## Supplementary Material

Gait Kinematic Parameters in Parkinson's Disease: A Systematic Review


Supplementary Material 1. Flow diagram of study selection process

Supplementary Material 2. Forest plot analysis for the different gait parameters

| Study or Subgroup | Mean | $\begin{gathered} \text { PD } \\ \text { SD } \end{gathered}$ | Total | Mean | ontrol SD | Total | Weight | Mean Difference <br> IV, Random, 95\% CI |  | Mean D IV, Rando | ifference om, 95\% CI |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1.11.1 Wearable sensors |  |  |  |  |  |  |  |  |  |  |  |  |
| Ealtadjleva 2006 | 1.1 | 0.21 | 35 | 1.3 | 0.24 | 22 | 5.7\% | -0.20 [-0.32, -0.08] |  |  |  |  |
| Beck 2013 | 1.16 | 0.2 | 101 | 1.18 | 0.24 | 39 | 6.3\% | -0.02[-0.10, 0.06] |  |  |  |  |
| Bernad-Elazarl 2016 | 1.12 | 0.2 | 99 | 1.18 | 0.26 | 38 | 6.2\% | -0.06 [-0.15, 0.03] |  |  |  |  |
| Brodie 2015 | 1.21 | 0.15 | 10 | 1.41 | 0.16 | 20 | 5.8\% | $-0.20[-0.32,-0.08]$ |  |  |  |  |
| Hatanaka 2016 | 0.89 | 0.24 | 124 | 1.1 | 0.22 | 24 | 6.1\% | $-0.21[-0.31,-0.11]$ |  |  |  |  |
| Hausdorf 1998 | 1 | 0.2 | 15 | 1.35 | 0.16 | 16 | 5.6\% | -0.35 [-0.48, -0.22] |  |  |  |  |
| Kluge 2017 | 1.01 | 0.24 | 4 | 1.34 | 0.37 | 11 | 2.7\% | $-0.33[-0.65,-0.01]$ |  |  |  |  |
| Lewts 2000 | 1.06 | 0.21 | 14 | 1.39 | 0.22 | 14 | 5.1\% | -0.33[-0.49, -0.17] |  |  |  |  |
| Lord 2008 | 0.92 | 0.16 | 12 | 1.2 | 0.15 | 11 | 5.6\% | $-0.28[-0.41,-0.15]$ |  |  |  |  |
| Lowry 2009 | 1.1 | 0.3 | 11 | 1.3 | 0.3 | 11 | 3.6\% | $-0.20[-0.45,0.05]$ |  |  |  |  |
| Matsushima 2017 | 0.96 | 0.27 | 61 | 1.34 | 0.13 | 57 | 6.5\% | -0.38 [-0.46, -0.30] |  |  |  |  |
| Rocchl 2014 | 1.1 | 0.2 | 70 | 1.3 | 0.2 | 15 | 5.9\% | $-0.20[-0.31,-0.09]$ |  |  |  |  |
| Warkop 2017 | 1.18 | 0.19 | 14 | 1.47 | 0.17 | 10 | 5.3\% | -0.29 [-0.43, -0.15] |  |  |  |  |
| Yogev 2005 <br> Subtotal (95\% CI) | 1.05 | 0.23 | $\begin{array}{r} 30 \\ 600 \end{array}$ | 1.31 | 0.19 | $\begin{array}{r} 28 \\ 316 \end{array}$ | $\begin{array}{r} 6.0 \% \\ 76.6 \% \end{array}$ | $\begin{aligned} & -0.26[-0.37,-0.15] \\ & -0.23[-0.30,-0.16] \end{aligned}$ |  |  |  |  |
| Heterogenelty: $\mathrm{Tav}^{2}=0.01 ; \mathrm{Chr}^{2}=59.17, \mathrm{df}=13\left(\mathrm{P}<0.00001\right.$ ); $\mathrm{r}^{2}=78 \%$ Test for overall effect: $Z=6.60$ ( $\mathrm{P}<0.00001$ ) |  |  |  |  |  |  |  |  |  |  |  |  |
| 1.11.2 Non-wearable sensors |  |  |  |  |  |  |  |  |  |  |  |  |
| Alcock-2 2018 | 1.2 | 0.26 | 36 | 1.28 | 0.2 | 38 | 6.0\% | -0.08 [-0.19, 0.03] |  |  |  |  |
| De Melo Rotz 2010 | 0.77 | 0.14 | 12 | 0.59 | 0.2 | 15 | 5.6\% | 0.18 [0.05, 0.31] |  |  |  |  |
| Lord 2008 | 0.98 | 0.17 | 12 | 1.21 | 0.14 | 11 | 5.6\% | -0.23[-0.36, -0.10] |  |  |  |  |
| UranlSilva 2019 | 1.23 | 0.2 | 25 | 1.33 | 0.15 | 29 | 6.2\% | -0.10 [-0.20, -0.00] |  |  |  |  |
| Rafferty 2017 | 1.22 | 23 | 24 | 1.36 | 26 | 23 | 0.0\% | -0.14 [-14.20, 13.92] |  |  |  |  |
| Subtotal (95\% CI) |  |  | 109 |  |  | 116 | 23.4\% | -0.06 [-0.21, 0.09] |  |  |  |  |
| Heterogeneity: Taur $^{2}=0.02 ; \mathrm{Chr}^{2}=21.05, \mathrm{df}=4(\mathrm{P}=0.0003) ; \mathrm{r}^{2}=81 \%$ Test for overall effect: $Z=0.79$ ( $\mathrm{P}=0.43$ ) |  |  |  |  |  |  |  |  |  |  |  |  |
| Total (95\% CI) |  |  | 709 |  |  | 432 | 100.0\% | -0.19 [-0.26, -0.12] |  |  |  |  |
| Heterogenelty: $\mathrm{Tau}^{2}=0.02 ; \mathrm{Ch}^{2}=102.27, \mathrm{df}=1 \mathrm{~B}\left(\mathrm{P}<0.00001\right.$ ); $\mathrm{I}^{2}=82 \%$ Test for overall effect: $Z=5.53$ ( $\mathrm{P}<0.00001$ ) <br> Test for subgroup differences: $\mathrm{Ch}^{2}=4.30, \mathrm{df}=1(\mathrm{P}=0.04), \mathrm{I}^{2}=76.7 \%$ |  |  |  |  |  |  |  |  | -0.5 | [experimental] | $0 \quad 0.25$ | 0.5 |

Forest Plot 1. Gait velocity parameter: comparison between different type of devices (WS and NWS)


Forest Plot 2. Gait velocity: comparison between different sensor locations

| Study or Subgroup | Mean | PD | Total | Control |  |  | Weight | Mean Difference <br> IV, Random, 95\% CI | Mean Difference <br> IV, Random, 95\% CI |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1.10.1 Accelerometer |  |  |  |  |  |  |  |  |  |  |  |  |
| Beck 2018 | 1.16 | 0.2 | 101 | 1.18 | 0.24 | 39 | 8.6\% | -0.02[-0.10, 0.06] |  |  |  |  |
| Bernad-Elazarl 2016 | 1.12 | 0.2 | 99 | 1.18 | 0.26 | 38 | 8.4\% | $-0.06[-0.15,0.03]$ |  |  |  |  |
| Brodle 2015 | 1.21 | 0.15 | 10 | 1.41 | 0.16 | 20 | 7.7\% | -0.20 [-0.32, -0.08] |  |  |  |  |
| Hatanaka 2016 | 0.89 | 0.24 | 124 | 1.1 | 0.22 | 24 | 8.2\% | -0.21[-0.31, -0.11 ] |  |  |  |  |
| Lord 2003 | 0.92 | 0.16 | 12 | 1.2 | 0.15 | 11 | 7.4\% | -0.28 [-0.41, -0.15$]$ |  |  |  |  |
| Lowry 2009 | 1.1 | 0.3 | 11 | 1.3 | 0.3 | 11 | 4.2\% | -0.20 [-0.45, 0.05] |  |  |  |  |
| Matsushima 2017 | 0.96 | 0.27 | 61 | 1.34 | 0.13 | 57 | B.B\% | -0.38 [-0.46, -0.30] |  |  |  |  |
| Rocchl 2014 | 1.1 | 0.2 | 70 | 1.3 | 0.2 | 15 | 7.8X | -0.20[-0.31, -0.09$]$ |  |  |  |  |
| Warkop 2017 | 1.18 | 0.19 | 14 | 1.47 | 0.17 | 10 | 6.8\% | -0.29 [-0.43, -0.15] |  |  |  |  |
| Subtotal (95\% CI) |  |  | 502 |  |  | 225 | 67.8\% | -0.20 [-0.29, -0.11] |  |  |  |  |
| Heterogenelty: $\mathrm{Tau}^{2}=0.02 ; \mathrm{Chr}^{2}=51.05, \mathrm{df}=\mathrm{B}(\mathrm{P}<0.00001) ; \mathrm{I}^{2}=84 \%$ Test for overall effect: $\mathrm{Z}=4.32$ ( $\mathrm{P}<0.0001$ ) |  |  |  |  |  |  |  |  |  |  |  |  |
| 1.10.2 Other type of sensors |  |  |  |  |  |  |  |  |  |  |  |  |
| Baltadjleva 2006 | 1.1 | 0.21 | 35 | 1.3 | 0.24 | 22 | 7.5\% | -0.20[-0.32, -0.08] |  |  |  |  |
| Hausdorff 1998 | 1 | 0.2 | 15 | 1.35 | 0.16 | 16 | 7.3\% | -0.35[-0.48, -0.22$]$ |  |  |  |  |
| Kluge 2017 | 1.01 | 0.24 | 4 | 1.34 | 0.37 | 11 | 3.1\% | -0.33[-0.65, -0.01] |  |  |  |  |
| Lewts 2000 | 1.06 | 0.21 | 14 | 1.39 | 0.22 | 14 | 6.4\% | -0.33[-0.49, -0.17] |  |  |  |  |
| Yogev 2005 | 1.05 | 0.23 | 30 | 1.31 | 0.19 | 28 | 7.9\% | $-0.26[-0.37,-0.15]$ |  |  |  |  |
| Subtotal (95\% CI) |  |  | 98 |  |  | 91 | 32.2\% | -0.28 [-0.34, -0.22] |  |  |  |  |
| Heterogenelty: $\mathrm{Tau}^{2}=0.00 ; \mathrm{Ch}^{2}=3.40, \mathrm{df}=4(\mathrm{P}=0.49) ; \mathrm{r}^{2}=0 \%$ Test for overall effect: $\mathbf{Z}=\mathbf{B} . \mathrm{B} 5$ ( $\mathrm{P}<0.00001$ ) |  |  |  |  |  |  |  |  |  |  |  |  |
| Total (95\% CI) |  |  | 600 |  |  | 316 | 100.0\% | $-0.23[-0.30,-0.16]$ |  |  |  |  |
| Heterogenelty: $\mathrm{Tau}^{2}=0.01 ; \mathrm{Chr}^{2}=59.17, \mathrm{df}=13(\mathrm{P}<0.00001) ; \mathrm{r}^{2}=7 \mathrm{PK}$ <br> Test for overall effect: $\mathbf{Z}=6.60$ ( $\mathrm{P}<0.00001$ ) <br> Test for subgroup differences: $\mathrm{Ch}^{2}=1 . \mathrm{B1}, \mathrm{df}=1(\mathrm{P}=0.18), \mathrm{I}^{2}=\mathbf{4 4 . 7 \%}$ |  |  |  |  |  |  |  |  | $\begin{array}{r} -0.5 \\ \text { Favour: } \end{array}$ | $\stackrel{-0.25}{\text { xperimental] }}$ |  | $0.2500 .5$ |

Forest Plot 3. Gait velocity: comparison between different type of sensors


Forest Plot 4. Cadence: comparison between of the mean values between PD and HC subjects using WS

| Study or Subgroup | PD |  |  | Control |  |  |  | Mean Difference <br> IV, Random, 95\% CI | Mean Difference IV, Random, 95\% CI |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Mean | SD | Total | Mean | SD | Total | Weight |  |  |  |  |  |
| 1.3.1 Wearable sensors |  |  |  |  |  |  |  |  |  |  |  |  |
| Ealtadjleva 2006 | 1.23 | 0.19 | 35 | 1.38 | 0.22 | 22 | 11.4\% | -0.15[-0.26, -0.04] |  |  |  |  |
| Demonceau 2015 | 1.29 | 0.2 | 64 | 1.43 | 0.16 | 32 | 13.3\% | -0.14[-0.21, -0.07] |  |  |  |  |
| Frenkel-Toledo 2005 | 1.25 | 0.16 | 36 | 1.33 | 0.11 | 30 | 13.6\% | -0.08 [-0.15, -0.01] |  |  |  |  |
| Kluge 2017 | 1.25 | 0.18 | 4 | 1.45 | 0.21 | 11 | 6.3\% | -0.20 [-0.42, 0.02] |  |  |  |  |
| Lewts 2000 | 1.1 | 0.25 | 14 | 1.42 | 0.18 | 14 | 9.0\% | -0.32[-0.48, -0.16] |  |  |  |  |
| Lowry 2009 | 1.4 | 0.2 | 11 | 1.4 | 0.2 | 11 | 8.7\% | $0.00[-0.17,0.17]$ |  |  |  |  |
| Subtotal (95\% CI) |  |  | 164 |  |  | 120 | 62.8\% | -0.14 [-0.20, -0.07] |  |  |  |  |
| Heterogenelty: $\mathrm{Tav}^{2}=0.00 ; \mathrm{Ch}^{2}=10.3 \mathrm{~B}, \mathrm{df}=5(\mathrm{P}=0.07) ; \mathrm{r}^{2}=52 \%$ Test for overall effect: $Z=3.97$ ( $\mathrm{P}<0.0001$ ) |  |  |  |  |  |  |  |  |  |  |  |  |
| 1.3.2 Non-wearable sensors |  |  |  |  |  |  |  |  |  |  |  |  |
| De Melo Rotz 2010 | 1.03 | 0.13 | 12 | 0.79 | 0.22 | 15 | 10.3\% | 0.24 [0.11, 0.37] |  |  |  |  |
| Makdan 2016 | 1.09 | 0.019 | 68 | 1.28 | 0.019 | 38 | 15.2\% | -0.19[-0.20, -0.18] |  | - |  |  |
| Rafferty 2017 | 1.32 | 0.19 | 24 | 1.42 | 0.18 | 23 | 11.7\% | $-0.10[-0.21,0.01]$ |  |  |  |  |
| Subtotal (95\% CI) |  |  | 104 |  |  | 76 | 37.2\% | -0.02[-0.25, 0.20] |  |  |  |  |
| Heterogenety: $\mathrm{Tau}^{2}=0.04 ; \mathrm{Chr}^{2}=42.45, \mathrm{df}=2(\mathrm{P}<0.00001) ; \mathrm{I}^{2}=95 \%$ Test for overall effect: $\mathbf{Z}=0.22$ ( $\mathrm{P}=0 . \mathrm{B} 3$ ) |  |  |  |  |  |  |  |  |  |  |  |  |
| Total (95\% CI) |  |  | 268 |  |  | 196 | 100.0\% | -0.10 [-0.18, -0.03] |  |  |  |  |
| Heterogenelty: $\mathrm{Tau}^{2}=0.01 ; \mathrm{Chr}^{2}=62.16, \mathrm{df}=\mathrm{B}\left(\mathrm{P}<0.00001\right.$ ); $\mathrm{I}^{2}=87 \%$ Test for overall effect: $\mathbf{Z = 2 . 7 2 ( P = 0 . 0 0 7 )}$ <br> Test for subgroup differences: $\mathrm{Ch}^{2}=0.87, \mathrm{df}=1(\mathrm{P}=0.35), \mathrm{r}^{2}=0 \mathrm{x}$ |  |  |  |  |  |  |  |  | -0.5 | erimental] | $0<\frac{0.25}{0}$ | 0.5 |

Forest Plot 5. Stride length: comparison between different type of devices (WS and NWS)

| Study or Subgroup | Mean |  | Total | Mean | $\begin{gathered} \text { ontrol } \\ \text { SD } \\ \hline \end{gathered}$ | Total | Weight | Mean Difference <br> IV, Random, 95\% CI |  | Mean D IV, Rando | $\begin{aligned} & \text { ifference } \\ & \mathrm{m}, 95 \% \mathrm{CI} \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1.4.1 Lower back |  |  |  |  |  |  |  |  |  |  |  |
| Beck 2018 | 1.09 | 0.09 | 101 | 1.04 | 0.06 | 39 | 44.7\% | 0.05 [0.02, 0.08] |  |  | - |
| Lowry 2009 | 1.1 | 0.1 | 11 | 1.1 | 0.1 | 11 | 4.2\% | $0.00[-0.08,0.08]$ |  |  |  |
| Welss 2011 | 1.18 | 0.1 | 22 | 1.09 | 0.09 | 17 | 8.3\% | 0.09 [0.03, 0.15] |  |  |  |
| Subtotal (95\% CI) |  |  | 134 |  |  | 67 | 57.2\% | 0.05 [0.02, 0.09] |  |  |  |
| Heterogenelty: Taur $^{2}=0.00 ; \mathrm{Ch}^{2}=3.06, \mathrm{df}=2(\mathrm{P}=0.22) ; \mathrm{r}^{2}=35 \%$ Test for overall effect: $Z=2.187$ ( $\mathrm{P}=0.004$ ) |  |  |  |  |  |  |  |  |  |  |  |
| 1.4.2 Feet |  |  |  |  |  |  |  |  |  |  |  |
| Frenke1-Toledo 2005 | 1.12 | 0.07 | 36 | 1.08 | 0.09 | 30 | 19.0\% | 0.04 [0.00, 0.08] |  |  | - |
| Kluge 2017 | 1.27 | 0.15 | 4 | 1.13 | 0.18 | 11 | 0.9\% | $0.14[-0.04,0.32]$ |  |  |  |
| Yogev 2005 | 1.08 | 0.15 | 30 | 1.07 | 0.08 | 28 | 7.9\% | 0.01 [-0.05, 0.07] |  |  |  |
| Subtotal (95\% CI) |  |  | 70 |  |  | 69 | 27.7\% | 0.03 [0.00, 0.07] |  |  |  |
| Heterogenelty: $\mathrm{Tau}^{2}=0.00 ; \mathrm{Ch}^{2}=1.99$, $\mathrm{df}=2(\mathrm{P}=0.37) ; \mathrm{P}^{2}=0 \mathrm{X}$ <br> Test for overall effect: $Z=2.0 \mathrm{~B}$ ( $\mathrm{P}=0.04$ ) |  |  |  |  |  |  |  |  |  |  |  |
| 1.4.3 Other locations |  |  |  |  |  |  |  |  |  |  |  |
| Baltadjleva 2006 | 1.13 | 0.11 | 35 | 1.07 | 0.07 | 22 | 13.6\% | $0.06[0.01,0.11]$ |  |  |  |
| Salarlan 2004 | 1.2 | 0.2 | 10 | 1.1 | 0.1 | 10 | $1.5 \%$ | $0.10[-0.04,0.24]$ |  |  |  |
| Subtotal (95\% CI) |  |  | 45 |  |  | 32 | 15.1\% | $0.06[0.02,0.11]$ |  |  |  |
| Heterogenelty: $\mathrm{Tau}^{2}=0.00 ; \mathrm{Chr}^{2}=0.29, \mathrm{df}=1(\mathrm{P}=0.59) ; \mathrm{I}^{2}=0 \%$ <br> Test for overall effect: $\mathbf{Z}=2.84$ ( $\mathrm{P}=0.005$ ) |  |  |  |  |  |  |  |  |  |  |  |
| Total (95\% CI) |  |  | 249 |  |  | 168 | 100.0\% | 0.05 [0.03, 0.07] |  |  |  |
| Heterogenety: $\mathrm{Tau}^{2}=0.00 ; \mathrm{Chr}^{2}=6.5 \mathrm{~B}, \mathrm{df}=7(\mathrm{P}=0.47) ; \mathrm{I}^{2}=0 \%$ <br> Test for overall effect: $\mathbf{Z}=5.59$ ( $\mathrm{P}<0.00001$ ) <br> Test for subgroup differences: $C h^{2}=1.20, \mathrm{df}=2(\mathrm{P}=0.55), \mathrm{I}^{2}=0 \mathrm{x}$ |  |  |  |  |  |  |  |  | $\begin{gathered} -0.2 \\ \text { Favours [ex } \end{gathered}$ | $-0.1$ | $\begin{array}{cc} 0.1 & 0.2 \\ \text { Favours } \\ \text { [control] } \end{array}$ |

Forest Plot 6. Stride time: comparison between different sensor locations


Forest Plot 7. Stride time variability: comparison between different sensor locations


Forest Plot 8. Step length: comparison between different type of devices (WS and NWS)


Forest Plot 9. Step time: comparison between of the mean values between PD and HC subjects using WS


Forest Plot 10. Swing time: comparison between of the mean values between PD and HC subjects using WS


Forest Plot 11. Double support time: comparison between of the mean values between PD and HC subjects using WS

