

# Finite Element Simulation of the Dynamic Pressure Distribution of A Typical Compression Sports Bra During Wearing<sup>\*</sup>

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## Abstract

In order to study the pressure comfort of women in the process of wearing a typical compression sports bra, a simulation model was established using the finite element method to simulate women wear a typical compression sports bra, and the contact analysis of the human chest and the sports bra during the wearing process, Obtain the dynamic pressure changes during the wearing of the sports bra. In order to obtain a more accurate pressure value, the human body model is simplified into four layers, namely skin layer, fat layer, muscle layer, and bone layer. The skin layer and sports bra model are obtained through the method of reverse modeling, and then through the deletion calculation Generate adipose layer, muscle layer, bone layer and breast structure. The simulation results show: the pressure distribution between the sports bra and the human body: the pressure value at the human breast is 0.67 Kpa-1.87 Kpa, the shoulder pressure is 1.87 Kpa-3.68 Kpa, and the pressure at the bending part is 1.13 Kpa-1.74 Kpa. The pressure of the back shoulder strap and the part that is in contact with the human body is relatively uniform, ranging from 0.54 Kpa-1.14 Kpa. The experimental data in the literature proves that the finite element model is effective and reasonable.

*Keywords:* Sports bra; Simplified model; Contact analysis; Pressure distribution

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## 1 Introduction

The pressure comfort of sports bras is one of the important influencing factors of overall comfort. As people have higher and higher requirements for comfort, the research on the pressure of sports bras is very important to improve comfort. Excessive or excessive pressure does not meet physiological requirements. Excessive pressure is too low to achieve protective effects and improve exercise efficiency. Excessive pressure is not conducive to human health [1]. Pressure comfort to professional athletes are crucial.

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<sup>\*</sup>Project supported by the Xi'an Polytechnic University 2020 Graduate Innovation Fund Project (Grant No. chx2020011)

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Establishing an effective contact model of the sports bra and the finite element of the human body is the premise of the simulation calculation. Y Li, Zhang X and Yeung [2] established the contact model of sports bra and human body earlier, and used the finite element method to study the dynamic mechanical contact between sports bra and chest. After that, the finite element method is gradually used in the clothing field [3-4]. In terms of breast material prediction, Maximilian Eder and Stefan Raith [5] use finite element analysis (FE) to analyze biomechanical breast models to predict 3-D breast deformation and shows that the superelastic constitutive model better performance than the linear elastic model. Qiu Jiangyuan [6] used the SYMCAD three-dimensional body scanner system to scan the commonly used three-dimensional female body platform to build a contact model between the sports bra and the human body. The horizontal and vertical pretensions of the bra were given to simulate the wearing force, but this method has errors And the size of the pretension is difficult to determine. Kang Xuelian [7] simulated the waist support belt of pregnant women through the method of belt stretching. This method provides a method for the simulation of clothing wearing. Yue Sun [8] and Shichen Zhang [9] constructed a more realistic contact model of bra and human body finite element, simplified the human body model, but did not consider the hierarchical structure of the human body surface. Different structural layers of the human body surface have different material properties. For accurate calculation of the pressure of the human body wearing a bra, it is very important to divide the different structural layers of the human body and assign the correct material properties.

Based on the above research status, research scholars at home and abroad have made various degrees of research on the finite element analysis of bras. However, the mannequins used in previous studies are all rigid structures or replaced by elastic rubber, and the wearing process of the simulated sports bra is achieved by setting a pretension on the surface of the human body by the bra. This article will divide the human body model into a skeleton layer, a muscle layer, a adipose layer, a skin layer, and will use the stretching of the shoulder strap and the back strap to complete the simulation of sports bra wearing. Through the digital simulation, the changes of pressure and displacement during the wearing of sports bras can be obtained, which provides a reference for the research on the pressure comfort of sports bras.

## 2 Construction of Human Body Model and Sports Bra Model

### 2.1 Construction of the Human Model

In order to construct accurate human body models and sports bra geometric models, reverse engineering modeling methods are used. In reverse engineering, point cloud data collection and processing, and surface processing are very important for the subsequent finite element simulation accuracy and convergence influences. In this paper, a 3D laser body scanner (Vitus, Human Solutions, Germany) is used to capture the point cloud data of the 75B female dummy and sports bra model, thereby providing accurate body measurement data for the establishment of the geometric model. The human body data is processed through reverse engineering software to generate an accurate human body surface model.

The construction of the human body three-dimensional tissue model is relatively complicated. Determine the boundary contour of the breast according to the human breast anatomy [10-11],