20. Impact of footing and fatigue on Energy Cost of Running (ECOR)

In our book (www.thesecretofrunning.com) we have discussed the Energy Cost of Running (ECOR) in several separate chapters.

First, we have shown that on a level and hard course, the ECOR is typically 0.98 kJ/kg/km. Of course, this number will not be the same for everyone: it depends on your body posture and your running style. Generally, it is believed that the ECOR of highly efficient elite runners could be as low as 0.90 kJ/kg/km, whereas the ECOR of inefficient joggers could be as high as 1.10 kJ/kg/km. So far, we have seen that our own data and those of many other runners are quite close to 1.00 kJ/kg/km.

Obviously, a lower ECOR means that you are running more efficiently and consequently you can run faster. So every runner should try to lower his ECOR! Unfortunately, we cannot change our body posture (apart from shedding excess body fat). The Kenyan elite runners share many advantages like slim calves and (relatively) long legs.

Calculate your ECOR

However, we can try to optimize our running style in order to lower our ECOR. The Stryd gives us the tool to do this as can calculate our ECOR on a daily basis:

ECOR (in kJ/kg/km) = Specific power (in Watt/kg) divided by the speed (in m/s)

This means that every day we can try to optimize our running style and see the impact on our ECOR. We suggest that you note the ECOR-value every day in your running spreadsheet. Now you need to collect a lot of data and relate the values of ECOR with your running form, so cadence, GCT, oscillation, stride length, etcetera. Remember that the conditions of the run (weather, footing) may also have an impact. Therefore we recommend that you collect data regularly at a standard training course to get reproducible results. This should enable you to recognize the conditions in which you are able to run most economically, i.e. with the lowest value of ECOR.

Impact of hills on ECOR

In our paper no. 17 (http://hetgeheimvanhardlopen.nl/wp-content/uploads/2017/02/17.-The-Energy-Cost-of-Running-on-hills.pdf) , we showed that uphill the ECOR is increased and downhill it is decreased. As it is always best to run at constant power, this means that uphill you should reduce your pace to maintain constant power. Uphill the reverse is the case.

Impact of cadence on ECOR

In our paper no. 18 (http://hetgeheimvanhardlopen.nl/wp-content/uploads/2017/02/18.-Run-efficient-lower-your-ECOR.pdf) , we showed that the ECOR can be reduced by increasing the cadence. Obviously, increasing the cadence will automatically also lead to a reduction in stride length, oscillation and Form Power.

Impact of wind on ECOR

In our paper no. 19 (http://hetgeheimvanhardlopen.nl/wp-content/uploads/2017/03/19.-The-impact-of-wind-on-ECOR-1.pdf) we showed that the Stryd power data do not reflect the additional air-resistance by the wind. Stryd is currently working on two possible solution to handle this and they may come up with a product later this year. At the moment, the best thing we can do is to use the theoretical calculations from our book to predict the required pace as a function of the wind speed and direction.

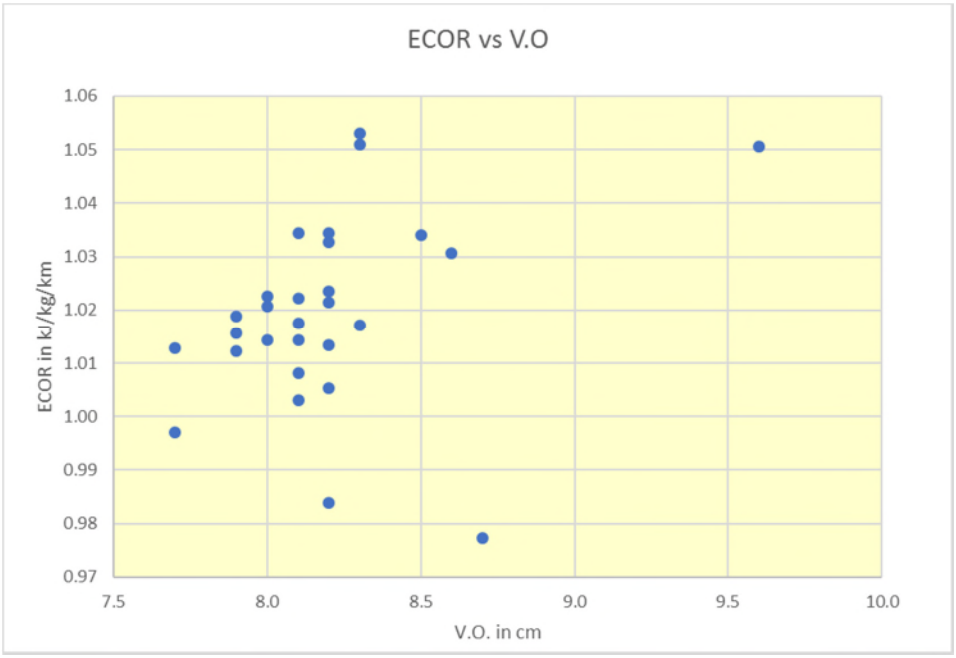
An experiment to test the impact of the footing and fatigue on ECOR

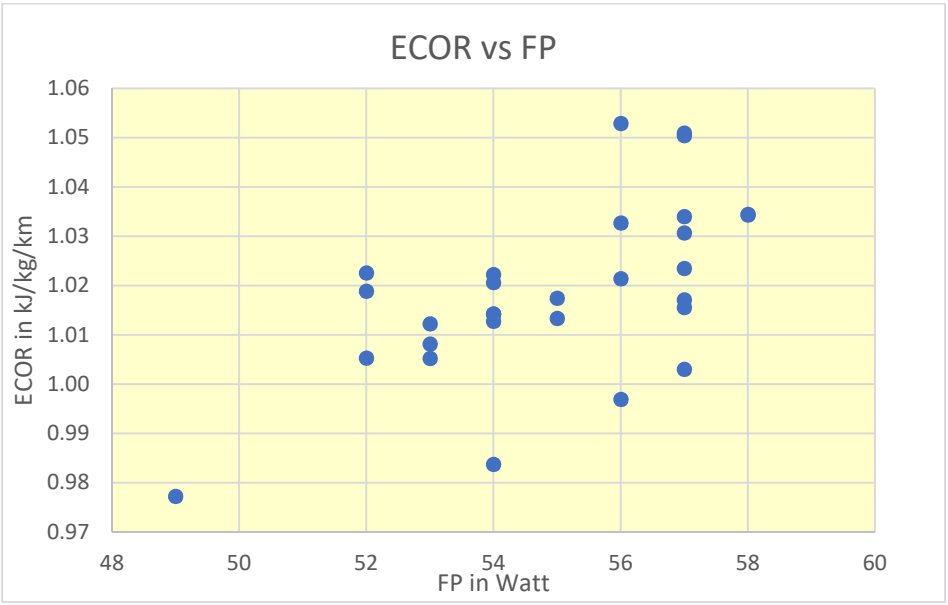
Authors Hans and Ron performed such an experiment on Sunday 06-03-2017. They went for an LSD training run of some 33 km. During this run they encountered different footings. Next to asphalt, the ran on an unpaved bike road, an even forest trail, crossed through loose of sand and some muddy trails. The course also included some hills and obviously they got tired toward the end of the 33 km. So, what was the impact of all these factors on the ECOR and the other running metrics? The results of author Hans are presented in the table below (the results of Ron were similar):

Results experiment footing 05-03-2017													
Distance	Pace Gar	Speed	Power	ECOR	Altitude	Footing	Cadance	Stride length	V.O.	GCT	FP	LSS	HR
km	min:sec/km	m/s	Watt	kJ/kg/km	m		spm	m	cm	msec	Watt	kN/m	bpm
1	06:23	2.61	148	0.98	-1	asphalt	175	0.90	8.7	268	49	9	110
2	05:43	2.92	170	1.01	-1	asphalt	177	0.99	8.2	258	52	8	120
3	05:38	2.96	173	1.01	3	asphalt	178	1.01	8.1	257	53	9	125
4	05:37	2.97	176	1.02	8	asphalt	179	1.00	8.0	255	52	8	128
5	05:32	3.01	178	1.02	3	asphalt	179	1.01	7.9	254	52	9	131
6	05:28	3.05	179	1.01	-2	asphalt	179	1.03	7.9	250	53	9	130
7	05:25	3.08	181	1.01	3	bike road	177	1.05	8.1	244	54	8	129
8	05:26	3.09	183	1.02	-3	forest trail	177	1.04	8.1	246	54	8	127
9	05:21	3.12	183	1.01	1	bike road	177	1.07	7.7	242	54	8	127
10	05:18	3.14	185	1.01	1	asphalt	177	1.07	8.0	243	54	8	131
11	05:19	3.13	185	1.02	-2	asphalt	176	1.07	8.1	243	55	8	130
12	05:16	3.16	186	1.01	3	asphalt	175	1.09	8.2	242	55	8	127
13	05:17	3.15	180	0.98	-6	forest trail	176	1.08	8.2	240	54	8	130
14	05:20	3.13	185	1.02	2	**sand**	176	1.07	8.0	233	54	8	**142**
15	05:12	3.27	196	1.03	-1	forest trail	175	1.11	**8.5**	236	**57**	9	**138**
16	05:11	3.22	196	**1.05**	**5**	**muddy trail**	174	1.11	**8.3**	236	**57**	9	132
17	06:01	2.77	179	**1.11**	**6**	**muddy trail**	**171**	0.98	**9.6**	243	**57**	8	133
18	05:54	2.82	194	**1.18**	**29**	**muddy trail**	176	0.98	**8.8**	245	52	8	133
19	05:33	3.00	186	**1.07**	-1	**muddy trail**	175	1.03	**8.6**	242	54	8	133
20	05:14	3.18	170	**0.92**	**-26**	**muddy trail**	175	1.10	**8.3**	241	56	9	128
21	05:16	3.16	179	**0.98**	**-12**	**muddy trail**	177	1.08	**8.4**	242	54	8	125
22	05:19	3.13	191	**1.05**	-2	**muddy trail**	176	1.07	**8.6**	240	**57**	9	127
23	05:13	3.19	191	1.03	2	asphalt	175	1.10	**8.3**	238	**56**	9	130
24	05:10	3.23	197	**1.05**	-2	**muddy trail**	175	1.11	**8.3**	238	**57**	9	130
25	05:01	3.32	196	1.02	-6	asphalt	175	1.14	7.9	234	**57**	9	133
26	04:56	3.38	199	1.02	-5	asphalt	175	1.16	8.1	234	**58**	9	136
27	05:00	3.33	200	**1.03**	4	**muddy trail**	174	1.15	8.2	233	**58**	9	137
28	05:03	3.30	198	**1.03**	-2	**muddy trail**	176	1.12	8.2	231	**57**	9	140
29	05:06	3.27	194	1.02	2	asphalt	176	1.11	8.2	236	56	9	139
30	05:01	3.32	199	**1.03**	-1	asphalt	176	1.13	8.1	236	**57**	9	140
31	04:48	3.47	202	1.00	-1	asphalt	178	1.17	7.7	231	56	9	143
32	04:17	3.89	225	1.00	1	asphalt	**186**	**1.26**	6.7	**216**	53	9	152
33	04:59	3.34	195	1.01	1	asphalt	180	1.10	8.2	232	56	9	138
Average	05:18	3.14	186.3	1.02	0	-	177	1.07	8.2	242	54.7	8.5	132

We have indicated the most striking data in bold. After careful analysis, we believe we can conclude the following from this experiment:

1. The Stryd power data do NOT reflect the impact of the footing directly. This is shown most clearly from the results of km 14, where we crossed through loose sand along the beach of a forest lake. We really struggled there and definitely used more power, which is also evidenced from the increased heart rate. However, the ECOR during this stretch was only 1.02, which is comparable to the forest trail and even some asphalt sections!
2. The hilly sections of km 16-21 were clearly reflected in the Stryd power data, as we reported earlier in paper no. 17. Uphill the ECOR increased to 1.18 and downhill it decreased to 0.92, which is conform theory and our earlier paper.
3. The muddy trail sections in the second half of the run did show some increased ECOR-values. During these sections, there were so many pools and even broken down trees on the trail, that we had to jump back and forth. As a result our oscillation was higher than normal, which was reflected in the increased ECOR, as shown in our earlier paper no. 18. To support this statement, we have prepared the figures below, which relate the ECOR to the vertical oscillation and the Form Power.





4. The impact of fatigue was not shown in the data. During the final km's the ECOR, FP and LSS were similar to the early km's. Nevertheless, we have to admit that we felt really tired at the end of the run!

Discussion and conclusions

The experiment has revealed some clear results: the impact of fatigue and footing is NOT reflected directly by the Stryd data (Power, FP, LSS) and the ECOR-values. So, for all the benefits of the Stryd (including the use in hilly courses, the use for optimization of running form and the use to run at perfect power during training and race) we cannot use it to optimize our power and pace in crosses and the like. It would be very welcome if Stryd could develop an update for this. Of course, there are still a number of buts…

First, this is just one experiment, so it needs to be verified by other experiments. We will certainly do this, and we hope other Stryders will follow our example. Second, we do not know yet to what extent these results depend on the running style of Hans and Ron. Other runners may get different results. Third, the results have been obtained during a training run at lower than race speed. So, we still need to see the impact during a race.

In spite of these limitations, we are very excited that the Stryd provides us with an opportunity to determine our ECOR on a daily basis so we can try to optimize our running style. We are sure that this will pave the way to concrete improvements in our ECOR and race results.
We realize that this will not be easy because for us -and for most people- the running form has been habituated in many years of running. We will not be able to change it overnight. But with time and concrete data, we are confident we will be able to get some improvement.
We hope that many readers will join us in this effort. Let's share our data and conclusions on how we can measure and improve our ECOR! We are curious to the reactions and experiences of the readers, we welcome you to share these at www.thesecretofrunning.com**.**

Hans van Dijk and Ron van Megen
www.the secretofrunning.com

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