Normative data of 100 persons acquired during level floor walking

Participants:

100 participants (50 women, 50 men) participated in this data collection. Participants were stratified according to gender and age to collect data from 50 women and men with 10 participants of each gender in each of the following age groups: 18-29 years, 30 39 years, 40-49 years, 50-59 years, and 60-70 years. Participants were included if they provided informed consent and matched the following inclusion criteria: Age between 18 – 70 years, body mass index between 18 – 28 points, no acute or chronic musculoskeletal, cardio-pulmonary, or neurological conditions, no amputations, no scoliosis, and no pregnancy. This research complied with the tenets of the Declaration of Helsinki. The medical Ethics Committee of Canton Zurich approved the study (2017-01520).

Data Collection:

Retroreflective markers were applied to different body segments (rearfoot, shank, thigh, pelvis) and recorded by a 3D-highspeed camera system with 12 cameras (Vicon Vantage V5, Vicon Motion Systems Ltd, Oxford, UK) with a sampling rate of 240 Hz. The motion capture was collected in combination with two AMTI force plate sensors (OR6-7- 2000, AMTI Inc, Watertown, US) to record Ground Reaction Forces (GRF) at 1200Hz. Before analysis, kinematic data were filtered using a low-pass Butterworth filter (4th-order) with a cut-off frequency of 7 Hz, while kinetic data were filtered using a low-pass Butterworth filter (4th-order) with a cut-off frequency of 395 Hz. Participants walked at their own self-selected speed and at three predetermined walking speeds that correspond to slow (1.25 m/s), normal (1.5 m/s) and fast (1.75 m/s). Walking speed was measured using two photocell timing lights (Witty, Microgate, Bolzano, Italy). The participants were asked to walk normally and not to aim at the force plates which were concealed in the floor. If the participants did not touch the force plates completely with their right foot the trial was repeated. If walking speed was outside a 5% tolerance interval from the target speed the trial was also repeated. Ten trials were acquired per participant and walking speed. Before the walking trials were performed, the participants executed knee flexions and hip rotations for a modified functional calibration to determine the knee joint center and axis of rotation and hip joint center (List et al., 2013). In addition, a static trial was performed with markers at additional anatomical landmarks to define the joints. A combination of the functional calibration and anatomical landmark coordinates was used to define coordinate systems of the segments. Data were collected at the movement laboratory of Zurich University of Applied Sciences in Winterthur, Switzerland.

Joint angles were calculated based on the standards defined by the International Society of Biomechanics (Grood and Suntay, 1983). All kinematic data are plotted from 0 to 100% of gait cycle (0% is the heel touch-down, whereas 100% corresponds to the consecutive touch-down of the same heel). Then, dynamic analysis was performed to extract moments at the participants lower limbs articulation level. All force and kinetic data are plotted from 0 to 100% of stance phase (0% is the heel touch down, whereas 100% corresponds to foot-off of the same foot).

Data structure:

Data are structured according the demographic groups, walking speed and variables (kinematic, force, kinetic and spatio-temporal gait variables). According to demographics the participants are grouped into "all" (all 100 participants), “women” (all 50 female participants) and “men” (all 50 male

participants). The groups “women” and “men” are further subdivided into five age groups (from 18-29 years old until 60-70 years old). Additionally, all data are further divided according to walking speed. Only data corresponding to the right lower limb are included in the data base. Additional information on the data can be found in the “information” structures in the matlab file “normative_data_zhaw.mat”.

Spatiotemporal parameters:

Spatiotemporal parameters were calculated as discrete values (described in Table 1) during one gait cycle.

Table 1: Spatiotemporal parameters

Parameter	Unit	Description
Step length	% Leg length	Right step length equals the distance in the walking direction from a left heel strike to the next right heel strike
Step width	% Leg length	The lateral distance between the left and right heel markers during a right step
Step time	Seconds	Right step time equals the time from the left heel strike to the next right heel strike
Stride length	% Leg length	Right stride length equals the distance in walking direction from a right heel strike to the next right heel strike
Stride time	Seconds	The time from a right heel strike to the next right heel strike
Swing phase duration	% Gait cycle	The right swing phase duration is the time from right toe off to right heel strike in percentage of the whole gait cycle
Stance phase duration	% Gait cycle	The right stance phase duration is the time of right heel strike to right toe off relative to the whole gait cycle
Single support duration	% Gait cycle	The right single support duration is the time from left toe off to the next left heel strike (the time with only right-side support) in percentage of the whole gait cycle
Cadence	Steps per minute	Calculated from the step time
Double support duration	% Gait cycle	The time with right and left side support is the time from right heel strike to left toe off and from left heel strike to right toe off added up

To normalize spatio-temporal parameters, leg length was calculated as the distance between anterior iliac spine and medial malleolus during upright stance. The normalized spatio-temporal parameters ($Tempspat_{norm}$) were calculated by the equation (1):

$$Tempspat_{norm} = \frac{Tempspat}{Leglength} * 100 \ (1)$$

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