International Journal of Industrial Ergonomics 46 (2015) 69–75

Contents lists available at ScienceDirect

International Journal of Industrial Ergonomics

journal homepage: www.elsevier.com/locate/ergon

Research on lower body shape of late pregnant women in Shanghai area of China

Gaihong Wu [a, d], Shuqiang Liu [b], Xiongying Wu [c, *], Xuemei Ding [a, d]

[a] Fashion and Art Design Institute, Donghua University, Shanghai 200051, China
[b] Institute of Textile Engineering, Taiyuan University of Technology, Taiyuan 030021, China
[c] Shanghai Entry-Exit Inspection and Quarantine Bureau, Shanghai 200135, China
[d] Key Laboratory of Clothing Design & Technology, Donghua University, Ministry of Education, Shanghai 200051, China

ARTICLE INFO

Article history:
Received 23 May 2014
Received in revised form
4 September 2014
Accepted 14 December 2014
Available online 9 January 2015

Keywords:
Late pregnant
Lower body
Anthropometric measurement
Body shape
Body classification

ABSTRACT

Anthropometric data, especially the data of lower body of late-pregnant women, has become an immediate need for ergonomic design of maternity products, such as clothing, related motherhood supplies, maternity support products, and so on. So 55 late pregnant women in Shanghai area of China were randomly selected for this lower body shape research. By anthropometric measurement method 18 dimensions were measured to characterize lower body shape of late pregnant women. Mean values, standard deviations (SD), coefficients of variation, and percentiles for each variable were estimated. It was found that the morphology of hip and abdomen mostly influenced the lower body shape. Then according to the characters of hip and abdomen, the late pregnant women's lower body shapes were divided into two types. Moreover this paper also analyzed the change trend of lower body shape along late pregnancy months (7 to 9th months). As a result of this research, the late pregnant women's lower body shapes were described from different aspects which were thought to provide a guide for the maternity products design.

Relevance to industry: The anthropometric data is essential to design reasonable and professional maternity products for late pregnant women, such as maternity support products, maternity clothing and so on. Especially this study can benefit the maternity garment industry. Moreover utilization of the anthropometric data, product designers would be able to outfit to a wider range of target users.

1. Introduction

When the women are pregnant, their body shape will change a lot because of the fetuses. Obviously, the body shape of pregnant women will changed the most in late pregnancy, and their weight, height, girth, body morphology, etc., will be more different from ordinary women. Through investigating the behaviors of pregnant women in purchasing clothes, it drew the conclusion that every pregnant woman would want suitable and reasonably structured maternity clothes or other living products designed especially for her (Amasya üniversitesi et al. 2013). However several garment or other pregnant support products' related problems exist which might lead to poor adherence behavior (Ho et al., 2009; Nakahara et al., 2007). From the view of protecting pregnant women, safety and harmlessness clothes or other maternity products are necessary (Wei, 2009). Anthropometry data is the fundamental information used in the design process of products and environments to assure ergonomics and provide a better comfort (Pheasant, 1996), so it is very important to master the figure of pregnancy women. Many previous studies focused on the anthropometric measurement of young female (Kim et al., 2012), male (Khadem and Islam, 2014), children (Chambers et al., 1993) or the elderly (Hu et al., 2007). As for the pregnant women, researchers tend to focus the study on medicine area (Menon et al., 2014). Dumas et al. (2009) compared posture and muscle activity in the back and upper extremity of women in late pregnancy and non-pregnant controls, and also some researchers studied the psychology of pregnant women (Dimidjiana and Goodman, 2014). However, there has been

* Corresponding author. Tel.: +86 13601785882.
E-mail address: wuxy@shciq.gov.cn (X. Wu).

http://dx.doi.org/10.1016/j.ergon.2014.12.007
0169-8141/

no publication of anthropometric data of the late pregnant population, let alone the lower body, but the lower body part is the emphasis to analyze pregnant women. There are only several Chinese scholars having done part of the study. Zhao (2008) did a study on size specifications and pants prototype about maternity dress; Zhang (2012) mainly explored the body shape of mid-pregnancy women; Zheng (2013) analyzed the development trend and hygienic security design on maternity clothing. Wang (2008) put forward some reasonable advises on maternity clothing pattern design. In conclusion, the study on pregnant women is not comprehensive and limited. It is necessary to master the body figure of pregnant women to serve for relative maternity industries. And of course the late pregnant women's body data is much more meaningful to the industries. This study fills part of this gap by supplying anthropometric data of the late-pregnant women's lower body.

The present study also extends prior work by examining systematically different dimensions of aspects. The first aim was to provide anthropometric data of lower body of the late pregnant women based on samples drawn from Shanghai area; the second aim was to describe the characteristics of lower body shape in the late pregnant women.

2. Method

2.1. Measuring tools

The semi-high-tech or high-tech anthropometric equipment is considered as reliable and accurate for measuring the dimensions (Chuan et al., 2010). But usually these equipment is high cost, huge and inconvenient to move, it is infeasible to take anthropometric measurement for late pregnant women. Traditional equipment is portable, easy to use and inexpensive (Meunier and Yin, 2000), it is enough for this research. Thus, a traditional manual Martin-type anthropometric toolbox (Fig. 1) that included a 2-m graduated rod, one caliper and one measuring tape were adopted as the equipment in this study. The 2-m graduated rod that has one fixed edge and another sliding ruler at a right angle is to measure distance. Some circumferences or non-linear dimensions were measured by tape. The caliper was used to measure short distances.

2.2. Subjects

The research subjects are late pregnant women in Shanghai area of China whose stature are 155 cm–165 cm (This height can be easily compared with normal medial human body, and the anthropometric data of normal body can be obtained from Chinese National Standard GB/T 1335.1–2008: Standard sizing systems for garments—women), aged 20–35 years old and in 7–9 months pregnancy. And the demographics of the subjects are shown in Table 1. The measurement work was carried out in maternal and child health hospitals. Considering the climate should be comfortable for the pregnant women to be lightly dressed, we choose the season of spring or autumn. In spring or autumn people would wear fewer clothes and the measuring data is close to the size of bare body.

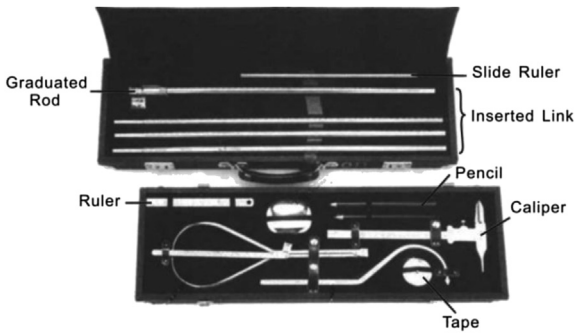

Fig. 1. Apparatus for anthropometric measurements: Martin-type toolbox.

Table 1
Demographic record of subjects.

	%(Statistics)
Pregnant month	
7th	32.73%(18)
8th	25.45%(14)
9th	41.82%(23)
Occupation	
Office clerk	38.18%(21)
Shop assistant	10.91%(6)
Teacher	12.73%(7)
Nurse or doctor	9.09%(5)
Accountant	3.64%(2)
Self-employed	14.55%(8)
others	10.91%(6)
Age	
20~25	9.09%(5)
25~30	49.09%(27)
30~35	41.82%(23)
Sample size: N = 55	

The measurements were performed by two experimenters. Both experimenters were trained in the data collection procedures (the techniques to measure the dimensions and complete the dimension form). Before the start of data collection, the measurement procedure was explained in detail to these late pregnant women. And after they fully had a rest, the measurement could begin.

2.3. Dimensions measurement

An adequate description of the human body may require over 300 dimensions (Pheasant, 1986; Roebuck et al., 1975). But the scope of this study was limited to measurement of lower body which was considered important for maternity products' design for the late pregnant women. 18 body dimensions (16 dimensions in the standing posture, as shown in Fig. 2, and 2 dimensions in the sitting posture) were selected, and anthropometric dimensions were defined as listed in Table 2. All dimensions were defined as the Chinese National Standard GB/T 5703 1999 (equivalent to ISO 7250:1996): basic human body measurements for technological design. To describe these dimensions simply, the abbreviations of these dimensions were also listed in Table 2.

2.4. Sample size

This paper adopts random sampling method to select the late pregnant women, the number of subjects was estimated according to the equation provided by ISO 15535:2012 "General requirements for establishing anthropometric databases" for a 95% confidence interval for the 5th and 95th percentiles:

$$N \geq 1.96^2 \times (CV)^2/A^2 \quad (1)$$

Where CV represents the coefficient of variation which is the ratio of sample standard deviation and mean value. "A" is relatively permissible error; empirical value of "A" is 3.5% which adopts in ordinary scientific research project. The CV of 18 dimensions is calculated by SPSS, and then we can get the sample size "N". The result is about 30 subjects for this late pregnant women's lower