THE RELATIONSHIP BETWEEN ANTHROPOMETRY AND HAND GRIP STRENGTH AMONG OLDER MALAYSIAN PEOPLE

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ABSTRACT

Physiological changes and loss of hand grip strength are natural consequences of the ageing process. Previous studies have shown that physiological changes will affect the hand grip strength of elderly people. However, to date, there are no studies which have developed models that predicts the hand grip strength of elderly Malaysians as a function of anthropometric dimensions. Knowledge on the correlation between these variables is crucial in order to create a suitable living environment as well as designing and developing products that cater specifically to the needs of the elderly. Hence, the main objective of this study is to examine the correlation between anthropometric dimensions and hand grip strength in a representative sample of the elderly population in Malaysia and developing the regression models that predicts the hand grip strength of elderly Malaysian males and females.

In order to achieve the objectives, a total of ninety one (91) anthropometric dimensions along with hand grip strength data are collected from a sample of 112 subjects aged 60 years and above. The subjects comprises of 56 males and 56 females, recruited from a densely populated urban area in Selangor, namely, Petaling Jaya. The anthropometric parameters are measured using standard anthropometric set whereas hand grip strength is measured using Jamar hydraulic hand dynamometer. Statistical analysis was then carried out to identify the anthropometric dimensions that significantly influence hand grip strength, and the results indicate that only 37 anthropometric dimensions significantly influence the hand grip strength of elderly Malaysians.

In addition, the anthropometric dimensions and hand grip strength data were obtained and compared with the data for two age groups (20-30 years and 50-59 years) in order to determine if there is a significant difference in the measurements between these groups. In general, it can be observed that the ageing adult group exhibits lower values for the

majority of anthropometric parameters and hand grip strength compared to the young adult group. This finding indicates the importance for product designers to gain an understanding on the differences in the physiological dimensions of elderly people with those of other age groups in order to create ergonomic products that account for their special needs.

Two regression models have been developed in this study, which predicts the hand grip strength of elderly Malaysian males and females. In both of these models, the hand grip strength is predicted by a regression equation as a function of anthropometric dimensions. A case study has been carried out to validate the prediction models, in which the subjects are required to open bottles of different sizes. Five bottles are chosen for this purpose; the first one, a perfume vial, second, a vitamin supplement bottle, the third, a tall, narrow-mouthed jar of blueberry jam, the fourth, a short, wide-mouthed jar of orange marmalade and the fifth, a mini shower cream bottle. These bottles are typical objects which are available at home and are therefore representative of the actual scenario faced by the elderly. The results indicate that there is a relationship between hand anthropometric dimensions and hand grip strength for elderly Malaysians, whereby the size and surface texture of the lid affects their ability to open the bottles.

The significant contributions of this study are as follows. First, the findings of this study can be used to build a database of anthropometric and hand grip strength measurements for the elderly population in Malaysia. Second, the regression models developed in this study can be used as a means to predict the hand grip strength of the elderly populations in Malaysia, which will assist product designers in creating ergonomically designed products. Third, an improved methodology was being proposed in this study which will be useful for researchers who intend to deepen their understanding

on the relationship between anthropometric parameters and hand grip strength of elderly Malaysians.

ABSTRAK

Perubahan fisiologi serta kehilangan kekuatan genggaman merupakan perkara semulajadi yang berlaku dalam proses penuaan. Kajian-kajian yang lepas telah menunjukkan bahawa perubahan fisiologi pada tangan akan mempengaruhi kekuatan genggaman warga tua. Walaubagaimanapun, sehingga kini belum ada kajian yang membangunkan model yang meramal kekuatan genggaman warga tua khususnya di Malaysia. Hubungan antara kekuatan genggaman dan dimensi antropometrik adalah penting untuk mewujudkan lingkungan kehidupan dan membangunkan produk yang memenuhi keperluan warga tua. Oleh yang demikian, objektif utama kajian ini adalah untuk mengkaji hubungan antara dimensi antropometrik dan kekuatan genggaman warga tua dan membangunkan model regresi yang meramal kekuatan genggaman warga tua lelaki dan perempuan di Malaysia.

Untuk mencapai objektif di atas, sejumlah 91 dimensi antropometrik beserta data kekuatan genggaman telah dikumpul dari suatu sampel yang terdiri daripada 112 subjek berumur 60 tahun ke atas. Subjek terdiri daripada 56 lelaki dan 56 perempuan dan telah direkrut daripada kawasan bandar yang mempunyai kepadatan penduduk yang tinggi di Selangor, iaitu Petaling Jaya. Dimensi antropometrik telah diukur dengan menggunakan set antropometrik piawai manakala kekuatan genggaman diukur dengan menggunakan dinamometer tangan hidraulik Jamar. Analisis statistik telah dilaksanakan untuk mengenalpasti dimensi antropometrik yang mempengaruhi kekuatan genggaman secara signifikan, dan hasil keputusan menunjukkan bahawa 37 dimensi antropometrik sahaja yang mempengaruhi kekuatan genggaman warga tua di Malaysia.

Satu perbandingan juga telah dibuat, di mana data dimensi antropometrik dan kekuatan genggaman telah dibandingkan dengan data dari dua kumpulan dengan lingkungan umur yang berlainan (20-30 tahun dan 50-59 tahun) untuk menentukan sama ada terdapat

perbezaan yang signifikan antara kumpulan. Secara umumnya, hasil keputusan menunjukkan bahawa kebanyakan dimensi antropometrik dan juga kekuatan genggaman bagi kumpulan dewasa berumur adalah rendah berbanding dengan kumpulan dewasa muda. Hasil penemuan ini menunjukkan betapa pentingnya bagi pereka produk untuk memahami perbezaan fisiologi warga tua dengan golongan lain demi menghasilkan produk ergonomik yang mengambil kira keperluan khusus golongan ini.

Dua model regresi telah dibangunkan dalam kajian ini dan bertujuan meramal kekuatan genggaman warga tua lelaki dan perempuan di Malaysia. Kedua-dua model ini terdiri daripada persamaan regresi yang menunjukkan hubungan antara kekuatan genggaman dengan dimensi antropometrik. Satu kajian kes telah dilaksanakan untuk mengesahkan kedua-dua model tersebut, di mana para subjek dikehendaki untuk membuka lima jenis botol dengan saiz berlainan. Lima jenis botol telah dipilih untuk tujuan ini; pertama, vial minyak wangi, kedua, botol vitamin, ketiga, balang jem beri biru yang tinggi dan bermulut kecil, keempat, balang marmalad oren yang pendek dan bermulut luas dan kelima, botol krim mandian yang kecil. Botol-botol tersebut merupakan objek yang biasa dijumpai di dalam rumah dan menunjukkan keadaan sebenar yang biasa dihadapi oleh warga tua. Hasil kajian menunjukkan bahawa terdapat hubungan antara dimensi antropometrik dan kekuatan genggaman untuk warga tua di Malaysia, di mana saiz dan tekstur permukaan penutup botol mempengaruhi kebolehan warga tua untuk membuka botol.

Sumbangan signifikan kajian ini adalah seperti berikut. Pertama, hasil penemuan kajian ini boleh digunakan untuk membina satu pangkalan data dimensi antropometrik dan kekuatan genggaman bagi warga tua khususnya di Malaysia. Kedua, kedua-dua model regresi yang dibangunkan dalam kajian ini boleh digunakan sebagai suatu alat untuk meramal kekuatan genggaman warga tua dan ini akan membantu pereka produk

untuk merekacipta produk ergonomik. Ketiga, suatu kaedah diperbaiki telah dicadangkan dalam kajian ini, di mana ia akan memberi manfaat kepada para penyelidik yang ingin mendalami ilmu berkenaan hubungan antara dimensi antropometrik dan kekuatan genggaman warga tua di Malaysia.

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LIST OF SYMBOLS AND ABBREVIATIONS

ADL	:	Activity of Daily Living
IADL	:	Instrumental of Activity of Daily Living
BMI	:	Body Mass Index
CV	:	Coefficient of Variation
SPSS	:	Statistical Package for Social Science
SD	:	Standard Deviation
SEE	:	Standard Error of Estimate

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REFERENCES

Afzan, Z. Z., S.A., H., Shamsul, B. T., Zailina, H., Nada, I., & Siti Rahmah, A. R. (2012). *Mismatch between school furniture and anthropometric measures among primary school children in Mersing, Johor, Malaysia.* Paper presented at the Southeast Asian Network of Ergonomics Societies Conference (SEANES), Langkawi, Kedah, Malaysia.

Aghazadeh, F., Lee, K., & Waikar, A. I. (1993). Impact of anthropomatric and personal variables on grip strength. *J Hum Ergol, 22*, 75-81.

Ahmad, R.K.R., Ping-Yap, A., Lin, P., & Kamarul, T. (2010). *Linear and nonlinear modelling of adult Malaysian Population's Hand Grip Strength.* Paper presented at the Mathematical/ Analytical Modelling and Computer Simulation (AMS), Langkawi, Malaysia.

Angst, F., Drerup, S., Werle, S., Herren, D. B., Simmen, B. R., & Goldhahn, J. (2010). Prediction of grip and key pinch strength in 978 healthy subjects. *BMC Musculoskelet Disord, 11*(94), 13-20.

Anne, H. Y. C., & Moy, F. M. (2013). Association between physical activity and metabolic syndrome among Malay adults in a developing country, Malaysia. *Journal of Science and Medicine in Sport, xxx (2013) xxx– xxx*, 6.

Apovian, C. M., Frey, C. M., Wood, G. C., Rogers, J. Z., Still, C. D., & Jensen, G. L. (2002). Body Mass Index and Physical Function in Older Women. *Obesity Research, 10*(8), 740-747.

Atchley, R. C. (1991). *The influence of aging or frailty on perceptions and expressions of the self: theoretical and methodological issues* (J.E. Birren, J.E. Lubben, J.C. Rowe, D.E. Deutchman, The concpet and measurement of quality of life in the frail elderly ed.). San Diego, CA: Academis Press.

Australian Safety and Compensation Council. (2009). Sizing Up Australia: How contemporary is the Anthropometric Data Australian Designers Use: Australian Government.

Azouz, Z. B., Rioux, M., Shu, C., & Lepage, R. (2006). Characterizing Human Shape Variation Using 3-D Anthropometric Data. *Visual Computer, 22*, 302-314.

Bae, A., & Armstrong, T. J. (2011). A finger motion model for reach and grasp. *Int J Ind Ergon, 41*(1), 79-89.

Ball, R., Shu, C., Xi, P., Rioux, M., Luximon, J., & Molenbroek, J. (2010). A comparison between Chinese and Caucasian head shapes. *Applied Ergonomics, 41*(6), 823-839.

Balogun, J., Akomolafe, C., & Amusa, L. (1991). Grip strength: Effects of testing posture and elbow position. *Archives of Physical Medicine and Rehabilitation, 72*, 280-283.

Balogun, J. A., Akomolafe, C. T., & Amusa, L. O. (1991). Grip strength: effects of testing posture and elbow position. *Arch Phys Med Rehabil, 72*(5), 280-283.

Bari, S. B., Othman, M., & Mohd Salleh, N. (2010). Foot anthropometry for shoe design among preschool children in Malaysia. *Pertanika Journal of Social Sciences & Humanities, 18*(1), 69-79.

Bartali, B., Salvini, S., Turrini, A., Lauretani, F., Russo, C. R., Corsi, A. M., & Ferrucci, L. (2003). Age and disability affect dietary intake. *J. Nutr., 133*(9), 2868-2873.

Baumgartner, R. N., Koehler, K. M., Gallagher, D., Romero, L., Heymsfield, S. B., Ross, R. R., & Lindeman, R. D. (1998). Epidemiology of sarcopenia among the elderly in New Mexico. *American journal of epidemiology, 147*(8), 755-763.

Beaton, D. E., O'Driscoll, S. W., & Richards, R. R. (1995). Grip strength testing using the BTE work simulator and the Jamar dynamometer: a comparative study. Baltimore Therapeutic Equipment. . *J Hand Surg [Am], 20*(2), 293-298.

Bellamy, N., Campbell, J., Haraoui, B., Buchbinder, R., Hobby, K., & Roth, J. (2002). Dimensionality and clinical importance of pain and disability in hand osteoarthritis: development of the. Australian/Canadian (auscan) osteoarthritis hand index. *Osteoarthritis Cartilage, 10*(11), 855-862.

Bermúdez, O. I., Becker, E. K., & Tucker, K. L. (1999). Development of sex-specific equations for estimating stature of frail elderly Hispanics living in the northeastern United States. *Am J Clin Nutr, 69*(5), 992-998.

Bhoomiah, D., & Jennifer, W. (2009). *Is there a correlation between a person's BMI and their grip strength?* Paper presented at the 4th Congress of the Asian Pasific Federation of Societies for Hand Therapist, Kaohsiung City, Taiwan.

Bohannon, R. W. (2003). Grip strength: a summary of studies comparing dominant and nondominant limb measurements. *Percept Mot Skills, 96*(3), 728-730.

Bohannon, R. W. (2008). Hand-Grip Dynamometry Predicts Future Outcomes in Aging Adults. *Journal of Geriatric Physical Therapy, 31*(1), 3-10.

Bohannon, R. W., & Schaubert, K. L. (2005). Test–Retest Reliability of Grip-strength Measures Obtained over a 12-week Interval from Community-dwelling Elders. *Journal of Hand Therapy, 18*(4), 426-428.

Borg, G. (1998). *Human Kinetics.* IL, US: Champaign.

Brubaker, T. H. (1976). The stereotype of "old": A review and alternative approach. *Journal of Gerontology, 31*(4), 4441-4447.

Brubaker, T. H., & Powers, E. A. (1976). The stereotype of "old". A review and alternative approach. *Journal of Gerontology, 31*(4), 441-447.

Burkholder, J. F. (2000). Osteoarthritis of the hand: a modifiable disease. *J Hand Ther., 13*, 79-89.

Cardoso, H. F. V., & Canina, M. (2010). Secular trends in social class differences of height, weight and BMI of boys from two schools in Lisbon, Portugal (1910–2000). *Economics & Human Biology, 8*(1), 111–120.

Carmeli, E., Patish, H., & Coleman, R. (2003). The aging hand. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences, 58*(2), 146-152.

Chong, Y. Z., & Leong, X. J. (2011). *Preliminary findings on anthropometric data of 19-25 year old Malaysian university students.* Paper presented at the 5th Kuala Lumpur International Conference on Biomedical Engineering 2011, Kuala Lumpur, Malaysia.

Chuan, T. K., Hartono, M., & N., K. (2010). Anthropometry of the Singaporean and Indonesian populations. *International Journal of Industrial Ergonomics, 40*(2010), 757-766.

Cole, T. J. (2003). The secular trend in human physical growth: a biological view. *Economics & Human Biology, 1*(2), 162-268.

Corish, C. A., & Kennedy, N. P. (2003). nthropometric measurements from a cross-sectional survey of Irish free-living elderly subjects with smoothed centile curves. *Br. J. Nutr., 89*(1), 137-145.

Cowgill, D. O., & Holmes, L. O. (1994). *Aging and Modernization.* New York: AppletonCentury-Crofts.

Crawford, J. O., Graveling, R. A., Cowie, H. A., & Dixon, K. (2010). The health safety and health promotion needs of older workers. *Occupational Medicine, 60*(3), 184-192.

Crosby, C. A., Wehbe, M. A., & Mawr, B. (1994). Hand strength: normative values. *J Hand Surg [Am], 19*(4), 665-670.

da Silva Coqueiro, R., Barbosa, A. R., & Borgatto, A. F. (2009). Anthropometric measurements in the elderly of Havana, Cuba: Age and sex differences. *Nutrition, 25*(1), 33-39.

da Silva, C. R., Rodrigues, B. A., & Ferreti, B. A. (2009). Anthropometric measurements in the elderly of Havana, Cuba: age and sex differences. *Nutrition, 25*, 33-39.

Dangour, A. D., Farmer, A., Hill, H. L., & Ismail, S. J. (2003). Anthropometric status of Kazakh children in the 1990s. *Economics & Human Biology, 1*(1), 45-53.

Daruis, D. (2011). Malaysian sitting anthropometry for seat fit parameters. *Journal Human Factors in Ergonomics & Manufacturing, 21*(5), 443-455.

de Castro, A. P., Rubens Rebelatto, J., & Rabiatti Aurichio, T. (2010). The relationship between wearing incorrectly sized shoes and foot dimensions, foot pain, and diabetes. *Journal of sport rehabilitation, 19*(2), 214.

De Onis, M., Onyango, A. W., Van den Broeck, J., Chumlea, W. C., & Martorell, R. (2004). Measurement and standardization protocols for anthropometry used in the construction of a new international growth reference or the WHO Multicentre Growth Reference Study Group. *Food and Nutrition Bulletin, 25*(1), 27-36.

Department of Statistics Malaysia. (2010). Population projection, Malaysia 2010 - 2040. Retrieved 10 November 2013, 2013.

Department of Statistics Malaysia. (2013). Population Projection, Malaysia 2010 - 2040. Retrieved 10 November 2013, 2013.

Deros, B. M., Mohamad, D., Ismail, A. R., Soon, O. W., Lee, K. C., & Nordin, M. S. (2009). Reccomended chair and work surfaces dimensions of VDT tasks for Malaysian citizens. *European Journal of Scientific Research, 34*(2), 156-167.

Desrosiers, J., Bravo, G., Hebert, R., & Mercier, L. (1995). Impact of elbow position on grip strength of elderly men. *J Hand Ther, 8*(1), 27-30.

Dewangan, K. N., Owary, C., & Datta, R. K. (2008). Anthropometric data of female farm workers from north eastern India and design of hand tools of the hilly region *International Journal of Industrial Ergonomics, 38*(1), 90-100.

Dewangan, K. N., Owary, C., & Datta, R. K. (2010). Anthropometry of male agricultural workers of north-eastern India and its use in design of agricultural tools and equipment. *international Journal of Ergonomics, 40*(5), 560-573.

Dey, D. K., Rothenberg, E., Sundh, V., Bosaeus, I., & Steen, B. (1999). Height and body weight in the elderly. I. A 25 year longitudinal study of a population aged 70 to 95 years. *European Journal of Clinical Nutrition, 53*(905-14).

Di Monaco, M., Di Monaco, R., Manca, M., & Cavanna, A. (2000). Handgrip strength is an independent predictor of distal radius bone mineral density in postmenopausal women *Clinical Rheumatology, 19*(2000), 473-476.

Edgren, C. S., Radwin, R. G., & Irwin, C. B. (2004). Grip force vectors for varying handle diameters and hand sizes. *Human Factors: The Journal of the Human Factors and Ergonomics Society, 46*(2), 244-251.

Erikson, E. H. (1959). *Identity and the life cycle.* NewYork: W.W. Norton & Co.

Estes, J. P., Bochenek, C., Fassler, P., & Fasler, P. (2000). Osteoarthritis of the fingers. *J Hand Ther., 13*, 108-123.

Evans, W. J., & Hurley, B. F. (1995). Age, gender, and muscular strength. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences, 50*(Special Issue), 41-44.

Foo, L. H. (2007). Influence of body composition, muscle strength, diet and physical activity on total body and forearm bone mass in Chinese adolescent girls. *Br J Nutr, 98*, 1281-1287.

Freund, A. M., & Smith, J. (1997). Self-definition in old age. *Zeitschrift fur Sozialpsychologie, 28*(1-2), 44-59.

Fried, L. P., & Guralnik, J. M. (1997). Disability in older adults: evidence regarding significance, etiology, and risk. *Journal of the American Geriatrics Society 45*, 92-100.

Frontera, W. R., Hughes, V. A., Lutz, K. J., & Evans, W. J. (1991). A cross-sectional study of muscle strength and mass in 45- to 78-yr-old men and women. *J Appl Physiol August, 71*(2), 644-650.

Fry, A. C., Ciroslan, D., Fry, M. D., Leroux, C. D., Schilling, B. K., & Chiu, L. Z. (2006). Anthropometric and performance variables discriminating elite American junior men weightlifters. *Journal of Strength and Conditioning Research, 20*(4), 861-866.

Glascock, A. P., & Feinman, S. L. (1980). A holocultural analysis of old age. *Comparative Social Research, 3*, 311-332.

Goodpaster, B. H., Park, S. W., Harris, T. B., Kritchevsky, S. B., Nevitt, M., Schwartz, A. V, Simonsick, E.M., Tylavsky, F.A., & Newman, A. B. (2006). The loss of skeletal muscle strength, mass, and quality in older adults: the health, aging and body composition study. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences, 61*(10), 1059-1064.

Gordon, C. C., & Bradtmiller, B. (1992). Interobserver Error in a Large Scale Anthropometric Survey. *American Journal of Human Biology, 4*(2), 253-263.

Gorman, M. (1999). *Development and the rights of older people* (J. Randel Ed. The ageing and development report: poverty, independence and the world's older people ed.). London: Earthscan Publications Ltd.

Günther, C. M., Bürger, A., & Rickert, M. (2008). Grip strength in healthy Caucasian adults: reference values. *J Hand Surg Am, 33*(2008), 558–565.

Hamilton, A., Balnave, R., & Adams, R. (1994). Grip strength testing reliability. *J Hand Ther, 7*(3), 163-170.

Harris, T. B., Visser, M. E., Everhart, J., Cauley, J., Tylavsky, F., Fuerst, T., Zamboni, M., Taaffe D., Resnick H.E., Scherzinger, A., & Nevitt, M. (2000). Waist circumference and sagittal diameter reflect total body fat better than visceral fat in older men and women:The health, aging and body composition study. *Ann NY Acad Sci, 904*, 462-473.

Helmuth, H. (1983). Anthropometry and the secular trend in growth of Canadians. *Zeitschrift für Morphologie und Anthropologie74, 1*(75-90).

Hisham, S., Mamat, C. R., & Ibrahim, M. A. (2012). Regression analysis for stature estimation from foot anthropometry in Malaysian Chinese. *Australian Journal of Forensic Sciences, 44*(4), 331-341.

Hu, H., Li, Z., Yan, J., Wang, X., Xiao, H., Duan, J., & Zheng, L. (2007). Anthropometric measurement of the Chinese elderly living in the Beijing area. *International Journal of Industrial Ergonomics, 37*(2007), 303-311.

Hulens, M., Vansant, G., Lysens, R., Claessens, A. L., Muls, E., & Brumagne, S. (2001). Study of differences in peripheral muscle strength of lean versus obese women: an allometric approach. *International Journal of Obesity, 25*, 676-681.

Hussain, F., & Abdul Kadir, M. R. (2010). *Three dimensional anthropometric measurements of the distal femur and proximal tibia for the Malay population.* Paper presented at the IEEE EMBS Conference on Biomedical Engineering & Sciences (IECBES 2010), Kuala Lumpur, Malaysia.

Imrhan, S. N., & Mandahawt, N. (2010). Handgrip prediction models for children, adults and the elderly. *Journal of human ergology, 39*(2), 111-120.

Incel, N. A., Ceceli, E., Durukan, B. P., Erdem, H. R., & Yorgancioglu, Z. R. (2002). Grip strength: effect of hand dominance. *Singap. Med. J., 43*(5), 235–239.

Innes, E. (2002). Handgrip strength testing: A review of the literature review. *Australian Occupational Therapy Journal, 46*(3), 120-140.

Jarosz, E. (1999). Anthropometry of elderly women in Poland: dimensions for design. *Int J Ind Ergon, 25*, 203-213.

Johansson, C. A., Kent, B. E., & Shepard, K. (1983). Relationship between verbal command volume and magnitude of muscle contraction. *Phys Ther, 63*(8), 1260-1265.

Johnson, M. (1976). Is 65+ old? *Social Policy*, 9-12.

Jung, M. C., & Hallbeck, M. S. (1999). *The effects of instruction, verbal encouragement, and visual feedback on static handgrip strength.* Paper presented at the Proceedings of the Human Factors and Ergonomics Society 43rd Annual Meeting.

Jurimae, T., Hurbo, J., & Jurimae, J. (2009). Relationship of handgrip strength with anthropometric and body composition variables in prepubertal children. *J Copmar Hum Biol, 60*, 225-238.

Kärkkäinen, M., Tuppurainen, M., Salovaara, K., Sandini, L., Rikkonen, T., Sirola, J., & Kröger, H. (2010). Effect of calcium and vitamin D supplementation on bone mineral density in women aged 65–71 years: a 3-year randomized population-based trial (OSTPRE-FPS). *Osteoporosis international, 21*(12), 2047-2055.

Karmegam, K., Sapuan, S. M., Ismail, M. Y., Ismail, N., Shamsul Bahri, M. T., Shuib, S., & Hanapi, M. J. (2011). Anthropometric study among adults of different ethnicity in Malaysia. *International journal of the Physical Sciences, 6*(4), 777-788.

Kart, C. S., & Ford, M. E. (2002). Exploring the Factorial Structure of the EORTC QLQ-C30 Racial Differences in Measuring Health-Related Quality of Life in a Sample of Urban, Older Adults. *Journal of aging and health, 14*(3), 399-421.

Kaur, M. (2009). Age-related changes in hand grip strength among rural and urban Haryanvi Jat females. *J Copmar Hum Biol, 60*, 441-450.

Kerr, A., Syddall, H. E., Cooper, C., Turner, G. F., Briggs, R. S., & Sayer, A. A. (2006). Does admission grip strength predict length of stay in hospitalized older patients? *Age and ageing, 35*, 82-84.

Kinnunen, T. I., Luoto, R., Gissler, M., & Hemminki, E. (2003). Pregnancy weight gain from 1960s to 2000 in Finland. *Int J Obes Relat Metab Disord, 27*, 1572-1577.

Kirvesoja, H., Väyrynen, S., & Häikiö, A. (2000). Three evaluations of task-surface heights in elderly people's homes. *Applied Ergonomics, 31*(2), 109-119.

Koley, S., Kaur, N., & Sandhu, J. S. (2009). A study on hand grip strength in female labourers of Jalandhar, Punjab, India. *J Life Sci, 1*(1), 57-62.

Koley, S., & Kumaar, B. S. (2012). The relation between handgrip strength and selected hand-anthropometric variables in Indian inter-university softball players. *Physical Education and Sport, 10*(1), 13 - 21.

Kouchi, M., Mochimaru, B., Bradtmiller, H., Daanen, P., Li, B., Nacher , Y., & Nam, Y. (2012). A protocol for evaluating the accuracy of 3D body scanners. *Work, 41*(4010-4017).

Kouchi, M., Mochimaru, B., Bradtmiller, H., Daanen, P. Li, & Nacher, Y. (2011). Errors in landmarking and the evaluation of the accuracy of traditional and 3D anthropometry. *Applied Ergonomics, 42*, 518-527.

Kroemer, K. H. E., & Grandjean, E. (1997). *Fitting the task to the human: A textbook of occupational ergonomics*. Philadelphia: Taylor & Francis.

Kroemer, K. H. E., Kroemer, H. J., & Kroemer-Elbert, K. E. (1986). *Engineering physiology: Physiologic bases of human factors/ergonomics*. Amsterdam: Elsevier.

Li, K., Hewsona, D. J., Duchênea, J., & Hogrelc, J. Y. (2010). Predicting maximal grip strength using hand circumference. *Manual Therapy, 15*(6), 579-585.

Lim, T. O., & Ding, L. M. (2000). Distribution of body weight, height and body mass index in a national sample of Malaysian adults. *Med J Malaysia, 55*, 108-128.

Lin, Y., Wang, M. J., & Wang, E. M. (2004). The comparisons of anthropometric characteristics among four peoples in East Asia. *Applied Ergonomics, 35*(2004), 173–178.

Liu, B. (2008). Incorporating anthropometry into design of ear-related products. *Applied Ergonomics, 39*(2008), 115–121.

Lloyd-Sherlock, P. (2000). Population ageing in developed and developing regions: implications for health policy. *Social Science & Medicine, 51*(6), 887-895.

Luna-Heredia, E., Martin-Pena, G., & Ruiz-Galiana, J. (2005). Handgrip dynamometry in health adults. *Clinical Nutrition, 24*(2), 250-258.

MacDermid, J., Fehr, L., & Geiger, K. (2002). The effect of physical factors on grip strength and dexterity. *Br J Hand Ther, 7*(1), 112-118.

Massy-Westropp, N. M., Gill, T. K., Taylor, A. W., Bohannon, R. W., & Hill, C. L. (2011). Hand Grip Strength: age and gender stratified normative data in a population-based study. *BMC Research Notes, 4*(2011), 127-132.

Mathiowetz, V. (2006). Comparison of Rolyan and Jamar dynamometers for measuring grip strength. *Occupational Therapy International, 9*(3), 201-209.

Mathiowetz, V., Rennells, C., & Donahoe, L. (1985). Effect of elbow position on grip and key pinch strength. *J Hand Surg Am, 10*(5), 694-697.

Matsuoka, J., Berger, R., Berglund, L. J., & An, K. N. (2006). An analysis of symmetry of torque strength of the forearm under resisted forearm rotation in normal subjects. *Journal of Hand Surgery, 31*, 801-805.

Mendoza-Núñez, V. M., García-Sánchez, A., Sánchez-Rodríguez, M., Galván-Duarte, R. E., & Fonseca-Yerena, M. E. (2002). Overweight, Waist Circumference, Age, Gender, and Insulin Resistance as Risk Factors for Hyperleptinemia. *Obesity Research, 10*(4), 253-259.

Merkies, I. S., Schmitz, P. I., van der Meche, F. G., & van Doorn, P. A. (2000). Psychometric evaluation of a new sensory scale in immunemediated polyneuropathies Inflammatory Neuropathy Cause and Treatment (INCAT) Group. *Neurology, 54*, 943–949.

Metter, E. J., Talbot, L. A., Schrager, M., & Conwit, R. (2002). Skeletal Muscle Strength as a Predictor of All-Cause Mortality in Healthy Men. *J Gerontol A Biol Sci Med Sci, 57*(10), 359-365.

Miyatake, N., Miyachi, M., Tabat, I., Sakano, N., & Hirao, T. (2012). Relationship between muscle strength and anthropometric, body composition parameters in Japanese adolescents. *Health, 4*(1), 1-5.

Mohamad, D., Md Deros, B., Ismail, A. R., & Indah, D. D. (2010). *Development of a Malaysian anthropometric database.* Paper presented at the Malaysia Conference on Manufacturing Technology and Management, Kuching, Sarawak.

Mohammad, Y. A. (2005). Anthropometric characteristics of the hand based on laterality and sex among Jordanian. *International Journal of Industrial Ergonomics, 35*(8), 747-754.

Molenbroek, J. F. M. (1987). Anthropometry of elderly people in the Netherlands; research and applications Applied Ergonomics. *18*(3), 187–199.

Mosallanezhademail, Z., Hörder, H., Salavati, M., Nilsson-Wikmar, L., & Frändin, K. (2012). Physical activity and physical functioning in Swedish and Iranian 75-year-olds: A comparison. *Archives of Gerontology and Geriatrics, 55*(2), 422-430.

Nair, K. S. (2005). Aging muscle. *Am J Clin Nutr, 81*(5), 953-963.

Nasarwanji, M. F. (2012). *Understanding alternate physical interaction strategies to improve product design for older adults.* (Doctor of Philosophy), State University of New York, New York.

Nasir, N., Abdullah, A. H., Shuib, M. F., & Rashid, H. (2011). *Anthropometric study of Malaysian youths- a case study in Universiti Teknologi Mara.* Paper presented at the IEEE Colloquium on Humanitites, Science and Engineering Research (CHUSER 2011), Penang.

Nazif, N. K. A., Hani, S. E., Lee, C. K., & Rasdan, I. A. (2011, 5-6 December 2011). *A study on the suitability of science laboratoty furniture in Malaysian secondary school.* Paper presented at the Asia Pasific symposium on Advancements in Ergonomics and Safety (ERGOSYM2011), Perlis, Malaysia.

Ngoh, H. J., Chen, S. T., & Harith, S. (2011). Anthropometric measurements among institutionalized elderly men in Northern Peninsular Malaysia. *Journal of Medical Health, 8*(1), 58-62.

Nicolay, C. W., & Walker, A. L. (2005). Grip strength and endurance: Influences of anthropometric variation, hand dominance, and gender. *International Journal of Industrial Ergonomics, 35*(7), 605-618.

Niempoog, S., Siripakarn, Y., & Suntharapa, T. (2007). An estimation of grip strength during puberty. *Journal Medical Association of Thailand, 90*(4), 699.

Nikolaidis, P. (2012). Development of isometric muscular strength in adolescent soccer players. *Physical Education and Sport, 10*(3), 231-242.

Nybo, H., Christensen, K., Gaist, D., & Jeune, B. (2001). Functional Status and Self-Rated Health in 2,262 Nonagenarians: the Danish 1905 Cohort Study. *Journal American Geriatics, 49*, 601-609.

Ohn, S. K., Yoo, W., Kim, D. Y., Ahn, S., Jung, B., Choi, I., & Jung, K. (2013). Measurement of synergy and spasticity during functional movement of the post-stoke hemiplegic upper limb. *Journal of Electromyography and Kinesiology, 23*(2), 501-507.

Oliveira, M. N. G., Cezar, A., Henrique, E., & de Abreu, E. (2000). Comparison of the anthropometric assessment of adolescents of privileged and unpriviliged social and economic levels. *Nutrition Research 20*(10), 1423-1436.

Oyewole, S. A., Joel, M. H., & Andris, F. (2010). The ergonomic design of classroom furniture/computer work station for first graders in the elementary school. *International Journal of Industrial Ergonomics, 40*(2010), 437-447.

Palloni, A., McEniry, M., Dávila, A. L., & García Gurucharri, A. (2005). The influence of early conditions on health status among elderly Puerto Ricans. *Social biology, 52*(3/4), 132-164.

Paquet, V., & Feathers, D. (2004). An anthropometric study of manual and powered wheelchair users. *Int J Ind Ergon, 33*(3), 191-204.

Parsons, K. C. (1995). Ergonomics and international standards: introduction, brief review of standards for anthropometry and control room design and useful information. *Applied Ergonomics, 26*(4), 239-247.

Payette, H., Coulombea, C., Boutiera, V., & Gray-Donaldb, K. (2000). Nutrition risk factors for institutionalization in a free-living functionally dependent elderly population. *Journal of Clinical Epidemiology, 53*(6), 579-587.

Pennathur, A., Contreras, L. R., Arcaute, K., & Dowling, B. (2003). Manual dexterity of older Mexican American adults: a cross-sectional pilot experimental investigation. *Int J Ind Ergon, 32*(6), 419-431.

Pennathur, A., & Dowling, W. (2003). Effect of age on functional anthropometry of older Mexican American adults: a cross-sectional study. *International Journal of Industrial Ergonomics, 32*(1), 39-49.

Perissinotto, E., Pisent, C., Sergi, G., & Grigoletto, F. (2002). Anthropometric measurements in the elderly: age and gender differences. *Br J Nutr., 87*(2), 177-186.

Petersen, P., Petrick, M., Connor, H., & Conklin, D. (1989). Grip strength and hand dominance: challenging the 10% rule. *Am J Occup Ther, 43*(7), 444-447.

Pheasant, S., & Haslegrave, C. M. (2006). *Bodyspace: Anthropometry, Ergonomics and the Design of Work* (3rd ed ed.). Boca Raton, FL: Taylor & Francis Group.

Pheasant, S. T. (1986). *Bodyspace: Anthropometry, ergonomics and design.* London, UK: Taylor & Francis.

Pieterse, S., Manandhar, M., & Ismail, S. (2002). The association between nutritional status and hand grip strength in older Rwandan refugees. *Eur J Clin Nutr, 56*, 933-939.

Pigeyre, M., Duhamel, A., Poulain, J., Rousseaux, J., Barbe, P., Jeanneau, S., & Romon, M. (2012). Influence of social factors on weight-related behaviors according to gender in the French adult population. *Appetite, 58*(2012), 703-709.

Pini, R., Tonon, E., Cavallini, M. C., Bencini, F., Bari, M. D., Masotti, G., & Marchionni, N. (2001). Accuracy of Equations for Predicting Stature From Knee Height, and Assessment of Statural Loss in an Older Italian Population. *Gerontol A Biol Sci Med Sci, 56*(1), 3-7.

Portney, L. G., & Watkins, M. P. (2000). *Foundations of clinical research: applications to practice. Vol. 2.* Upper Saddle River, NJ: Prentice Hall.

Potter, J. M., Caroline, J., & McKee, M. D. (2007). Does delay matter? The restoration of objectively measured shoulder strength and patient oriented outcome after immediate fixation versus delayed reconstruction of displaced midshaft fractures of the clavicle. *Journal of Shoulder and Elbow Surgery, 16*(5), 514-518.

Ramadan, M. Z., & Al-Shayea, A. M. (2013). A modified backpack design for male school children. *Int J Ind Ergon, 43*(5), 462-471.

Rantanen, R., Harris, T., Leveille, S. G., Visser, M., Foley, D., & Masaki, K. (2000). Muscle strength and body mass index as long-term predictors of mortality in initially healthy men. *J Gerontol A Biol Sci Med Sci, 55*(3), 168-173.

Rashid, S. N. S. A., Hussain, M. R. H., & Yusuff, R. M. (2008). Designing homes for the elderly based on the anthropometry of older Malaysians. *Asian Journal of Gerontology Geriatrics, 3*, 75-83.

Richards, L. G., Olson, B., & Palmiter-Thomas, P. (1996). How forearm position affects grip strength. *Am J Occup Ther, 50*(2), 133-138.

Roberts, D. F., Provins, K. A., & Morton, R. J. (1959). Arm strength and body dimensions. *Human Biology, 31*(4), 334-343.

Roberts, H. C., Denison, H. J., Martin, H. J., Patel, H. P., Syddall, H., Cooper, C., & Sayer, A. A. (2011). A review of the measurement of grip strength in clinical and epidemiological studies: towards a standardised approach. *Age and ageing, 40*, 423–429.

Robinette, K. M., & Hudson, J. (2006). *Chapter 12. Anthropometry. Handbook of Human Factors and Ergonomics* (3rd ed.). New Jersey: John Wiley and Sons.

Roebuck, J. (1979). When does old age begin?: the evolution of the English definition. *Journal of Social History, 12*(3), 416-428.

Rosnah, M. Y., Mohd Rizal, H., & Sharifah Norazizan, S. A. R. (2009). Anthropometry Dimensions of Older Malaysians: Comparison of Age, Gender and Ethnicity. *Asian Social Science, 5*(6), 133-140.

Samson, M. M., Meeuwsen, I. B., Crowe, A., Dessens, J. A., Duursma, S. A., & Verhaar, H. J. (2000). Relationships between physical performance measures, age, height and body weight in healthy adults. *Age and ageing, 29*, 235-242.

Sayer, A. A., Syddall, H. E., Gilbody, H. J., Dennison, E. M., & Cooper, C. (2004). Does sarcopenia originate in early life? Findings from the Hertfordshire cohort study. *J Gerontol A Biol Sci Med Sci, 59*(9), 930-934.

Schlüssel, M. M., dos Anjos, L. A., de Vasconcellos, M. T. L., & Kac, G. (2008). Reference values of handgrip dynamometry of healthy adults: A population-based study. *Clinical Nutrition, 27*(4), 601-607.

Schmidt, R. T., & Toews, J. V. (1970). Grip strength as measured by the Jamar dynamometer. *Archives of Physical Medicine and Rehabilitation, 51*(6), 321-327.

Schoch, T., Staub, K., & Pfister, K. (2012). Social inequality and the biological standard of living: An anthropometric analysis of Swiss conscription data, 1875–1950. *Economics & Human Biology, 10*(2), 154-173.

Scott, G., Menz, H. B., & Newcombe, L. (2007). Age-related differences in foot structure and function. *Gait & posture, 26*(1), 68-75.

Shahar, S., & Pooy, N. S. (2003). Predictive equations for estimation of stature in Malaysian elderly people. *Asia Pasific J Clin Nutr, 12*(1), 80-84.

Shechtman, O., MacKinnon, L., & Locklear, C. (2001). Using the BTE Primus to measure grip and wrist flexion strength in physically active wheelchair users: an exploratory study. *Am J Occup Ther, 55*(4), 393-400.

Simmons, K. P., & Istook, C. (2001). *Comparison of 3-Dimensional Body Scanners for Usage Potential.* Paper presented at the 81st World Congress of the Textile Institute, Melbourne.

Simmons, K. P., & Istook, C. L. (2003). Body measurement techniques: Comparing 3D body-scanning and anthropometric methods for apparel applications. *Journal of Fashion Marketing and Management: An International Journal, 7*(3), 306-332.

Singh, R. (2010). Secular trends of anthropometry and cardio-respiratory parameters of Malaysian females. *Journal of Science and Medicine in Sport, 12*(2010), 1-232.

Siti Zawiah Md Dawal, Hilma Raimona Zadry, Sharifah Nadya Syed Azmi, Siti Rusyida Rohim, & Sari Julia Sartika. (2012). Anthropometric Database for the Learning Environment of High School and University Students. *International Journal of Occupational Safety and Ergonomics, 18*(4), 461-472.

Smith, T., Smith, S., Martin, M., Henry, R., Weeks, S., & Bryant, A. (2006). *Grip strength in relation to overall strength and functional capacity in very old and oldest old females*: The Haworth Press Inc.

Staheli, L. T., Chew, D. E., & Corbett, M. (1987). The longitudinal arch. *J Bone Joint Surg, 69*(3), 426-428.

Steenbekkers, L. P. A., & Van Beijsterveldt, C. E. M. (1998). *Design-relevant Characteristics of Ageing Users.* Delft: Delft University Press.

Stoudt, H. W. (1981). The Anthropometry of the Elderly. *Human Factors, 23*(1), 29-37.

Su, C. Y., Lin, J. H., Chien, T. H., Cheng, K. F., & Sung, Y. T. (1994). Grip strength in different positions of elbow and shoulder. *Arch Phys Med Rehabil, 75*(7), 812-815.

Sulaiman, R., Taha, S., & Md Dawal, S. Z. (2013). Application of Anthropometric Dimensions for Estimating Stove Height, Stove Depth and Cooking Task Envelope for Malaysian Elderly Population. *Pertanika J.Sci. & Technol., 21*(1), 15-28.

Suriah, A. R., Zalifah, M. K., Zainorni, M. J., Shafawi, S., Mimie Suraya, S., Zarina, N., & Wan Zainudin, W. A. (1998). Anthropometric measurements of the elderly. *Malaysian Journal of Nutrition, 4*(55), 55-63.

Syddall, H., Cooper, C., Martin, F., Briggs, B., & Saye, A. (2003). Is grip strength a useful single marker of frailty? *Age and ageing, 32*(6), 650-656.

Taha, Z., Jomoah, I. M., & Zadry, H. R. (2009). A study of anthropometric characteristics between Malaysian and Saudi Arabian males aged 20 to 30 years. *J Hum Ergol, 38*(1), 27-32.

Thane, P. (1978). The muddled history of retiring at 60 and 65. *New Society, 45*(826), 234-236.

Togonu-Bickersteth, F. (1988). Perception of old age among Yoruba aged. *Journal of Comparative Family Studies, 19*(1), 113-123.

Toomingas, A., & Gavhed, D. (2008). Workstation layout and work postures at call centres in Sweden in relation to national law, EU-directives and ISO-standards, and to operators' comfort and symptoms. *International Journal of Industrial Ergonomics, 38*(11), 1051-1061.

Tsang, C. C. (2005). Reference values for 6-minute walk test and hand-grip strength in healthy Hong Kong Chinese adults. *Hong Kong Physiotherapy Journal, 23*(2005).

Tsunawake, N., Tahara, Y., Moji, K., Muraki, S., Minowa, K., & Yukawa, K. (2003). Body composition and physical fitness of female volleyball and basketvall players of the japan inter-high school championship teams. *Journal of Physiological Anthropology and Applied Human Science, 22*, 195-201.

United Nations. (2001). *World population prospects: the 2000 revision.* New York: United Nations.

United Nations. (2011). World Population Ageing 2013. New York.

Voorbij, A. I. M., & Steenbekkers, L. P. A. (2002). The twisting force of aged consumers when opening a jar. *Applied Ergonomics, 33*(1), 105-109.

Watanabe, T., Owashi, K., Kanauchi, Y., Mura, N., Takahara, M., & Ogino, T. (2005a). The short-term reliability of grip strength measurement and the effects of posture and grip span. *J Hand Surg [Am], 30*(3), 603-609.

Watanabe, T., Owashi, K., Kanauchi, Y., Mura, N., Takahara, M., & Ogino, T. (2005b). The short-term reliability of grip strength measurement and the effects of posture and grip span. *The Journal of Hand Surgery, 30*(3), 603-609.

Werle, S., Goldhahn, J., Drerup, S., Simmen, B. R., Sprott, H., & Herren, D. B. (2009). Age- and gender-specific normative data of grip and pinch strength in a healthy adult Swiss population. *The Journal of Hand Surgery, 34*(1), 76-84.

WHO. (1995). Physical status: the use and interpretation of anthropometry *World Health Organization Technical Report* (Vol. 854). Geneva: World Health Organization.

Wu, S. W., Wu, S. F., Liang, H. W., Wu, Z. T., & Huang, S. (2009). Measuring factors affecting grip strength in a Taiwan Chinese population and a comparison with consolidated norms. *Applied Ergonomics, 40*(4), 811-815.

Xu, X., Mirka, G. A., & Hsiang, S. M. (2008). The effects of obesity on lifting performance. *Applied Ergonomics, 39*(1), 93-98.

Yang, J., & Malek, K. A. (2009). Human reach envelope and zone differentiation for ergonomic design. *Human Factors and Ergonomics Manufacturing & Service Industries, 19*(1), 15-34.

Yap, W. S., Chan, C. C., Chan, S. P., & Wang, Y. T. (2001). Ethnic differences in anthropometry among adult Singaporean Chinese, Malays and Indians, and their effects on lung volumes. *Respiratoty Medicine, 95*, 297–304.

Yen, W.-T. (2011). *Product Physical Interface Design Characteristics for Older Adults with Hand Limitations.* (Degree Doctor of Philosophy), The Ohio State University

Yen, W. T. (2011). *Product physical interface design characteristics for older adults with hand use limitations.* (Doctor of Philosophy), The Ohio State University, Ohio.

Yoxall, A., & Janson, R. (2008). Fact or friction: a model for understanding the openability of wide mouth closures. *Packag. Technol. Sci., 21*, 137-114.

Yoxall, A., Janson, R., Bradbury, S. R., Langley, J., Wearn, J., & Hayes, S. (2006). Openability: producing design limits for consumer packaging. *Packag. Technol. Sci., 19*, 219-225.

Yoxall, A., Rodriguez-Falcon, E. M., & Luxmoore, J. (2013). Carpe diem, Carpe ampulla: A numerical model as an aid to the design of child-resistant closures. *Applied Ergonomics, 44*(1), 18-26.

Zakaria, N. (2011). Sizing system for functional clothing-uniforms for school children. *Indian Journal of Fibre and Textile Research 36*(2011), 348-357.

Zainal, N. Z. (2010). Full compilation of the Malaysian Journal of Psychiatry (September 2007, Vol. 16, No. 2). *Malaysian Journal of Psychiatry, 16*(2).

Zarith Afzan, Z., Azizan Hadi, S., Shamsul, B. T., Zailina, H., Nada, I., & Siti Rahmah, A. R. (2012). *Mismatch between school furniture and anthropometric measures among primary school children in Mersing, Johor, Malaysia.* Paper presented at the Southeast Asian Network of Ergonomics Societies Conference (SEANES), Langkawi, Malaysia.

Zhuang, Z., Shu, C., Xi, P., Bergman, M., & Joseph, M. (2013). Head-and-face shape variations of U.S. civilian workers. *Applied Ergonomics, 44*(5), 775–784.