

# Breast Geometry and Sports Bra Design Study for Adolescent Girls

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## Abstract

Breast measurement presents a complex challenge in the design of sports bras, particularly for adolescent girls whose bodies are rapidly changing. This study aimed to explore breast anthropometry among adolescents. A survey involving 23 girls aged 10 to 14 assessed their understanding of bra-related problems. In comparison, a wear trial with 7 girls sized 30AA to 32A evaluated their preferences through five bra conditions, 3D scanning and questionnaires. The study revealed a significant knowledge gap, with only 8.7% having had a bra fitting and less than half knowing how to determine their bra size. Notably, the upper bust measurement was significantly correlated with the level of “coolness” ( $r = -0.395$  and  $p = 0.038$ ), and the under bust measurement was correlated with the level of “comfort” ( $r = -0.441$  and  $p = 0.019$ ). The findings suggest a need for breathable fabrics in the upper bust while a preference for a stretchable underband to accommodate body growth. These results highlight the need to design sports bras tailored to the unique needs of adolescent girls, providing designers with critical insights into the necessary features and dimensions for optimal comfort during physical activity.

*Keywords:* Breast Shape; Body Measurement; 3D Scan; Subjective Questionnaire; Early Bra Education

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## 1 Introduction

Sports participation has a strong and positive impact on physical and mental health, which has led to an increasing number of women becoming active in recent years. Promoting an active lifestyle, the global sports bra market has been growing and recorded a revenue of US\$43.7 billion in 2020, expected to reach US\$93.7 billion by 2027 [1]. The statistics also indicate the increasing demand for sports bras in different regions, including the United States (US) and the United Kingdom (UK), but especially the Asia-Pacific region [2,3]. In China, 83.9% of women wear a sports bra during physical activity, significantly higher than in the UK at 67.2% [2]. Despite the

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importance of proper breast support for active females, problems of wearing ill-fitting bras and inadequate bra designs are frequently reported. The high occurrence of breast pain during sports activities also implies that current sports bra designs are not sufficiently catering to the needs of all active women. Precise breast measurements can help select the correct bra size, but the varying shapes of breasts indicate the need for more diverse and inclusive designs [4]. This is especially crucial for adolescent girls, whose bodies are still growing and developing with changes in body shape geometry and different needs for bra fit and breast support.

In the design of well-fitted sports bras, breast measurement is one of the most challenging aspects due to the de-formability of breast tissues and the variety of profiles of breasts [5]. This complexity is heightened when considering the specific needs of adolescent girls. They are self-conscious of their body image, particularly feeling embarrassed about excessive breast movement during exercise. Tank tops and/or camisole tops that adolescents traditionally wear for exercise usually lack suitable breast support, protection and shaping. At the same time, the sizes are relatively vague, such as small, medium, and large. To the best of our knowledge, there has been no comprehensive research into the body and breast shapes of adolescent girls about the design of sports bras. Further research is strongly recommended to fill this knowledge gap. This study aims to investigate the breast measurements of adolescent girls, providing valuable information for bra designers to create optimal designs for comfort during physical activities.

Adolescence is a period of rapid physical, cognitive and psycho-social growth. Research has shown active adolescents better perceive life and improve physical, mental, social, and emotional health [6]. The World Health Organization also suggests that adolescents engage in 60 minutes of moderate to vigorous exercise daily [6]. However, 85% of adolescent girls do not meet the recommended level of physical activity, often due to breast issues [7]. In the United Kingdom, 76% of girls reported that their breasts and related bouncing during exercise are a barrier to their participation in physical activities, which is more prevalent in larger-breasted girls [8]. Their concerns also include breast discomfort, lack of bra support, and embarrassment when getting changed due to exposure of their breasts or bras. As compared to daily outerwear, bras are more personal and individualised. Personal characteristics, such as age, body shape and cultural background, influence its use. As a unique group of consumers, adolescent girls have specific needs and preferences for sports bras due to their breast growth and changes in figure during puberty, as well as perceived wear comfort. Commercial sports bras designed for active women may not meet these adolescents' needs, leading to repeated problems with bra fit and breast support during exercise. Despite the importance of proper breast support, education is rarely provided by public health services or schools. Recent studies have emphasised the need for breast education for adolescent girls, ideally starting before the age of 18 [9]. However, there has been no research on this topic among Hong Kong's adolescent girls on breast education. Therefore, a survey is needed to investigate bra-related issues among Hong Kong's adolescent girls.

As shown above, adolescents have unique needs for bra fitting and breast support. When their breasts grow, they may also experience tenderness or soreness. They are often self-conscious about their bodies, particularly about excessive breast movement during exercise. This study aims to evaluate the fit, support, and function of sports bras for adolescent girls and to provide recommendations for improving the design of sports bras to ensure optimal fit, comfort, and protection during sports activities.