

Preliminary Investigation of Bikram Yoga Apparel for Improved Mobility and Comfort

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Introduction: Bikram yoga is a form of Hatha yoga that consists of 26 poses executed in a specific order for 90 minutes in a room heated to approximately 40°C (105°F) with 40% relative humidity (RH), generating a reliable baseline for studying the health and physiological effects of Bikram yoga (Tracy & Hart, 2013; Green 2014). The apparel currently used for Bikram yoga causes wearer discomfort, restricts body motion, and unwanted skin exposure (D. Green, personal communication, October 2016). The purpose of this study was to understand the clothing needs for Bikram yoga practice, to investigate dynamic change of body dimension through anthropometric measurements in select Bikram yoga postures, and to propose improved designs to meet consumers' needs in performance and comfort. **Methodology:** For this preliminary investigation, six female participants (experience of Bikram yoga: 5.6 ±4.9 years) were recruited from a Bikram yoga studio in Ithaca, NY with Institutional Review Board approval. A mixed methods research approach was undertaken comprising of four parts:

1. Interviews with participants for demographic information, Bikram yoga experience, perceptions of current yoga apparel, and potential unmet needs.
2. Anthropometric data was collected in standing position and in four Bikram yoga postures: (Ardha Chandrasana) Half Moon, (Ustrasana) Camel Pose, (Padahasthasana) Head to Feet, and (Sasangasana) Rabbit Pose (see Figure 1). Tape measurements, a portable 3D scanner, and a full-size scanner were used to collect measurements within Bikram yoga environmental conditions (30°C-40°C, 50%RH). Measurements included height, chest, waist, hip, maximum circumference of right thigh, length from seventh cervical vertebra to center of back waistline, length from center front neck baseline to center of front waistline, length from center of side bustline to center of side waistline, waist to crotch length, crotch length (total), and waist to hip length.

Figure 1. Illustrations of Bikram Yoga Poses



Half Moon



Camel Pose



Head to Feet



Rabbit Pose

3. Five prototypes iterations were constructed and evaluated by the research team for fit, ease of movement, and aesthetics with a final prototype for evaluation by research participants.
4. Follow-up interviews were conducted with four participants where the final prototype was tried on and comments about satisfaction levels and suggested changes were given.

Results and Discussion: Interviews revealed that the ideal garment for four of the participants were spandex shorts with a tight waistband worn with a sleeveless tank top over a sports bra with thick straps or tank tops with built-in breast support. There was a preference for racerback style tank tops and for bra-tops with open midriff as this helped to engage with postures. Subjects had difficulties with the high waistband and tight shorts placing too much pressure on their waistlines. Loose silhouettes were not considered appropriate for this exercise due to unintended exposure when practicing poses.

Anthropometric data suggested that body dimensions change significantly when performing Bikram yoga, especially when performing postures such as Rabbit and Camel. For the Camel pose, front waist-to-crotch length increased 54% on average compared to a standing position. For the Head to Feet pose, the length from back waist-to-crotch increased an average of 77% from original standing pose length. For Rabbit posture, considerable change occurred in the back torso-to-crotch area, 70% on average. All these data indicated corresponding needs for stretch in the waist-to-crotch area, especially to release the pressure executed on the crotch. Based on the interview and anthropometric data, prototyping trials were conducted. Prototype development centered on creating a unitard with elastic ruched center panel for less garment shifting in the torso area yet still allowing for maximum flexibility. While participants did discuss the desire to see their midriff, the researchers anticipated a unitard would satisfactorily solve issues voiced about tight and constrictive waistbands. The fabric used was 88% Polyester-12% Spandex blend, with 60% stretch. To allow for mobility, 33% ease was added into the torso panel to accommodate an average of 70% extension in the back waist to crotch measurement for the Rabbit pose and the dimensional increase of 54% in the Camel pose. A crotch seam and gusset were created to allow for full leg abductions.

Four of the available participants were asked to try on the prototypes before their class session and performed stretches that they felt would give them insight to its functionality. Two participants voiced satisfaction with the final prototype as having adequate support in the chest area. Two participants highlighted how the ruching in the mid-section of the garment was 'baggy' relative to their body type. When performing half-moon, camel, head to feet, and rabbit the consensus was that the prototype did not create any hindrances and had adequate mobility.

Actual performance of the prototype during a class session did not take place but would be necessary for further development of this research. To continue this study, an online survey of Bikram yoga practitioners will be conducted and wear testing during yoga practice will be used to inform further prototyping.

Tracy, B. L., & Hart, C. E. (2013). Bikram yoga training and physical fitness in healthy young adults. *Journal of Strength and Conditioning Research*, 27(3), 822-830.

Green, D. (2014). Mind-body transformations: Appearance and yoga in the hot room. *Culture Track*. Paper presented at International Textile and Apparel Association Conference. Charlotte, NC, November 12-14 (pp. 8-9). Ames, Iowa: Iowa State University