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Technical note

The comparisons of anthropometric characteristics among four peoples in East Asia

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Abstract

This study presents comparisons of ethnic difference in anthropometric characteristics among four peoples, i.e., Chinese, Japanese, Korean, and Taiwanese, in East Asia. Anthropometric data from the four East Asian countries were compared. The means of 33 body dimensions and 31 bodily proportions are presented. Also, 15 segmental proportions are illustrated. The results of statistical analyses showed that there is a significant morphological difference among these peoples in the same region. The Mainland Chinese body shape has a narrower body with mid-range limbs. The Japanese body shape is wider with shorter limbs. The Korean body shape is mid-range among the four peoples, but the upper limbs are longer. The Taiwanese body shape has wide shoulder and narrow hip with large hands and long legs. The ethnic diversity in bodily proportions should be considered as well as the mean dimensions.

Keywords: Bodily proportion; Anthropometric data; Ethnic difference; East Asia

1. Introduction

It is clear that anthropometric data are very important for product design and other applications. Many countries have been making great efforts in establishing an anthropometric database for different population groups such as civilians, military personnel, students, and workers. (e.g. Bolstad et al., 2001; Wang et al., 2002). Ethnic diversity is always a significant factor that may affect the anthropometric data and the scopes of its applications. Pheasant (1996) suggested that the variations of body dimensions of different groups can be observed in terms of overall body size and bodily proportions. The mean anthropometric dimensions, for example stature and sitting height, are the most typical distinctions among ethnic groups. Another significant ethnic difference lies in the ratios of body dimensions, i.e. bodily proportions. The bodily proportion is a scaling relation calculated with a ratio of one body dimension to a specific reference dimension. The most common reference dimension is mean stature (Roebuck et al., 1975).

The anthropometric differences among races are greater than among nations. Different nations of the same race may also have varied body sizes and bodily proportions due to the differences in social and economic environment. In terms of race, the peoples in the region of East Asia, i.e., Chinese, Japanese, Korean, and Taiwanese, belong to the Mongolian race and are highly associated historically. It will be interesting to find out whether there are significant differences in mean body dimensions and bodily proportions of these peoples under varied social and economic situations. Therefore, the aim of this study was to compare the differences in anthropometric dimensions and bodily proportions among the four East Asian peoples.

2. The anthropometric databases

Four anthropometric databases for adults from China, Japan, Korea and Taiwan were collected. The Chinese anthropometric database has been published as

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a Chinese national standard of human dimensions for adults (China Standards, GB/T 10000-1988, 1988). The database involves 47 anthropometric dimensions measured from 11,164 males with age ranging from 18 to 60 years old and from 11,150 females with age ranging from 18 to 55 years old. The Japanese anthropometric database includes 178 anthropometric items from more than 34,000 people with age ranging from 7 to 90 years old (Research Institute of Human Engineering for Quality Life, 1994). For the adult population, this database includes 12,100 males and 8600 females with age ranging from 18 to 59 years old. For the Korean anthropometric database, 120 dimensions from 13,000 people were measured. The adult sample includes 2090 males and 2014 females with age ranging from 18 to 59 (Lee, 2000). The Taiwanese anthropometric database includes 265 static dimensions measured from 11,000 people with age ranging from 6 to 65 years old. The adult sample includes 1322 males and 799 females with age ranging from 18 to 65 years old (Wang et al., 1999, 2001).

3. Anthropometric data and bodily proportions

For the purpose of comparison, thirty-three commonly used anthropometric dimensions were selected. The mean data for males and females of different ethnic groups are listed in Table 1. Further, the bodily proportions of the 31 dimensions (excluding stature and body weight) with reference to mean stature are presented in Table 2. The empty data cells are due to data being unavailable or the definition of the measurement being different between studies.

Simple statistical tests were carried out to compare the significance of mean differences among the four peoples. The test results showed that there are significant differences in most of the mean dimensions as well as all of the bodily proportions among the four ethnic groups. These suggest that the morphological characteristics among the four peoples in East Asia are dissimilar.

Furthermore, based on the bodily proportions presented in Table 2, 15 particular dimensions were chosen to illustrate the differences of bodily proportions in both

Table 1
The mean anthropometric data for East Asian adults

Unit (mm)	Taiwanese		Chinese		Japanese		Korean	
	Male	Female	Male	Female	Male	Female	Male	Female
Stature	1699	1573	1678	1570	1690	1569	1707	1588
Eye height	1579	1457	1568	1454	1566	1448	1588	1480
Jaw height	1467	1354	1455	1354	1455	1348	NA	NA
Shoulder height	1391	1285	1367	1271	1374	1270	1383	1289
Elbow height (straight arm)	1088	1007	1054	987	1064	983	NA	NA
Wrist height	849	794	817	774	826	766	NA	NA
Fingertip height	657	620	NA	NA	659	611	644	604
Head length	232	219	223	216	235	221	182	173
Upper arm length	302	281	313	284	315	291	NA	NA
Forearm length	240	213	237	213	253	230	NA	NA
Hand length	192	174	183	171	182	168	189	175
Biacromial breadth	375	331	375	351	388	348	391	352
Shoulder breadth	453	410	431	397	449	402	451	406
Chest breadth	322	293	280	260	312	281	NA	NA
Hip breadth	318	322	306	317	339	333	322	319
Armpit height	1274	1178	NA	NA	1260	1171	1279	1202
Trochanter height	859	804	909	915	NA	NA	842	791
Knee height	449	412	444	446	449	412	NA	NA
Left lateral malleolus height	68	61	NA	NA	46	41	NA	NA
Horizontal Fingertip reach (from wall)	826	757	NA	NA	820	751	821	760
Elbow height (flexed arm)	1055	980	1024	960	1043	965	1046	977
Waist height	1000	919	NA	NA	980	908	1026	966
Crotch height	731	702	790	732	748	704	757	718
Vertical fingertip reach	2120	1940	NA	NA	2095	1928	2125	1961
Elbow height, sitting	263	254	263	251	270	253	265	263
Eye height, sitting	788	735	798	739	789	732	809	758
Sitting height	907	848	908	855	909	850	921	866
Vertical fingertip reach, sitting	1331	1218	NA	NA	1314	1208	1346	1248
Knee height, sitting	523	472	493	458	NA	NA	508	470
Popliteal height, sitting	408	379	413	382	396	362	410	384
Buttock to popliteal length, sitting	454	439	457	433	452	437	470	449
Buttock to front of knee length, sitting	558	530	554	529	559	531	553	528
Weight (kg)	67.5	53.8	59.0	52.0	65.5	52.2	66.0	53.5

Table 2
The bodily proportions to the mean stature for East Asian adults

Unit (mm)	Taiwanese		Chinese		Japanese		Korean	
	Male	Female	Male	Female	Male	Female	Male	Female
Eye height	0.929	0.926	0.934	0.926	0.927	0.923	0.930	0.932
Jaw height	0.864	0.861	0.867	0.862	0.861	0.859	NA	NA
Shoulder height	0.819	0.817	0.815	0.810	0.813	0.809	0.810	0.812
Elbow height (straight arm)	0.641	0.640	0.628	0.629	0.630	0.626	NA	NA
Wrist height	0.499	0.505	0.487	0.493	0.489	0.488	NA	NA
Fingertip height	0.386	0.394	NA	NA	0.390	0.389	0.377	0.381
Head length	0.136	0.139	0.133	0.138	0.139	0.141	NA	NA
Upper arm length	0.178	0.179	0.187	0.181	0.186	0.185	NA	NA
Forearm length	0.141	0.135	0.141	0.136	0.149	0.146	NA	NA
Hand length	0.113	0.111	0.109	0.109	0.108	0.107	0.111	0.110
Biacromial breadth	0.221	0.210	0.223	0.224	0.230	0.222	0.229	0.221
Shoulder breadth	0.267	0.261	0.257	0.253	0.266	0.256	0.264	0.256
Chest breadth	0.190	0.186	0.167	0.166	0.185	0.179	NA	NA
Hip breadth	0.187	0.204	0.182	0.202	0.201	0.212	0.188	0.201
Armpit height	0.750	0.749	NA	NA	0.746	0.746	0.749	0.757
Trochanter height	0.506	0.511	NA	NA	NA	NA	0.493	0.498
Knee height	0.265	0.262	0.265	0.284	0.266	0.262	NA	NA
Left lateral malleolus height	0.040	0.039	NA	NA	0.027	0.026	NA	NA
Horizontal Fingertip reach (from wall)	0.486	0.482	NA	NA	0.485	0.478	0.481	0.479
Elbow height (flexed arm)	0.621	0.623	0.610	0.611	0.617	0.615	0.613	0.615
Waist height	0.588	0.584	NA	NA	0.580	0.578	0.601	0.608
Crotch height	0.430	0.446	0.471	0.466	0.443	0.449	0.444	0.452
Vertical fingertip reach	1.248	1.233	NA	NA	1.240	1.229	1.245	1.235
Elbow height, sitting	0.155	0.162	0.157	0.160	0.160	0.161	0.155	0.166
Eye height, sitting	0.464	0.467	0.476	0.471	0.467	0.467	0.474	0.477
Sitting height	0.534	0.539	0.541	0.545	0.538	0.542	0.540	0.546
Vertical fingertip reach, sitting	0.784	0.774	NA	NA	0.777	0.770	0.789	0.786
Knee height, sitting	0.308	0.300	0.294	0.292	NA	NA	0.298	0.296
Popliteal height, sitting	0.240	0.241	0.246	0.243	0.234	0.231	0.240	0.242
Buttock to popliteal length, sitting	0.267	0.279	0.272	0.276	0.267	0.278	0.275	0.283
Buttock to front of knee length, sitting	0.329	0.337	0.330	0.337	0.331	0.338	0.324	0.333

Table 3
The definitions of dimensions used in segment proportions

	Dimension	Definition
1	Eye height	Vertical distance from the level of eye to the floor when the person stands
2	Shoulder height	Vertical distance from the level of acromion to the floor
3	Head length	Vertical distance from the superior aspect of head to the inferior aspect of head
4	Hand length	Maximum perpendicular hand length
5	Shoulder breadth	Horizontal distance between right and left deltoid muscles
6	Hip breadth	Maximum horizontal distance across hip
7	Knee height	Vertical distance from the level of the patella to the floor
8	Elbow height (flexed arm)	Vertical distance from the elbow of flexed arm to the floor
9	Elbow height, sitting	Vertical distance from the underside of elbow to seat surface with flexed arm
10	Eye height, sitting	Vertical distance from the level of eye to the seat surface
11	Sitting height	Vertical distance from the superior level of the head to the seat surface
12	Knee height, sitting	Vertical distance from the highest point of patella to the floor
13	Popliteal height, sitting	Vertical distance from the popliteal to the floor with bend knees and ankles at right angles
14	Buttock to popliteal length, sitting	Horizontal distance from posterior aspect of buttock to popliteal
15	Buttock to front of knee length, sitting	Horizontal distance from posterior aspect of buttock to anterior aspect of kneecap

standing and sitting postures. The definitions of the 15 anthropometric dimensions are presented in Table 3. Figs. 1 and 2 demonstrate eight bodily proportions in standing posture, i.e. eye height, shoulder height, elbow height with flexed arm, knee height, head length, hand length, shoulder breadth and hip breadth. Figs. 3 and 4 demonstrate seven bodily proportions in sitting posture, i.e. sitting height, sitting eye height, sitting elbow height,

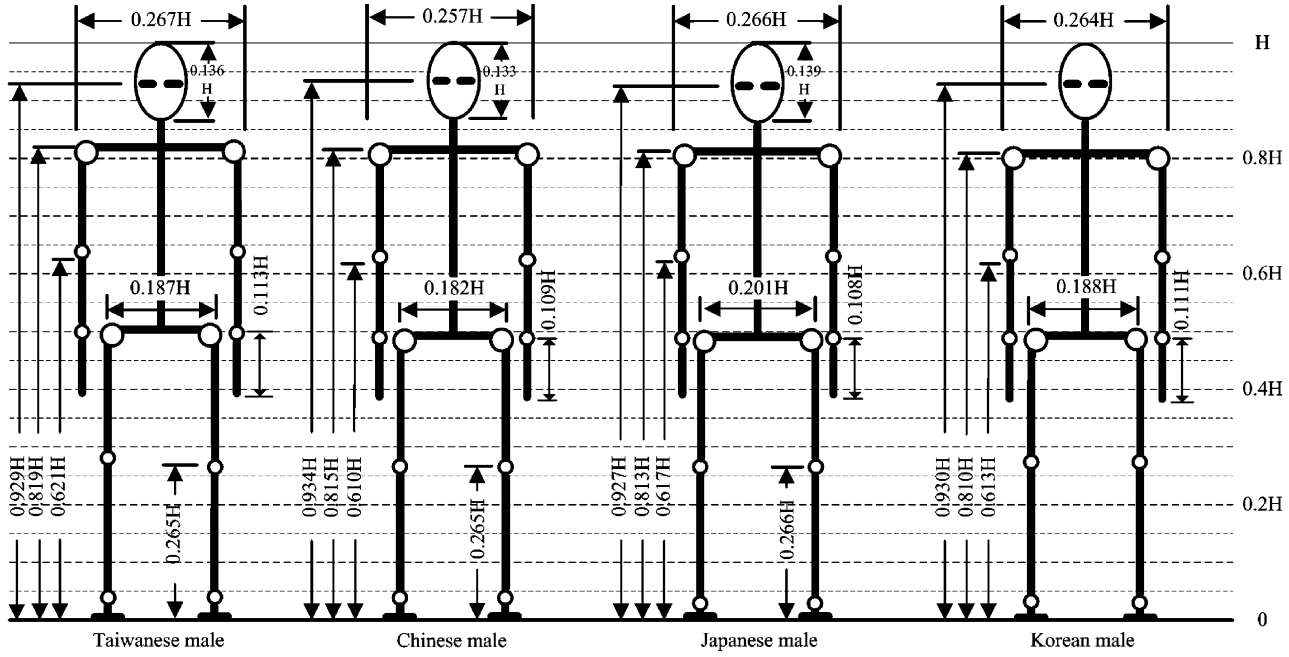

Fig. 1. The illustration of segment proportions for East Asian male adults in standing posture.

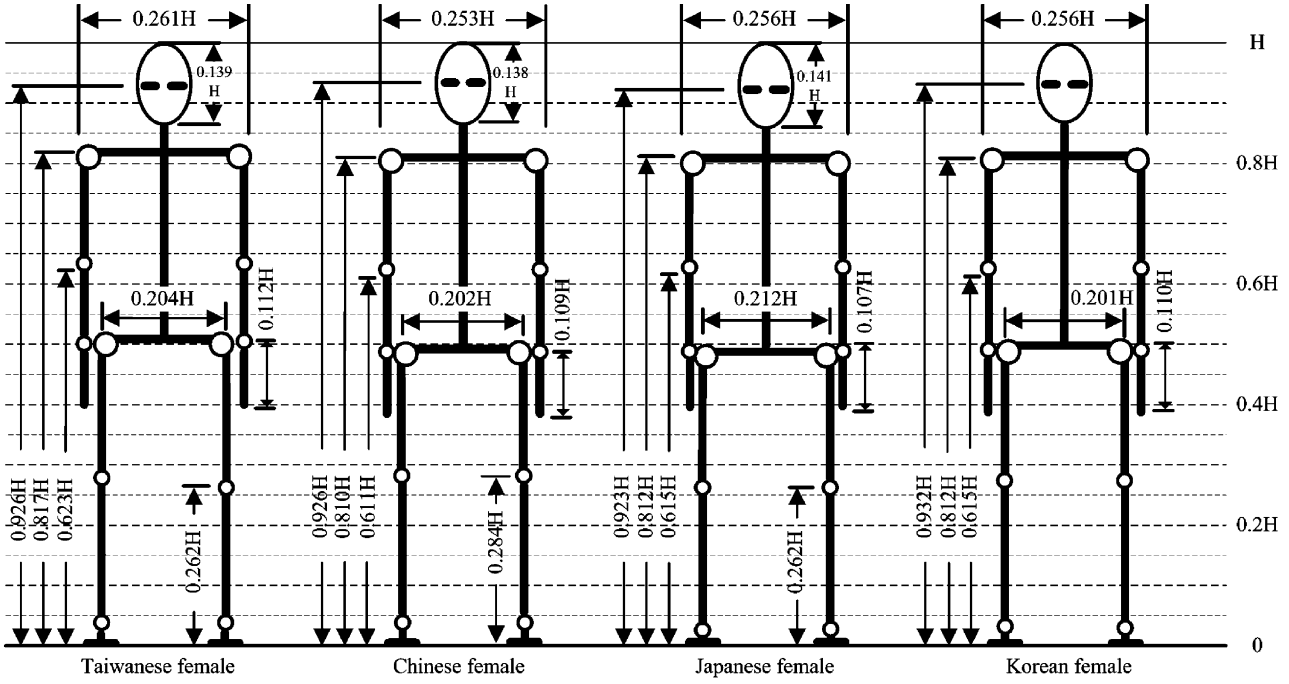

Fig. 2. The illustration of segment proportions for East Asian female adults in standing posture.

sitting knee height, sitting popliteal height, sitting buttock to popliteal length and sitting buttock to front of knee length.

4. Comparisons

The comparison of body dimensions and bodily proportions in standing posture shows that the Japanese have the largest head length but the smallest eye height. As for torso dimensions, the Taiwanese have the highest and widest shoulder but a narrower hip. The Japanese have a relatively wider torso associated with the wider shoulder and the widest hip. The Koreans have a moderate torso with a lower shoulder. For the Mainland Chinese, the torso tends to be a little smaller than those of the other groups. As for the comparison of the dimensions related to upper and lower limbs, the

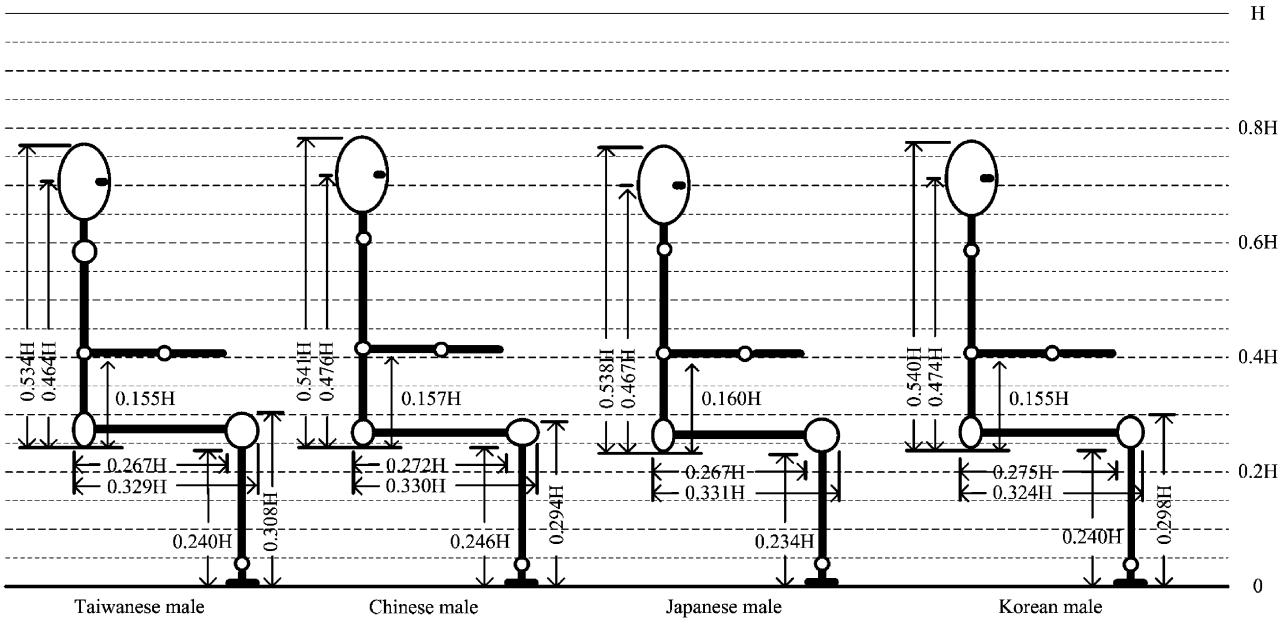

Fig. 3. The illustration of segment proportions for East Asian male adults in sitting posture.

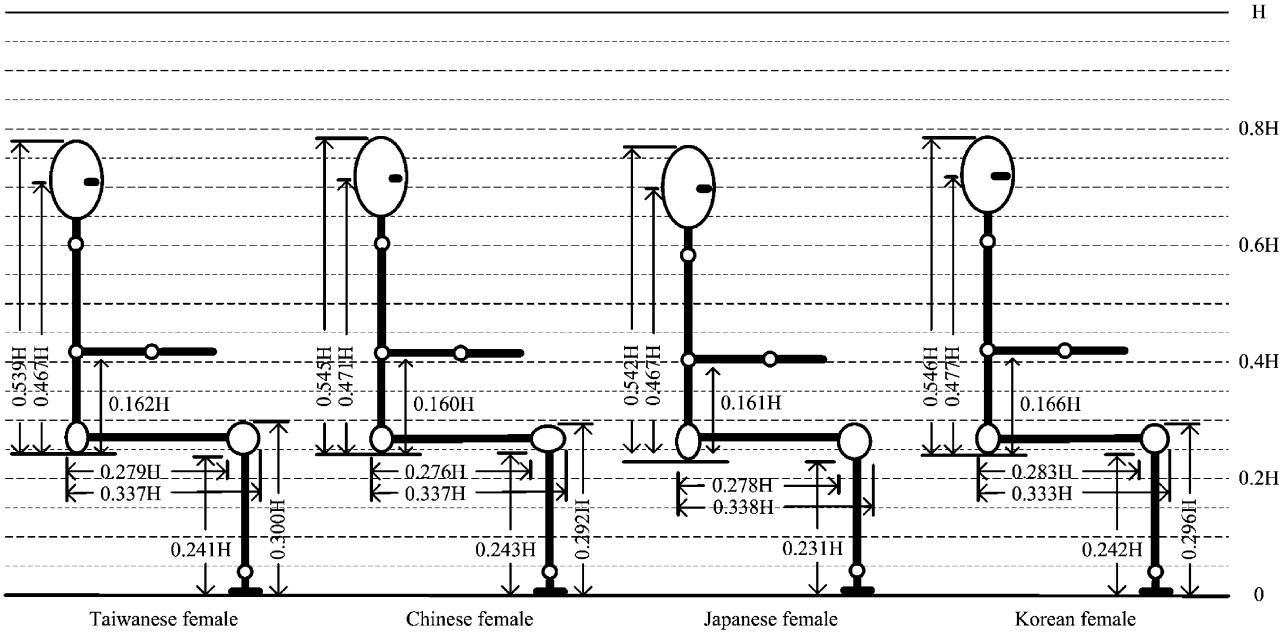

Fig. 4. The illustration of segment proportions for East Asian female adults in sitting posture.

Taiwanese have the longest hands, and the greatest wrist and elbow heights (both straight arm and flexed arm). The Japanese male has the greatest fingertip height and relatively lower but not the lowest shoulder height. As for the sitting posture, the Taiwanese has the lowest sitting height and eye height. The Japanese male has the greatest elbow height but the shortest popliteal height. The Korean has the greatest sitting height and sitting eye-height. In summary, the Taiwanese tends to have a wide shoulder and a narrower hip with large hands and long legs. The Chinese body shape tends to have a narrow body with moderate limbs. The Japanese shape is wider with shorter limbs. The Korean body shape is moderate among the four peoples, but the upper limbs are longer. Hereditary influences, economic development, social environment, type of work and labor structure all affect the ethnic differences in body shape.

5. Conclusion

Four East Asian anthropometric databases were collected and 33 anthropometric dimensions are

presented in this paper. Both the body dimensions and bodily proportions of the four peoples were compared. Statistical analyses were conducted to determine the differences among these groups. The test results showed that most of mean dimensions and all of the bodily proportions have significant differences. The morphological characteristics among the four East Asian peoples are not the same. The Chinese tend to have a narrow torso with moderate limbs. The Japanese tend to have a wider torso and shorter limbs. The body shape of Korean is moderate among the four groups, but the upper limbs are longer. The Taiwanese body shape has wide shoulder and narrow hip with large hands and long legs.

References

Bolstad, G., Benum, B., Rokne, A., 2001. Anthropometry of Norwegian light industry and office workers. Appl. Ergon. 32 (3), 239–246.

China Standards GB/T 10000-1988, 1988. Human dimensions of Chinese adults. Administration of Technology Supervision. People's Republic of China (in simplified Chinese).

Lee, Y.S., 2000. Applied Korean anthropometric database for product design: clothing design. Agency for Technology and Standards, MOCIE, Korea.

Pheasant, S., 1996. Bodyspace: Anthropometry, Ergonomics and Design of Work. Taylor & Francis, New York, pp. 15–45, 174–193.

Research Institute of Human Engineering for Quality Life, 1994. Japanese body size data. Human Engineering for Quality Life, Japan (in Japanese).

Roebuck, J.A., Kroemer, K.H.E., Thomson, W.G., 1975. Engineering Anthropometry Method, 2nd Edition. Wiley, New York, pp. 20–46, 173–186.

Wang, E.M.Y., Wang, M.J., Yeh, W.Y., Shih, Y.C., Lin, Y.C., 1999. Development of anthropometric work environment for Taiwanese workers. Int. J. Ind. Ergon. 23, 3–8.

Wang, M.J., Wang, E.M.Y., Lin, Y.C., 2001. Anthropometric Data Book of the Chinese People in Taiwan. Ergonomics Society of Taiwan (in Chinese).

Wang, M.J., Wang, E.M.Y., Lin, Y.C., 2002. The anthropometric database for children and young adults in Taiwan. Appl. Ergon. 33, 583–585.