Anthropometric Estimations for Iranian General Population

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Abstract

Background: An essential requirement exists for a single exhaustive source of anthropometric databank in Iran. Available information about Iranian bodily dimensions is not applicable to the general population due to the sample of people investigated. This study aimed to present the first Iranian anthropometric databank by estimation.

Methods: After a systematic review, 24 relevant sources of information were found and included. No time limit was considered. The method of Rapid Anthropometrics Scaled for Height was used.

Results: Overall, 36 bodily dimensions were estimated, for which the seven percentiles of 1st, 5th, 25th, 50th, 75th, 95th, and 99th were calculated, stratified by sex.

Conclusion: The resulting tables can be claimed as the most representative anthropometric databank for Iranian general 20-64 yr population now. Data are suitable for practical purpose and are applicable in both occupational and community setting.

Keywords: Anthropometry; Estimation; Iran

Introduction

The main principle of ergonomics is to design the activity to match the characteristics of the user. On the other word, if an instrument, a workplace or a system is intended for human use, then its design should be based upon the characteristics of its human users. This principle, so-called “user-centered design”, could result in many enhancements in terms of functional efficiency, comfort, health, safety and quality of life (1). In contrast, the lack of incorporating anthropometric information in the design phase would result in an increase in the frequency of work-related injuries, as well as a decrease in human performance and well-being.

However, human beings are not all the same. Their anthropometric (e.g. body size, shape strength, and endurance), physiological, Biomechanical and psychological characteristics differ from one to another. In addition, factors such as age, sex, race, job, diet, physical exercise and so on influence human body dimensions (1, 2). These variabilities need to be taken into account by designers in order to provide adequate adjustability of workstations, tools, products and human-machine interfaces.

Because of the above mentioned human inter and intra-individual changes, the majority of developed and developing countries have produced their own anthropometric databank. Some examples include anthropometric data of Asian (3, 4), African (5, 6), European (7, 8) and American (9, 10) peoples. However, although publication of the first systematic anthropometric tables dated on 1950s, no anthropometric survey has yet been

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conducted on Iranian general population with regard to the occupational health application. Available data on this topic is mainly limited to Iranian industrial (11) and army (12) personnel which would not be presentative for the general population. Apart from its vital importance for designing various work stations and spaces, national anthropometric tables are required to fabricate any ease of use urban spaces such as public buildings, leisure facilities, general transportation services, and so on. Since anthropometric surveys are often costly and time-consuming, ergonomists prefer to prepare anthropometric databases based on more simple methods such as estimation rather than measurement. One of the most widely employed methods of estimation is that proposed by Barkla (13) and Roebuck et al. (14). Entitled “Rapid Anthropometrics Scaled for Height” (RASH) by Pheasant, this method was validated and employed to estimate British anthropometric database (15, 16). The RASH method requires only data on the stature (i.e. mean and standard deviation) of an unknown population to which scaling factors derived from a known homogeneous population is applied. The technique was used in some similar researches afterward all over the world (17, 18).

An important need for appropriate anthropometric source on Iranian body characteristics exists among national ergonomists and designers. Recently, existed anthropometric data for Iranian population is not sufficiently comprehensive with respect to both sample size and representativeness (19). Therefore, the present study is the first attempt to provide a single comprehensive and representative source of anthropometric information on Iranian general population. Such database is extensively applicable as a key element to provide ergonomic design requirements and to create products, hand tools, furniture, workstations, etc. as much fit as possible to the nation. In this regard, after an integrated review of related published literature, a dataset is assembled using the RASH method assumed to be sufficiently exhaustive and accurate for practical purpose; especially in terms of the creation of spaces in various public or industrial environments.

Materials and Methods

The method of RASH was applied for estimating anthropometric database of Iranian general population. This method is based on the assumption that although people vary greatly in size, they are likely to be similar in proportions (2). It requires only know the mean (m) and standard deviation (s) of stature of an unknown population (i.e. target population). Scaling factors for intended bodily dimensions would be calculated from a known population (i.e. reference population) and then applied to the height data in the target one. Coefficient $e_m$ was calculated using following formula (15): $e_m = \frac{x}{h}$

Where $x$ is the mean value of the intended bodily dimension and $h$ is the mean stature in the reference population. Then, scaling ratio ($E_m$) was obtained as arithmetic mean of $e_m$ (15, 16): $E_m = \frac{\sum e_m}{n}$

The same method was used for estimating coefficients ($e_s$) and scaling ratios ($E_s$) related to the standard deviations. Calculations were made as a function of sex.

The reference population

Conducting a systematic review using Google Scholar, Medline, SID, IranMedex, Magiran, MedLib and Civilica, an integrative collection of ever published anthropometric datasets of Iranian adults was developed. No time limit was considered. This collection was considered as the reference population. Studies were included as a function of their aim and methodology. Therefore, cases hypothesized any relationship between body variables (e.g. weight, BMI, wrist circumferences, etc.) and health problems (obesity, diseases, etc.) or conducted on children were excluded. Repeated datasets (i.e. same data published in more than one source) were also removed. As presented in Table 1, altogether 24 sources of information were found.
Table 1: The reference population

| References                        | Sample size | Study population            |
|-----------------------------------|-------------|-----------------------------|
| 1 Shahnavaz and Davies (39)       | 400         | Iranian steel workers       |
| 2 Mououdi (21)                    | 179         | University students         |
| 3 Abarghouie and HoseiniNasab (22)| 330         | Iranian office workers      |
| 4 Motamedzade et al. (38)         | 303         |                             |
| 5 Sadeghi and Habibi (23)         | 95          | Bus drivers                 |
| 6 Vafee et al. (24)               | 115         | University students         |
| 7 Mirmohammadi et al. (46)        | 911         | University students         |
| 8 Mohammadi et al. (26)           | 70          | Iranian women               |
| 9 Shokoohi H, Khoshroo (40)       | 853         | Military personnel          |
| 10 Osquei-Zadeh et al. (25)       | 267         | University students         |
| 11 Habibi et al. (47)             | 768         | University students         |
| 12 Abedini et al. (27)            | 194         | University students         |
| 13 Mououdi (28)                   | 178         | Iranian men                 |
| 14 Mohammadi et al. (29)          | 140         | Iranian women               |
| 15 Hemmatjoo et al. (30)          | 80          | Military personnel          |
| 16 Falahati et al. (31)           | 70          | University students         |
| 17 Ilbeigi et al. (32)            | 120         | Iranian men                 |
| 18 Davoudiantalab et al. (33)     | 400         | Iranian male workers        |
| 19 Bahrampour et al. (34)         | 194         | University students         |
| 20 Pourtaghi et al. (12)          | 12635       | Military personnel          |
| 21 Moshkdanian et al. (35)        | 300         | Iranian adults              |
| 22 Eftekhar Vaghefi et al. (36)   | 1599        | Medical personnel           |
| 23 Famil Alamdar and Famil Alamdar (37) | 144 | Iranian adults              |
| 24 Sadeghi et al. (11)            | 3720        | Iranian workers             |

The target population

For the target population, we have selected recent nationwide surveillance on non-communicable disease risk factors, which in our knowledge is the best representative of the general population in terms of sample size, age, sex, socio-economic, and geographical distribution. Using a random multistage cluster sampling method, the study measured, among other variables, stature of 79,611 Iranian rural and urban citizens (50.1% men; 49.9% women) aged from 20 to 64 yr with standardized and calibrated instruments (20).

Results

Scaling factors for 36 anthropometric estimations are presented in Table 2. Accordingly, stature has the highest ratios with eye and shoulders heights; and the smallest ratios with hand and foot breadths. Indeed, body dimensions of men and women are likely to follow a similar scaling profile (Table 2).

Tables 3 and 4 show anthropometric estimates calculated based on these scaling factors for men and women, respectively. Iranian men’s average height is estimated to be 1697 mm versus 1564 mm for female. The tallest Iranian man is about 348 mm taller than the shortest one; while the tallest Iranian woman is about 317 mm taller than the shortest woman is.

Discussion

The main purpose of the present study was to estimate as much as comprehensive and accurate anthropometric database for Iranian adults which could be applicable in industrial and nonindustrial design. Assembling the totality of relevant published tables by means of the simple, rapid and
valid method of RASH, this study was able to present the first single source of anthropometric information for Iranian general population. It is therefore not illogical to claim that the present set of estimations is the most valid representation of the anthropometrics of the Iranian general 20-64 yr people achieved now. The pioneer in using this method was Pheasant, who developed an anthropometric source for British civilian adults based on a combination of the main previously published datasets (15).

Table 2: Scaling ratios for mean ($E_m$) and standard deviation ($E_s$) of 36 bodily dimensions

| Dimensions                        | Women |        |        |        | Men  |        |        |        |
|-----------------------------------|-------|--------|--------|--------|------|--------|--------|--------|
|                                   | $E_m$ | $E_s$  | $n$    | $E_m$  | $E_s$| $n$    | $E_m$  | $E_s$  |
| 1 Stature                         | 1.000 | 1.000  | 7      | 1.000  | 1.000| 10     | 1.000  | 1.000  |
| 2 Eye height                       | 0.928 | 1.224  | 7      | 0.936  | 1.021| 9      | 0.966  | 0.764  |
| 3 Shoulder height                  | 0.829 | 1.274  | 7      | 0.835  | 0.966| 9      |        |        |
| 4 Elbow height                     | 0.624 | 1.117  | 7      | 0.629  | 0.764| 10     |        |        |
| 5 Hip height                       | 0.540 | 1.165  | 4      | 0.533  | 0.855| 5      |        |        |
| 6 Knuckle height                   | 0.421 | 0.985  | 4      | 0.458  | 0.582| 4      |        |        |
| 7 Fingertip height                 | 0.391 | 0.746  | 7      | 0.400  | 0.585| 6      |        |        |
| 8 Sitting height                   | 0.531 | 0.779  | 7      | 0.581  | 0.685| 11     |        |        |
| 9 Sitting eye height               | 0.467 | 0.897  | 6      | 0.521  | 0.667| 10     |        |        |
| 10 Sitting elbow height            | 0.151 | 0.753  | 8      | 0.152  | 0.464| 10     |        |        |
| 11 Thigh thickness                 | 0.087 | 0.538  | 6      | 0.086  | 0.330| 8      |        |        |
| 12 Sitting shoulder height         | 0.374 | 0.911  | 7      | 0.360  | 0.444| 6      |        |        |
| 13 Buttock knee length             | 0.350 | 1.025  | 7      | 0.337  | 0.524| 9      |        |        |
| 14 Buttock to popliteal length     | 0.280 | 0.924  | 8      | 0.271  | 0.499| 11     |        |        |
| 15 Knee height                     | 0.306 | 0.604  | 8      | 0.306  | 0.519| 10     |        |        |
| 16 Popliteal height                | 0.251 | 0.608  | 10     | 0.246  | 0.451| 11     |        |        |
| 17 Shoulder breadth (bi-deltoid)   | 0.251 | 0.495  | 10     | 0.258  | 0.452| 12     |        |        |
| 18 Shoulder breadth (bi-acromial)  | 0.199 | 0.897  | 3      | 0.198  | 0.588| 3      |        |        |
| 19 Hip breadth                     | 0.224 | 0.562  | 9      | 0.207  | 0.449| 10     |        |        |
| 20 Chest depth                     | 0.150 | 0.462  | 8      | 0.131  | 0.508| 9      |        |        |
| 21 Abdominal depth                 | 0.157 | 0.917  | 6      | 0.134  | 0.527| 8      |        |        |
| 22 Shoulder elbow length           | 0.208 | 0.681  | 8      | 0.212  | 0.443| 8      |        |        |
| 23 Elbow fingertip length          | 0.262 | 0.466  | 4      | 0.257  | 0.590| 4      |        |        |
| 24 Upper limb length               | 0.446 | 0.784  | 4      | 0.472  | 0.864| 4      |        |        |
| 25 Shoulder grip length            | 0.373 | 0.816  | 5      | 0.368  | 0.855| 4      |        |        |
| 26 Head length                     | 0.113 | 0.638  | 4      | 0.110  | 0.460| 5      |        |        |
| 27 Head breadth                    | 0.087 | 0.540  | 4      | 0.087  | 0.253| 5      |        |        |
| 28 Hand length                     | 0.107 | 0.459  | 4      | 0.109  | 0.172| 5      |        |        |
| 29 Hand breadth                    | 0.044 | 0.245  | 5      | 0.048  | 0.118| 6      |        |        |
| 30 Foot length                     | 0.145 | 0.229  | 6      | 0.151  | 0.210| 7      |        |        |
| 31 Food breadth                    | 0.053 | 0.183  | 6      | 0.054  | 0.124| 7      |        |        |
| 32 Vertical grip reach (standing)  | 1.198 | 2.525  | 4      | 1.215  | 1.171| 5      |        |        |
| 33 Vertical grip reach (sitting)   | 0.718 | 0.787  | 3      | 0.809  | 0.783| 4      |        |        |
| 34 Forward grip reach              | 0.420 | 1.052  | 5      | 0.440  | 1.020| 4      |        |        |
| 35 Span                            | 0.254 | 0.533  | 2      | 0.271  | 0.412| 2      |        |        |
| 36 Elbow span                      | 0.257 | 0.726  | 2      | 0.269  | 0.568| 3      |        |        |

n=Number of available sources in each sex category;

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For being representative, a sample should be an unbiased indication of the intended population. In the case of previously reported Iranian anthropometric datasets, one of the limitations face to the representativeness of data is that the sample size for about 80% of them is under 500 (21-39). Moreover, being conducted on the specified groups of industrial (11, 33, 39) or army (12, 30, 40) employees or in a specified location (32, 35), not across Iran, is the fact supporting the inaccuracy of using previous datasets for the general population. Anthropometric dimensions significantly differ between various occupational groups (41). Incorrect design of workplaces and products due to the lack of having access to an appropriate source of anthropometric databank could cause work-related physiological damages because of prolonged exposure to awkward postures. This could at least partly explain the high prevalence of musculoskeletal disorders in different Iranian industrial and nonindustrial sectors (42-45). Anthropometric dimensions should also be taken into consideration in the design of urban spaces such as public buildings, restaurants, hospitals and so on in order to provide an environment that supports the majority of residents especially with respect to some aspects such as clearance and reach.
Some key anthropometric dimensions are “knee height”, “sitting height” and “arms reach” (1). A good anthropometric database should also be up-to-date. This feature is essential since human body characteristics vary over time and from generation to another. Our proposed set of estimations has the potential of being rapidly updated as soon as a more recent source of Iranian height would be available. Indeed, these data could be easily repeated for any sub-group of the general population.

Errors associated with using this technique are small and would be considered as negligible, even in comparison with common interpretation errors or those arising from the corrections for shoes and cloths (16). However, one could suggest that this method is much better applicable to body dimensions which best depend on the length of bones than circumferential dimensions. If relevant, this may be considered as a limitation of this study.

**Conclusion**

Even though estimated data should be employed with prudence, but data prepared with this method is sufficiently reliable for many purposes (15). The application of the present anthropometric databank would be beneficial to better match the numerous manmade products and spaces with individual users. Therefore, a better match between national designs and Iranian users; as well

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**Table 4: Anthropometric estimates for Iranian female adults (all dimensions in mm)**

| Dimensions                  | 1th | 5th  | 25th | 50th | 75th | 95th | 99th | SD  |
|-----------------------------|-----|------|------|------|------|------|------|-----|
| Stature                     | 1405| 1452 | 1518 | 1564 | 1609 | 1676 | 1722 | 68  |
| Eye height                  | 1258| 1315 | 1396 | 1452 | 1508 | 1589 | 1646 | 83  |
| Shoulder height             | 1095| 1154 | 1238 | 1296 | 1354 | 1439 | 1498 | 87  |
| Elbow height                | 799 | 851  | 925  | 976  | 1027 | 1101 | 1153 | 76  |
| Hip height                  | 659 | 713  | 791  | 844  | 897  | 974  | 1028 | 79  |
| Knee height                 | 502 | 548  | 613  | 658  | 703  | 769  | 814  | 67  |
| Fingertip height            | 494 | 529  | 578  | 612  | 646  | 696  | 730  | 51  |
| Sitting height              | 706 | 742  | 794  | 830  | 865  | 917  | 953  | 53  |
| Sitting eye height          | 589 | 630  | 690  | 731  | 772  | 831  | 873  | 61  |
| Sitting elbow height        | 117 | 152  | 202  | 236  | 270  | 320  | 355  | 51  |
| Thigh thickness             | 50  | 75   | 111  | 135  | 160  | 196  | 221  | 37  |
| Sitting shoulder height     | 440 | 483  | 543  | 585  | 626  | 687  | 729  | 62  |
| Buttock knee length         | 385 | 433  | 501  | 548  | 594  | 662  | 710  | 70  |
| Buttock to poplitical length| 292 | 335  | 396  | 438  | 480  | 542  | 585  | 63  |
| Knee height                 | 382 | 410  | 450  | 478  | 505  | 545  | 574  | 41  |
| Popliteal height            | 297 | 325  | 365  | 393  | 421  | 461  | 489  | 41  |
| Shoulder breadth (hi-deltoid)| 314 | 337  | 370  | 393  | 415  | 448  | 471  | 34  |
| Shoulder breadth (hi-acromial)| 170 | 211  | 271  | 312  | 353  | 412  | 454  | 61  |
| Hip breadth                 | 261 | 287  | 324  | 350  | 375  | 413  | 439  | 38  |
| Chest depth                 | 162 | 183  | 214  | 235  | 256  | 287  | 308  | 31  |
| Abdominal depth             | 100 | 142  | 203  | 245  | 287  | 347  | 390  | 62  |
| Shoulder elbow length       | 218 | 250  | 295  | 326  | 357  | 402  | 434  | 46  |
| Elbow fingertip length      | 335 | 357  | 388  | 409  | 430  | 461  | 483  | 32  |
| Upper limb length           | 573 | 610  | 662  | 697  | 733  | 785  | 822  | 53  |
| Shoulder grip length        | 453 | 491  | 545  | 583  | 620  | 674  | 712  | 56  |
| Head length                 | 76  | 105  | 148  | 177  | 206  | 248  | 278  | 43  |
| Head breadth                | 51  | 76   | 112  | 136  | 161  | 197  | 222  | 37  |
| Hand length                 | 95  | 116  | 147  | 168  | 189  | 219  | 240  | 31  |
| Hand breadth                | 30  | 41   | 58   | 69   | 80   | 96   | 108  | 17  |
| Foot length                 | 190 | 200  | 216  | 226  | 236  | 252  | 262  | 16  |
| Food breadth                | 53  | 62   | 74   | 83   | 91   | 103  | 112  | 12  |
| Vertical grip reach (standing)| 1474| 1591 | 1758 | 1874 | 1989 | 2156 | 2273 | 172 |
| Vertical grip reach (sitting)| 999 | 1035 | 1088 | 1124 | 1159 | 1212 | 1248 | 54  |
| Forward grip reach          | 489 | 538  | 608  | 656  | 704  | 774  | 823  | 72  |
| Span                        | 312 | 337  | 372  | 397  | 421  | 456  | 481  | 36  |
| Elbow span                  | 287 | 321  | 369  | 402  | 435  | 484  | 517  | 49  |

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as a more accurate evaluation of all products, machinery and spaces, either national or imported international ones, is expected. By means of integrating the presented tables into design phase, we hope national designers to provide greater safety, satisfaction and commonwealth for Iranian citizens.

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Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

Conflict of interest

The authors declare that there is no conflict of interests.

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