

## The Yoga Empowers Seniors Study (YESS): Design and Asana Series

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### Abstract

The practice of yoga asanas (postures) may be an optimal method of preserving or enhancing physical function in older men and women. However, the physical demands, efficacy and safety of an asana practice for seniors have not been well studied. The Yoga Empowers Seniors Study (YESS) is an intervention development study that created two senior-adapted series of asanas targeted for an ambulatory older population. YESS is using biomechanics and physical performance tests to acquire information about the physical demands placed on the muscles and joints by the asanas and the functional performance adaptations resulting from the yoga practice. This manuscript details the standardized, senior-adapted, YESS asana series and the additional asana modifications provided when participants had physical limitations. This presentation will enable the yoga research and teaching communities to interpret the biomechanics, physical performance and side effects outcomes of YESS.

**Keywords:** Yoga; Geriatrics; Physical performance; Biomechanics

### Introduction

Yoga is commonly viewed as a safe and effective means of increasing the strength, flexibility, and functional capacity of seniors. For example, the National Recreation & Park Association recommends Yoga as a “total-solution exercise” for older adults [1]. Similarly, the National Institute of Diabetes & Digestive & Kidney Diseases publication *Healthy Eating and Physical Activity across Your Lifespan* states, “yoga combines balance, flexibility, and strengthening benefits [2].” While we concur that Yoga holds great promise as a path to wellness in seniors, little scientific research quantifies the physical demands, efficacy, and safety of Yoga programs for older men and women. Formal study is warranted because we must understand the potential benefits and risks of Yoga in seniors – and how to maximize the former and minimize the latter. As a step toward this end, we conducted the Yoga Empowers Seniors Study (YESS). This manuscript provides a brief overview of the rationale and design of the study but mainly details the asana series that were used in the project.

In general, older adults have less joint range of motion, less strength and poorer balance than do younger persons [3]. With aging come more limiting musculoskeletal conditions, such as osteoarthritis and low back syndromes that likely put seniors at higher risk of musculoskeletal side effects from yoga and that demand targeted asana modifications. In our prior clinical trial of yoga for excess thoracic curvature (hyperkyphosis), conducted in men and women aged 60-90 years of age, approximately 60% of the 120 participants developed musculoskeletal soreness and/or pain significant enough to require additional variations of their poses (versions adapted for seniors with kyphosis were already being used) [4]. Further, participants with pre-existing musculoskeletal conditions (even quiescent ones) developed side effects earlier in the hyperkyphosis study than did those without pre-existing conditions.

While yoga for seniors may have several positive outcomes beyond the physical, YESS is focused on achieving muscular strength gains in a safe manner. In particular, YESS is attempting to create asana series that train major muscle groups, especially those that are associated with fall risk, such as the hip abductors [5,6]. We used a biomechanics approach to capture information about the physical demands placed on the muscles and joints by the specific asanas we employed, as

well as the functional performance adaptations (e.g. gait, strength or balance changes) associated with practicing these postures. In-depth descriptions of the biomechanics methods and results will be the topics of other reports. Here we will present the senior-adapted YESS asana series and the additional modifications provided when participants had physical limitations.

### Methods

#### Study design and setting

The Yoga Empowers Seniors Study (YESS) was a single-arm, non-masked, pre-post, intervention development study. Study activities took place at the YESS research offices at the University of California at Los Angeles (UCLA), the University of Southern California (USC) Musculoskeletal Biomechanics Research Laboratory (MBRL) and the TruYoga studio, Santa Monica, California. USC and UCLA Institutional Review Boards approved the protocol and participants gave written, informed consent.

Figure 1 summarizes the YESS design. To ensure a small Yoga class size, the intervention was delivered to two separate groups, with lagged start times. Each group had 2 weeks of preparatory Yoga classes (4 classes) prior to the first set of baseline biomechanics and physical performance measures, because they had to learn the yoga postures before they could undergo baseline biomechanical testing while performing the postures. Participants next attended twice-weekly, one-hour Yoga classes for 16 weeks, during which the Series I asanas were taught. We made interval biomechanics and physical performance

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measures after the first 16 weeks. Series II was instructed twice-weekly for 16 additional weeks and final biomechanics and performance measurements were taken.

### Recruitment and eligibility

Participants were recruited using mailing lists, physician referrals, flyers and newspaper advertisements. Initial eligibility (e.g., age) was evaluated by phone; at an in-person screening, additional inclusion and exclusion criteria were assessed. Women and men aged 65 years of age were eligible. The following were exclusions: active angina; uncontrolled hypertension (SBP > 160 or/and DBP > 90); high resting heart rate (greater than 90) or respiratory rate (greater than 24); unstable asthma or exacerbated chronic obstructive pulmonary disease; cervical spine instability or other significant neck injury; rheumatoid arthritis; unstable ankle, knee, hip, shoulder, elbow, or wrist joints; hemi paresis or par paresis; movement disorders; peripheral neuropathy; stroke with residual deficit; severe vision or hearing problems; walker or wheelchair use; not able to attend in-person classes; has not had check-up by regular provider within 12 months (if not taking any prescription medications) or in the past 6 months (if any regular medicines taken). Participants also had to execute the following safety tests stably and independently: transition from standing to recumbent on the floor and reverse; lift both arms to shoulder level; stand with feet side-by-side for 30 seconds; and stand with feet hip-width apart for 60 seconds.

### Measurements

Baseline, interval and final visit measures included: 1) demographic descriptors, medical conditions, health behaviors (physical activity, smoking and alcohol use) and health-related quality of life, using standardized questionnaires; 2) anthropometrics; and 3) biomechanical measures and physical performance testing. Measurements will not be described further herein, but will be the subject of additional papers describing results.

### Yoga intervention

We delivered a Yoga intervention, 2 days per week, one hour per session, for 32 weeks (exclusive of preparatory sessions (Figure 1). We used Hatha yoga, which teaches asanas (postures) and pranayama (breathing). By emphasizing mental and physical focus during the practice of asanas, Yoga attempts to build concentration and body awareness. We created two sets of postures, Series I and Series II, designed to be progressive (i.e., to advance in difficulty) and to train major muscle groups that are integral to conducting activities of daily living, including: the shoulder/upper extremity (necessary for

reaching, for example, to procure items from an overhead cabinet and for carrying light loads such as groceries or parcels); trunk stabilizers (for balance); and hip/lower extremity (central to static and dynamic balance and to the capacity to transfer safely from sitting to standing). We used modified versions of standard asanas, tailored in a manner that we believed to be suitable to the ambulatory senior population for whom this intervention is intended.

### Design of the YESS asana series

Series were constructed to meet the following training goals: 1) to offer a safe, yet challenging, practice for ambulatory seniors; 2) to include a range of foundational asanas, targeting functional muscle groups (defined above); 3) to incorporate asanas intended to improve balance; and 4) to include asanas aimed at increasing joint range of motion (JROM). Specific postures intended to achieve each of the 4 training goals were selected by GAG, LK and GS, based on their combined knowledge of yoga, physical therapy and movement science. Reproducibility was also a specific goal. We therefore modeled the YESS program after the Ashtanga School, which uses a standard set of opening and closing postures, and variable middle series, which progress in difficulty. Each set of Ashtanga middle postures is preset and is done in an un changing order. Analogously, YESS used set opening and closing sequences and two ordered, progressive middle sequences, termed Series I (first half of the study) and Series II (second half of the study). Using this standardized approach facilitates describing what we taught and makes the intervention transparent to both the research and the teaching communities. An additional benefit of the ordered, standardized series is that it constrained the poses to a number that we could feasibly study in the biomechanics laboratory.

### Implementation of the YESS series

During the preparatory instruction (first 2 weeks) Series I poses were gradually introduced. At the end of the preparatory period, all opening, middle and closing poses had been taught. Participants were therefore ready to attend their first biomechanics session, where they were instrumented and measured while practicing each pose under the supervision of the yoga instructor (LK). Series I was then taught twice per week, for 16 weeks and was followed by a second set of biomechanics assessments. The same process was repeated for Series II (Figure 1).

After the second week of teaching the full Series I sequence, we determined that 4 opening postures, 12 middle postures and 4 closing postures was an overly ambitious agenda for a one-hour Yoga class – there was no time to hone in on matters that needed clarification,

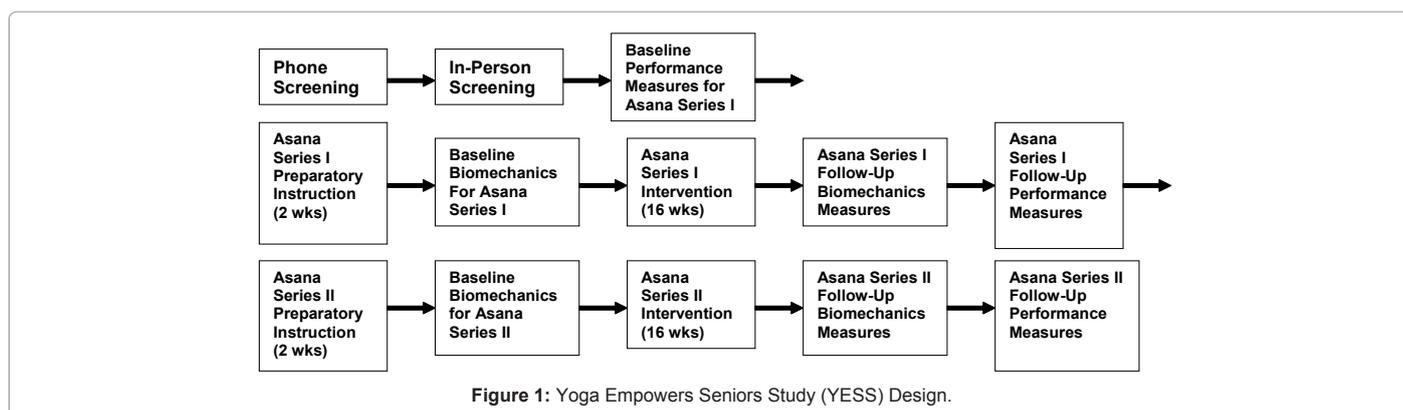


Figure 1: Yoga Empowers Seniors Study (YESS) Design.

Illustration of Posture	English Name Sanskrit Name	Description of pose
<b>Opening Postures</b>		
 1a	3 Part Breathing, Recumbent <i>Dirga Pranayama</i>	Isolation of inhalation to abdomen, mid-thorax, upper thorax and reverse for exhalation
 1b	Cat-Cow <i>Marjariyasana/ Bitilasna</i>	From starting position on hands and knees, a fluid alternation between spinal flexion and extension
 1c	Mountain Pose <i>Tadasana</i>	Standing tall with hands at sides and feet hip-width apart
 1d	Partial Sun Salute <i>Surya Namaskar</i>	Standing tall, transition to standing forward bend with knees extended and up to 90° of hip flexion (anteriorly)
<b>Middle Sequence</b>		
 1e	Chair <i>Utkatasana</i>	Standing posture that emulates sitting in a chair, with buttocks leaning against wall, hips flexed to a maximum of 90° (anteriorly) and shoulders flexed to maximum of 180°
 1f	Wall-Plank <i>Chaturanga</i>	A standing push up, done facing a wall; starting position is hands positioned on wall slightly below shoulder height and feet arm's length from wall
 1g	Tree <i>Vrikshasana</i>	A one-legged standing balance; less-weight bearing hip is externally rotated to approximately 45; less-weight bearing foot placed on medial aspect of ankle of the support leg (toes touching ground); chair in front for balance aid
 1h <small>*picture shows hand at wall rather than on chair</small>	Warrior II <i>Virabhadrasana II</i>	A lateral lunge; forward hip is externally rotated and knee is flexed to approximately 45° (posteriorly); rear hip is internally rotated and rear heel braced against the angle made by the floor-wall; rear foot turned in 30°. One arm placed on chair for balance and other arm abducted to a maximum of 90°, with shoulder in neutral rotation
 1i	Warrior I <i>Virabhadrasana I</i>	A forward lunge; forward knee is flexed to approximately 45° (posteriorly); rear heel braced against the angle made by the junction of the floor and wall; rear foot turned in 30; one arm flexed at the shoulder to a maximum of 180° with shoulder in external rotation; other arm placed on chair for balance
 1j	Downward Facing Dog <i>Adho Mukha Svanasana</i>	A standing forward bend; feet hip-width apart and hip flexion to a maximum of 90° (anteriorly) with shoulders flexed to a maximum of 180° and hands pressing on wall
 1k	Side Stretch <i>Parsvottanasana</i>	A standing forward bend; feet in semi-tandem position, hip-width apart. As much distance placed between front and rear foot as is comfortable; forward leg hip flexion to a maximum of 90° (anteriorly) and shoulders flexed to a maximum of 180°, hands pressing on wall
 1l	Chair Twist <i>Bharadvajasana</i>	A seated twist, on a firm chair; feet are planted on ground hip-width apart, thoracic and cervical spine are axially rotated to right and then to left
 1m	Cobra <i>Bhujangasana</i>	A prone back extension; with blanket under hips and lower ribs, palms are pressed to the floor beneath shoulders, elbows are bent, scapulae are retracted and depressed
 1n	Bridge <i>Setu Bhandasana</i>	A recumbent back extension; from a recumbent (supine) position with knees flexed to 45° (posteriorly), torso is elevated as hips are moved into bilateral extension
 1o	Abdominal Cultivation <i>N/A</i>	A recumbent abdominal strengthening position; starting with hips flexed to 90° (anteriorly) and knees flexed to 90° (posteriorly), hips are alternately extended to a maximum of 120° (anteriorly); neutral spine is maintained

Finishing Postures		
 1p	Supine Pigeon <i>Supta Kapotasana</i>	A recumbent posture with bilateral hips, knees and ankles flexed; one leg remains neutral with knee flexed to 45° (posteriorly) and foot pressed into floor; hip of the opposite leg in external rotation to a maximum of 45°, knee flexed to a maximum of 90° (posteriorly) and ankle flexed to 90° resting on the knee of the supporting leg
 1q	Simple Reclining Twist <i>Supta Ardha Jathara Parivartanasana</i>	A recumbent twisting posture; starting with arms in abduction, shoulders in external rotation, feet next to each other and knees flexed to a maximum of 45° (posteriorly); shoulders are maintained on floor, pelvis and lumbar spine are slowly rotated so that knees fall together towards the right; asana is repeated to left.
 1r	Corpse pose <i>Savasana</i>	Recumbent complete relaxation, with normal breathing

Table 1: Yoga Empowers Seniors Study, Asana Series I.

amplification or illustration. We therefore inaugurated a rule that was maintained throughout the remainder of Series I and all of Series II: in each class, 3 middle sequence postures could be omitted. But, the skipped postures alternated, so that no posture was left out for more than 3 weeks running. We recorded the postures performed in each class, to assure that this mandate was met. Teaching 9 rather than 12 middle sequence postures during each class allowed the instructor time to provide in-depth, highlighted teaching of the intended muscular actions, alignment, etc.

### YESS series I

The middle sequence postures for Series I (English names) were: Chair, Wall Plank, Tree, Warrior II, Warrior I, Downward Facing Dog, Side Stretch, Chair Twist, Cobra, Bridge and Abdominal Cultivation. Table 1 illustrates the YESS senior-adaptation of each posture. The main ways in which our senior adaptations differed from the “standard” asanas, and rationale for these adaptations, are enumerated next. Chair was done at the wall for support and with a yoga block between the knees to enhance alignment. Plank, customarily done on the floor, was practiced at the wall to lessen the upper extremity load. Tree was done with hands on the wall for support and with the foot of the flexed leg bearing partial weight. In Warrior II and Warrior I, a chair was used to assist balance and the rear foot was braced against the wall-floor junction for added stability. Downward Facing Dog and Side Stretch were practiced with the hands placed on the wall, to lessen upper extremity loading and reduce demands on hamstring flexibility and balance. A seated twist (Chair Twist) was done in the chair rather than on the floor to allow participants to use the back of the chair as a lever and to lessen hamstring and hip flexibility requisites. The pelvis was padded in Cobra pose in an attempt to counter excessive lumbar

lordosis. Bridge was done in a neutral, rather than extended, spine position. Abdominal Cultivation (not a classical asana) consisted of extensions, but knees were maintained in a flexed position to minimize lumbar loading.

Illustration of Posture	English Name Sanskrit Name	Description of pose
<b>Opening Postures</b>		
 2a	Crossed legs on floor <i>Sukhasana</i>	A seated posture on the floor, with back leaning against a wall, legs crossed at the mid-shins, blankets underneath hips and blocks underneath knees for support
 2b	Seated Twist on floor <i>Parivrtta Sukhasana</i>	A cross-legged seated posture, on floor; thoracic and cervical spine are axially rotated to the right and then to left, using one hand on knee and one hand on floor to assist rotation
 2c	Cat-cow, seated <i>Marjariyasana/Bitilasna</i>	A seated posture in chair, sitting tall with hands on knees; fluid alternation between spinal extension and flexion
 2d	Mountain Pose <i>Tadasana</i>	Standing tall with hands at sides and feet hip width apart
 2e	Partial Sun Salute <i>Surya Namaskar</i>	Standing tall, transition to standing forward bend with knees extended and up to 90° of hip flexion (anteriorly)
<b>Middle Sequence</b>		
 2f	Chair <i>Utkatasana</i>	A standing posture that emulates sitting in a chair, hips flexed to a maximum of 90° (anteriorly) and shoulders flexed to maximum of 180° Advancement from series I: no support from the wall
 2g	Tree <i>Vrikasana</i>	A one-legged standing balance, with non-weight bearing hip externally rotated to approximately 45° Advancement from Series I: non-weight bearing foot placed on medial ankle of the support leg; only stand on one leg and no use of external chair support (if feasible)

 <p>2h</p>	<p>Warrior II <i>Virabhadrasana II</i></p>	<p>A lateral lunge, with forward hip externally rotated and knee flexed to approximately 45° (posteriorly); rear hip is internally rotated, rear foot turned in 30° Advancement from Series 1: Both arms abducted to 90°, with shoulders in neutral rotation; rear foot not braced against the angle made by the junction of the floor and wall</p>	 <p>2o</p>	<p>Reclining Leg Stretch <i>Supta Padangusthasana</i></p>	<p>A recumbent hip flexion posture; extended right leg is flexed at the hip to a maximum of 90° (anteriorly) while the other leg remains extended and pressing into the floor; repeat on opposite side (Yoga strap is used on flexed leg)</p>
 <p>2i</p>	<p>Wall-Plank <i>Chaturanga</i></p>	<p>A standing pushup, facing the wall Advancement from Series 1: hands placed more caudally, mid-way between shoulders and waist; feet placed farther from wall, approximately 6 inches more than arm's distance</p>	 <p>2p</p>	<p>Bridge, with hip flexion <i>Salamba Eka Pada Setu Bandha</i></p>	<p>A recumbent back extension and hip flexion; from a recumbent (supine) position with knees flexed to 45° (posteriorly), torso is elevated as hips are moved into bilateral extension Advancement from Series 1: After bilateral hip extension is attained, right hip is moved into 90° of flexion (anteriorly) with right knee flexed to 90°. Pelvis is maintained stable. Repeat on left side</p>
 <p>2j</p>	<p>One-Legged Balance <i>Utthita Hasta Padangusthasana</i></p>	<p>A single-leg stand with back resting on wall for support; non-support leg knee flexed to 90° (posteriorly), hip flexed to 90° (anteriorly) and foot pressed into block; shoulders flexed to a maximum of 180°</p>	 <p>2q</p>	<p>Abdominal Cultivation <i>Supta Pada Sanchalāsana</i></p>	<p>A recumbent abdominal strengthening position; bilateral hips and knees are flexed to 90°, and feet are off of the floor. Then hips are extended to a maximum of approximately 120° (anteriorly); extension and flexion of hips are alternated</p>
 <p>2k</p>	<p>Crescent <i>Ashta Chandrasana</i></p>	<p>A forward lunge, with heel braced against the wall, front knee flexed to a maximum of 90° and rear hip and knee extended; both shoulders flexed to a maximum of 180°, with external rotation</p>	<b>Finishing Postures</b>		
 <p>2l</p>	<p>Side Stretch <i>Utthita Parsvotanāsana</i></p>	<p>A standing forward bend, with feet in semi-tandem position, hip-width apart. As much distance placed between front and rear foot as is comfortable Modification from Series 1: hands placed on back of a chair; flex shoulders and slide chair away until anterior hip is flexed to a maximum of 90° (anteriorly); neutral spine is maintained</p>	 <p>2r</p>	<p>Hip Flexor Stretch <i>Supta Saithalyāsana</i></p>	<p>A recumbent twist; starting posture is arms in abduction, shoulders in external rotation, feet mat-width apart, and knees flexed to 45° (posteriorly); then knees are allowed to slowly drop toward the right. A blanket or block support is used under knees as needed.</p>
 <p>2m</p>	<p>Chair Twist <i>Bharadvajasana</i></p>	<p>A seated twist, on a firm chair; feet are planted on ground hip-width apart, thoracic and cervical spine are axially rotated to right and then to left</p>	 <p>2s</p>	<p>Wide-legged Seated Forward Bend <i>Upavishta Konāsana</i></p>	<p>A seated forward bend on the floor; forehead rests on chair, hips are at 90° of flexion (anteriorly) and legs are in abduction (approximately 45°). Blankets are used underneath hips and forehead and blocks are used underneath knees for support as needed</p>
 <p>2n</p>	<p>Cobra <i>Bhujangāsana</i></p>	<p>A prone back extension; with blanket under hips and lower ribs, palms are pressed to the floor beneath shoulders, elbows are bent, scapulae are retracted and depressed Advancement from Series 1: Hand position placed lower, at approximately mid-thorax</p>	 <p>2t</p>	<p>Corpse pose <i>Savasana</i></p>	<p>Recumbent complete relaxation with normal breathing</p>

Table 2: Yoga Empowers Seniors Study, Asana Series II.

### YESS series II

The middle sequence postures for Series II were: Chair, Wall Plank, Tree, Warrior II, Crescent, One-Legged Balance, Side Stretch, Chair Twist, Recumbent Leg Stretch, Bridge and Abdominal Cultivation. An illustration and description of each is provided in Table 2. For the postures that were already taught in Series I, we provided more advanced versions. Chair and Warrior II were progressed to standard versions. For the remainder of Series II, the ways in which our senior adaptations differed from the standard versions of the asanas, and/or the ways in which we advanced already-taught poses to more challenging senior versions, are described next. Plank was still practiced at the wall, but the hands were placed more towards the waist and the feet placed farther from the wall, to increase the upper extremity loading compared to the Series I version. Tree was again practiced with hands on the wall for support, but the contralateral foot was placed on the opposite leg, to increase the work of the weight bearing limb; if possible, we allowed participants to progress to a single-leg tree without use of the wall, to further train balance. Crescent was newly introduced in Series II, with a chair to assist balance and the rear foot braced against the wall-floor junction for added stability. One-Legged Balance was another new pose, done against the wall to aid balance. Participants progressed

	Percent of Classes at which Pose was Performed*	Greatest Number of Consecutive Classes at Which Pose Skipped**
<b>Series I</b>		
Chair	94	1
Wall-Plank	93	1
Tree	97	1
Warrior II	94	2
Warrior I	94	1
Downward Facing Dog	89	2
Side Stretch	88	2
Chair Twist	99	2
Cobra	86	2
Bridge	72	4
Abdominal Cultivation	78	3
<b>Series II</b>		
Chair	97	1
Tree	91	1
Warrior II	86	1
Wall-Plank	74	2
One-Legged Balance	86	2
Crescent	77	2
Side Stretch	97	1
Chair Twist	97	1
Cobra	83	1
Recumbent Leg Stretch	91	1
Bridge, with hip flexion	86	2
Abdominal Cultivation	91	2

\*Percentages are based on combined results for Groups 1 and 2. Results did not differ when Groups 1 and 2 were analyzed separately (data not shown).

\*\* Maximum number of consecutive classes skipped is based on the highest number reported in either group.

**Table 3:** Yoga Empowers Seniors Study: Frequency of Performance of each Middle Sequence Pose.

<b>Neck: Limited Flexion, Extension, Rotation</b>		
<b>Asanas</b>		
Cat/Cow		Only bend neck backwards and forwards as far as feels comfortable (reduce cervical flexion/extension)
Cobra		Allow forehead to rest on blanket (facilitate cervical extension)
Warrior II Seated Twist Simple Reclining Twist		Only turn head as far as feels comfortable (reduce cervical rotation)
Wide-Legged Seated Forward Bend		Place more blankets underneath hips and/or under forehead (reduce cervical flexion)
<b>Lower Back: Limited Flexion, Extension, Rotation</b>		
Crossed Legs On Floor Wide-Legged Seated Forward Bend		Place more blankets underneath hips (reduce hamstring stretch to facilitate lumbar extension)
Crossed Legs On Floor		Loop a strap around knees and/or sit in chair (reduce hamstring/adductor stretch to facilitate extension)
Cat/Cow		Only arch spine backwards and bend spine forward as far as feels comfortable (reduce flexion/extension)
Partial Sun Salute		Limit amount of hip hinge and/or bend knees as hips hinge (reduce hamstring stretch to facilitate lumbar extension)
Seated Twist		Allow pelvis to turn in direction of twist (reduce rotation)
Abdominal Cultivation		Press lower back to floor (reduce extension)
Simple Reclining Twist		Press on block between inner thighs as knees turn toward the side (reduce rotation) or place support underneath knees (reduce rotation)
Wide-Legged Seated Forward Bend		Sit against a wall (reduce hamstring stretch to facilitate lumbar extension)
Savasana		Place a blanket/bolster underneath knees or place legs on the seat of a chair (decrease lumbar extension)
<b>Shoulder: Limited Flexion, Abduction, External Rotation</b>		
Partial Sun Salute		Take arms to front instead of out to side or take arms wider than shoulder width in a "V" shape (change movement from shoulder abduction and external rotation to limited shoulder flexion)*
Partial Sun Salute Chair Warrior I Puppy Dog and Side Stretch Crescent One-legged balance		Only raise arms as high as feels comfortable or take arms wider than shoulder width in a "V" shape (reduce shoulder rotation)*
Chair Warrior I Warrior II Crescent One-legged balance		Use "airplane" arms or "W" arms position (reduce or eliminate shoulder flexion and external rotation)*

<b>Wrist: Limited Extension</b>		
	Cat/Cow Movement	Use handlebars or make fists and press knuckles into mat or place hands on wedges or perform movement seated (reduce or eliminate wrist extension)
	Wall Push-Up	Bend elbows as much as needed to get hands to wall (reduce wrist extension)
	Wall Push-Up	Perform posture using fingertips (reduce wrist extension)
<b>Hip: Limited Flexion, Abduction, and/or External Rotation</b>		
	Crossed legs on floor	Place more blankets underneath hips or loop strap around knees or sit in chair (reduce hamstring/adductor stretch)
	Warrior I	Allow torso to lean slightly forward towards front (bent) leg or place rear heel on wedge (reduce rear hip extension)
	Warrior II	Take a smaller stance or bend front knee less (reduce front hip flexion)
	Warrior II	Allow torso to lean slightly sideways, towards your bent leg (reduce front hip flexion) Place heel of straight leg on wedge (reduce rear hip extension)
	One-Legged Balance	Use fewer blocks under leg (reduce raised-leg hip flexion)
	Crescent	Allow back knee to bend (reduce rear hip extension)
	Supine Hip Opener	Only turn knee out as much as feels comfortable and use support under bottom knee (reduce external rotation)
<b>Knee: Limited Flexion Extension</b>		
	Crossed legs on floor	Sit in chair (limit knee flexion)
	Chair	Bend knees as far as is comfortable (limit knee flexion)
	Warrior I Warrior II	Place rear heel on wedge (reduce rear knee extension and medial loading) Bend front knee less (reduce front knee flexion) Limit stance width (reduce rear knee extension and medial loading)
	Wide-legged seated forward bend	Sit with legs crossed or place rolled blankets under knees (reduce knee extension)
<b>Ankle: Limited</b>		
	Cobra	Place a blanket underneath fronts of ankles and make the blanket underneath the pelvis higher (reduce plantar flexion)
	Bridge	Use wedge, braced against wall, as support under heels (reduce dorsiflexion)
	Side Stretch	Place back heel on wedge (reduce dorsiflexion)

\* Description of arm positions for shoulder variations:

“V” arms: arms are above head and a little wider than shoulder-width, making a V shape (maintain flexion and slightly abduct)

“Airplane” arms: arms are at sides, held out slightly wider than body (abduct arms 45°), analogous to the wings on a jet

“W” arms – arms are at sides, slightly wider than body, with elbows bent, forming a W shape (abduct arms 45° and flex elbows to 90°)

**Table 4:** Yoga Empowers Seniors Study: Modifications of Asanas for Persons with Physical Limitations, by Body Region.

through 3 versions of One Legged Balance: partial weight bearing of the lifted leg (knee flexed) with the lifted foot placed on blocks; partial weight bearing of the straight, lifted leg, allowing it to rest on a chair; and finally a single leg stand with a straight, lifted, unsupported leg. Side Stretch was advanced by placing the hands on a chair seat. Chair Twist was unaltered from Series I. Recumbent Leg Stretch was new to Series II; a strap was employed to lessen hamstring flexibility requirements. Bridge was advanced by lifting one leg. Abdominal Cultivation was advanced by using leg single alternating leg extensions.

### Consistent exposure to postures

To assure that participants received equal exposure to the asanas, and that none was missed for too many weeks, we specified that no middle series posture could be skipped for more than 3 consecutive weeks. The teaching assistant recorded all postures performed in each class. Table 3 summarizes the percent of classes in which each posture was done and the maximum numbers of skipped weeks for each, demonstrating that we met our goal.

### Highlighted teaching

By requiring that only 9 middle sequence postures were done in each class, we freed time for highlighted teaching exercises using props and hands-on cues, which may be especially important to senior students. Props and tactile cues provide exteroceptive cues which assist in accomplishing proper alignment. These augmentation techniques were employed in highlighted teaching exercises for many of the middle sequence poses.

### Additional modifications for physical limitations

Although we used senior-adapted asanas, intended to fit the capabilities of community-dwelling older persons, many participants had physical limitations that required further modifications of the senior-adapted postures. We believe that the limitations we encountered are characteristic of the ambulatory senior population in general, as most stemmed from common chronic diseases (e.g., knee and spine osteoarthritis) or pre-existing injuries (e.g., chronic rotator cuff tears).

Many of the postures have movements in common. For example, neck flexion, extension or rotation is components of Cat/Cow, Cobra, Warrior II, Seated Twist and Simple Reclining Twist poses. Organized by affected body region (e.g., neck, low back, shoulder, etc), we catalogue the additional modifications that might be necessary for each posture (Table 4). These modifications were instructed uniformly during the course of YESS.

### Discussion

The Yoga Empowers Seniors Study was an intervention development study, designed to quantify and rank the physical demands associated with the performance of 2 specified series of senior-adapted asanas. This manuscript presents descriptions of the asanas included in YESS and the additional modifications provided for participants with physical limitations.

We undertook this detailed description of the YESS series because we believe that explaining exactly how asanas were done is a critical element of reporting yoga research. Without a detailed description of the postures and sequencing, study results (in this case, the biomechanical, functional and side-effect outcomes) cannot be interpreted. This reporting requisite is especially relevant if the asanas were tailored to

meet the needs of a particular population, such as seniors: the more customized the postures, the greater the need for precise descriptions of what was actually taught. We acknowledge our own prior shortcomings in this arena, having instructed approximately 75 pose variations in the Yoga for Kyphosis Study but not having provided a detailed explanation of each [4]. Similarly, precise explanations of each asana are absent from several studies [7-9]. While others have not published manuscripts containing details of their entire series, they offer training (Silver Yoga Exercises) or have a manual available for purchase (yoga for chronic low back pain) [10-15].

We used a standardized intervention—the same series was done in each class. We acknowledge the tension between a set series and one that varies from class-to-class. In research, a uniform intervention enhances reproducibility; more clearly characterizes the treatment “dose” and is more aligned with principles of trial design because it maximizes treatment homogeneity. In multi-site studies, a uniform series makes it easier to train teachers, to monitor protocol fidelity and to minimize inter-teacher variation. A uniform intervention is also well-suited to dissemination because it can be well described and replicated. However, the repetition of a standardized series may be tedious to some, requires a reasonably homogenous population that is well-matched to the circumscribed series and does not allow the teacher to add new poses or progress to advanced variations (beyond those in the series) for those individuals who are developing at a faster pace than their counterparts.

In summary, the YESS research team’s overarching research mission is to develop a safe, effective and portable yoga program for seniors. We are implementing this research goal in a series of measured steps, the first of which is the intervention development study, the design of which is reported here. The intervention development study set out to rigorously examine the biomechanical characteristics, physical performance effects and side-effect profiles of 24 Yoga postures. This report gives the rationale underlying the YESS asana series, describes each posture, the order of postures within series and how asanas were advanced from Series I to II. This accounting will enable the yoga research and teaching communities to comprehend exactly how the yoga intervention was delivered, which is critical to the interpretation of the biomechanics, physical performance and side effects outcomes of YESS.

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#### **References**

1. Tummers N, Hendrick F (2006) older adults say yes to yoga. National Recreation and Park Association.
2. Young at Heart – Tips for Older adults (2002) National Institutes of Health.
3. Chodzko-Zajko WJ, Proctor DN, Fiatarone Singh MA, Minson CT, Nigg CR, et al. (2009) American College of Sports Medicine position stand. Exercise and physical activity for older adults. *Med Sci Sports Exerc* 41: 1510-1530.
4. Greendale GA, Huang MH, Karlamangla AS, Seeger L, Crawford S (2009) Yoga decreases kyphosis in senior women and men with adult-onset hyperkyphosis: results of a randomized controlled trial. *J Am Geriatr Soc* 57: 1569-1579.
5. Macrae PG, Lacourse M, Moldavon R (1992) Physical Performance-Measures That Predict Faller Status in Community-Dwelling Older Adults. *J Orthop Sports Phys Ther* 16: 123-128.
6. Rogers MW, Mille ML (2003) Lateral stability and falls in older people. *Exerc Sport Sci Rev* 31: 182-187.
7. Oken BS, Zajdel D, Kishiyama S, Flegal K, Dehen C, et al. (2006) Randomized, controlled, six-month trial of yoga in healthy seniors: effects on cognition and quality of life. *Altern Ther Health Med* 12: 40-47.
8. Schmid AA, Van Puymbroeck M, Koceja DM (2010) Effect of a 12-week yoga intervention on fear of falling and balance in older adults: a pilot study. *Arch Phys Med Rehabil* 91: 576-583.
9. Zettergren KK, Lubeski JM, Viverito JM (2011) Effects of a yoga program on postural control, mobility, and gait speed in community-living older adults: a pilot study. *J Geriatr Phys Ther* 34: 88-94.
10. Chen KM, Tseng WS, Ting LF, Huang GF (2007) Development and evaluation of a yoga exercise programme for older adults. *J Adv Nurs* 57: 432-441.
11. Chen KM, Chen MH, Hong SM, Chao HC, Lin HS, et al. (2008) Physical fitness of older adults in senior activity centres after 24-week silver yoga exercises. *J Clin Nurs* 17: 2634-2646.
12. Chen KM, Tseng WS (2008) Pilot-testing the effects of a newly-developed silver yoga exercise program for female seniors. *J Nurs Res* 16: 37-46.
13. Chen KM, Fan JT, Wang HH, Wu SJ, Li CH, et al. (2010) Silver yoga exercises improved physical fitness of transitional frail elders. *Nurs Res* 59: 364-370.
14. Fan JT, Chen KM (2011) Using silver yoga exercises to promote physical and mental health of elders with dementia in long-term care facilities. *Int Psychogeriatr* 23: 1222-1230.
15. Tilbrook HE, Cox H, Hewitt CE, Kang’ombe AR, Chuang LH, et al. (2011) Yoga for chronic low back pain: a randomized trial. *Ann Intern Med* 155: 569-578.