Kiester Comfort: Chair Preferences as Observed in a Rheumatology Practice

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Abstract: *Objective:* This study was performed to determine why patients preferred either a standard height or a modified taller chair, when asked to sit and stand.

Design: One hundred consecutive patients presenting to a rheumatology practice were asked to sit and subsequently arise from chairs of standard 18-inch and 22-inch seat heights. Chair preference and rationale were assessed against demographic, anthropometric and rheumatology diagnostic variations (osteoarthritis and inflammatory arthritis, soft tissue disorders and inflammation, etc.).

Results: Both groups (shorter and taller) preferred the conventional height chair, but preference was more prevalent in individuals with shorter limbs. Osteoporosis was the only statistically significant sign/disease factor associated with chair height choice. Among the 61 who preferred the shorter conventional chair, 13 did so because it was easier from which to arise, 17 reported that it was simply "more comfortable," while 30 reported that they preferred that their feet touch the floor.

Conclusion: Assessment of the rationale for patient chair height preference must consider both factors of comfort and ease of standing. Some aspects of chair design can address patient comfort, while others address reducing joint loads and range of motion. Personal preference for chair height should be factored into social interactions.

Keywords: Arthritis, Activities of daily living, Locomotion, Patient preference.

INTRODUCTION

Transition from a seated position to standing (sit-to-stand function) is one of the most mechanically demanding daily activities and one of the most important functions for people with arthritis [1, 2] and most limiting [3], helping to determine an individual's functional level [4]. It is required for upright mobility and thus for performance of many routine daily activities [5-9].

Anatomical and physiologic criteria for chair design [10-12] do not fully represent patient needs. The biomechanics of sit-to-stand are reviewed as background for this study of chair height preferences. Riley and colleagues [8, 13] divided arising from a chair into three phases: Generation of upper body momentum, transfer of upper body momentum to total body (horizontal to vertical translation), and an extension phase producing vertical ascent.

"Chair seat height is one of the most important determinants of a sit-to-stand task" (9, p. 2), confirming the observations of Kerr *et al*. [3], affecting peak hip and knee moments [14]. Peak hip and knee moment increased 2.4 and 1.9-fold, respectively, with decrease of seat height from 64 (25") to 43 cm (17") [14]. Decrease from 115% to 65% of height/knee height ratio was associated with hip and knee joint moment increased 1.1 and 2.3 times [2]. Reduction of mechanical load with seat elevation contrasts with results for standard and lower seats, in which joint moment was equivalent [9]. Hip maximum flexion moment changed less than 12% for 65-115% chair regarding knee joint height. Knee flexion moment doubled from highest to lowest position [2]. Another factor is floor reaction forces, related to lower leg length [15].

Center of gravity is lowered with decreased chair height [16]. That difficulty in lift-off initiation is accommodated by increased trunk flexion angular velocity [16]. Older individuals required greater muscle activity to stand [17].

Comfort and being "comfortable" is the subjective physical and psychological impression of relaxation and well-being, and freedom from pain, tiredness, soreness, and numbness [18]. Chair comfort is in part derived from the physical congruence, or fit, between the limb-segment lengths and the chair component dimensions (seat pan height and depth, backrest height). The fit of the chair leads to perceptions of pressure points and the presence or lack of support,

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and can result in postural deviations from natural/neutral body and limb positions. Compatibility of body and chair dimensions impacts the placement of the feet upon the floor, location of the seat pan edge across the back of the thighs, and the ability to use the seat backrest. The interaction of these surfaces can impose less than optimal joint ranges-of-motion and the need for additional upper body momentum generation when rising from the chair. Thus the aspects of comfort, fit, and biomechanical function are intertwined, and so, are important considerations when examining preference.

The study was performed in an attempt to determine preferences and the reason(s) why patients preferred either the standard 18-inch (45.7 cm) height chair or the modified, taller 22-inch (55.9 cm) height chair, when asked to sit in them both and subsequently arise to a standing position.

Given the difficulty many patients have in arising, we anticipated that the taller chair would be preferred, similar to experience with toilet risers [19].

Biomechanical studies of the sit-to-stand motion have identified the varying influences of chair dimensions on muscular contraction, joint loads and ranges-of-motion, and angular momentum. The contribution of body and limb size variation, and other factors such as age, have also been shown to influence mechanical functioning. However, this study will reveal that prediction of the "best" chair for patient examinations involves more than optimization of fit and force, but is sometimes counterintuitive. The addition of comfort and patient preference to the equation should enhance future studies of chair biomechanics and seat design when the goal is maximizing patient acceptance. Furthermore, chair selection and the options made available for patient exam rooms, waiting rooms, and for rehabilitation and aged care facilities might also benefit from the insights derived from studies incorporating patient preference.

MATERIALS AND METHODS

The study was performed with written informed consent, as approved by the Western Reserve Care System. One hundred (100) consecutive patients presenting to a community rheumatology practice were asked to sit in and subsequently arise from a standard (cushioned, straight-backed) 18-inch (45.7 cm) seat height Gasser Prelude series chair (Gasser Chair Company Inc., 4136 Logan Way, Youngstown, OH 44505) and from one modified by the company to provide a 22-inch (55.9 cm) seat height, analogous to the study by Gillette and Stevermer [20] for chair height reduction. Chair heights were measured from their middle anterior surface. Patient chair preference and rationale were requested.

Height, knee to heel length, and crown-rump length were measured. The knee to heel measurement was obtained by assessing the distance from the base of the foot to the top of the knee while the patient was seated. Crown-rump length was measured from the top of the head to the seat pan surface while the patient was seated. The mean values of the measurements within this patient dataset were used to establish a cutoff for dividing the patients into two groupings, those above and below the threshold for each measure. The cutoff point for height was 170 cm (5'7"), for crown-rump length was 80 cm (32"), and for knee to heel length was 42 cm (17").

These above/below groupings were then used to compare and evaluate chair height preference and rationale differences.

Additional lower limb mechanical factors assessed included presence of trochanteric bursitis, knee instability, chondromalacia patellae, metatarsalgia and pedal stress fractures. Upper extremity factors potentially related to “push off” that were considered included presence of bicipital tendonitis, epicondylitis, and carpal tunnel syndrome. In addition to these mechanical factors that potentially influence ability to arise from a chair, presence of joint stiffness, fibromyalgia, osteoporosis, vertebral compression fractures, inflammatory arthritis and interference with ability to perform activities of daily living (ADL) were also assessed.

Chair preference was assessed according to age, sex, race, height, weight, crown-rump and knee-heel measurements and their differential, presence of osteoarthritis, inflammatory arthritis [as a general category and individually as rheumatoid arthritis, spondyloarthropathy, calcium pyrophosphate deposition disease (CPPD) and gout], trochanteric bursitis, knee instability, chondromalacia patellae, metatarsalgia, pedal stress fractures, carpal tunnel syndrome, epicondylitis, bicipital tendonitis, joint stiffness, fibromyalgia, osteoporosis, compression fractures and absence of difficulty with performing activities of daily living (ADL) utilizing Chi square, and Fisher Exact and T tests.

RESULTS

Demographics are presented in Table **1**. There was no statistically significant difference in age, sex, race, or weight between the normal and modified chair preference groups (Table **1**).

Table 1: Demographics of Individuals According to Chair Type Preference

Character	Conventional 45.7 cm/18 in	Elevated Chair 55.9 cm/22 in	Statistical Test
Caucasian	57	37	Fisher exact test, p = 0.32430, n.s.
African American	4	2	Fisher exact test, p = 0.3243, n.s.
Male	12	8	Chi square = 0.001600, n.s.
Female	49	31	Chi square = 0.001600, n.s.
Age – range	38-77	32-78	T test = 0.22319, n.s.
– average	51	53	T test = 0.74741, n.s.
Height – range	150-183 cm	152-183 cm	T test = 0.04417, n.s.
– average	164 cm	162 cm	T test = 0.52624, n.s.
– > 170 cm	15	24	**Chi square = 16.5153, p = 0.00017**
– < 170 cm	48	13	**Chi square = 16.5153, p = 0.00017**
Weight – range	45.9 -152.7 kg	53.2 – 112.3 kg	T test = 0.27117, n.s.
– average	82.7 kg	83.6 kg	T test = 0.94154, n.s.
Crown-rump > 80 cm	43 (70% of conventional)	32 (82 % of elevated)	**Chi square = 6.4815, p = 0.00109**
< 80 cm	15 (26% of conventional)	10 (26% of elevated)	**Chi square = 6.4815, p = 0.00109**
Height minus crown rump	Average 78.81, sd 5.26	Average 80.93, sd 4.29	T test = 1.77731, n.s.
Knee-heel > 42 cm	22 (36% of conventional)	18 (46% of elevated)	**Chi square = 12.7160, p = 0.00363**
Knee-heel < 42 cm	42 (69% of conventional)	18 (46% of elevated)	**Chi square = 12.7160, p = 0.00363**
Rump minus knee height	Average 38.14, sd 4.95	Average 39.25, sd 3.78	T test =1.01072, n.s.
Osteoarthritis (by x-ray)	26 (43% of conventional)	20 (51% of elevated)	Chi square = 0.262354, n.s.
Inflammatory arthritis	42 (68% of conventional)	22 (56% of elevated)	Chi square = 0.293376, n.s.
Rheumatoid	22 (36% of conventional)	12 (31% of elevated)	Chi square = 0.742208, n.s.
Spondyloarthropathy	10 (16% of conventional)	2 (5% of elevated)	Chi square = 0.090865, n.s.
CPPD	6 (10% of conventional)	6 (15% of elevated)	Chi square = 0.404953, n.s.
Gout	4 (7% of conventional)	0 (0% of elevated)	Fisher exact test, p = 0.1331, n.s.
Trochanteric bursitis	6 (10% of conventional)	6 (15% of elevated)	Chi square = 0.404953, n.s.
Knee instability	48 (79% of conventional)	32 (82% of elevated)	Chi square = 0.681772, n.s.
Chondromalacia patellae	6 (10% of conventional)	6 (15% of elevated)	Chi square = 0.404953, n.s.
Metatarsalgia	28 (46% of conventional)	18 (46% of elevated)	Chi square = 0.000600, n.s.
Pedal stress fractures	0 (0% of conventional)	2 (5% of elevated)	Fisher exact test, p = 0.1497, n.s.
Carpal tunnel syndrome	10 (18% of conventional)	10 (24% of elevated)	Chi square = 0.495103, n.s.
Epicondylitis	6 (10% of conventional)	4 (10% of elevated)	Chi square = 0.004700, n.s.
Bicipital tendonitis	1 (2% of conventional)	0 (0% of elevated)	Fisher Exact Test, p = 0.6100, n.s.
No ADL problems	46 (75% of conventional)	24 (65% of elevated)	Chi square = 2.179800, n.s.
Joint stiffness	18 (30% of conventional)	9 (24% of elevated)	Chi square = 0.499200, n.s.
Fibromyalgia	16 (26% of conventional)	10 (24% of elevated)	Chi square = 0.004300, n.s.
Osteoporosis	8 (13% of conventional)	0 (0% of elevated)	**Fisher Exact Test, p = 0.0212**
Compression fractures	2 (3% of conventional)	4 (10% of elevated)	Fisher Exact test, p = 0.2050, n.s.

Thirty-seven patients were taller than 5'7" (170 cm), 24 of whom preferred the taller chair.

Sixty-three patients were shorter than 170 cm, 48 of whom preferred the conventional chair. The difference in preferences was statistically significant (Chi square = 16.5153, p = 0.00017).

Seventy-five individuals had crown-rump measurements greater than 80 cm; 25, less. Forty-three of 75 individuals with crown-rump measurements greater than 80 cm preferred conventional chairs compared to 15 of 25 with crown-rump measurements less than 80 cm, statistically significant preference differences (Chi square = 6.4815, p = 0.00109). Forty individuals had knee-heel length greater than 42 cm (17"), 18 of whom preferred the taller chair; 22, the conventional one. Among the 60 with shorter legs, 42 preferred the conventional chair; 18, the taller one. The difference in preference was statistically significant (Chi square = 12.7160, p = 0.00363).

There was no correlation at the 5% level of chair preference with any of the other symptoms/signs/diagnoses considered, with the exception of osteoporosis. Osteoporosis was the only statistically significant sign/disease factor associated with chair height choice, associated with preference of the normal (lower), rather than modified (higher) chair. Thirty-nine individuals preferred the taller chair, reporting that it was easier from which to arise. Among the 61 who preferred the conventional chair, 13 did so because it was easier from which to arise (to a standing position). Seventeen reported that it was simply "more comfortable," while 30 reported that they preferred that their feet touch the floor. One felt that it provided better back support.

DISCUSSION

Fotoohabadi *et al*. [21], Riley *et al*. [13] and Janssen *et al*. [4] examined the biomechanics of sit-to-stand activity, but that may not be the only factor affecting the standing behavior or perceived comfort. Although, it provides a starting point for evaluating seat height preferences. Such is explored in this study.

Identified Chair Height Preferences

Chair height preference was independent of age, sex, race, and weight (Table **1**). Sixty-one percent of taller individuals preferred taller chairs, confirming our initial hypothesis, while shorter individuals preferred conventional chairs. However, it was not all or none, with statistically significant differential overlap. Examining the relationship of crown-rump and knee-heel measurements on preference, both groups preferred conventional chairs, but that preference was more prevalent in individuals with measurements less than 80 cm and 42 cm, respectively.

Osteoporosis was the only statistically significant sign/disease factor associated with chair height choice, associated with preference of the normal, rather than modified chair. There was no statistically significant correlation of chair preference with presence of trochanteric bursitis, knee instability, chondromalacia patellae, metatarsalgia or pedal stress fractures, mechanical factors that could potentially affect ability to extend the knee or hip or modify stance [22, 23]. Nor was there correlation with presence of bicipital tendonitis, epicondylitis or carpal tunnel syndrome, mechanical factors that could potentially compromise use of the arms, hands and wrists in "pushing off" [22]. Preference was also independent of presence of inflammatory arthritis, appendicular joint osteoarthritis, fibromyalgia and vertebral compression fractures. Limitation of ability to perform routine ADL was not a factor in chair preference.

Rationale for Chair Height Preferences

Thirty-nine individuals (39%) preferred the taller modified chair, reporting that it was easier from which to arise. Among the 61 (61%) who preferred the shorter conventional chair, 13 did so because it was easier from which to arise (to a standing position). Seventeen reported that it was simply "more comfortable," while 30 reported that they preferred that their feet touch the floor. One felt that it provided better back support.

Assessment of the rationale for chair height preference must consider both factors of comfort, and factors of biomechanical ease of the motion. The mechanics involved include foot and limb positioning upon initiation of standing, as well as the magnitude of muscular contraction, joint loads, and the range of motion required.

For shorter patients, sitting and arising from a higher chair, several concerns are identified. Short patients in a high chair can't fully rest the feet flat upon the floor. Their toes might touch the floor, but the weight of their legs is unsupported. This lack of support can cause the thighs and buttocks to slide forward, and impede the ability to maintain contact with the seat back, resulting in lower back discomfort. Shorter patients sitting in a taller chair for a prolonged period of time could experience a feeling of foot and calf swelling, and loss of circulation in the thighs, adding to their discomfort. To stand from a higher chair, shorter patients first need to slide their thighs and buttocks forward on the seat to allow their feet to touch the floor. Then they must reposition their feet on the floor, lean forward to get their upper body center of mass over the foot position, and then stand. It is common practice to incorporate a removable or adjustable back rest into the design of a chair to accommodate shorter patients and improve comfort.

For taller patients, sitting and arising from a shorter chair, several correlate concerns are identified. While the feet can be firmly placed on the floor, the knee angle is more extremely flexed. When standing from the shorter chair is initiated, the knee joint passes through a much longer range of motion. This required action is vulnerable to causing additional discomfort in some patients. In extremely tall patients seated in a shorter chair, the knee flexion can be extreme to the point of being almost in a crouch, which then requires additional forward leaning and momentum generation in the upper body to establish the vertical standing motion.

The take away conclusion from this is that some aspects of chair design can address patient comfort, while others address reducing joint loads and range of motion. Yoshioka *et al*. [9] reported that seat height did not actually affect the mechanical load of sit-to-stand activity, instead relating it to the timing of horizontal positioning of the thigh. While Burdett *et al*. [14] found that increased chair height reduced forces and the required range of motion for sit-to-stand activity, which did not appear to affect preference in the current study. Thus, it seems reasonable to suggest that personal preference for chair height be factored into social interactions.

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