

Physical demands of tennis across the different court surfaces, performance levels, and sexes: a systematic review with meta-analysis

Sports Medicine

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Supplementary File 7. Stroke speeds

7.1 Peak Serve Speed (km/h)

Group	Author (Year)	Study results		Study conditions			Comment	Meta-analysis	Reason for exclusion from MA	
		Mean	SD	N (Matches)	Surface	Sex				Playing Level
Men International Hard	Cui et al. (2020a)	208.9	11.0	269	Hard	Men	International	Australian Open 2015-2017 Seeded	No	Only two studies for analysis
	Cui et al. (2020a)	204.6	11.0	223	Hard	Men	International	Australian Open 2015-2017 Non-seeded	No	Only two studies for analysis
	Cui et al. (2020a)	209.2	11.0	157	Hard	Men	International	US Open 2015-2017 Seeded	No	Only two studies for analysis
	Cui et al. (2020a)	204.4	10.0	105	Hard	Men	International	Australian Open 2014-2016 27.9-30%	No	Only two studies for analysis
	Reid et al. (2016)	206.3	11.8	88	Hard	Men	International	Australian Open 2012-2014 - peak serve speed	No	Only two studies for analysis
	Smith et al. (2018a)	202.7	13.7	NR	Hard	Men	International	Australian Open 2014-2016 <22.2°C	No	ELO-adjusted matches, nr of matches not reported
	Smith et al. (2018b)	203.4	13.0	NR	Hard	Men	International	Australian Open 2014-2016 22.3-27.9°C	No	ELO-adjusted matches, nr of matches not reported
	Smith et al. (2018c)	206.5	11.5	NR	Hard	Men	International	Australian Open 2014-2016 27.9-30%	No	ELO-adjusted matches, nr of matches not reported
	Smith et al. (2018d)	206.3	16.4	NR	Hard	Men	International	Australian Open 2014-2016 30.1-32.2°C	No	ELO-adjusted matches, nr of matches not reported
	Smith et al. (2018e)	206.2	9.9	NR	Hard	Men	International	Australian Open 2014-2016 >32.3°C	No	ELO-adjusted matches, nr of matches not reported
Men International Clay	Whitehead et al. (2015)	202.3	9.3	40	Hard	Men	International	Top ranked: Australian Open 2012-2014 - peak serve speed	No	Subgroup analysis (Reid et al 2016)
	Whitehead et al. (2015)	196.5	11.6	40	Hard	Men	International	Lower ranked: Australian Open 2012-2014 - peak serve speed	No	Subgroup analysis (Reid et al 2016)
	Cui et al. (2020a)	205.2	10.0	106	Clay	Men	International	French Open 2015-2017 Seeded	No	Only one study for analysis
	Cui et al. (2020a)	199.7	9.0	48	Clay	Men	International	French Open 2015-2017 Non-seeded	No	Only one study for analysis
Men International Grass	Cui et al. (2020a)	210.2	10.0	162	Grass	Men	International	Wimbledon 2015-2017 Seeded	No	Only one study for analysis
	Cui et al. (2020a)	203.4	9.0	118	Grass	Men	International	Wimbledon 2015-2017 Non-seeded	No	Only one study for analysis
	Reid et al. (2016)	171.8	10.5	82	Hard	Women	International	Australian Open 2012-2014	No	Only study for analysis
Women International Hard	Smith et al. (2018)	166.7	10.9	NR	Hard	Women	International	Australian Open 2014-2016 <22.2°C	No	ELO-adjusted matches, nr of matches not reported
	Smith et al. (2018a)	158.2	10.8	NR	Hard	Women	International	Australian Open 2014-2016 22.3-27.9°C	No	ELO-adjusted matches, nr of matches not reported
	Smith et al. (2018a)	170.9	19.0	NR	Hard	Women	International	Australian Open 2014-2016 27.9-30°C	No	ELO-adjusted matches, nr of matches not reported
	Smith et al. (2018a)	168.0	21.7	NR	Hard	Women	International	Australian Open 2014-2016 30.1-32.2°C	No	ELO-adjusted matches, nr of matches not reported
	Smith et al. (2018a)	168.3	22.3	NR	Hard	Women	International	Australian Open 2014-2016 >32.3°C	No	ELO-adjusted matches, nr of matches not reported

Notes: NR = Not Reported

7.2 First Serve Speed (km/h)

Group	Author (Year)	Study results		Study conditions			Comment	Meta-analysis	Reason for exclusion from MA	
		Mean	SD	N (Matches)	Surface	Sex				Playing Level
Men International Hard	Cui et al. (2020a)	186.9	10.0	269	Hard	Men	International	Australian Open 2015-2017 Seeded Deuce court	Yes	Included in MA
	Cui et al. (2020a)	183.6	10.0	223	Hard	Men	International	Australian Open 2015-2017 Non-seeded Deuce court	Yes	Included in MA
	Cui et al. (2020a)	187.7	11.0	269	Hard	Men	International	Australian Open 2015-2017 Seeded Ad court	Yes	Included in MA
	Cui et al. (2020a)	184.1	10.0	223	Hard	Men	International	Australian Open 2015-2017 Non-seeded Ad court	Yes	Included in MA
	Cui et al. (2020a)	185.9	10.0	157	Hard	Men	International	US Open 2015-2017 Seeded Deuce court	Yes	Included in MA
	Cui et al. (2020a)	181.8	10.0	105	Hard	Men	International	US Open 2015-2017 Non-seeded Deuce court	Yes	Included in MA
	Cui et al. (2020a)	185.2	11.0	157	Hard	Men	International	US Open 2015-2017 Seeded Ad court	Yes	Included in MA
	Cui et al. (2020a)	180.9	10.0	105	Hard	Men	International	US Open 2015-2017 Non-seeded Ad court	Yes	Included in MA
	Horney et al. (2007)	178.0	9.0	17	Hard	Men	International	ATP (21.4 y)	Yes	Included in MA
	Kovalich and Reid (2017)	179*	NR	21	Hard	Men	International	Australian Open 2012-2017	Yes	Only one study for analysis
Men International Clay	Reid et al. (2016)	184.3	9.3	88	Hard	Men	International	Australian Open 2012-2014 - mean first serve speed	Yes	Included in MA
	Smith et al. (2018b)	181.8	7.9	NR	Hard	Men	International	Australian Open 2014-2016 <22.2°C	No	ELO-adjusted matches, nr of matches not reported
	Smith et al. (2018b)	182.0	8.0	NR	Hard	Men	International	Australian Open 2014-2016 22.3-27.9°C	No	ELO-adjusted matches, nr of matches not reported
	Smith et al. (2018b)	183.7	11.4	NR	Hard	Men	International	Australian Open 2014-2016 27.9-30°C	No	ELO-adjusted matches, nr of matches not reported
	Smith et al. (2018b)	182.0	9.4	NR	Hard	Men	International	Australian Open 2014-2016 30.1-32.2°C	No	ELO-adjusted matches, nr of matches not reported
	Smith et al. (2018b)	181.9	9.1	NR	Hard	Men	International	Australian Open 2014-2016 >32.3°C	No	ELO-adjusted matches, nr of matches not reported
	Whitehead et al. (2015)	175.0	9.9	40	Hard	Men	International	Top ranked: Australian Open 2012-2014 - mean first serve	No	Subgroup analysis (Reid et al 2016)
	Whitehead et al. (2015)	171.9	8.7	40	Hard	Men	International	Lower ranked: Australian Open 2012-2014 - mean first serve	No	Subgroup analysis (Reid et al 2016)
	Cui et al. (2020a)	186.3	9.3	106	Clay	Men	International	French Open 2015-2017 Seeded Deuce court	Yes	Included in MA
	Cui et al. (2020a)	182.6	9.0	48	Clay	Men	International	French Open 2015-2017 Non-seeded Deuce court	Yes	Included in MA
Men International Grass	Cui et al. (2020a)	181.7	9.0	106	Clay	Men	International	French Open 2015-2017 Seeded Ad court	Yes	Included in MA
	Cui et al. (2020a)	180.9	10.0	48	Clay	Men	International	French Open 2015-2017 Non-seeded Ad court	Yes	Included in MA
	Fitapatrick et al. (2019)	181.8	9.7	244	Clay	Men	International	Roland Garros 2016, 2017 - winning players	Yes	Included in MA
	Fitapatrick et al. (2019)	180.9	10.7	244	Clay	Men	International	Roland Garros 2016, 2017 - losing players	Yes	Included in MA
	Horney et al. (2007)	172.0	14.0	20	Clay	Men	International	ATP (21.4 y)	Yes	Included in MA
	Brown et al. (2021)	188.0	14.3	1140	Grass	Men	International	Wimbledon 2004-2019	Yes	Included in MA
	Cui et al. (2020a)	189.2	9.0	162	Grass	Men	International	Wimbledon 2015-2017 Seeded Deuce court	Yes	Included in MA
	Cui et al. (2020a)	184.9	9.0	118	Grass	Men	International	Wimbledon 2015-2017 Non-seeded Deuce court	Yes	Included in MA
	Cui et al. (2020a)	192.1	10.0	10.0	Grass	Men	International	Wimbledon 2015-2017 Seeded Ad court	Yes	Included in MA
	Cui et al. (2020a)	185.2	9.0	118	Grass	Men	International	Wimbledon 2015-2017 Non-seeded Ad court	Yes	Included in MA
Junior Men International Hard	Fitapatrick et al. (2019)	188.6	8.8	241	Grass	Men	International	Wimbledon 2016, 2017 - winning players	Yes	Included in MA
	Fitapatrick et al. (2019)	185.2	10.2	241	Grass	Men	International	Wimbledon 2016, 2017 - losing players	Yes	Included in MA
	Maquarain et al. (2016)	187.9	9.4	15	Grass	Men	International	Wimbledon 2015	Yes	Included in MA
	Kovalich and Reid (2017)	158*	NR	12	Hard	Men	International	Australian Open 2012-2017 (junior)	Yes	Only one study for analysis
	Kovalich and Reid (2017)	153*	NR	21	Hard	Women	International	Australian Open 2012-2017	Yes	Only one study for analysis
	Reid et al. (2016)	155.5	9.8	82	Hard	Women	International	Australian Open 2012-2014	Yes	Only one study for analysis
	Smith et al. (2018a)	151.9	10.9	NR	Hard	Women	International	Australian Open 2014-2016 <22.2°C	No	ELO-adjusted matches, nr of matches not reported
	Smith et al. (2018a)	151.4	10.7	NR	Hard	Women	International	Australian Open 2014-2016 22.3-27.9°C	No	ELO-adjusted matches, nr of matches not reported
	Smith et al. (2018a)	155.2	9.7	NR	Hard	Women	International	Australian Open 2014-2016 27.9-30°C	No	ELO-adjusted matches, nr of matches not reported
	Smith et al. (2018a)	150.3	19.7	NR	Hard	Women	International	Australian Open 2014-2016 30.1-32.2°C	No	ELO-adjusted matches, nr of matches not reported
Women International Clay	Smith et al. (2018a)	150.2	20.0	NR	Hard	Women	International	Australian Open 2014-2016 >32.3°C	No	ELO-adjusted matches, nr of matches not reported
	Fitapatrick et al. (2019)	155.3	10.5	250	Clay	Women	International	Roland Garros 2016, 2017 - winning players	Yes	Only one study for analysis
	Fitapatrick et al. (2019)	154.7	9.9	250	Clay	Women	International	Roland Garros 2016, 2017 - losing players	Yes	Only one study for analysis
	Brown et al. (2021)	160.0	13.1	1070	Grass	Women	International	Wimbledon 2004-2019	Yes	Included in MA
	Fitapatrick et al. (2019)	159.4	9.5	249	Grass	Women	International	Wimbledon 2016, 2017 - winning players	Yes	Included in MA
	Fitapatrick et al. (2019)	158.4	8.4	249	Grass	Women	International	Wimbledon 2016, 2017 - losing players	Yes	Included in MA
	Kovalich and Reid (2017)	146*	NR	6	Hard	Women	International	Australian Open 2012-2017 (junior)	No	Only one study for analysis

Notes: *Median, NR = Not Reported

7.3 Second Serve Speed (km/h)

Group	Author (Year)	Study results		Study conditions			Comment	Meta-analysis	Reason for exclusion from MA	
		Mean	SD	N (Matches)	Surface	Sex				Playing Level
Men International Hard	Cui et al. (2020a)	155.3	11.0	269	Hard	Men	International	Australian Open 2015-2017 Seeded Deuce court	Yes	Included in MA
	Cui et al. (2020a)	153.3	10.0	223	Hard	Men	International	Australian Open 2015-2017 Non-seeded Deuce court	Yes	Included in MA
	Cui et al. (2020a)	150.9	12.0	269	Hard	Men	International	Australian Open 2015-2017 Seeded Ad court	Yes	Included in MA
	Cui et al. (2020a)	149.2	11.0	223	Hard	Men	International	Australian Open 2015-2017 Non-seeded Ad court	Yes	Included in MA
	Cui et al. (2020a)	153.6	11.0	157	Hard	Men	International	US Open 2015-2017 Seeded Deuce court	Yes	Included in MA
	Cui et al. (2020a)	149.7	10.0	105	Hard	Men	International	US Open 2015-2017 Non-seeded Deuce court	Yes	Included in MA
	Cui et al. (2020a)	149.4	12.0	157	Hard	Men	International	US Open 2015-2017 Seeded Ad court	Yes	Included in MA
	Cui et al. (2020a)	146.0	11.0	105	Hard	Men	International	US Open 2015-2017 Non-seeded Ad court	Yes	Included in MA
	Horney et al. (2007)	135.0	10.0	17	Hard	Men	International	ATP (21.4 y)	Yes	Included in MA
	Reid et al. (2016)	152.1	9.6	88	Hard	Men	International	Australian Open 2012-2014 - mean second serve speed	Yes	Included in MA
Men International Clay	Smith et al. (2018b)	147.5	8.8	NR	Hard	Men	International	Australian Open 2014-2016 <22.2°C	No	ELO-adjusted matches, nr of matches not reported
	Smith et al. (2018b)	147.6	9.1	NR	Hard	Men	International	Australian Open 2014-2016 22.3-27.9°C	No	ELO-adjusted matches, nr of matches not reported
	Smith et al. (2018b)	150.0	11.8	NR	Hard	Men	International	Australian Open 2014-2016 27.9-30%	No	ELO-adjusted matches, nr of matches not reported
	Smith et al. (2018b)	148.7	10.1	NR	Hard	Men	International	Australian Open 2014-2016 30.1-32.2°C	No	ELO-adjusted matches, nr of matches not reported
	Smith et al. (2018b)	148.6	10.2	NR	Hard	Men	International	Australian Open 2014-2016 >32.3°C	No	ELO-adjusted matches, nr of matches not reported
	Whitehead et al. (2015)	145.7	9.3	40	Hard	Men	International	Top ranked: Australian Open 2012-2014 - mean second serve	No	Subgroup analysis (Reid et al 2016)
	Whitehead et al. (2015)	144.4	10.3	40	Hard	Men	International	Lower ranked: Australian Open 2012-2014 - mean second serve	No	Subgroup analysis (Reid et al 2016)
	Cui et al. (2020a)	152.7	9.0	106	Clay	Men	International	French Open 2015-2017 Seeded Deuce court	No	Only two studies for analysis
	Cui et al. (2020a)	150.8	10.0	48	Clay	Men	International	French Open 2015-2017 Non-seeded Deuce court	No	Only two studies for analysis
	Cui et al. (2020a)	145.9	10.0	106	Clay	Men	International	French Open 2015-2017 Seeded Ad court	No	Only two studies for analysis
Men International Grass	Cui et al. (2020a)	144.5	10.0	48	Clay	Men	International	French Open 2015-2017 Non-seeded Ad court	No	Only two studies for analysis
	Horney et al. (2007)	134.0	12.0	20	Clay	Men	International	ATP (21.4 y)	No	Only two studies for analysis
	Brown et al. (2021)	157.0	15.3	1140	Grass	Men	International	Wimbledon 2004-2019	Yes	Included in MA
	Cui et al. (2020a)	157.0	11.0	118	Grass	Men	International	Wimbledon 2015-2017 Seeded Deuce court	Yes	Included in MA
	Cui et al. (2020a)	159.0	13.0	10.0	Grass	Men	International	Wimbledon 2015-2017 Seeded Ad court	Yes	