

# Predicting the polyethylene wear rate in pin-on-disc experiments in the context of prosthetic hip implants: deriving a data-driven model using machine learning methods

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## Supplementary Material

**Table A1** Orthopedic polyethylene PoD wear experiment dataset

#	Study	Year	Normal load [N]	Contact area [mm <sup>2</sup> ]	Frequency [Hz]	Sliding distance per cycle [mm/C]	Wear path shape [mm]	Wear path aspect ratio	Lubricant temp. [°C]
1	Bragdon [50]	2001	305.376*	63.62	1	30	Rectangle 5x10	2	25
2	Bragdon [50]	2001	305.376*	63.62	2	30	Rectangle 5x10	2	25
3	Saikko [43]	2001	70.7	62.49	1.02	31.42	Circle d=10	1	-
4	Saikko [43]	2001	70.7	62.49	1.02	31.42	Circle d=10	1	-
5	Saikko [43]	2001	70.7	62.49	1.02	31.42	Circle d=10	1	-
6	Saikko [43]	2001	70.7	62.49	1.02	31.42	Circle d=10	1	-
7	Saikko [43]	2001	70.7	62.49	1.02	31.42	Circle d=10	1	-
8	Saikko [43]	2001	70.7	62.49	1.02	31.42	Circle d=10	1	-
9	Saikko [43]	2001	70.7	62.49	1.02	31.42	Circle d=10	1	-
10	Saikko [43]	2001	70.7	62.49	1.02	31.42	Circle d=10	1	-
11	Saikko [43]	2001	70.7	62.49	1.02	31.42	Circle d=10	1	-
12	Saikko [43]	2001	70.7	62.49	1.02	31.42	Circle d=10	1	-
13	Saikko [43]	2001	70.7	62.49	1.02	31.42	Circle d=10	1	-
14	Saikko [43]	2001	70.7	62.49	1.02	31.42	Circle d=10	1	-
15	Saikko [43]	2001	70.7	62.49	1.02	31.42	Circle d=10	1	-
16	Saikko [43]	2001	70.7	62.49	1.02	31.42	Circle d=10	1	-
17	Saikko [43]	2001	70.7	62.49	1.02	31.42	Circle d=10	1	-
18	Saikko [43]	2001	70.7	62.49	1.02	31.42	Circle d=10	1	-
19	Saikko [43]	2001	70.7	62.49	1.02	31.42	Circle d=10	1	-
20	Saikko [43]	2001	70.7	62.49	1.02	31.42	Circle d=10	1	-

21	Saikko [43]	2001	70.7	62.49	1.02	31.42	Circle d=10	1	-
22	Saikko [43]	2001	70.7	62.49	1.02	31.42	Circle d=10	1	-
23	Saikko [43]	2001	70.7	62.49	1.02	31.42	Circle d=10	1	-
24	Saikko [43]	2001	70.7	62.49	1.02	31.42	Circle d=10	1	-
25	Saikko [43]	2001	70.7	62.49	1.02	31.42	Circle d=10	1	-
26	Saikko [43]	2001	70.7	62.49	1.02	31.42	Circle d=10	1	-
27	Turell [68]	2003	192	63.62	1	20	Square 5x5	1	37
28	Turell [68]	2003	192	63.62	1	20	Rectangle 4x6	1.5	37
29	Turell [68]	2003	192	63.62	1	20	Rectangle 3x7	2.3	37
30	Turell [68]	2003	192	63.62	1	20	Rectangle 2x8	4	37
31	Turell [68]	2003	192	63.62	1	20	Rectangle 1x9	9	37
32	Yao [56]	2003	445	63.62	1	60	Square 15x15	1	-
33	Yao [56]	2003	445	63.62	1	60	Square 15x15	1	-
34	Gul [53]	2003	267*	63.62	2	30	Rectangle 5x10	2	-
35	Gul [53]	2003	267*	63.62	2	30	Rectangle 5x10	2	-
36	Gul [53]	2003	267*	63.62	2	30	Rectangle 5x10	2	-
37	Gul [53]	2003	267*	63.62	2	30	Rectangle 5x10	2	-
38	Gul [53]	2003	267*	63.62	2	30	Rectangle 5x10	2	-
39	Gul [53]	2003	267*	63.62	2	30	Rectangle 5x10	2	-
40	Gul [53]	2003	267*	63.62	2	30	Rectangle 5x10	2	-
41	Mazz- ucco [69]	2003	223	31.7	1	40	Square 10x10	1	37
42	Mazz- ucco [69]	2003	223	71.3	1	40	Square 10x10	1	37
43	Mazz- ucco [69]	2003	111	31.7	1	40	Square 10x10	1	37
44	Murat- ogu [57]	2003	381.7*	63.62	2	30	Rectangle 10x5	2	37
45	Murat- ogu [57]	2003	381.7*	63.62	2	30	Rectangle 10x5	2	37
46	Murat- ogu [57]	2003	381.7*	63.62	2	30	Rectangle 10x5	2	37

47	Murat- ogu [57]	2003	381.7*	63.62	2	30	Rectangle 10x5	2	37
48	Murat- ogu [57]	2003	381.7*	63.62	2	30	Rectangle 10x5	2	37
49	Murat- ogu [57]	2003	381.7*	63.62	2	30	Rectangle 10x5	2	37
50	Green- baum [58]	2004	381.72*	63.62	2	30	Rectangle 5x10	2	-
51	Green- baum [58]	2004	381.72*	63.62	2	30	Rectangle 5x10	2	-
52	Green- baum [58]	2004	381.72*	63.62	2	30	Rectangle 5x10	2	-
53	Green- baum [58]	2004	381.72*	63.62	2	30	Rectangle 5x10	2	-
54	Saikko [44]	2004	70.7	62.49	1.02	31.4	Elliptic	1	25
55	Saikko [44]	2004	70.7	62.49	1.02	30	Elliptic	1.1	25
56	Saikko [44]	2004	70.7	62.49	1.02	28.6	Elliptic	1.22	25
57	Saikko [44]	2004	70.7	62.49	1.02	27.3	Elliptic	1.37	25
58	Saikko [44]	2004	70.7	62.49	1.02	26	Elliptic	1.57	25
59	Saikko [44]	2004	70.7	62.49	1.02	24.8	Elliptic	1.83	25
60	Saikko [44]	2004	70.7	62.49	1.02	23.7	Elliptic	2.2	25
61	Saikko [44]	2004	70.7	62.49	1.02	22.6	Elliptic	2.75	25
62	Saikko [44]	2004	70.7	62.49	1.02	21.7	Elliptic	3.67	25
63	Saikko [44]	2004	70.7	62.49	1.02	20.9	Elliptic	5.5	25
64	Saikko [44]	2004	70.7	62.49	1.02	20.3	Elliptic	10.98	25
65	Oral [59]	2004	381.7*	63.62	2	30	Rectangle 10x5	2	-
66	Oral [59]	2004	381.7*	63.62	2	30	Rectangle 10x5	2	-
67	Hill [70]	2007	102	17.8	1.5	40	Square 10x10	1	37
68	Laraia [60]	2007	104	15.9	2	30	Rectangular 5x10	2	-
69	Laraia [60]	2007	104	15.9	2	30	Rectangular 5x10	2	-
70	Laraia [60]	2007	104	15.9	2	30	Rectangular 5x10	2	-
71	Laraia [60]	2007	104	15.9	2	30	Rectangular 5x10	2	-
72	Laraia [60]	2007	104	15.9	2	30	Rectangular 5x10	2	-

73	Laraia [60]	2007	104	15.9	2	30	Rectangular 5x10	2	-
74	Sawae [45]	2008	197.9	28.27	0.2	94.25	Circle d=30	1	-
75	Kilgour [61]	2009	94.5*	19.63	1.15	49.67	Elliptic 10x20	2	37
76	Kilgour [61]	2009	94.5*	19.63	1.15	49.67	Elliptic 10x20	2	37
77	Korduba [71]	2011	75	71.18	1	20	Square 5x5	1	-
78	Korduba [71]	2011	75	71.18	1	20	Square 5x5	1	-
79	Korduba [71]	2011	75	71.18	1	20	Rectangle 4x6	1.5	-
80	Korduba [71]	2011	75	71.18	1	20	Rectangle 4x6	1.5	-
81	Korduba [71]	2011	75	71.18	1	20	Rectangle 3x7	2.3	-
82	Korduba [71]	2011	75	71.18	1	20	Rectangle 3x7	2.3	-
83	Korduba [71]	2011	75	71.18	1	20	Rectangle 2x8	4	-
84	Korduba [71]	2011	75	71.18	1	20	Rectangle 2x8	4	-
85	Korduba [71]	2011	75	71.18	1	20	Rectangle 1x9	9	-
86	Korduba [71]	2011	75	71.18	1	20	Rectangle 1x9	9	-
87	Bistolfi [72]	2011	192	63.62	1	20	Square 5x5	1	37
88	Bistolfi [72]	2011	192	63.62	1	20	Square 5x5	1	37
89	Wimmer [73]	2013	198	71.33	1	20	Square 5x5	1	37
90	Wimmer [73]	2013	198	71.33	1	20	Square 5x5	1	37
91	Wimmer [73]	2013	198	71.33	1	20	Square 5x5	1	37
92	Wimmer [73]	2013	198	71.33	1	20	Square 5x5	1	37
93	Wimmer [73]	2013	198	71.33	1	20	Square 5x5	1	37
94	Wimmer [73]	2013	198	71.33	1	20	Square 5x5	1	37
95	Harsha [46]	2013	70.7	63.62	1	25.5	Elliptic 10x6	1.7	22
96	Harsha [46]	2013	70.7	63.62	1	25.5	Elliptic 10x6	1.7	22
97	Harsha [46]	2013	70.7	63.62	1	34.6	Elliptic 12x10	1.2	22
98	Harsha [46]	2013	70.7	63.62	1	34.6	Elliptic 12x10	1.2	22
99	Baykal [6]	2013	77.5	71.2	1	59.2	Circle	1	-

100	Baykal [6]	2013	128	63.62	1	24.8	Circle	1	-
101	Baykal [6]	2013	128	63.62	1	24.8	Circle	1	-
102	Hua [47]	2014	7	7.07	1	31.42	Circle d=10	1	20
103	Hua [47]	2014	7	7.07	1	31.42	Circle d=10	1	20
104	Kurtz [48]	2014	127.2	63.62	1	24	Elliptic 5x10	2	37
105	Kurtz [48]	2014	127.2	63.62	1	24	Elliptic 5x10	2	37
106	Escud- eiro [74]	2015	106.32	70.88	1	60	Square 15x15	1	37
107	Doshi [40]	2015	324.72*	63.62	2	30	Rectangle 5x10	2	-
108	Doshi [40]	2015	324.72*	63.62	2	30	Rectangle 5x10	2	-
109	Doshi [40]	2015	324.72*	63.62	2	30	Rectangle 5x10	2	-
110	Guent- her [75]	2015	330*	70.88	1.6	40	Square 10x10	1	37
111	Guent- her [75]	2015	330*	70.88	1.6	40	Square 10x10	1	37
112	Oral [41]	2015	305.376*	63.62	2	30	Rectangle 5x10	2	25
113	Hunt [49]	2016	70.7	63.62	1	34.6	Ellipse 12x10	1.2	22
114	Hunt [49]	2016	70.7	63.62	1	34.6	Ellipse 12x10	1.2	22
115	Saikko [51]	2017	7.777	7.07	1	31.42	Circle d=10	1	20
116	Saikko [51]	2017	17.49	15.9	1	31.42	Circle d=10	1	20
117	Saikko [51]	2017	31.097	28.27	1	31.42	Circle d=10	1	20
118	Saikko [51]	2017	69.982	63.62	1	31.42	Circle d=10	1	20
119	Saikko [51]	2017	124.41	113.1	1	31.42	Circle d=10	1	20
120	Saikko [51]	2017	194.381	176.71	1	31.42	Circle d=10	1	20
121	Saikko [51]	2017	434.071	394.61	1	31.42	Circle d=10	1	20
122	Saikko [51]	2017	777.546	706.86	1	31.42	Circle d=10	1	20
123	Saikko [51]	2017	126	12.57	1	31.42	Circle d=10	1	20
124	Saikko [51]	2017	126	28.27	1	31.42	Circle d=10	1	20
125	Saikko [51]	2017	126	50.26	1	31.42	Circle d=10	1	20
126	Saikko [51]	2017	126	78.54	1	31.42	Circle d=10	1	20
127	Saikko [51]	2017	126	113	1	31.42	Circle d=10	1	20

128	Nakanishi [42]	2018	381.72	63.62	0.95	17.76	Elliptic 8.26x2.11	3.9	-
129	Langhorn [15]	2018	330*	70.88	1.6	60	square 10x20	2	37

\* Maximum value, + Average value

#	Lubricant protein concentration [mg/ml]	Average disc surface roughness $R_a$ [ $\mu\text{m}$ ]	Polyethylene GUR	Polyethylene radiation dose [kGy]	Test duration [MC]	Polyethylene wear rate [mg/MC]	Note
1	-	0.05	-	0	2	10.40	
2	-	0.05	-	0	2	10.00	
3	21	0.022	1020	32.5+	3	3.76	
4	21	0.023	1020	32.5+	3	3.92	
5	21	0.027	1020	32.5+	3	4.53	
6	21	0.031	1020	32.5+	3	5.14	
7	21	0.033	1020	32.5+	3	5.44	
8	21	0.054	1020	32.5+	3	8.52	
9	21	0.058	1020	32.5+	3	9.09	
10	21	0.075	1020	32.5+	3	11.48	
11	21	0.08	1020	32.5+	3	12.18	
12	21	0.135	1020	32.5+	3	19.60	
13	21	0.166	1020	32.5+	3	23.66	
14	21	0.237	1020	32.5+	3	32.72	
15	21	0.014	1050	95	3	0.00	
16	21	0.021	1050	95	3	0.01	
17	21	0.023	1050	95	3	0.01	
18	21	0.028	1050	95	3	0.02	
19	21	0.032	1050	95	3	0.03	
20	21	0.054	1050	95	3	0.11	
21	21	0.055	1050	95	3	0.12	
22	21	0.087	1050	95	3	0.37	
23	21	0.096	1050	95	3	0.48	
24	21	0.13	1050	95	3	1.01	
25	21	0.165	1050	95	3	1.83	
26	21	0.215	1050	95	3	3.54	
27	23	0.015	1050	0	1	8.45	Only multidirectional wear paths are reported (excluded linear wear path)
28	23	0.015	1050	0	1	8.45	
29	23	0.015	1050	0	1	9.60	
30	23	0.015	1050	0	1	2.11	
31	23	0.015	1050	0	1	1.88	
32	0.69	0.003	1050	100	1	0.10	Only base cases of non-hydrated, non-

							irradiated, and HXPE are reported
33	0.69	0.003	1050	0	1	5.97	
34	-	0.38	415	0	1	9.88	
35	-	0.38	405	0	1	7.87	
36	-	0.38	405	0	1	8.75	
37	-	0.38	405	0	1	9.36	
38	-	0.38	1900	0	1	9.87	
39	-	0.38	1900	0	1	9.10	
40	-	0.38	1900	0	1	8.68	
41	29	0.0375 +	1150	0	1.5	6.44	Only lubricant protocol B is reported
42	29	0.0375 +	1150	0	1.5	14.85	
43	29	0.0375 +	1150	0	1.5	7.31	
44	-	0.05	1050	38	2	13.40	Only un-aged polyethylene are reported
45	-	0.05	1050	38	2	11.00	
46	-	0.05	1050	95	2	1.50	
47	-	0.05	1050	50	2	5.70	
48	-	0.05	1050	75	2	1.70	
49	-	0.05	1050	100	2	1.10	
50	-	-	1050	0	2	9.80	
51	-	-	1050	95	2	1.40	
52	-	-	1050	0	2	9.90	
53	-	-	1050	95	2	1.10	
54	21	0.014	1020	32.5+	3	3.84	Elliptical wear path with 388.21 aspect ratio is eliminated since the motion is almost linear
55	21	0.014	1020	32.5+	3	3.50	
56	21	0.014	1020	32.5+	3	3.17	
57	21	0.014	1020	32.5+	3	2.86	
58	21	0.014	1020	32.5+	3	2.55	
59	21	0.014	1020	32.5+	3	2.26	
60	21	0.014	1020	32.5+	3	1.97	
61	21	0.014	1020	32.5+	3	1.68	
62	21	0.014	1020	32.5+	3	1.40	
63	21	0.014	1020	32.5+	3	1.11	
64	21	0.014	1020	32.5+	3	0.77	
65	-	0.05	1050	92	2	1.90	Only un-aged polyethylene are reported. Total radiation dose is reported
66	-	0.05	1050	127	2	0.90	
67	23	0.5	-	32.5+	2	2.16	Only un-coated discs are reported

68	-	0.02	1050	0	2.5	2.53	
69	-	0.02	1050	150	2.5	0.41	
70	-	0.02	1050	0	2.5	2.02	
71	-	0.02	1050	150	2.5	0.59	
72	-	0.02	1050	0	2.5	2.14	
73	-	0.02	1050	150	2.5	0.61	
74	1.1 wt%	0.009	415	0	0.1	6.02	Only the experiment with bovine serum lubricant average value is reported
75	22	0.01	1050	0	3	3.25	Only elliptical wear path is reported (excluded linear wear path)
76	22	0.01	1050	100	3	0.30	
77	20	0.01	1020	0	1	1.67	This study definition of aspect ratio is reverse of what we have used in our study. Linear wear path is excluded
78	20	0.01	1020	30	1	0.00	
79	20	0.01	1020	0	1	1.63	
80	20	0.01	1020	30	1	0.00	
81	20	0.01	1020	0	1	2.44	
82	20	0.01	1020	30	1	0.03	
83	20	0.01	1020	0	1	2.51	
84	20	0.01	1020	30	1	0.01	
85	20	0.01	1020	0	1	2.09	
86	20	0.01	1020	30	1	0.01	
87	23	0.015	1050	0	1.6	8.13	Only experiments with CoCr are reported
88	23	0.015	1050	50	1.6	1.26	
89	30	0.02	415	32.5+	1.25	1.89	Only base bovine serum lubricant is reported (lubricant A until 1.25MC without Gentamicin and Fungizone)
90	30	0.02	415	32.5+	1.25	2.80	
91	30	0.02	415	32.5+	1.25	2.90	
92	30	0.02	415	32.5+	1.25	4.64	
93	30	0.02	415	32.5+	1.25	5.40	
94	30	0.02	415	32.5+	1.25	5.53	
95	22	0.015+	1020	0	3.2	9.21	
96	22	0.015+	1020	72	3.2	2.06	
97	22	0.015+	1020	0	2.5	7.86	
98	22	0.015+	1020	72	2.5	1.50	
99	20	0.005	1020	0	-	7.50	
100	20	0.005	1020	0	-	7.40	



101	20	0.005	1020	0	-	6.00	
102	-	0.015+	-	-	2	1.92	Fiber-enhanced polyethylene is not reported
103	-	0.015+	-	-	2	0.82	
104	20	0.001	1050	32.5+	2.5	6.70	Shelf-Aged polyethylene is not reported
105	20	0.001	1050	32.5+	2.5	6.52	
106	30	0.008	1050	0	2	15.59	Only uncoated CoCr vs. UHMWPE is reported
107	-	0.05	1050	65	1	6.40	Only normal irradiated polyethylene is reported (irradiated and melted high pressure crystallization is not reported)
108	-	0.05	1050	100	1	3.90	
109	-	0.05	1050	150	1	2.20	
110	34	0.015	1020	50	0.99	3.12	Only alpha calf serum diluted by deionized water is reported
111	34	0.015	1050	50	0.99	1.60	
112	-	0.05	1050	100	1.2	1.80	Only conventionally melted virgin UHMWPE is reported
113	22	0.013	1020	0	2.5	9.40	
114	22	0.015	1050	0	2.5	8.50	
115	20	0.01	1050	0	0.4	1.17	
116	20	0.01	1050	0	0.4	2.69	
117	20	0.01	1050	0	0.4	4.68	
118	20	0.01	1050	0	0.4	10.13	
119	20	0.01	1050	0	0.4	17.64	
120	20	0.01	1050	0	0.4	26.98	
121	20	0.01	1050	0	0.4	34.61	
122	20	0.01	1050	0	0.4	27.56	
123	20	0.01	1050	0	3.2	1.90	
124	20	0.01	1050	0	3.2	4.84	
125	20	0.01	1050	0	3.2	7.44	
126	20	0.01	1050	0	3.2	13.02	
127	20	0.01	1050	0	3.2	14.89	
128	30	0.012	1050	0	1	10.72	Only non-textured surface is reported
129	64.8	0.05	1020	50	1.98	6.83	Only non-textured surface is reported

\* Maximum value, + Average value