



Evaluation,
Tests d'effort,
Profil psychologique,...

Préparation,
Programme d'entraînement individualisé, ...
Sophrologie, Relaxation, Visualisation...

Suivi du sportif.
Activité de Conseil & Formation.
Recherche & Développement.

Médecine du sport,
Physiologie du sport,
Nutrition,
Psychologie du sport,
Sophrologie,

Presentation

Population:

This study was realized on 19 persons practicing cycling for many years in competition; only 3 of them were used to use a non circular chain wheel for 3 months.

Averages (Age: 31 +/-8,52, - Weight: 69,9 kg +/-6,39)

Material:

Ergometry duty at the “Centre Cardio-Thoracique de Monaco”.

Ergo metric system Tunturi, using a same size circular and non circular chain wheel.

Electrocardiogram Marquette Case 12.

Aerobe metabolism measure chain EOS Jaegger.

Methodology:

➤ **Effort protocol:** we decided to use a standard protocol that doesn't allow to traduce an aerobic maximum power data, but that allows to have comparable data at each intermediary level.

We used effort protocols weight by weight.

1 level = 2 minutes.

This test was run until each person's exhaustion. No encouragement during efforts. No data exchanged, excepted time, 30 seconds before changing level.

➤ **Tests:** Two comparative tests were realized after 2 days; with total rest 5 days before the first test. Persons tested are asked to have the same meal the day before and the test day. Each person will undergo the test following a draw lots.

At each session, people are asked to use a circular chain wheel test alternated with a non circular chain wheel test.

Tested persons and people managing the experience aren't informed about which chain wheel is used during the test.

Measure device parameters are done before and after each person's test.

➤ **Working data:** Each 30 seconds, data are recorded and calculated. These data are: sizes number, effort power (watt), heart rate, breathed out volume (BoV), Oxygen consummation (VO₂), CO₂ breathed out (VCO₂), breathing quotient (BQ = VCO₂/VO₂), breathing equivalence O₂ and CO₂ (Eq O₂ = BoV/VO₂ Eq CO₂ = BoV/VCO₂). O₂ beats (VO₂/HR) and the output (provided energy/consummated energy).

From these data, we can calculate decline straights following HR/power, VO₂/power and VO₂max value.

V. Comparison of relative evolutions

Data are represented into % of the aerobic maximum power that is reached during tests with circular chain wheels and non circular chain wheels.

At the same % of maximum effort, the difference is not significant, so that absolute effort power is higher during tests with the non circular chain wheel.

Data in % of MPA reached with a circular chain wheel, 299 Watt													
% MPA	Dura°	Level	Watt	FC min-1	BoV Lmin-1	O2V Lmin-1	CO2V Lmin-1	BQ	BQ O2	BQ CO2	O2 Beats ml. Bets-1	O2V ml.kg.1.min-1	Output
10%	2,0	0,98	30	100	19,6	0,92	0,73	0,79	21	27	9	13	9%
20%	3,9	1,95	60	109	27,6	1,29	1,13	0,68	21	25	12	19	13%
30%	5,9	2,93	90	119	35,5	1,66	1,53	0,92	21	23	14	24	16%
40%	7,8	3,90	120	128	43,4	2,03	1,93	0,95	21	23	16	29	17%
50%	9,8	4,88	149	137	51,3	2,39	2,32	0,97	22	22	17	34	18%
60%	11,7	5,85	179	147	59,3	2,76	2,72	0,99	22	22	19	40	19%
70%	13,7	6,83	209	156	68,1	3,13	3,12	1,00	22	22	20	45	19%
80%	15,6	7,80	239	165	83,7	3,49	3,73	1,07	24	23	21	50	20%
90%	17,6	8,78	269	175	104,3	3,86	4,43	1,15	27	24	22	55	20%
100%	19,5	9,75	299	184	125,2	4,23	5,17	1,22	30	24	23	61	20%

Data in % of MPA reached with a non circular chain wheel, 312 Watt													
% MPA	Dura°	Level	Watt	FC min-1	BoV Lmin-1	O2V Lmin-1	CO2V Lmin-1	BQ	BQ O2	BQ CO2	O2 Beats ml. Bets-1	O2V ml.kg.1.min-1	Output
10%	2,0	1,01	134	97	21,0	0,99	0,79	0,82	22	27	10	14	9%
20%	4,1	2,03	62	107	28,7	1,34	1,16	0,88	22	25	13	19	14%
30%	6,1	3,04	94	118	36,4	1,68	1,53	0,91	22	24	14	24	16%
40%	8,1	4,05	125	126	44,1	2,03	1,90	0,94	22	23	16	29	18%
50%	10,1	5,07	156	136	51,7	2,38	2,27	0,95	22	23	17	34	19%
60%	12,2	6,08	187	146	59,4	2,72	2,64	0,97	22	23	19	39	20%
70%	14,2	7,09	218	156	67,1	3,07	3,01	0,98	22	22	20	44	20%
80%	16,2	8,11	249	166	83,6	3,42	3,58	1,04	24	23	21	49	21%
90%	18,2	9,12	281	176	102,2	3,76	4,20	1,11	27	24	21	54	21%
100%	20,3	10,13	312	186	128,4	4,11	4,97	1,21	31	26	22	59	22%

Relative difference on observable data (circular and non circular) for an equal MPA %													
% MPA	Dura°	Level	Watt	FC min-1	BoV Lmin-1	O2V Lmin-1	CO2V Lmin-1	BQ	BQ O2	BQ CO2	O2 Beats ml. Bets-1	O2V ml.kg.1.min-1	Output
10%	3,9%	3,9%	4,3%	-3,3%	7,1%	7,1%	8,5%	3,9%	2,0%	-1,7%	10,5%	7,3%	-0,6%
20%	3,9%	3,9%	4,3%	-2,5%	4,1%	3,5%	2,9%	-0,1%	1,1%	1,3%	5,9%	3,7%	1,4%
30%	3,9%	3,9%	4,3%	-1,9%	2,5%	1,5%	0,2%	-1,3%	1,1%	2,4%	3,2%	1,7%	3,0%
40%	3,9%	3,9%	4,3%	-1,3%	1,5%	0,2%	-1,4%	-1,8%	1,2%	3,0%	1,4%	0,5%	4,0%
50%	3,9%	3,9%	4,3%	-0,8%	0,8%	-0,7%	-2,4%	-2,1%	1,4%	3,3%	0,1%	-0,4%	4,9%
60%	3,9%	3,9%	4,3%	-0,4%	0,3%	-1,3%	-3,1%	-2,2%	1,5%	3,6%	-1,0%	-1,0%	5,5%
70%	3,9%	3,9%	4,3%	0,0%	-1,4%	-1,8%	-3,7%	-2,2%	0,2%	2,3%	-1,8%	-1,5%	6,0%
80%	3,9%	3,9%	4,3%	0,3%	-0,1%	-2,2%	-3,9%	-2,1%	1,8%	3,6%	-2,5%	-1,9%	6,4%
90%	3,9%	3,9%	4,3%	0,6%	-2,0%	-2,5%	-5,2%	-3,1%	0,0%	2,8%	-3,1%	-2,2%	6,7%
100%	3,9%	3,9%	4,3%	0,9%	-2,6%	-2,8%	-3,8%	-1,0%	5,2%	6,1%	-3,6%	-2,5%	7,0%

Otherwise, the output difference in favor of the non circular chain wheel is significant as soon as the power provided reaches and exceeds 50 % of the aerobic maximum power.

Student t(t) (meaning test when t(t)>1,96)													
% MPA	Dura°	Level	Watt	FC min-1	BoV Lmin-1	O2V Lmin-1	CO2V Lmin-1	BQ	BQ O2	BQ CO2	O2 Beats ml. Bets-1	O2V ml.kg.1.min-1	Output
10%	-1,07	-1,07	-1,33	0,92	-1,10	-1,33	-1,57	-0,67	-0,27	0,31	-1,93	-1,40	0,09
20%	-1,07	-1,07	-1,33	0,78	-0,97	-0,91	-0,78	0,02	-0,27	-0,33	-1,52	-0,99	-0,31
30%	-1,07	-1,07	-1,33	0,63	-0,70	-0,45	-0,06	0,62	-0,37	-0,79	-0,98	-0,53	-0,81
40%	-1,07	-1,07	-1,33	0,47	-0,43	-0,07	0,41	1,34	-0,47	-1,10	-0,46	-0,15	-1,30
50%	-1,07	-1,07	-1,33	0,31	-0,22	0,20	0,70	1,39	-0,52	-1,28	-0,02	0,13	-1,71
60%	-1,07	-1,07	-1,33	0,15	-0,08	0,40	0,89	1,30	-0,54	-1,38	0,33	0,32	-2,03
70%	-1,07	-1,07	-1,33	0,01	0,38	0,54	1,02	1,20	-0,07	-0,96	0,60	0,46	-2,25
80%	-1,07	-1,07	-1,33	-0,12	0,02	0,64	0,82	0,89	-0,54	-1,28	0,82	0,56	-2,42
90%	-1,07	-1,07	-1,33	-0,24	0,34	0,72	1,01	1,13	0,01	-0,84	1,00	0,64	-2,53
100%	-1,07	-1,07	-1,33	-0,34	-0,49	0,78	0,81	0,43	-1,45	-1,89	1,15	0,70	-2,62

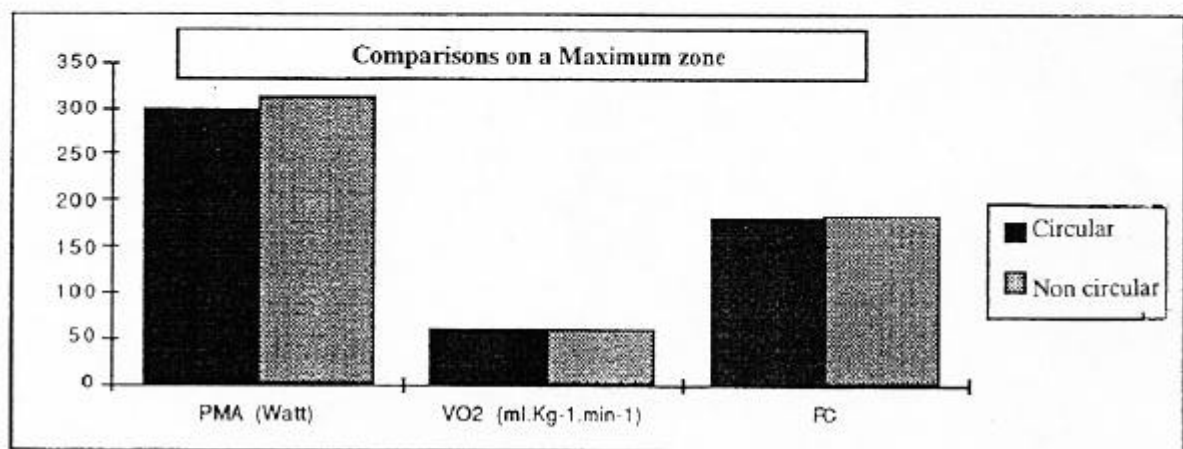
RESULTS: AVERAGES COMPARISON OBSERVED

I. Maximum effort reached

The test type used objective is not to show maximum power differences. We can observe that effort is supported a little more during non circular chain wheel tests (20,6 (+/- 2,2) vs (+/- 2,1) min), $t = 1,64$, the difference is not significant with 5 % of mistake risk.

II. Aerobic maximum zone

	Circular	Non circular	Diff.	t	Conclusions
PMA (Watt)	299 (+/- 28)	312 (+/- 32)	4%	-1,334	D.n.S. 5/100
VO2 (ml.Kg-1.min-1)	62 (+/- 8)	60 (+/- 7)	-3%	0,846	D.n.S. 5/100
FC	182 (+/- 13)	184 (+/- 13)	1%	-0,271	D.n.S. 5/100
Rendement	20,0% (+/- 1,8%)	21,4% (+/- 1,6%)	7%	-2,613	D.S. 1/100



Aerobic maximum power.

People reach an aerobic maximum power higher during the test using the non circular chain wheel, 3,12 (+/- 32) vs 299(+/- 28) watt. $t = 1,8$, the difference is not significant with 5 % of mistake risk.

(NB: the difference observed between an aerobic maximum power and the reached maximum power is bigger with the non circular chain wheel; this observation let suppose a bigger pedaling easiness in spite of effort power. This hypothesis must be confirmed with a more specific test).

Maximum heart rate.

The HRmax variation is not significant (182(+/- 13) vs 184(+/- 13), so 1 %), non significant difference.

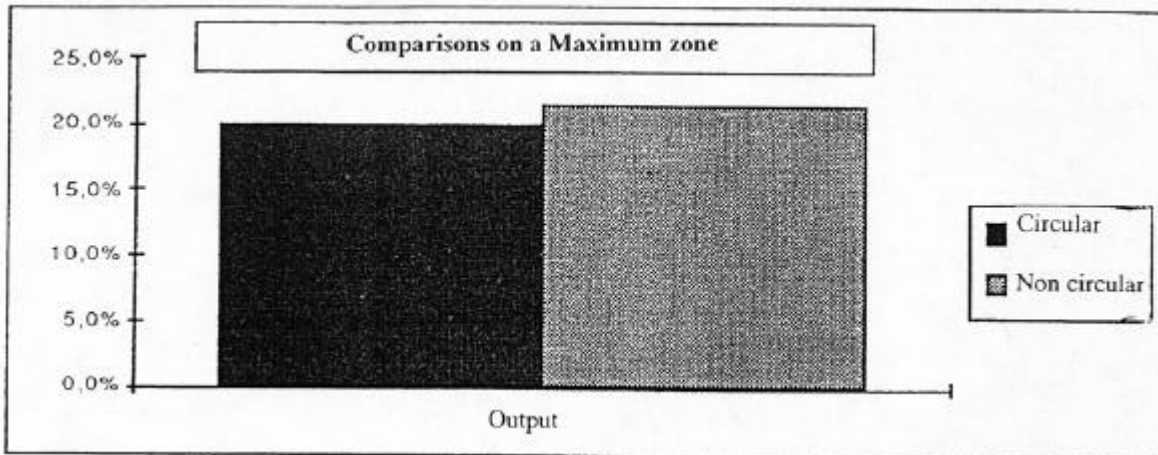
VO2max.

The VO2max is lower during test realized on a non circular chain wheel (60(+/- 7) vs 62(+/- 8) ml. Kg. min-1, so -3 %, $t = 0,85$; the difference is not significant with 5 % of mistake risk.

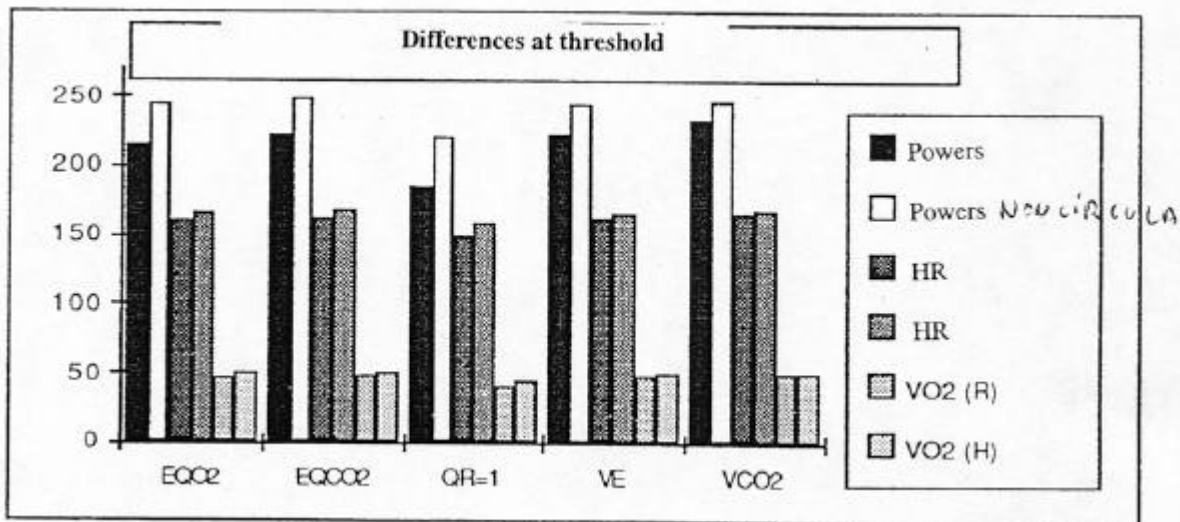
Output (Provided energy/consummated energy)

The output observed is better during tests with the non-circular chain wheel (21,4(+/-1,6)% vs. 20(+/-1,8)%, so +7 %).

$t = 2,61$, the difference is significant 1 % of mistake risk.



III. Threshold zone:



The effort power (Tab. ZV1)

For each chosen threshold, the effort power observed is higher during tests realized with the non-circular chain wheel.

The difference varies from 6 % to 18 % (average = 11 %) of additional power. Differences are significant.

Level	Circular	Non circular	Diff.	t	Conclusions
EQO2	215 (+/-27)	244 (+/-26)	13%	-3,354	D.S. 1/1000
EQOO2	223 (+/-30)	249 (+/-27)	12%	-2,811	D.S. 1/100
QR=1	185 (+/-52)	219 (+/-51)	18%	-2,050	D.S. 5/100
VE	222 (+/-22)	244 (+/-26)	10%	-2,857	D.S. 1/100
VCO2	233 (+/-16)	246 (+/-19)	6%	-2,309	D.S. 5/100

HR (Tab. ZV2)

HR observed during threshold are a little higher during tests with the non-circular chain wheel, but the differences are not significant, and that can be observed so that the effort intensity is superior.

Level	Circular	Non circular	Diff.	t	Conclusions
EQO2	160 (+/-16)	167 (+/-14)	4%	-1,378	D.n.S. 5/100
EQO2O2	162 (+/-16)	168 (+/-14)	4%	-1,212	D.n.S. 5/100
QR=1	149 (+/-21)	159 (+/-20)	6%	-1,396	D.n.S. 5/100
VE	162 (+/-14)	167 (+/-14)	3%	-1,047	D.n.S. 5/100
VCO2	166 (+/-12)	167 (+/-12)	1%	-0,447	D.n.S. 5/100

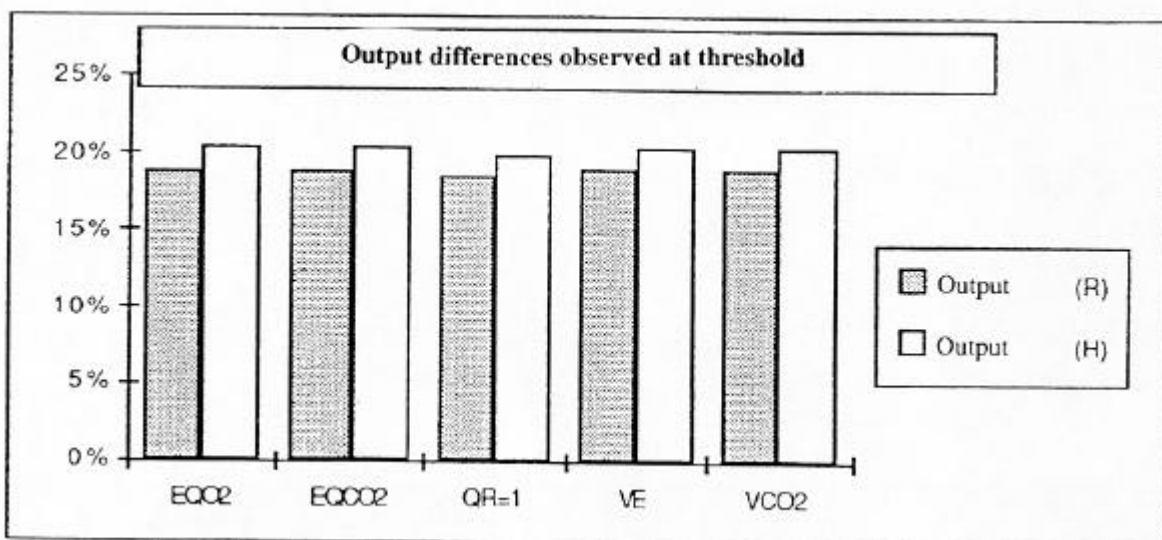
VO2 (Tab. ZV3)

The O2 consumption observed at the threshold is a little higher during tests with the non circular chain wheel. The difference is not significant. That can be observed so that the effort power is higher.

Level	Circular	Non circular	Diff.	t	Conclusions
EQO2	47 (+/-7)	49 (+/-7)	5%	-1,085	D.n.S. 5/100
EQO2O2	48 (+/-7)	50 (+/-7)	4%	-0,800	D.n.S. 5/100
QR=1	41 (+/-10)	45 (+/-10)	10%	-1,311	D.n.S. 5/100
VE	48 (+/-6)	49 (+/-7)	3%	-0,612	D.n.S. 5/100
VCO2	50 (+/-5)	50 (+/-7)	-1%	0,201	D.n.S. 5/100

The output (Tab. ZV4)

The output (provided energy/consummated energy) is higher for tests realized with the non circular chain wheel.



(Tab.ZV4) **Output**

Level	Circular	Non circular	Diff.	t	Conclusions
EQ02	19% (+/-1,6%)	20% (+/-1,7%)	8%	-2,758	D.S. 1/100
EQ002	19% (+/-1,5%)	20% (+/-1,7%)	8%	-2,725	D.S. 1/100
QR=1	18% (+/-1,8%)	20% (+/-2,2%)	8%	-2,159	D.S. 5/100
VE	19% (+/-1,5%)	20% (+/-1,7%)	7%	-2,594	D.S. 1/100
V002	19% (+/-1,5%)	20% (+/-1,6%)	6%	-2,373	D.S. 2/100

The output difference varies from + 6 % to + 8 %. These differences are significant.

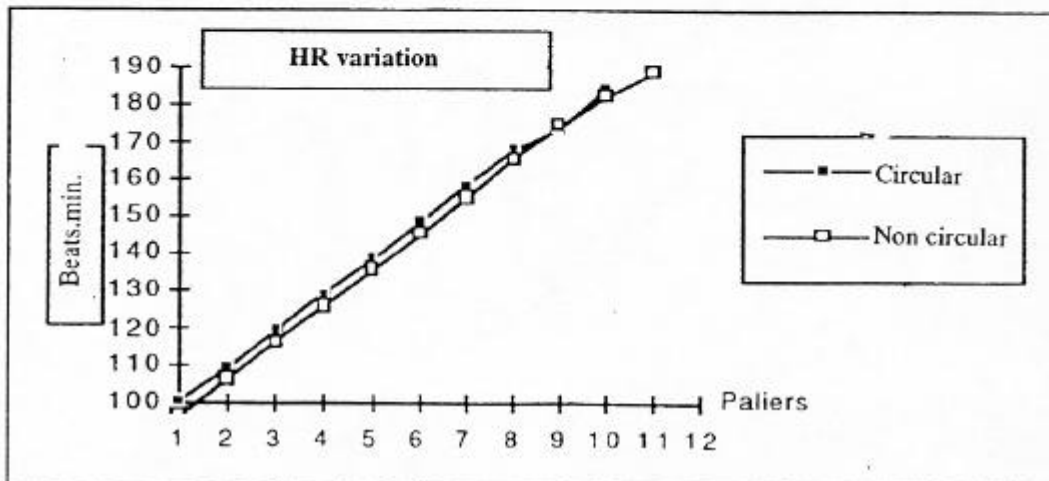
IV. Study of physiological parameters evolution observed during tests

HR:

At equal level, the HR average is a little lower during tests with the non circular chain wheel, but the difference is not significant.

HR variation

Level	Circular	Non circular	Diff.	t	Conclusions
1	100 (+/-12)	97 (+/-9)	-3,7%	1,048	D.n.S. 5/100
2	110 (+/-12)	106 (+/-9)	-3,2%	1,034	D.n.S. 5/100
3	120 (+/-12)	116 (+/-9)	-2,9%	1,004	D.n.S. 5/100
4	129 (+/-11)	126 (+/-9)	-2,5%	0,958	D.n.S. 5/100
5	139 (+/-12)	136 (+/-10)	-2,2%	0,897	D.n.S. 5/100
6	149 (+/-12)	146 (+/-10)	-2,0%	0,826	D.n.S. 5/100
7	158 (+/-12)	155 (+/-11)	-1,8%	0,749	D.n.S. 5/100
8	168 (+/-13)	165 (+/-11)	-1,6%	0,668	D.n.S. 5/100
9	174 (+/-13)	175 (+/-12)	0,3%	-0,14	D.n.S. 5/100
10	184 (+/-12)	183 (+/-11)	-0,9%	0,454	D.n.S. 5/100
11	#N/A #N/A	189 (+/-10)	#N/A	#N/A	#N/A
12	#N/A #N/A	#N/A #N/A	#N/A	#N/A	#N/A



Breathed out Volume (BoV) and VCO₂:

At equal level, the BoV average and the VCO₂ average are a little lower during tests with the non circular chain wheel, but the difference is not significant.

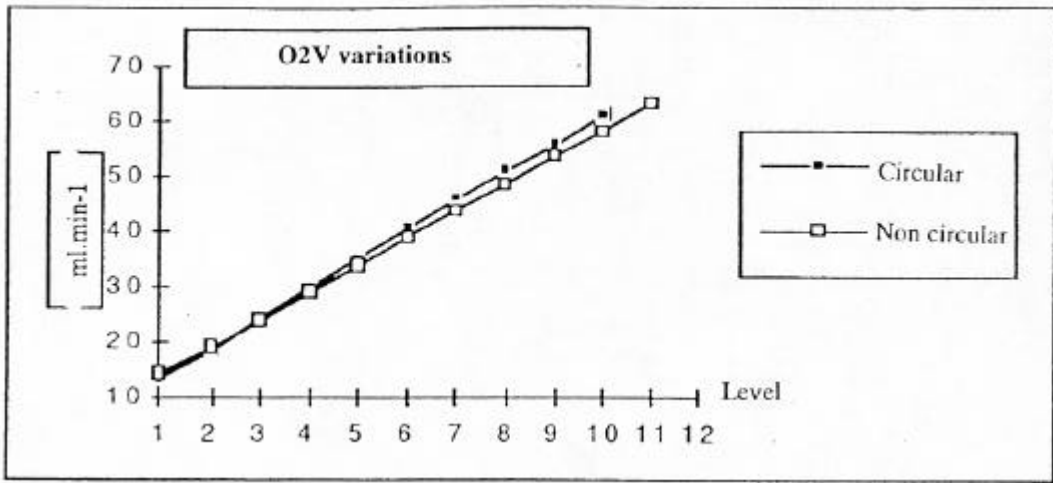
BoV variation					
Level	Circular	Non circular	Diff.	t	Conclusions
1	20 (+/-4)	21 (+/-4)	5,4%	-0,84	D.n.S. 5/100
2	28,2 (+/-5)	29 (+/-4)	1,9%	-0,4	D.n.S. 5/100
3	36,5 (+/-5)	36 (+/-5)	0,0%	3E-04	D.n.S. 5/100
4	44,7 (+/-7)	44 (+/-6)	-1,2%	0,258	D.n.S. 5/100
5	53 (+/-8)	52 (+/-8)	-2,1%	0,416	D.n.S. 5/100
6	61,6 (+/-11)	60 (+/-9)	-3,2%	0,603	D.n.S. 5/100
7	71,8 (+/-16)	68 (+/-12)	-5,5%	0,853	D.n.S. 5/100
8	81,4 (+/-15)	80 (+/-19)	-2,2%	0,309	D.n.S. 5/100
9	96 (+/-17)	92 (+/-20)	-4,1%	0,655	D.n.S. 5/100
10	111 (+/-22)	107 (+/-18)	-3,3%	0,574	D.n.S. 5/100
11	#N/A #N/A	128 (+/-18)	#N/A	#N/A	#N/A
12	#N/A #N/A	#N/A #N/A	#N/A	#N/A	#N/A

CO ₂ V variation					
Level	Circular	Non circular	Diff.	t	Conclusions
1	0,74 (+/-0,2)	0,8 (+/-0,1)	6,4%	-1,07	D.n.S. 5/100
2	1,16 (+/-0,2)	1,2 (+/-0,2)	0,3%	-0,07	D.n.S. 5/100
3	1,57 (+/-0,2)	1,5 (+/-0,2)	-2,5%	0,579	D.n.S. 5/100
4	1,98 (+/-0,3)	1,9 (+/-0,3)	-4,2%	0,962	D.n.S. 5/100
5	2,39 (+/-0,3)	2,3 (+/-0,3)	-5,3%	1,197	D.n.S. 5/100
6	2,81 (+/-0,4)	2,6 (+/-0,4)	-6,2%	1,361	D.n.S. 5/100
7	3,24 (+/-0,4)	3,0 (+/-0,5)	-7,4%	1,535	D.n.S. 5/100
8	3,68 (+/-0,5)	3,5 (+/-0,6)	-6,1%	1,202	D.n.S. 5/100
9	4,27 (+/-0,5)	4,0 (+/-0,6)	-7,3%	1,455	D.n.S. 5/100
10	4,84 (+/-0,6)	4,5 (+/-0,7)	-6,1%	1,048	D.n.S. 5/100
11	#N/A #N/A	5,0 (+/-0,8)	#N/A	#N/A	#N/A
12	#N/A #N/A	#N/A #N/A	#N/A	#N/A	#N/A

VO₂:

The VO₂ is a little lower; this difference becomes significant with the threshold zone (level 7 and 8).

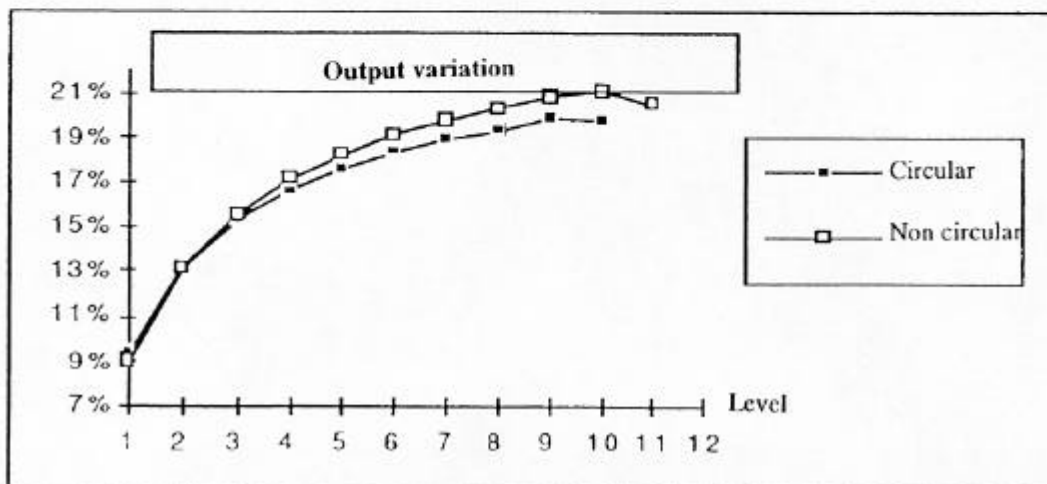
CO ₂ V variation (ml.kg-1.min-1)					
Level	Circular	Non circular	Diff.	t	Conclusions
1	13,4 (+/-1,8)	14,1 (+/-2,4)	6,4%	-1,08	D.n.S. 5/100
2	18,8 (+/-1,7)	19,1 (+/-2,3)	0,3%	-0,37	D.n.S. 5/100
3	24,3 (+/-1,9)	24,0 (+/-2,3)	-2,5%	0,364	D.n.S. 5/100
4	29,7 (+/-2,2)	28,9 (+/-2,4)	-4,2%	0,999	D.n.S. 5/100
5	35,1 (+/-2,6)	33,9 (+/-2,5)	-5,3%	1,474	D.n.S. 5/100
6	40,5 (+/-3,1)	38,8 (+/-2,8)	-6,2%	1,806	D.n.S. 5/100
7	45,9 (+/-3,6)	43,7 (+/-3,1)	-7,4%	2,034	D.S. 5/100
8	51,2 (+/-4,2)	48,6 (+/-3,4)	-6,1%	2,039	D.S. 5/100
9	56,0 (+/-4,9)	53,5 (+/-4,0)	-7,3%	1,676	D.n.S. 5/100
10	61,2 (+/-6,5)	58,2 (+/-4,4)	-6,1%	1,684	D.n.S. 5/100
11	#N/A #N/A	63,1 (+/-5,1)	#N/A	#N/A	#N/A
12	#N/A #N/A	#N/A #N/A	#N/A	#N/A	#N/A



The output:

The output average observed is higher during tests realized with the non circular chain wheel. The output difference becomes significant when the effort reaches and exceeds the threshold zone.

Level	Circular	Non circular	Diff.	t	Conclusions
1	9% (+/-1,2%)	9% (+/-2,4%)	-2,8%	0,417	D.n.S. 5/100
2	13% (+/-1,1%)	13% (+/-2,1%)	-0,2%	0,045	D.n.S. 5/100
3	15% (+/-1,1%)	16% (+/-1,9%)	1,6%	-0,49	D.n.S. 5/100
4	17% (+/-1,1%)	17% (+/-1,7%)	2,9%	-1,03	D.n.S. 5/100
5	18% (+/-1,2%)	18% (+/-1,6%)	3,8%	-1,46	D.n.S. 5/100
6	18% (+/-1,3%)	19% (+/-1,6%)	4,5%	-1,78	D.n.S. 5/100
7	19% (+/-1,3%)	20% (+/-1,6%)	5,1%	-2	D.S. 5/100
8	19% (+/-1,4%)	20% (+/-1,6%)	5,1%	-2,01	D.S. 5/100
9	20% (+/-1,5%)	21% (+/-1,7%)	4,9%	-1,83	D.n.S. 5/100
10	20% (+/-1,6%)	21% (+/-1,8%)	6,4%	-2,31	D.S. 5/100
11	#N/A #N/A	21% (+/-1,2%)	#N/A	#N/A	#N/A
12	#N/A #N/A	#N/A #N/A	#N/A	#N/A	#N/A



CONCLUSIONS

This study has been realized on 19 cyclists. It's a comparative study showing different parameters researched for this experimentation; all these parameters allow to make a favorable conclusion concerning the non circular chain wheel contribution.

The most important observations are:

- ✓ **The power increase observed for the threshold zone (+ 6 % to + 18 %), (difference average for 5 criterions used + 11,8 %). This is particularly important because the effort level observed in cycling corresponds to efforts in threshold zone.**
- ✓ **The energetic output improvement (provided energy/consummated energy) and all the more so since that the effort is in the competition intensity zone.**

This is due to a better effort adaptation to the muscular potential, the ray variation, that is adapted to the muscular power variation during the pedaling.

Even not significant, favorable differences concerning the non circular chain wheel have been observed, comparing HR, BoV, VO₂, VCO₂, QR and let suppose a bigger effort easiness.

We can precise that no element in this study shows any difference, even not significant, in favor of a circular chain wheel.

“At last, we can remind that 17 cyclists on 19 ever used a non circular chain wheel, before being volunteer for this study, and weren't used to use that pedaling technique. It's reasonable to think that differences observed would have been bigger with cyclists using a non circular chain wheel for a long time.

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Here are a few estimates we have calculated following data of a on circular chain wheel.

Speed differences and power differences observed (C. KYLHES formulas).

Aerobic maximum powers:

Circular: 299 watt = 40,6 km/h
Non circular: 312 watt = 41,3 km/h
Difference: + 0,7 km/h

(Aerobic maximum power is supported a tenth minutes, in the best case).

Threshold zone powers:

Circular: 185-233 watt = 34,5 to 37,2
Non circular: 219-249 watt = 36,5 to 38,0
Difference: +2 to +0,8

(Power observed on a cycling course corresponds to the provided power in thresholds zone).

Average performance estimate during "Tour de France 1993»: average speed on base observed = 39 km/h; the estimated speed would be = 40,4 km/h.