



Science Arts & Métiers (SAM)

is an open access repository that collects the work of Arts et Métiers Institute of Technology researchers and makes it freely available over the web where possible.

This is an author-deposited version published in: <https://sam.ensam.eu>

Handle ID: <http://hdl.handle.net/10985/22135>



This document is available under CC BY-NC license

To cite this version :

Théo ROUVIER, Aude LOUESSARD, Emeline SIMONETTI, Samuel HYBOIS, Joseph BASCOU, Charles PONTONNIER, Hélène PILLET, Christophe SAURET - Manual wheelchair biomechanics while overcoming environmental barriers: a systematic review - PLoS ONE - 2022

Appendix: Biomechanical parameters definition

Spatio-temporal parameters

Stroke: propulsion cycle.

Push phase: phase of a propulsion cycle during which the hand pushes on the handrim to propel the manual wheelchair.

Recovery phase: phase of a propulsion cycle during which the hand is not in contact with the handrim.

Contact angle: angle distance travelled by the hand on the handrim during the push phase.

Push time: duration of a push phase.

Recovery time: duration of a recovery phase.

Cycle time: duration of a propulsion cycle.

Cycle frequency: inverse of average cycle time.

Speed: average speed of the manual wheelchair or average simulated speed of the manual wheelchair (on a roller ergometer or treadmill).

Kinematics

Joint angle: angle between two skeletal segments.

Kinetics

Rate of rise: represents the initial impact load on the pushrim. It has multiple definitions:

- Maximum value of the derivative of the resultant force with respect to time during the first third of the stroke (as defined in Koontz et al., 2005): $RoR = \max_{0 \leq t \leq \frac{T}{3}} \frac{dF_r}{dt}$, where RoR

is the Rate of Rise, t time, T the duration of the stroke, and Fr the resultant force applied to the handrim.

- Peak of the resultant force divided by the time to reach it since the beginning of the stroke (present in the literature, but not in our reviewed studies): $RoR = \frac{\widehat{F}_r}{T_{peak}}$, where *RoR is the Rate of Rise, \widehat{F}_r the peak of the resultant force applied at the handrim, and T_{peak} the time to reach \widehat{F}_r .*

Handrim forces: forces applied to the handrim by the hand.

Fraction of effective force: or mechanical effective force, represents the ratio between the forces useful to turn the rear wheel and the total force applied to the handrim. It has multiple definitions:

- Division of the square tangential force by the square resultant force (used in most of the reviewed studies): $FEF = \frac{F_t^2}{F_r^2}$, where *FEF is the Fraction of Effective Force, F_t the tangential force applied to the handrim, and F_r the resultant force applied to the handrim.*
- Propulsion moment squared divided by the handrim radius squared, all divided by the resultant force on the handrim squared: $FEF = \frac{M^2}{\frac{r_h^2}{F_r^2}}$, where *FEF is the Fraction of Effective Force, M the propulsion moment, r_h the handrim radius, and F_r the resultant force applied to the handrim.*

Net joint moment: minimum moment required at a joint to obtain the observed kinematics.

Mechanical power: product of handrim tangential forces and the manual wheelchair's speed

Mechanical work: time-integer of mechanical power