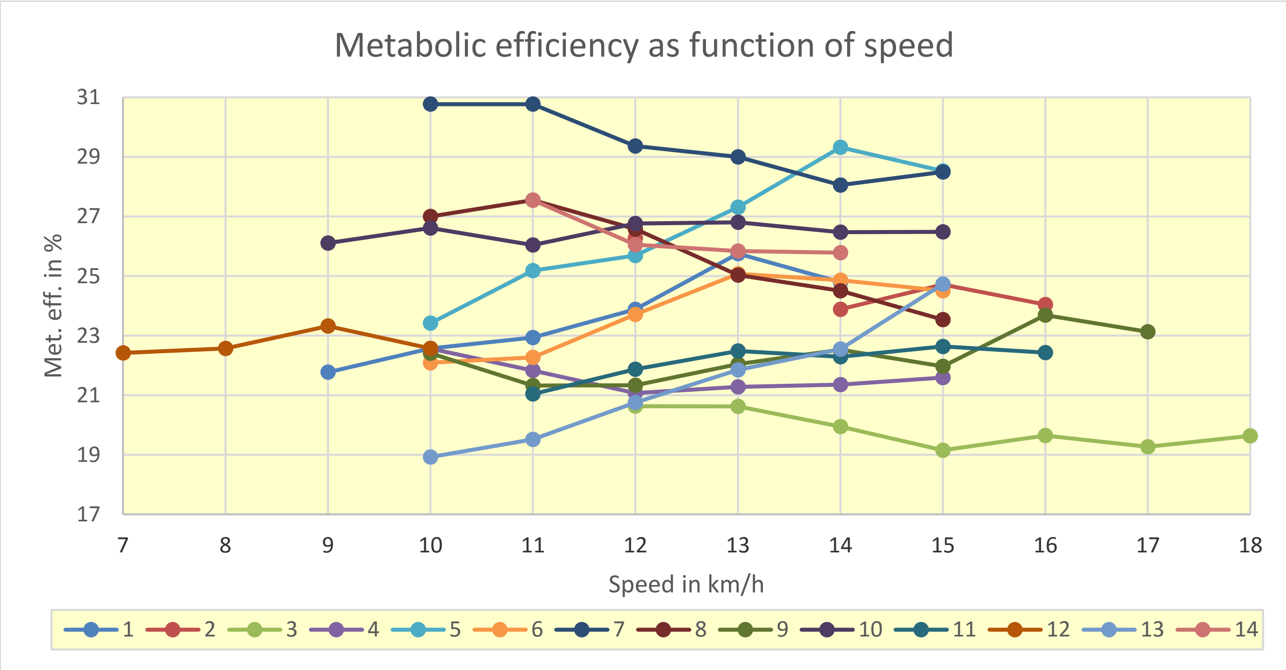
The ME data

From the SP (in Watt/kg) and the VO_2 measurements of the runners, the ME can be calculated with the following formula:

$ME = 100*SP/(VO_2*19.5*60)$

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

ME as function of speed															
v	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Avg
				85	81	69	69	71	57		83	78	58	80	
km/h	65 kg	50 kg	59 kg	kg	kg	kg	kg	kg	kg	104kg	kg	kg	kg	kg	
7												22.4			22.4
8												22.6			22.6
9	21.8									26.1		23.3			23.7
10	22.6			22.6	23.4	22.1	30.8	27.0	22.4	26.6		22.6	18.9		23.9
11	22.9			21.8	25.2	22.3	30.8	27.5	21.3	26.0	21.0		19.5	27.5	24.2
12	23.9	26.3	20.6	21.1	25.7	23.7	29.4	26.6	21.3	26.8	21.9		20.8	26.1	24.2
13	25.8		20.6	21.3	27.3	25.1	29.0	25.0	22.0	26.8	22.5		21.9	25.8	24.4
14	24.8	23.9	19.9	21.4	29.3	24.9	28.1	24.5	22.5	26.5	22.3		22.5	25.8	24.3
15		24.7	19.2	21.6	28.5	24.5	28.5	23.5	22.0	26.5	22.6		24.7		24.2
16		24.0	19.6						23.7		22.4				22.5
17			19.3						23.1						21.2
18			19.6												19.6
ME	23.6	24.7	19.8	21.6	**26.6**	23.7	**29.6**	**25.7**	22.3	26.5	22.1	22.7	21.4	26.3	**24.1**



In general the ME data seem logical and in the expected range. From the table and the graph we conclude that the average ME of our 14 runners was 24.1% (range 19.8-29.6%). In our book The Secret of Running (www.thesecretofrunning.com) , we have shown that from literature on average a value of no more than 25% could be expected.

Looking more closely at the data, we see that in particular runners 5, 7 and 8 have a suspiciously high ME (indicated in bold). This confirms our earlier hypothesis that the Stryd data for these runners have been too high (probably as a result of a too low placement of the chest band). When we exclude these outliers, the average ME of our runners was 23.2% (range 19.8-26.3%). Another interesting conclusion is that the ME for runners 2 and 12 are 'normal' (24.7% and 22.7%). Please note that these runners had both a high RE (246 and 248 ml/kg/km) and a high ECR (1.19 and 1.10

kJ/kg/km). So, for these runners we can conclude that their running style is definitely NOT economical. The high values are not caused by a low ME.

Impact of fuel mix

It can be expected that the fuel mix in the muscles has an impact on the ME. It is well known that the energy production from glycogen is higher than from fatty acids (19.8 vs 17.6 kJ/l O_2, in the table above we calculated with an average value of 19.5). At low speeds the fuel mix in the muscles may contain up to 50% of fatty acids, whereas at high speeds the fuel mix contains almost more than 90% of glycogen. This means that a higher speeds the fuel mix shifts and more energy is produced, so the calculated ME might increase a bit. For most runners, the experimental data seem to confirm this, although the impact in our runners seems to be small.

Discussion and conclusions

We determined the ME of 14 test runners from the SP and VO_2 measurements during a treadmill test at a physiological laboratory. The average ME of the 14 runners was 24.1% (range 219.8-29.6%). From literature a value of around 25% can be expected. The data of runners 5, 7 and 8 are suspiciously high (25.7, 26.6 and 29.6%). This confirms that the Stryd data of these runners must have been wrong, probably due to too low placement of the chest band. When we exclude these outliers, the average ME of our runners was 23.2% (range 19.6-26.3%). Another interesting conclusion is that the ME for runners 2 and 12 are 'normal' (24.7% and 22.7%). Please note that these runners had both a high RE (246 and 248 ml/kg/km) and a high ECR (1.19 and 1.10 kJ/kg/km). So, for these runners we can conclude that their running style is definitely NOT economical. The high values are not caused by a low ME.

Overall conclusion on RE, ECR and ME of the 14 test runners

The average RE of our test runners was 233 ml/kg/km (range 218-248). Compared to the literature average of 201 ml/kg/km, this is 16% higher.
The average ECR of our test runners was 1.05 kJ/kg/km (range 0.95-1.26). Compared to the literature average of 0.98 kJ/kg/km, this is 7% higher.
The average ME of our test runners was 24.1 % (range 19.8-29.6%). Compared to the literature data of 25%, this is 4% lower.
The Stryd data of runners 5, 7 and 8 are probably too high, due to too low placement of the chest band. This explains both the high values of their ECR (1.18, 1.26 and 1.19) and their ME (26.6, 29.6 and 25.7).
The runners 2 and 12 have a low RE and ECR, so they do NOT run economically.

When we consider the ECR to be the decisive parameter determining the running speed and we exclude the outliers (runners 5, 7 and 8), then our runners had an average ECR of 1.04 or 6% higher than the elite runners from literature.
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.

Hans van Dijk, Ron van Megen and Guido Vroemen

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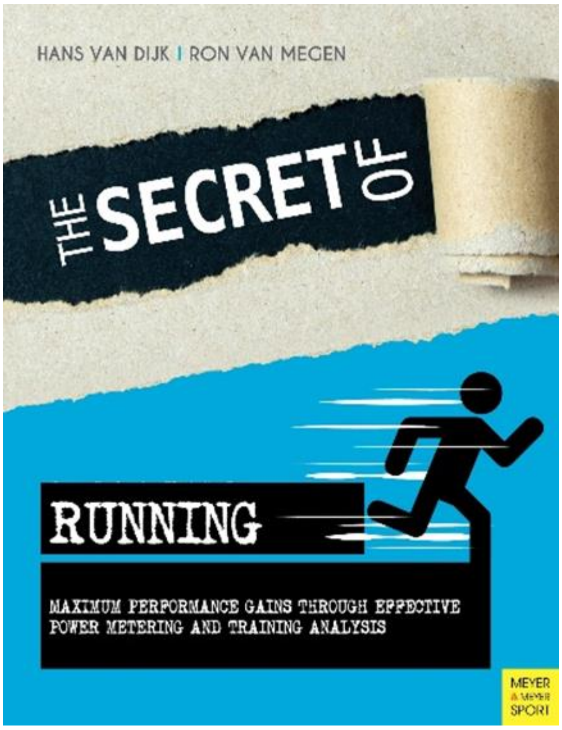
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