Determining Body Dimensions Measured in Anthropometric Survey for Agricultural Tools Design: A Literature Review

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Abstract. This study presents a literature review and a comparison of selected body dimensions included in many anthropometric surveys. The main purpose of this study is to determine the measurements and variables that need to be included in a study of anthropometry for agricultural workers in Madura Island, Indonesia. The comparison and review were performed with studies selected from publications that were found in a literature search performed on Scopus and Google Scholar databases. The considered studies have an explicit statement describing the reason of their data collection for the design of agricultural tools and equipment and report data collected later than 2000. The review was performed by identifying the measurement included in each study and by comparing their measuring device/ equipment and methods. Each study involved a different number of hand measures. Each study had their own reasons in defining the anthropometric measures involved. However, it can be generally concluded that the studies selected the measures based on certain criteria, especially the need of the relevant body dimensions in agricultural tools and equipment design.

Keywords: anthropometry · human body dimension · agricultural tools

1 Introduction

The availability of anthropometric data is important in the design of tools, equipment, and various other products that are used daily. The product design process must consider the user's anthropometry. Products, tools, and equipment that are designed without considering the characteristics of the user can cause physical harm to the users [1–3].

Many studies showed a relation between musculoskeletal, anthropometric, and biomechanical problems related to the use of hand tools, equipment, and various products [4]. The mismatch between anthropometric measurements and user hand measurements contributes to musculoskeletal disorders [5–7]. Similar cases were also found in the relationship between the anthropometry and the size of the tools and equipment they use in growing crops or harvesting agricultural products with musculoskeletal disorders of the farmers in some areas.

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Reference [8] described the causes of musculoskeletal injuries in elderly farmers in Thailand, including incompatibility between the physical capacity of farmers and the demands of their work, long static postures, manual handling of materials weighed more than 10 kg, and mismatch between their anthropometric dimensions and the tools and equipment they use. Few researchers also identified some causes of injuries or accidents in the agricultural sector. Their studies revealed a mismatch between user anthropometric measurements and hand tool sizes as one of the causes of injuries experienced by farmers [9, 10].

The current study presents the findings of a literature review in the planning phase of an anthropometric survey on agricultural workers in Madura Island. This study outlines a literature review and a comparison of selected hand anthropometric studies of many populations. The main purpose of this study is to compare the measurements in each study rather than the collected data itself. The rationale for this literature review is to determine the measurements and variables to be included in the main study on the anthropometric data collection relevant to the design of agricultural tools and equipment.

2 Material and Method

The comparison and review were performed on studies selected from publications that were found in a literature searched on Scopus and Google Scholar. Two keywords, namely "anthropometry" and "agricultural tools design" was used in the search phase. All selected studies explicitly aimed to measure the anthropometry by considering its use in designing agricultural tools and equipment were involved in the review phase. Studies that not explicitly stated their objectives relevant to the current study are not included in the selection. The selected studies also reported data collected later than 2000. Accordingly, all the publications with data collected before 2000 were not included in this review. The review was performed by identifying the measurements included in each study and by comparing their aims and methods.

3 Results and Discussion

Twenty-three studies focused on anthropometric measurement for agricultural tools and equipment design were included in this literature review and studies' comparison. All the selected studies have used manual methods to measure the hand dimensions such as measuring tape, calliper, measuring grid, and wooden cone. The studies have involved the populations of Nigeria, Indonesia, Uganda, Thailand, India, Columbia, Algeria, etc. The summary of studies included for review are listed in Table 1.

Anthropometric Measurement. Anthropometric measurements for workers in the agricultural sector have been carried out in several countries and certain tribes. A literature search found that these measurements were carried out on agricultural workers in north-eastern India [11–13], male agricultural workers in western India[14] agricultural workers in Allahabad, India [15], female farmers in North Gujarat, India [16], farmers in Kashmir, India [17], female agricultural workers in Kerala, India [18], farmers in northern Karnataka, India [19], and female agricultural workers in Hyderabad,

Karnataka, India [20]. Anthropometric measurements for workers in the agricultural sector have been carried out in several countries and certain tribes. A literature search found that thes anthropometric measurements were carried out on agricultural workers in north-eastern India [11–13], male agricultural workers in western India [14], agricultural workers in Allahabad, India [15], female farmers in North Gujarat, India [21], farmers in Kashmir, India [17], female agricultural workers in Kerala, India[18], farmers in northern Karnataka, India [19], and female agricultural workers in Hyderabad, Karnataka, India [20].

Anthropometric measurements of workers in the agricultural sector in several other countries are also widely found. It is easy to find the publication on the anthropometric measurements, including those carried out on farmers in Nakhon Ratchasima, Thailand [22], farmers in Algeria [23], farmers in Enugu State, south-eastern part of Nigeria [24], agricultural workers in south-eastern Nigeria [25], farmers in south-southern Nigeria [26], Abia State, Nigeria [27], and female farmers in Uganda [28].

Anthropometric measurements of farmers in Indonesia were widely carried out. The measurements included farmers in Wedung District, Demak Regency [29], female farmers in Dramaga District, Bogor Regency [30], male farmers in Dramaga District, Bogor Regency [31], farmers in West Sumatra [32], farmers in Java [33], and female agricultural workers from the Marind-Anim tribe, Merauke Regency, Papua [34].

Anthropometric measurements were also carried out on the hands which are the most widely used body parts in agricultural activities. Two of these were carried out on agricultural workers in Ebonyi State, Nigeria [35] and flower farm workers in Colombia [36]. A previous study also measured anthropometric dimensions by considering their use in designing the sickle handle for female acgricultural workers in West Java, Indonesia [30].

Measured Dimensions. Several studies determine the dimensions that were measured based on consideration of their needs in the design of agricultural tools and equipment. With these considerations, the dimensions suggested by [38] and [39], namely 36 dimensions were included in the measurements done by [24].

Several studies added other dimensions, such as those conducted by [12, 14, 30, 31] and [29]. On the other hand, there are other studies that include fewer and different anthropometric dimensions in their measurements as conducted by [11, 15, 18, 22, 25, 28, 33], and [36]. It should be noted that factually not all the dimensions suggested by [23] and [39] are required in the design of agricultural tools and equipment.

The literature search also found many relevant studies included fewer dimensions measured in their data collection. Twenty-one anthropometric dimensions were measured by [32], including body weight. Similar number of the measured dimensions was done by [16, 25, 26], and [20].

In general, the dimensions measured in the anthropometric data collection are determined based on two main considerations. First, measurements included in the previous studies. It is easy to see that anthropometric dimensions measured in most of the previous studies were adopted from [23] and [39]. Second, an initial assumption that a dimension is needed to be considered in the design of a tool/equipment can be a strong reason to include it in the measurement.

Tabel 1. Studies involved in the literature review.

Reference number	Measured population	Measuring tools and equipment	Number of measured dimensions
[11]	Tribal workers of north-eastern India	Integrated Composite Anthropometer (ICA) and weight scale	34
[12]	Male agricultural workers of north-eastern India	Anthropometric scale from Siber Hegner & Co., Switzerland, Integrated Composite Anthropometer (ICA), and weight scale	76
[13]	Female agricultural workers of north-eastern India	Anthropometric scale from SiberHegner & Co., Switzerland, Integrated Composite Anthropometer (ICA), and weight scale	76
[14]	Male agricultural workers of western India	Portable anthropometer, sliding calliper, segmometer, measuring tape, and weight scale	59
[16]	Female farmers in North Gujarat, India	N/A	22
[17]	Female farm workers in Kashmir Region, India	Integrated Composite Anthropometer (ICA) and weight scale	25
[18]	Female agricultural workers in Kerala Region, India	Integrated Composite Anthropometer (ICA), self-developed wooden cone, and weight scale	28
[20]	Female agricultural workers in Hyderabad, Karnataka Region, India	Self-developed anthropometer	24
[22]	Male and female farmers in Nakhon Ratchasima, Thailand	Portable anthropometer kits and weight scale	36
[23]	Male farmers from four agricultural regions in Algeria	Harpenden standard anthropometer kits and weight scale	36

(*continued*)

Tabel 1. (*continued*)

Reference number	Measured population	Measuring tools and equipment	Number of measured dimensions
[24]	Rural agricultural workers in Enugu State, south-eastern Nigeria	Measuring tape/ metre scale	37
[25]	Male and female agricultural workers of south-eastern Nigeria	Anthropometer kits, grip-size measuring device, grip strength dynamometer, and weight scale	30
[26]	Male and female farmers of south-southern Nigeria	Wall mounted height stadiometer, digital vernier calliper, and weight scale	22
[28]	Female smallholder farmers of Uganda	Portable anthropometer kits and weight scale	28
[29]	Male and female farmers in Wedung District, Demak Regency, Central Java, Indonesia	Portable anthropometer kits	50
[30]	Female farmers in Dramaga District, Bogor Regency, West Java, Indonesia	Measuring tape/ metre scale, calliper, measuring pipe cylinder	41
[31]	Male farmers in Dramaga District, Bogor Regency, West Java, Indonesia	Measuring tape/ metre scale, calliper, measuring pipe cylinder	41
[33]	Male and female farm workers on Java Island, Indonesia	Portable anthropometer kits and weight scale	30
[35]	Male and female agricultural workers in Ebonyi central state zone of Nigeria	Vernier calliper, measuring tape, and wooden cone	10
[36]	Male and female Colombian floriculture workers of the Bogota plateau	Spreading calliper, measuring tape, and anthropometric grid	35

(*continued*)

Tabel 1. (*continued*)

Reference number	Measured population	Measuring tools and equipment	Number of measured dimensions
[37]	Male agricultural workers in the Middle Euphrates Area, Iraq	Portable anthropometer, calliper, grip strength measuring device, and digital weight scale	27

Measurement Method. All measurements made by previous researchers were carried out using conventional anthropometer measuring instruments. This conventional measuring instrument was chosen for reasons of convenience to be carried around from one measurement place to another according to the location closest to the participant's residence. Another reason is its relatively affordable price, reliable capabilities, and accuracy that is not inferior to modern equipment [38].

4 Conclusion

The main purpose of this study was to determine the measurements and variables that need to be included in a study of anthropometry for farmer and agricultural workers in Madura Island. From the several studies reviewed it was clear that each study involved different number of body dimensions and that the selection of the involved dimensions were selected by different reasons. Some of those reasons were the relevance of the measures to the design of agricultural tools and other manual equipment, the inclusion of the measures in the previous/ other studies, and the availability of reliable measuring devices. However, it can be generally concluded that the studies selected the measures based on two main criteria, namely: the measurements included in the previous studies and an initial assumption that a dimension is needed to be considered in the design of a tool/equipment.

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