Effects of physical characteristics and residence style on alignment of lower extremity

Jangwon Lee1,*, Hye-Sang Park2

1Department of Sports Health Medicine, College of Health Science, Jungwon University, Goesan, Korea
2Department of Physiology, College of Medicine, Kyung Hee University, Seoul, Korea

This research was performed to identify the incidence of deformity of lower extremity and to identify the relationship of the incidence between the deformities. Once the incidences and relationship are found, next purpose was to find the effects of physical characteristics and residence styles on the development of lower extremity deformities. One hundred fifteen males and 108 females participated in this study. Data collecting was performed by questionnaire and visual postural evaluation. The incidence of genu varus was significantly high in standing-up life style compared to sitting-on life style (chi-square = 8.28; P = 0.004). However, the incidences of heel varus (chi-square = 13.223; P = 0.004) and femoral torsion (chi-square = 19.347; P < 0.0001) were significantly high in sitting-on life style than standing-up life style. The incidences of genu varus (chi-square = 24.18; P < 0.0001), heel varus (chi-square = 15.41; P < 0.0001), and tibial torsion (chi-square = 6.285; P < 0.012) were significantly high in sitting-on life style compared to standing-up life style (P < 0.05). The odd ratio result for sitting-on life style against standing-up life style showed 6.6 times significantly high relationship in femoral torsion (95% confidence range, 1.64–26.47) in men.

Keywords: Lower extremity deformity, Physical characteristics, Residence style

INTRODUCTION

The structure of the human pelvis permits an upright posture and locomotion on two legs rather than on lore legs like other mammals. Although these structures are well adapted for bipedal locomotion, an upright posture may cause problem. For instance, lower extremity malalignment leading to overload of the femur and tibia has been considered to be the main cause of cartilage degeneration and osteoarthritis of the knee (Aglietti et al., 2008; Babis et al., 2002). The alignment of lower extremity maintains correct posture of the upper body and prevents the body from pains due to bad posture (Eng and Pierrynowski, 1993). Koreans, mostly aged people, are accustomed to sitting-on life style and are disposed to have larger external rotation of hip joint, genu varus of the knee, and inversion of the ankle. The difference of the life style might have effects on the anatomical alignment of the lower extremity and the function of the lower extremity during walking, and might act as the potential risk factors of the knee and the ankle injury.

The purpose of the study is (a) to identify the incidence of each lower extremity alignment deformity and identify the relationship of the incidence between the deformities and (b) to identify the effects of physical characteristics (weight, height, age, and gender) and residence styles (sitting-on and standing-up life styles) on the development of 8 lower extremity deformities (genu valgus, genu varus, genu recurvatum, heel valgus, heel varus, tibial torsion, femoral torsion, and leg length discrepancy).

MATERIALS AND METHODS

Participants

One hundred fifteen males and 108 females participated in this study. Among them 58 males were collected from standing-up life style and 57 from sitting-on life style. Sixty-seven females
were collected from standing-up life style and 41 from sitting-on life style each. Characteristics of the subjects are listed in Table 1.

**Data collecting**

All subjects were screened and individuals were removed from the test if they had medical problems such as lumbago and previous lower extremity fracture. Each subject was asked wear pants and shirts only. No socks were permitted for the data collecting.

The subjects were asked to answer each question on the questionnaire including age, gender, height, weight, dominant arm

| Table 1. Physical characteristics of the subjects (n = 223) |
|----------------------------------------------------------|
| Group | Incidence | Over mid age | Age (yr) | Height (cm) | Weight (kg) |
|-------|-----------|---------------|----------|-------------|-------------|
| Men (n = 115) | | | | | |
| Stand up | 58 (50.4) | 22/58 (37.9) | 27.00 ± 12.00 | 174.33 ± 4.85 | 72.43 ± 11.58 |
| Sit on | 57 (49.6) | 44/57 (77.2) | 51.00 ± 15.90 | 170.86 ± 4.96 | 69.74 ± 9.21 |
| Women (n = 108) | | | | | |
| Stand up | 67 (62.0) | 24/67 (35.8) | 41.09 ± 11.82 | 163.16 ± 4.35 | 58.10 ± 7.44 |
| Sit on | 41 (38.0) | 34/41 (82.9) | 57.29 ± 15.97 | 158.93 ± 4.02 | 58.92 ± 9.73 |

Values are presented as number (%) or mean ± standard deviation.
Stand up, standing-up life style, Sit on, sitting-on life style.

| Table 2. Incidence of the lower extremity deformity for men and women according to the life styles |
|-----------------------------------------------------|
| Variable | Group | life style | No. (%) | Chi-square | P-value |
|----------|-------|------------|---------|------------|---------|
| gvalgus  | Men   | Stand up   | 3 (5.2) | 1.19       | 0.66    |
|          |       | Sit on     | 2 (3.5) |            |         |
|          | Women | Stand up   | 2 (3.0) | 2.22       | 0.14    |
|          |       | Sit on     | 4 (9.8) |            |         |
| gvarus   | Men   | Stand up   | 11 (19.0)| 8.28       | 0.004   |
|          |       | Sit on     | 25 (10.4)|            |         |
|          | Women | Stand up   | 7 (10.4) | 24.18      | < 0.0001|
|          |       | Sit on     | 22 (53.7)|            |         |
| grecur   | Men   | Stand up   | 1 (1.7) | 0.99       | 0.32    |
|          |       | Sit on     | 0 (0)   |            |         |
|          | Women | Stand up   | 4 (6.0) | 2.272      | 0.13    |
|          |       | Sit on     | 6 (14.6)|            |         |
| hvalgus  | Men   | Stand up   | 1 (1.7) | < 0.0001   | 0.99    |
|          |       | Sit on     | 1 (1.8) |            |         |
|          | Women | Stand up   | 2 (3.0) | 3.56       | 0.06    |
|          |       | Sit on     | 5 (12.2)|            |         |
| hvarus   | Men   | Stand up   | 18 (31.0)| 13.223     | < 0.0001|
|          |       | Sit on     | 37 (64.9)|            |         |
|          | Women | Stand up   | 13 (19.4)| 15.412     | < 0.0001|
|          |       | Sit on     | 23 (56.1)|            |         |
| ttorsion | Men   | Stand up   | 6 (10.3)| 0.082      | 0.77    |
|          |       | Sit on     | 5 (8.8) | 6.285      | 0.012   |
|          | Women | Stand up   | 3 (4.5) |            |         |
|          |       | Sit on     | 8 (19.5)|            |         |
| ftorsion | Men   | Stand up   | 4 (6.9) | 19.347     | < 0.0001|
|          |       | Sit on     | 24 (42.1)|            |         |
|          | Women | Stand up   | 4 (6.0) | 3.428      | 0.06    |
|          |       | Sit on     | 7 (17.1)|            |         |
| LLD      | Men   | Stand up   | 12 (20.7)| 1.272      | 0.26    |
|          |       | Sit on     | 17 (28.9)|            |         |
|          | Women | Stand up   | 7 (10.4) | 2.667      | 0.10    |
|          |       | Sit on     | 9 (15.8) |            |         |

gvalgus, genu valgus; gvarus, genu varus; grecur, genu recurvatum; hvalgus, heel valgus; hvarus, heel varus; ttorsion, tibial torsion; ftorsion, femoral torsion; LLD, leg length discrepancy; Stand up, standing-up life style, Sit on, sitting-on life style.
and leg. Also, questions about the residence area, years of residence, style of the house if the house is traditional or modern style, bedding style, table style for meal, toilet style, and sitting style for watching TV are included.

Experimental procedures

The visual postural examination of the lower extremity was conducted from anterior, posterior, lateral, sitting, and prone positions. From the anterior view, any sign of genu valgus, genu varus, or genu recurvatum was observed. From the posterior view, the observations for heel valgus or heel varus were performed. From the sitting position, any sign of tibial torsion or femoral torsion was observed. From the prone position, observation was performed if there is leg length discrepancy. This procedure was established and validated by Wen et al. (1998).

Statistical analysis

Each lower extremity deviation was considered as dependent variable in the study. The chi-square analysis was used to identify the difference between the residence styles for each dependent variable. Data were analyzed with SPSS ver. 16.0 (SPSS Inc., Chicago, IL, USA) and statistical significance was set at $P < 0.05$ for all tests.

RESULTS

Incidence of the lower extremity deviations for men and women according to the residence style was shown in Table 2. For men, the results of incidence of lower extremity deformity according to the life style showed that the incidence of genu varus was significantly high in standing-up life style compared to sitting-on life style (chi-square $= 8.28; P = 0.004$). However, the incidences of heel varus (chi-square $= 13.223; P = 0.004$) and femoral torsion (chi-square $= 19.347; P < 0.0001$) were significantly high in sitting-on life style than standing-up life style. For women, the incidences of genu varus (chi-square $= 24.18; P < 0.0001$), heel varus (chi-square $= 15.412; P < 0.0001$), and tibial torsion (chi-square $= 6.285; P < 0.012$) were significantly high in sitting-on life style compared to standing-up life style ($P < 0.05$). The odd ratio result for lower extremity deformities for men and women between life styles are shown in Table 3. For men, the odd ratio result for sitting-on life style against standing-up life style showed 6.6 times significantly high relationship in femoral torsion (95% confidence range [CI], 1.64–26.47) in men. For women, there were 3.8 times significantly high relationship in genu varus (95% CI, 1.07–13.17), 8.8 times in genu recurvatum (95% CI, 1.59–49.00), and 4.2 times in heel varus (95% CI, 1.47–11.88) in women.

DISCUSSION

The results of this study show that incidence of genu varus in men was significantly greater in standing-up life style compared to the counterpart. However, the incidence of heel varus and femoral torsion was significantly high in sitting-on life style. Genu varus is commonly observed postural disorders in adolescents (Bell et al., 2013) which is more frequent than genu valgus (Cahuzac et al., 1995). This deformity constitutes a risk factor biomechanically for knee osteoarthritis and aggravates it by increasing the load on the medial compartment (Lim et al., 2008; Sharma et al., 2010). High incidence of genu varus in standing-up life style group might be explained that traditionally Korean people are accustomed to the sitting-on life style rather than standing-up life style even though western life style is stabilized in their current daily life. Significantly high incidence of heel varus and femoral torsion might be due to large external rotation of the hip joint, large varus of the knee, and the large inversion of the ankle joint which is produced from sitting-on life style. Different from their counterpart, Korean women experience high incidence of genu varus, heel varus, and tibial torsion in sitting-on life style. The

Table 3. Odd ratio result for lower extremity deformities for men and women between life styles

| Variable | Group | Odd ratio | 95% CI     | P-value |
|----------|-------|-----------|------------|---------|
| Gvvalgus| Men   | 2.3       | 0.26–20.54 | 0.45    |
|         | Women | 2.8       | 0.35–22.80 | 0.33    |
| Gvvarus | Men   | 2.8       | 0.95–8.45  | 0.06    |
|         | Women | 3.8       | 1.07–13.17 | 0.04    |
| Grecur  | Men   | 8.5       | 1.45–7.83  | 0.08    |
|         | Women | 8.8       | 1.50–49.00 | 0.01    |
| Hvalgus | Men   | 0.6       | 0.005–66.65| 0.83    |
|         | Women | 0.6       | 0.05–5.99  | 0.64    |
| Hvarus  | Men   | 1.4       | 0.46–4.09  | 0.57    |
|         | Women | 4.2       | 1.47–11.88 | 0.007   |
| Ttorsion| Men   | 0.73      | 0.14–3.77  | 0.71    |
|         | Women | 5.8       | 0.75–45.15 | 0.09    |
| Ftorsion| Men   | 6.6       | 1.64–26.47 | 0.008   |
|         | Women | 1.33      | 0.24–7.28  | 0.74    |
| LLD     | Men   | 1.8       | 0.56–5.45  | 0.34    |
|         | Women | 1.95      | 0.52–7.32  | 0.32    |

Height and weight are used as covariance at all ages.

1.07–13.17, 8.8 times in genu recurvatum (95% CI, 1.59–49.00), and 4.2 times in heel varus (95% CI, 1.47–11.88) in women.
sitting on the surface of the floor makes the knee joint externally rotated which brings heel varus and tibial torsion.

According to the results, sitting-on life style has close relationship with the incidence of genu recurvatum in men while it has very high relationship with genu varus, genu recurvatum, and heel varus in women. Lack of femoral control might result in excessive adduction and external rotation of the knee (Hewett et al., 2006; Powers, 2003).

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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