



# Pelvic inclination angle and autonomic nervous activity while seated in a wheelchair

- Using the body tilt angle measurement method -

Etsuko Yokoyama<sup>1)</sup>, Yoko Tsuji<sup>2)</sup>, Yuka Saeki<sup>3)</sup>

1) National Defense Medical College, Tokorozawa, Saitama, Japan

2) Kanagawa University of Human Services, Yokosuka, Kanagawa, Japan

3) Ehime University, School of Medicine, Toon, Ehime, Japan

## Study background

- Nursing homes and welfare facilities for the elderly use wheelchairs to improve their level of activity and prevent them from becoming bedridden.
- 80-90% of the time that elderly people spend in wheelchairs is spent using the wheelchairs as chairs to sit in
- The loss of muscle strength leads to difficulties in maintaining a sitting posture in the wheelchair. The sitting posture worsens over time, resulting in either "sacral sitting" with the pelvis tilted backwards or "slanted sitting" with the trunk inclined to the side.
- Previously, studies have investigated the effects of different sitting postures qualitatively, assessing upright sitting, slouching, and forward tilting.
- ISO16840-1:2006 describes in detail, the method to measure a sitting posture by projecting two-dimensional planes of the sagittal, frontal, and horizontal planes. Measuring instruments that comply with ISO16840-1:2006 have been developed and are expected to come into use for various assessments and studies.

## Purpose of the study

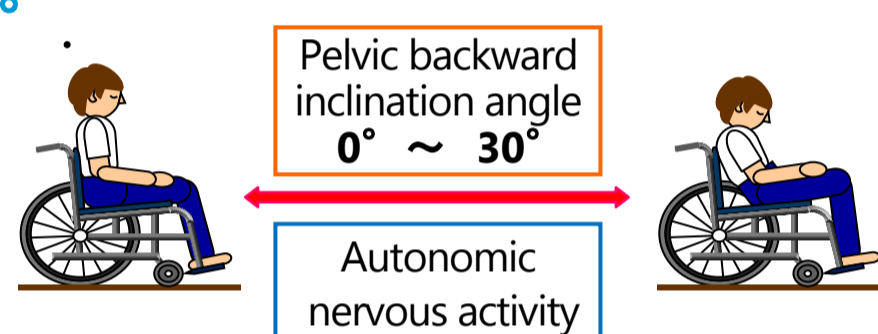
To elucidate and compare changes in autonomic nervous activity as a result of different wheelchair sitting postures in healthy individuals using postural measurement methods and to convert the results into normative data.

## Participants

13 healthy adults without any spinal disorders. All participants were female. The mean age was  $23 \pm 6$  years.

## Methodology

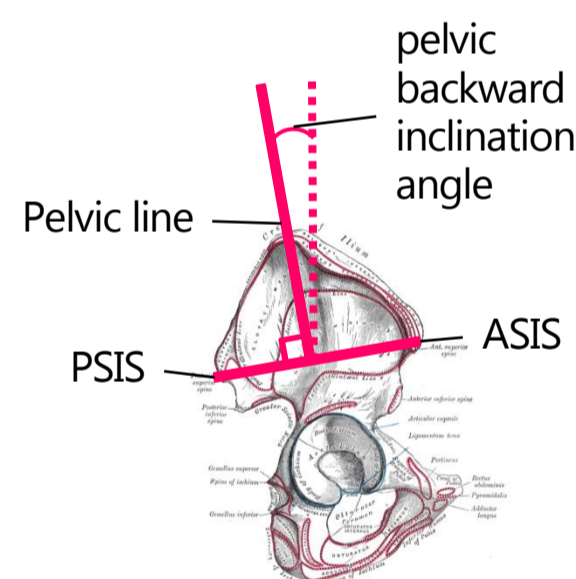
- Changes in autonomic nervous activity were measured for seven different wheelchair sitting postures.
- The postures changed in increments of  $5^\circ$  from an intermediate pelvic backward inclination in the sagittal plane from  $0^\circ$  to  $30^\circ$ .



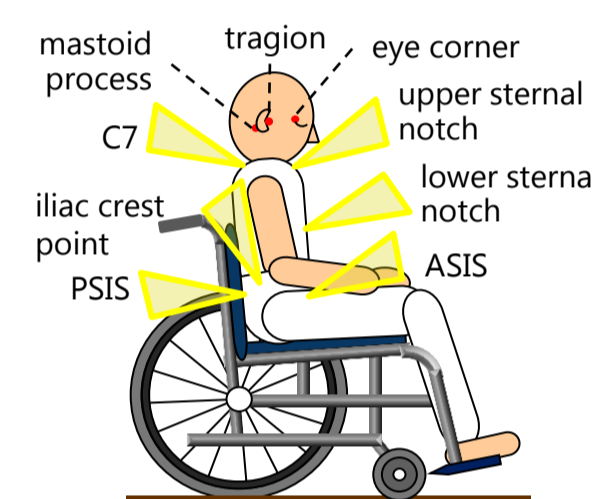
- Pelvic backward inclination angle was noninvasively measured using Horizon.
- Specific pelvic backward inclination angles as indicated by pointers on the anterior superior iliac spine (ASIS) and the posterior superior iliac spine (PSIS).



Horizon (Society for Research on Sitting Posture Measurement) measures sitting posture in accordance with ISO16840-1:2006.



- Once the sitting posture was achieved, it was recorded using digital photographs in the sagittal plane (from the right side).
- Sitting posture measurement software, Rysis (Society for Research on Sitting Posture Measurement), was then used to analyze the participants' posture and other body tilt angles from the images taken.



Digital photos in the sagittal plane for Rysis

- Between sitting posture measurements, a 5-minute rest period was scheduled and electrocardiographic readings were recorded with a BioLog DL-2000 device and DL-320 ECG.
- Using these readings, autonomic nervous activity was analyzed at a low frequency (LF) of 0.04–0.15 Hz and a high frequency (HF) of 1.15–0.40 Hz using the frequency analysis program MemCalc (GMS, Tokyo, Japan).
- Measurement values for each pelvic backward inclination angle were comparatively analyzed using the statistical software SPSS 20.0 with the significance level set at 5%.

## Results

### LF/HF ratio (sympathetic nervous activity index)

- A significant difference was seen in the LF/HF ratio between the intermediate pelvic inclination angles of  $0^\circ$  to  $10^\circ$  and the angles of  $25^\circ$  and  $30^\circ$ .
- A significant difference was also seen between pelvic backward inclination angle of  $0^\circ$  and the angles of  $15^\circ$  and  $20^\circ$ .

LF/HF	Mean $\pm$ SD	pelvic backward inclination angles						
		$0^\circ$	$5^\circ$	$10^\circ$	$15^\circ$	$20^\circ$	$25^\circ$	$30^\circ$
$0^\circ$	3.55 $\pm$ 2.09							
$5^\circ$	2.92 $\pm$ 1.69	.101						
$10^\circ$	3.16 $\pm$ 3.19	.133	.807					
$15^\circ$	2.40 $\pm$ 1.31	.033	.101	.463				
$20^\circ$	2.09 $\pm$ 1.70	.019	.064	.055	.311			
$25^\circ$	1.83 $\pm$ 1.42	.013	.019	.019	.064	.422		
$30^\circ$	1.91 $\pm$ 1.37	.016	.046	.023	.101	.650	.753	

Wilcoxon signed-rank test

### HF ratio (parasympathetic nervous activity index)

- At pelvic backward inclination angles of  $30^\circ$  and  $25^\circ$ , the HF ratio was significantly higher than that with  $0^\circ$  to  $15^\circ$ .
- At pelvic backward inclination angles of  $15^\circ$  and  $20^\circ$ , the HF ratio increased compared with that with  $0^\circ$  and  $5^\circ$ .
- Significant difference was also seen between the angles of  $0^\circ$  and  $10^\circ$ .

HF%	Mean $\pm$ SD	pelvic backward inclination angles						
		$0^\circ$	$5^\circ$	$10^\circ$	$15^\circ$	$20^\circ$	$25^\circ$	$30^\circ$
$0^\circ$	11.26 $\pm$ 6.35							
$5^\circ$	13.72 $\pm$ 8.24	.101						
$10^\circ$	15.79 $\pm$ 7.71	.046	.600					
$15^\circ$	16.61 $\pm$ 9.36	.009	.011	.221				
$20^\circ$	20.08 $\pm$ 9.01	.002	.013	.116	.087			
$25^\circ$	22.48 $\pm$ 9.45	.007	.011	.028	.039	.196		
$30^\circ$	25.44 $\pm$ 12.43	.003	.005	.009	.039	.152	.152	

Wilcoxon signed-rank test

## Discussion

It has been reported that parasympathetic nervous activity becomes dominant while resting in the supine position. In contrast, sympathetic nervous activity dominates when the head is lifted up. In this study, we found that sympathetic nervous activity was significant in an upright posture with pelvic inclination angles of  $0^\circ$  -  $10^\circ$  and parasympathetic nervous activity became dominant during a "slumped sitting" posture with pelvic inclination angles of  $\geq 25^\circ$ . The "slumped sitting" posture along with dominant parasympathetic nervous activity led to subjects being in a prolonged relaxed state, which made it easy for sitting posture to collapse. This future research should elucidate the postural characteristics of wheelchair-bound elderly individuals and clarify the assessment viewpoints of elderly individuals requiring assistance for sitting posture.