UCSF Department of Physical Therapy and Rehabilitation Science

LONG-TERM BENEFITS OF TARGETING HYPERKYPHOSIS IN OLDER COMMUNITY-DWELLING ADULTS

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Roadmap

- **Kyphosis background**
- **Specialized Center of Research (SCOR) Kyphosis Trial**
- **Long-term follow-up study**
- **Clinical application/impact**
- **Recent work**

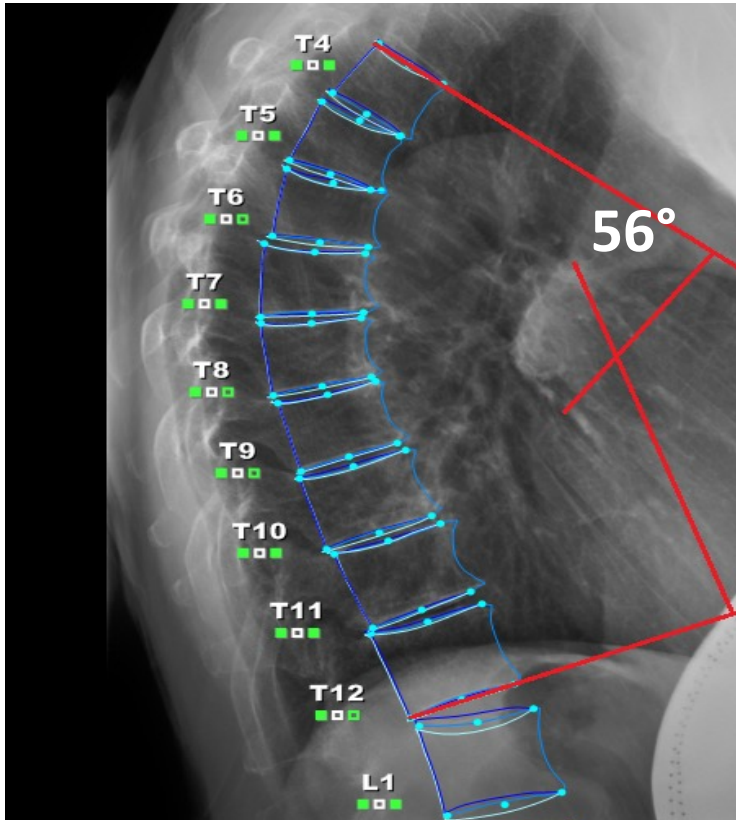
BACKGROUND

Age-related hyperkyphosis

- Anterior curvature in the thoracic spine greater than 40 degrees
- Kyphosis increases with age
- Associated with reduced physical mobility, health-related quality of life and mortality in older adults
- More common in older females than males

No standard intervention to reduce age-related hyperkyphosis.

HOW IS HYPERKYPHOSIS ASSESSED?



Gold standard radiographic Cobb angle of kyphosis

- **Angle formed by intersecting lines drawn through the superior endplate of T4 and the inferior endplate of T12**

Lordosis measured from L1 to L5

Clinical measures of kyphosis

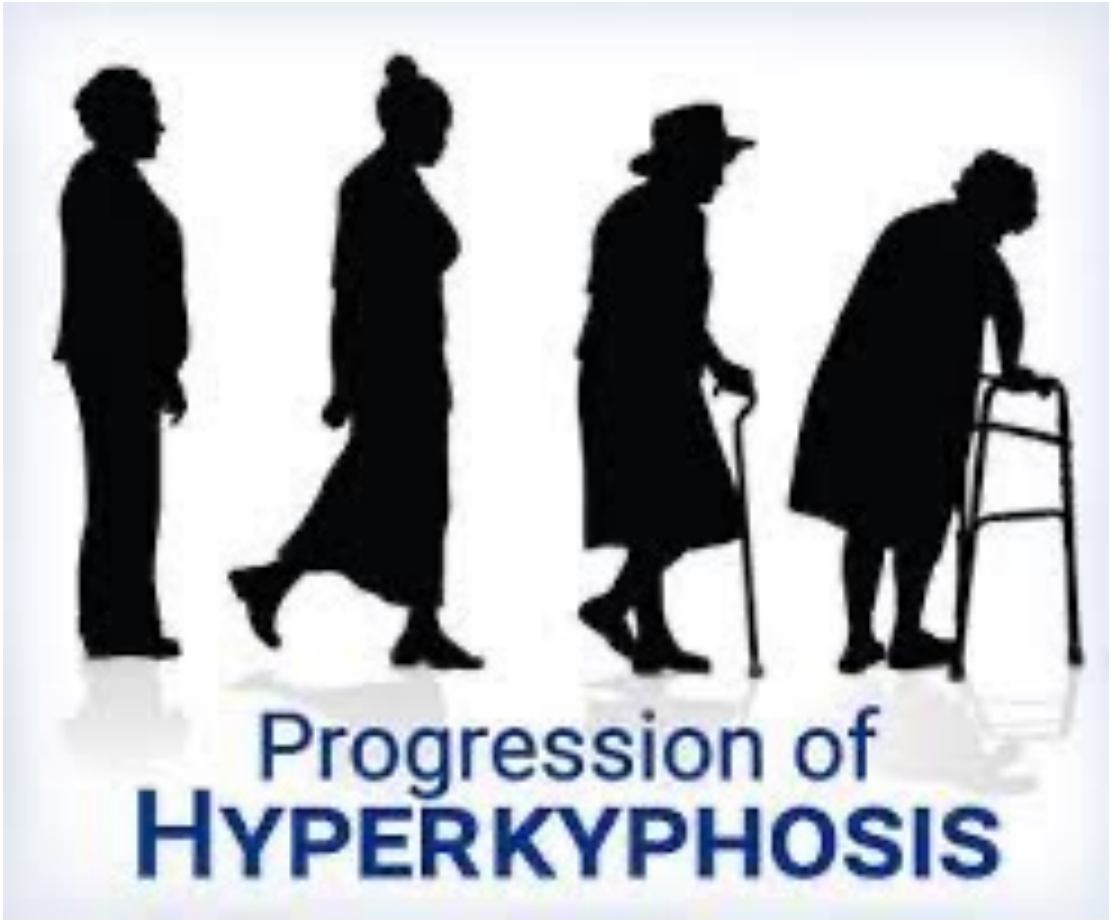
CLINICAL MEASURES OF KYPHOSIS AND LORDOSIS

Kyphometer-derived kyphosis

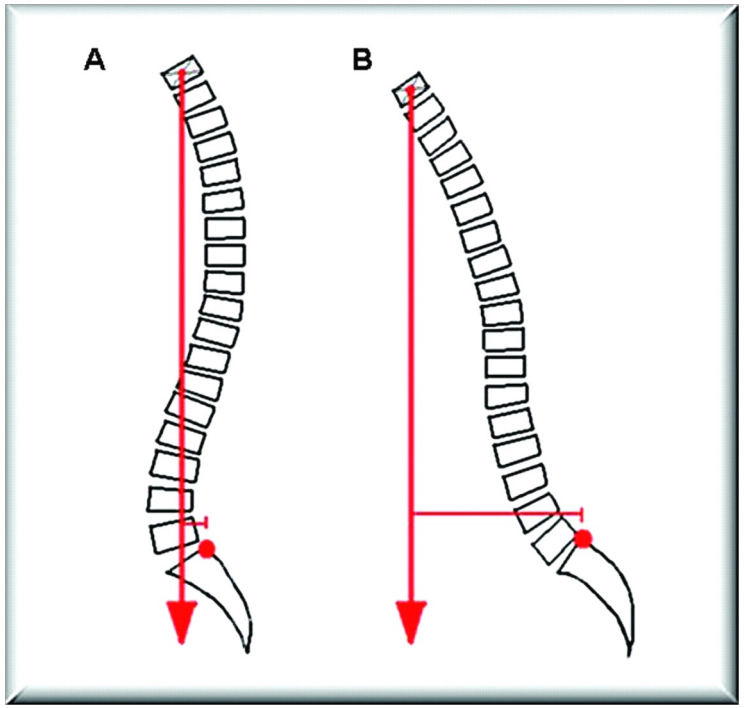
Inclinometer

Flexible ruler

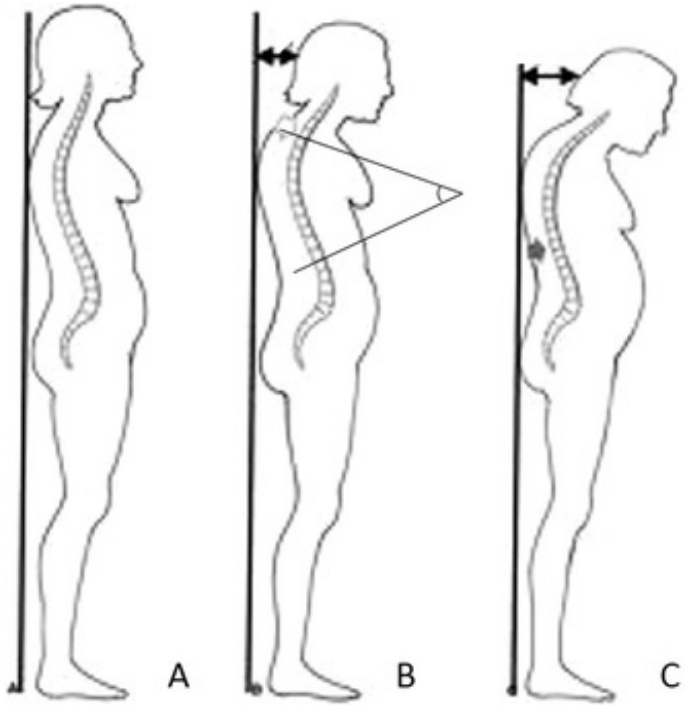
HYPERKYPHOSIS AND SAGITTAL ALIGNMENT



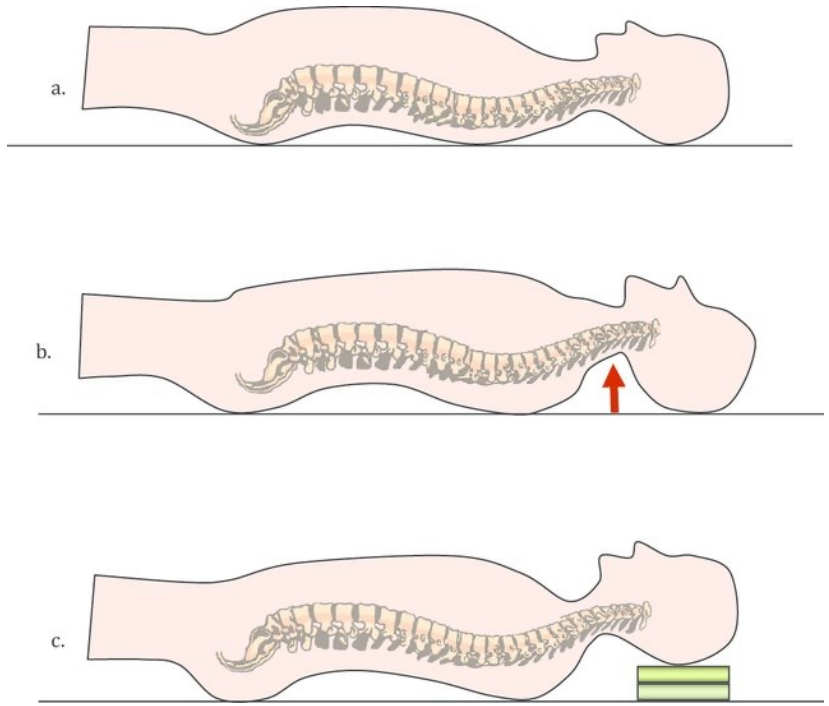
RADIOGRAPHIC AND CLINICAL MEASURES OF SAGITTAL BALANCE



Radiographic sagittal vertical axis



Occiput-to-wall



Block method

RESEARCH QUESTIONS

Is kyphosis modifiable in older adults?

What are effective treatment interventions?

Will improved kyphosis associate with change in physical function?

Kyphosis-specific exercise and posture training program

Warm-up (10 mins)

Increase core temperature with warm-up exercises on roller

Cool-down (5 mins)

- Neck and upper extremity stretches
- Lower extremity stretches

Spinal strength exercises (20 mins)

8-10 reps

Hard to somewhat hard Borg scale

Progress from 0 – 5#/theraband

- Prone trunk lift to neutral
- Quadruped arm/leg lift
- Alternating shoulder flexion/extension on roller
- Sidelying rotation extension
- Core stabilization on roller
- Wall push-ups with spine in neutral

Spinal mobility exercises (10 mins)

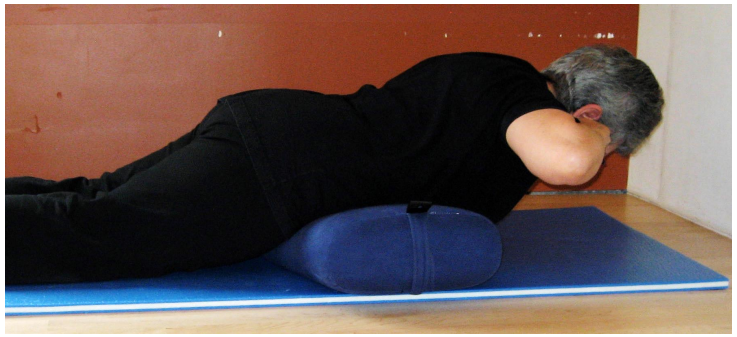
- Spine mobilization on roller
- Standing shoulder flexion/thoracic extension
- Quadruped thoracic extension mobilization

Spinal alignment (15 mins)

Postural training

- Bilateral and single leg stance
- Sit-to stand, squats, lateral stepping
- Diaphragmatic breathing
- Practice 3x/day with ADLs

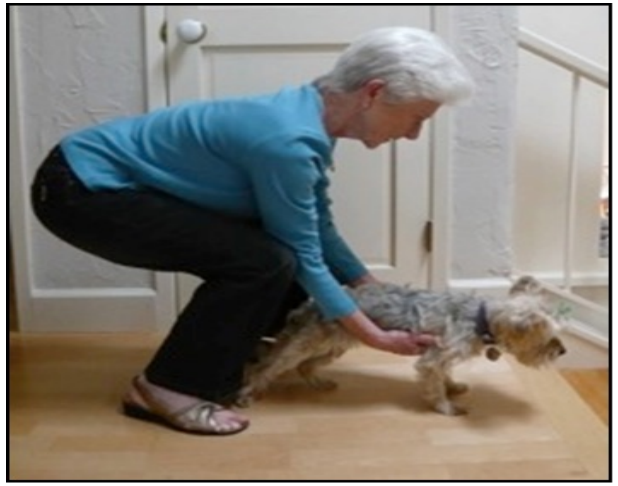
Kyphosis-specific exercise and posture training program

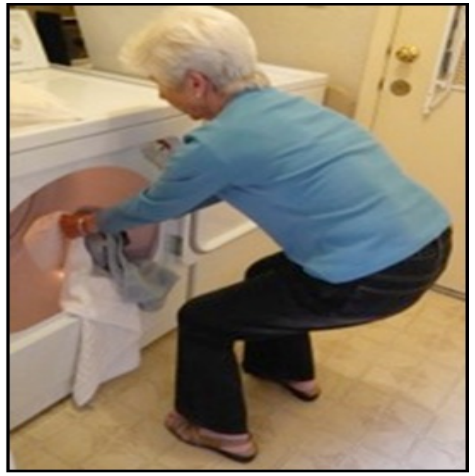


ABCs of good posture

Target	Example Cues
Forward head posture	• **A**lign the head over the shoulders, pelvis and feet • Pelvis is neutral
Core stability	• **B**reathe deep into the concavity of the spine and elongate the spine • Gently brace your abdomen as if someone were about to poke you in the stomach and reach the tailbone to the ground
Hyperkyphosis, rounded shoulders	• **C**orrect the upper back curvature • Show off jeweled necklace • Spread your “wings”, shoulders pressed down

Training for Best Posture – Integrating into ADLs






Photos: Do It Right, American Bone Health, Sherri Betz, PT,GCS

CHANGE IN FLEXED POSTURE, MUSCULOSKELETAL IMPAIRMENTS AND PHYSICAL PERFORMANCE AFTER GROUP EXERCISE IN COMMUNITY DWELLING OLDER WOMEN

Purpose: Determine whether flexed posture, strength, range of motion (ROM), and physical performance would be observed after 12 weeks of group exercise in older women.
Methods: Enrolled 21 women with thoracic kyphosis of 50° or greater. Assessed pre-post-test change in measured kyphosis, strength, ROM, and physical performance. Multidimensional group exercise performed 2 times a week for 12 weeks.
Results: Clinical measure of kyphosis, strength, ROM, and physical performance improved.
Conclusion: Multidimensional group exercise reduced kyphosis and improved physical performance.

Katzman, WB, Sellmeyer DE, Stewart AL, Wanek L, Hamel KA. Arch Phys Med Rehabil 2007;88:192-9.

UCSF Department of Physical Therapy and Rehabilitation Science

SPINE STRENGTHENING AND POSTURE TRAINING PROGRAM TO REDUCE HYPERKYPHOSIS IN OLDER ADULTS: RESULTS FROM THE SHEAF RANDOMIZED CONTROLLED TRIAL

Purpose: Assess efficacy of 6-month randomized controlled trial of spine strengthening exercise and posture training delivered 3x/week.
Methods: Enrolled 99 participants (71 women, 28 men), mean age 71 years, range 60–88, with baseline Cobb angle 57°. Assessed change in kyphosis, strength, physical performance and quality of life.
Results: Radiographic and clinical measures of kyphosis improved. Secondary measures of self image and satisfaction with appearance improved.
Conclusions: Spine-strengthening exercise and postural training may be an effective treatment option for older adults with hyperkyphosis; radiographic change in kyphosis at 6-months.

Katzman, WB, Vittinghoff E, Kado DM, et al. Osteoporos Int, 2017

SEX DIFFERENCES IN RESPONSE TO TARGETED KYPHOSIS SPECIFIC EXERCISE AND POSTURE TRAINING IN COMMUNITY DWELLING OLDER ADULTS: A RANDOMIZED CONTROLLED TRIAL

Design: Two arm randomized controlled waitlist design.

Participants: 112 males and females age ≥ 60 years with kyphosis angle ≥40°.

Methods: Exercise and posture training intervention, led by physical therapist 2x/week for 3 months. Waitlist controls received intervention after 3 months. Between group differences tested at 3-months. Sex differences explored.

Results: 1.7 degree between group difference in change in radiographic Cobb angle and 4.8 degree difference in kyphometer kyphosis. No change in physical function. No sex difference.

Conclusions: Intervention improved/slowed the progression of kyphosis. Magnitude of change did not differ by sex. Longer term follow-up may be needed.

Katzman, WB, Parimi, N, Gladin, A, et al., BMC Musculoskeletal Disorders (2017)

LONG-TERM EFFICACY OF TREATMENT EFFECTS AFTER A KYPHOSIS AND POSTURE TRAINING INTERVENTION IN OLDER COMMUNITY DWELLING ADULTS: A COHORT STUDY

Contacted all participants for follow-up.

- 43 returned for follow-up 3 years (range 2-4) later.
- No differences in short-term change in sample that returned for follow-up.
- Restricted analyses to participants who returned for long-term follow-up.

Compared short-term and long-term change in participants.

Compared short-term and long-term change in participants, stratified by sex.

Compared long-term change in males and females.

Katzman, WB, Parimi, N, Gladin, A, et al., Journal of Geriatric Physical Therapy: July/September 2021

MEASURES PRE-, POST- AND LONG-TERM (N=43)

	PRE-INTERVENTION	POST-INTERVENTION	LONG-TERM F/U	P-VALUE
	Mean ± Standard Deviation			
Kyphosis (degs)	53.8 ± 8.1	50.2 ± 9.7	48.9 ± 11.9	0.077
Lordosis (degs)	31.2 ± 12.5	29.8 ± 12.2	38.7 ± 11.5	0.002
Modified PPT (0-36 pts)	33.2 ± 1.9	33.7 ± 2.4	30.1 ± 2.1	<0.001
4-meter (m/s)	1.29 ± 0.28	1.31 ± 0.22	1.40 ± 0.25	0.051
Time up and go (secs)	7.26 ± 1.23	7.21 ± 1.28	7.70 ± 1.61	0.596
Time loaded standing (secs)	120.5 ± 46.1	126.6 ± 52.0	145.7 ± 46.7	0.017
Six minute walk (m)	512.6 ± 81.4	524.3 ± 77.1	432.9 ± 93.7	<0.001
PASE (0-400 pts)	118 ± 59	115 ± 57	120 ± 57	0.842

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MEASURES PRE-, POST- AND LONG-TERM (N=43)

	PRE-INTERVENTION	POST-INTERVENTION	LONG-TERM F/U	P-VALUE
	Mean ± Standard Deviation			
SRS 30 self-image (0-5 pts)	3.54 ± 0.62	3.81 ± 0.55	3.77 ± 0.67	0.147
PROMIS mental health t-score	53.2 ± 7.6	53.4 ± 7.9	54.7 ± 9.4	0.676
PROMIS physical health t-score	52.5 ± 5.7	53.8 ± 6.6	52.2 ± 7.0	0.476
PROMIS physical function t-score	49.2 ± 7.4	52.0 ± 9.7	51.5 ± 8.0	0.284
	Median and Interquartile Range (Q1 to Q3)			
Spinal flexion (peak torque/bw)	29.5 (22.7 to 36.8)	31.75 (23.6 to 35.8)	29 (23.0 to 38.4)	0.916
Spinal extension (peak torque/bw)	70.6 (55.7 to 81.0)	74.7 (60.3 to 82.9)	68 (55.9 to 79.2)	0.662

MEASURES PRE-, POST- AND LONG-TERM (N=43)

	PRE-INTERVENTION	POST-INTERVENTION	LONG-TERM F/U	P-VALUE
	Number (percentage)			
In general, how do you rate your health?				0.668
2: Fair	2 (4.65)	2 (4.65)	2 (4.76)	
3: Good	18 (41.86)	11 (25.58)	14 (33.33)	
4: Very Good	15 (34.88)	24 (55.81)	19 (45.24)	
5: Excellent	8 (18.6)	6 (13.95)	7 (16.67)	

COMPARING SHORT-TERM VS LONG-TERM CHANGE

	SHORT-TERM	LONG-TERM	P-VALUE
	Mean (95% CI)		
Kyphosis (degs)	**-3.8 (-5.6 to -2.0)**	**-1.5 (-3.9 to 1.0)**	**0.173**
Lordosis (degs)	**-1.1 (-2.9 to 0.7)**	**8.9 (6.2 to 11.6)**	**<0.001**
Modified PPT (0-36 pts)	0.4 (-0.2 to 1.0)	-3.6 (-4.4 to -2.7)	<0.001
4-meter (m/s)	**0.02 (-0.03 to 0.08)**	**0.08 (0.02 to 0.14)**	**0.105**
Timed up and go (secs)	-0.06 (-0.36 to 0.23)	0.49 (0.10 to 0.88)	0.031
Time loaded standing (secs)	**5.4 (-4.3 to 15.2)**	**17.7 (1.8 to 33.8)**	**0.053**
Six minute walk test (m)	14.4 (-6.9 to 35.8)	-93.1 (-119.2 to -67.0)	<0.001
PASE (0-400 pts)	-4 (-19 to 10)	4 (-16 to 24)	0.393

COMPARING SHORT-TERM VS LONG-TERM CHANGE

	SHORT-TERM	LONG-TERM	P-VALUE
	Mean (95% CI)		
Kyphosis (degs)	-3.8 (-5.6 to -2.0)	-1.5 (-3.9 to 1.0)	0.173
Lordosis (degs)	-1.1 (-2.9 to 0.7)	8.9 (6.2 to 11.6)	<0.001
Modified PPT (0-36 pts)	**0.4 (-0.2 to 1.0)**	**-3.6 (-4.4 to -2.7)**	**<0.001**
4-meter (m/s)	0.02 (-0.03 to 0.08)	0.08 (0.02 to 0.14)	0.105
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Six minute walk test (m)	**14.4 (-6.9 to 35.8)**	**-93.1 (-119.2 to -67.0)**	**<0.001**
PASE (0-400 pts)	-4 (-19 to 10)	4 (-16 to 24)	0.393

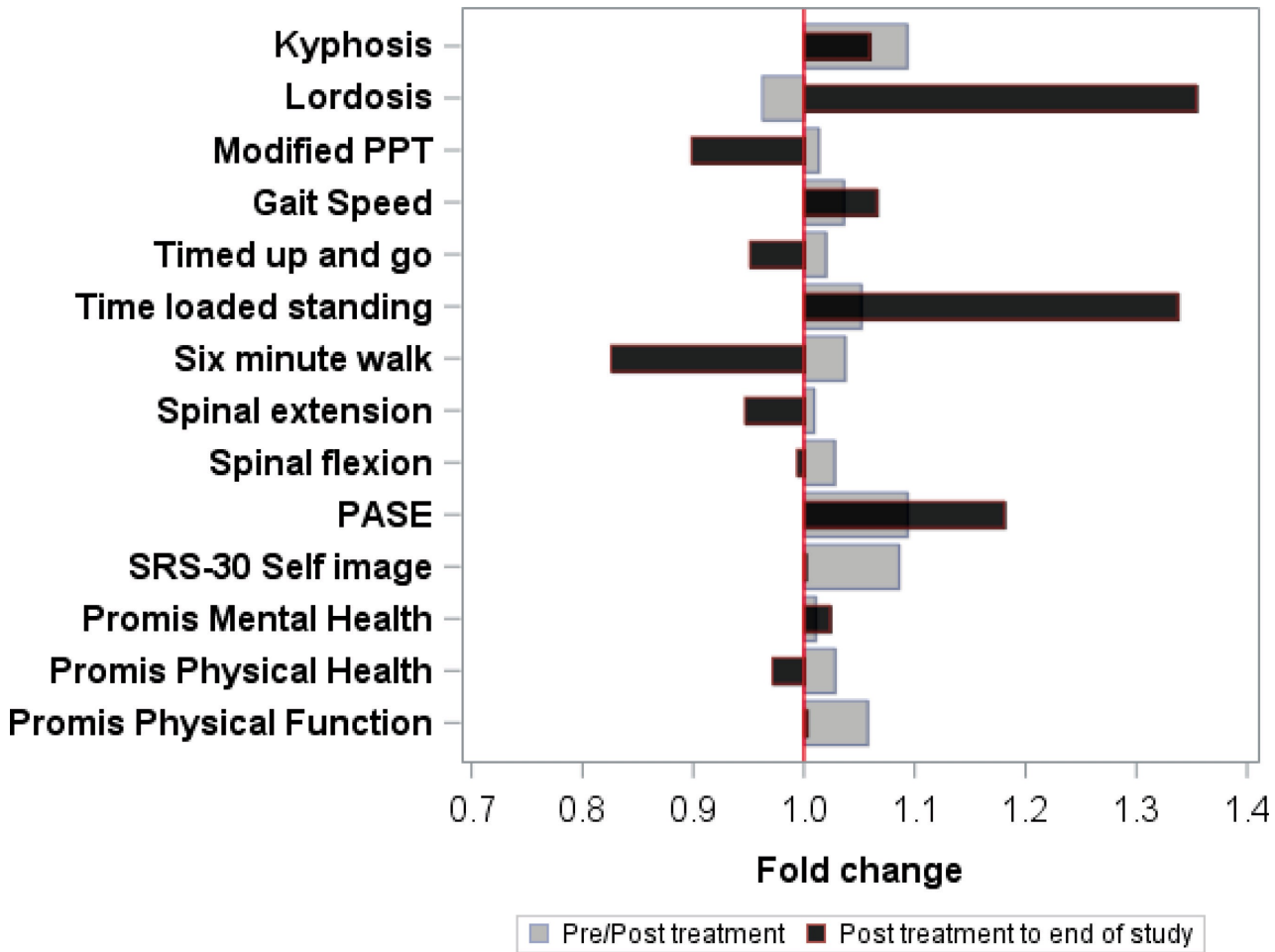
COMPARING LONG-TERM CHANGE MALES VS FEMALES

	MALES (n=16)	FEMALES (n=27)	P-VALUE
	Mean (95% CI)		
Kyphosis (degrees)	-1.7 (-5.4 to 2.0)	-1.3 (-4.8 to 2.1)	0.882
Lordosis (degrees)	10.0 (3.9 to 16.2)	8.2 (5.6 to 10.9)	0.839
Modified PPT (0-36 points)	-2.8 (-4.6 to -1.0)	-4.0 (-4.9 to -3.0)	0.293
4-meter (meters/second)	0.08 (-0.06 to 0.22)	0.08 (0.01 to 0.15)	0.599
Timed up and go (seconds)	0.95 (0.16 to 1.75)	0.22 (-0.20 to 0.64)	0.144
Time loaded standing (seconds)	**-14.6 (-46.7 to 17.6)**	**33.2 (16.8 to 49.6)**	**0.008**
Six minute walk (meters)	-88.7 (-122.2 to -55.2)	-95.7 (-133.7 to -57.6)	0.766
PASE (0-400 points)	**-15 (-38 to 7)**	**18 (-12 to 47)**	**0.092**

COMPARING LONG-TERM CHANGE MALES VS FEMALES

	MALES (n=16)	FEMALES (n=27)	P-VALUE
	Mean (95% CI)		
SRS-30 self-image (0-5 points)	**0.19 (-0.09 to 0.47)**	**-0.16 (-0.42 to 0.1)**	**0.069**
PROMIS mental health t-score	**3.3 (0.6 to 6.1)**	**-0.2 (-3.2 to 2.6)**	**0.073**
PROMIS physical health t-score	**0.6 (-1.9 to 3.1)**	**-3.2 (-5.3 to -1.2)**	**0.025**
PROMIS physical function t-score	**1.3 (-1.9 to 4.1)**	**-1.5 (-4.2 to 1.3)**	**0.005**
	Median and Interquartile Range (Q1 to Q3)		
Spinal flexion (peak torque/bw)	6.0 (-6.6 to 18.7)	0.8 (-3.5 to 5.1)	0.778
Spinal extension (peak torque/bw)	5.7 (-19.3 to 30.8)	-4.2 (-12.9 to 4.5)	0.572

COMPARING SHORT-TERM VS LONG-TERM CHANGE



LONG-TERM BENEFITS

Kyphosis improved short- and long-term.

- 3.8 degree short-term improvement (4.8 degree group difference)
- 1.5 degree long-term improvement
- Minimal Detectable Change (MDC) = 2.5 degrees
- Kyphosis did not progress as expected long-term

Lordosis improved long-term.

- No short-term improvement
- 8.9 degrees long-term improvement
- Exceeds MDC of 3.9 degrees

LONG-TERM BENEFITS

Gait speed improved 0.08 m/s long term.

- Minimal Clinically Important Difference (MCID) 0.05 m/s (Perera and Kwon, 2006; Pulignano, 2016).

Time loaded standing (TLS) improved long-term in females 33.2 s.

- MCID not reported.
- Exceeds 9.8 (SD=52.4) s change over 1 year after short-term (12 week) exercise intervention among older adults (Barker, et al. 2020).

PASE improved (in females) but not clinically meaningful amount

- MDC 87 s for older adults with osteoarthritis (Svege, 2012).

Modified PPT and 6MWT declined as expected over 3-years.

Changes comparable in males and females except in TLS, PASE.

STRENGTHS AND LIMITATIONS

- Insight into long-term efficacy of short-term treatment.
- 42% of the eligible cohort returned for follow-up.
- Follow-up time not consistent.
- Did not include radiographs for Cobb angle measurements of kyphosis long-term.
- 95% of our cohort rated health good to excellent, limiting generalizability.

SECONDARY ANALYSIS OF CHANGE IN PHYSICAL FUNCTION AFTER EXERCISE INTERVENTION IN OLDER ADULTS WITH HYPERKYPHOSIS AND LOW FUNCTION

Purpose: Determine whether older adults with low physical function and hyperkyphosis improve physical function after a kyphosis targeted intervention.

Methods: Twenty-six (26%) of the 101 participants who completed the SCOR trial were low functioning, with Short Physical Performance Battery (SPPB) of 9.6 (SD=1.2) points.

Results: After controlling for age, SPPB improved 0.77 (95% CI: 0.23 to 1.3) points in low function group, exceeding small meaningful change of 0.54 points. No adverse events.

Conclusions: Older adults with low physical function may safely participate in targeted high intensity kyphosis exercise and posture training. Low function participants may improve function, but larger adequately powered studies are needed.

Gladin, A, Katzman WB, Fukuoka Y, et al. BMC Geriatrics (2021) 21:133

EXERCISE FOR IMPROVING AGE-RELATED HYPERKYPHOSIS: A SYSTEMATIC REVIEW AND META-ANALYSIS WITH GRADE ASSESSMENT

Purpose: To determine the effects of exercise interventions on kyphosis angle and secondary back extensor muscle strength or endurance, physical function, quality of life, pain, falls, and adverse events in adults 45 years or older with hyperkyphosis.

Methods: 24 studies were included in the meta-analysis.

Results: Exercise or physical therapy improved kyphosis, back extensor muscle strength and endurance, health-related quality of life, pain, and Timed Up and Go scores. Effects on falls uncertain.

Conclusions: Interventions targeting hyperkyphosis, all included spinal strengthening, may improve kyphosis outcomes in adults with hyperkyphosis.

Ponzano, M, Tibert N, Bansal S, Katzman W, Giangregorio L, Archives of Osteoporosis, 2021

THE ASSOCIATION BETWEEN PHYSICAL FUNCTION AND HYPERKYPHOSIS IN OLDER FEMALES: A SYSTEMATIC REVIEW AND META-ANALYSIS

Purpose: Examine the association between hyperkyphosis and physical function in older females.

Methods: Three longitudinal cohort and 22 cross-sectional studies of fair to good quality were included.

Results: Hyperkyphosis was associated with lower physical function in older females.

Conclusions: Three cohort studies suggest that greater kyphosis angles may predict greater loss of physical function over time, supporting therapies to reduce hyperkyphosis may help preserve physical function with aging.

Roghani, T, Allen, D, Gladin, A, … Katzman WB. J of Geriatric PT, 2023; 00(0):1-12.

FEASIBILITY & ACCEPTABILITY OF TECHNOLOGY-BASED EXERCISE & POSTURE TRAINING IN OLDER ADULTS WITH AGE-RELATED HYPERKYPHOSIS: PRE-POST STUDY

Purpose: Assess feasibility and acceptability of a technology-based exercise and posture training program. Secondary aim to explore efficacy for kyphosis, physical function, and health-related quality of life.

Methods: Delivered video clip links and text messaging prompts via a mobile phone for 6-weeks.

Results: Kyphosis, occiput to wall distance, and physical activity significantly improved after the 6-week intervention.

Conclusions: Technology-based exercise and posture training using video clip viewing and text messaging reminders is feasible and acceptable for a small cohort of older adults with hyperkyphosis.

Katzman, WB, Gladin A, Lane NE, et al., JMIR Aging 2019

SUMMARY

Is kyphosis modifiable?

Targeted kyphosis-specific exercise and posture training decreases kyphosis in older adults and may prevent progression of kyphosis over time.

What are effective interventions?

Spinal strengthening is a necessary component, along with postural training to improve motor learning and muscle activation during ADLs.

Does change in kyphosis associate with change in physical function?

Reducing kyphosis improves physical function among low function older adults.
Moderate certainty in meta-analysis that exercise including spine strengthening improves kyphosis and physical function in adults 45 years+.
Slowing kyphosis progression may help prevent physical function decline.

UCSF Department of Physical Therapy and Rehabilitation Science

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P50 AR063043 grant from the Office of Research in Women's Health and the National Institute of Arthritis and Musculoskeletal and Skin Disorders (NIAMS).

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UCSF RAP program

BIRCWH Building Interdisciplinary Research Careers in Women's Health

Office of Research on Women's Health, National Institutes of Health

NIAMS National Institute of Arthritis and Musculoskeletal and Skin Diseases

National Institute on Aging

QUESTIONS?????

Relevant publications

1. **Katzman WB,** Sellmeyer DE, Stewart AL, Wanek L, Hamel KA. Changes in flexed posture, musculoskeletal impairments, and physical performance after group exercise in community-dwelling older women. Arch Phys Med Rehabil. 2007 Feb; 88(2):192-9. PMID: 17270517
2. Pawlowsky SB, Hamel KA, **Katzman WB.** Stability of kyphosis, strength, and physical performance gains 1 year after a group exercise program in community-dwelling hyperkyphotic older women. Arch Phys Med Rehabil. 2009 Feb; 90(2):358-61. PMID: 19236993. PMCID: PMC2907351
3. **Katzman WB,** Wanek L, Shepherd JA, Sellmeyer DE. Age-related hyperkyphosis: its causes, consequences, and management. J Orthop Sports Phys Ther. 2010 Jun; 40(6):352-60. PMID: 20511692. PMCID: PMC2907357
4. **Katzman WB**, Vittinghoff E, Ensrud K, Black DM, Kado DM. Increasing kyphosis predicts worsening mobility in older community-dwelling women: a prospective cohort study. J Am Geriatr Soc. 2011 Jan; 59(1):96-100. PMID:21198460; PMCID:PMC3696343.
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The revised Stand Tall™ exercise video is available from the UCSF Department of Physical Therapy and Rehabilitation Health and Wellness Center as an mp4 file.

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