



## Effect of Surya Namaskar yoga practice on flexibility in the pre-elderly and elderly

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### ABSTRACT

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Anatomical and physiological changes occur along with the aging process. One of the changes is decreased flexibility due to changes in the musculoskeletal system. Upper and lower limb flexibility is closely related to the ability to carry out daily activities, which affects the quality of life of the elderly. Surya Namaskar yoga is known to help increase flexibility because it integrates stretching components within its movement. This study aimed to investigate the effect of Surya Namaskar on flexibility in the pre-elderly and elderly. It was a quasi-experimental study with a pre-experimental one-group pretest-posttest research design. A total of 20 participants were selected using consecutive sampling according to the inclusion criteria. Flexibility measurements of the upper and lower limbs were carried out before and after the intervention using the back scratch test and chair sit and reach test methods. Surya Namaskar intervention was carried out for 8 wk. Data were analyzed using the Shapiro-Wilk normality test, paired t-test, and Wilcoxon test. The results showed that there was a highly significant difference between the mean value of the back-scratch test (for upper limb flexibility) before and after the intervention ( $p < 0.001$ ). Significant differences were also found in the mean values of chair-sit-and-reach test measurements (for lower extremity flexibility) before and after the intervention ( $p < 0.001$ ). In conclusion, Surya Namaskar exercises can improve the flexibility of the upper and lower extremities in the pre-elderly and elderly.

### ABSTRACT

Perubahan aspek anatomis maupun fisiologis terjadi seiring dengan berjalannya proses penuaan. Salah satunya berupa penurunan kemampuan fleksibilitas akibat terjadinya perubahan pada sistem muskuloskeletal. Fleksibilitas berkaitan erat dengan kemampuan menjalani aktivitas sehari-hari dan kualitas hidup pada lanjut usia. Yoga Surya Namaskar terbukti dapat membantu meningkatkan fleksibilitas karena komponen peregangan di dalam rangkaian gerakannya. Penelitian ini bertujuan mengkaji efek Surya Namaskar terhadap fleksibilitas pada kelompok pralansia dan lansia. Penelitian ini berjenis kuasi-eksperimental dengan rancangan penelitian *pre-experimental one group pretest-posttest*. Total responden sebesar 20 orang yang diambil menggunakan *consecutive sampling* sesuai dengan kriteria. Pengukuran fleksibilitas ekstremitas atas dan bawah dilakukan sebelum dan sesudah intervensi dengan metode *back scratch test* dan *chair sit and reach test*. Intervensi Surya Namaskar dilakukan selama 8 minggu. Analisis data menggunakan uji normalitas Shapiro-Wilk dan uji paired t-test serta Wilcoxon. Hasil penelitian menunjukkan adanya perbedaan signifikan terhadap antara rata-rata pengukuran *back-scratch test* (fleksibilitas ekstremitas atas) sebelum dengan sesudah dilakukannya intervensi ( $p < 0,001$ ). Perbedaan signifikan juga ditemukan pada rata-rata pengukuran *chair sit and reach test* (fleksibilitas ekstremitas bawah) sebelum dan sesudah dilakukannya intervensi ( $p < 0,001$ ). Dapat disimpulkan, latihan Surya Namaskar dapat meningkatkan kemampuan fleksibilitas ekstremitas atas dan bawah pada pralansia dan lansia.

### Keywords:

elderly;  
flexibility;  
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## INTRODUCTION

With increasing age, progressive changes occur in the anatomical and physiological aspects. One of them is a decrease in the components of physical endurance, such as flexibility, due to differences in the musculoskeletal system.<sup>1</sup> Flexibility is the ability to achieve the maximum range of motion (ROM) in the joint area. It is also related to the ability of the muscles around the joint to reach maximum extension without injury.<sup>1,2</sup> Daily activities, such as wearing clothes and reaching for objects, are related to upper limb flexibility, while activities involving bending movements and normal walking patterns are associated with lower limb flexibility.<sup>3</sup>

Several factors affect the decrease in flexibility with age. Joint components, such as ligaments and tendons, experience a reduction in elasticity due to the decline in the amount and changes in the collagen structure.<sup>4,5</sup> Moreover, there is a decrease in synovial fluid production, which functions as lubrication in the joint area, and cartilage thinning occurs due to the aging of cells and tissues, making them more susceptible to damage.<sup>6</sup>

Flexibility is known to decrease from the fourth to the fifth decade of life.<sup>6,7</sup> The range of motion of upper limb flexibility, such as the shoulder joint, is known to decrease by 0.5-0.6 degrees per yr. Meanwhile, the range of motion of lower limb flexibility, such as the hip area, reduces by 0.6-0.7 degrees per yr.<sup>3</sup> It is known that decreased flexibility in the lower limb is associated with increased falls in the elderly.<sup>1,3,8</sup> Women were found to have better flexibility and experience a slighter decrease in range of motion than men.<sup>6</sup>

The way to increase flexibility is through stretching exercises that increase the extensibility of the muscles around the joint area.<sup>7,9</sup> Stretching consists of several types, including static stretching

and dynamic stretching.<sup>10</sup> Surya Namaskar yoga is a form of physical activity that incorporates stretching components within its twelve postures. This yoga combines elements of static stretching, both active and passive static, as well as dynamic stretching.<sup>11</sup> Jakhotia *et al.*<sup>12</sup> reported that Surya Namaskar exercises can increase flexibility more significantly than other exercises, such as circuit training or running on a treadmill. These results are thought to be due to the various postures in Surya Namaskar, which require changes in movement between sequences to reach maximum ROM.

This study aimed to investigate the effect of Surya Namaskar on flexibility in pre-elderly and elderly individuals.

## MATERIAL AND METHODS

### Study design and subjects

This research was quasi-experimental with one group pretest-posttest design. The research was conducted from August 2021 to December 2022. Participants were selected using non-random sampling with consecutive sampling methods. The process started with the distribution of questionnaires containing primary data such as name, gender, age, weight, height, as well as medical histories and willingness to participate in the study. A written and signed informed consent was obtained from all participants to voluntarily involve in this study. Participants would be selected according to inclusion and exclusion criteria from the data obtained. The inclusion criteria of this study are: 1) pre-elderly (45-59 yr) and elderly (> 60 yr) age groups; 2) being able to participate in yoga exercises regularly according to the module 3 times per wk for 8 wk; and 3) being able to participate in measurements of the flexibility of the upper and lower limbs twice, at the

beginning and end of the intervention. The exclusion criteria for this study are: 1) inability to engage in yoga sessions as per the prescribed dose; 2) unable to complete the study or dropping out; and 3) having impaired mobility.

## Procedure

### Assessment

The outcome measures were assessed twice: at baseline and after eight weeks of intervention. Upper limb flexibility was measured using the back-scratch test method, while lower limb flexibility was measured using the chair sit-and-reach test.<sup>13-15</sup>

*Back-scratch test.* In standing upright, the participant is requested to place one hand on the lower back and move it upwards along the spine towards the head. The opposite hand was placed behind the neck, slowly moving it downward along the spine and aiming to place the third finger (long finger) as close as possible or to overlap the opposite hand. The distance between each fingertip of the third finger was then measured in cm. A positive number was recorded if the fingers were overlapping each other; a negative number was recorded if a gap existed between the fingers.

*Chair sit-and-reach test.* Start at the sitting position at the front tip of the chair. One leg is extended, and the other is at a 90-degree angle. Place both hands over each other and slowly try to reach the toes. Keep the knee and back as straight as possible and the neck up. The distance was measured between the fingertip and the toe. Zero value was recorded if the fingertips touched the toe, positive if the fingertip could overlap the toe, and negative if a gap existed between the fingertip and the toe.

Repeated measurements were performed twice on each side, right

and left. From the results obtained, the average value (in cm) for flexibility of the upper and lower limbs was calculated.

### Intervention

The Surya Namaskar intervention was carried out for eight weeks with 3 weekly exercises (24 times in total). Each training session is 50 min long (a total duration of 1200 min). The researchers gave a tolerance exercise dose of 20 exercises with 50 min per session (a total of 1000 min) before being declared a dropout. The intervention takes place from May to June 2022. Respondents were given a logbook to track their progress and problems during training. At the end of the intervention, the logbook was collected by the researcher.

The Surya Namaskar training module consists of 4 main components: centering (breathing), warming up, asanas (Surya Namaskar), and cooling down.<sup>16</sup> Centering consists of Samavritthi breathing exercises for 2-5 min. Warming-ups start from the head-to-toe area for 8-10 min. Asana (Surya Namaskar) is performed for three cycles, totaling 20-30 min. The practice closes with cooling down, savasana, and breathing exercises with Samavritthi breathing for 5-10 min. Each Surya Namaskar cycle consisted of a total of 12 movements: 1). Pranamasan: this movement is performed by standing upright with arms folded close to the chest and palms pressed against each other. 2). Hastauttanasan: this movement is done by raising both hands in the Pranamasan pose upward over the head while inhaling. Then bend the body and neck back. 3). Hastapadasana: this movement is performed by bending forward from the Hastauttanasan pose and slowly trying to touch the floor with both hands while exhaling. Do not bend the knees. 4). Aswasanchalanasan: this movement is done by stretching the left leg as far back as possible while

inhaling. At the same time, bend the right knee with fingers touching the floor, arching the back, and tilting the head backward. 5). Parvatasan: this movement is done by moving the right leg back from the Aswasanchalanasana pose and then placing it parallel to the left leg, accompanied by lifting the pelvis while exhaling. The hands are placed straight to support the body's weight, and the head is between the hands. 6). Ashtanganamaskar: in this pose, the body touches the ground at eight locations, namely the head, chest, two palms, two knees, and two toes. 7). Bhujangasana: this movement is performed by lifting the body using the hands from the Ashtanganamaskara pose, then the head is arched backward. 8). Parvatasan: same as position 5. 9). Aswasanchalanasana: same as position 4. 10). Hastapadasana: same as position 3. 11). Hastauttanasana: same as position 2. 12). Pranamasana: same as position 1

### **Statistical analysis**

The data were analyzed using SPSS version 26.0, consisting of univariate and bivariate analyses. The univariate analysis aims to describe the characteristics of the participants. Data normality was tested using Shapiro-Wilk ( $n < 50$ ). Bivariate analysis was performed using paired t-test for data with normal distribution and a Wilcoxon test for data with abnormal distribution.

### **Ethics**

The Declaration of Helsinki was addressed adequately, and the study has been approved by the ethics committee of Atma Jaya Catholic University of Indonesia with registration number 18/01/KEP-FKIKUAJ/2022.

## **RESULTS**

A total of 20 pre-elderly and elderly participants who met the criteria participated in this study. Participants consisted of 11 men (55%) and 9 women (45%). The participants in the pre-elderly age group (45-59 yr) and the elderly (> 60 yr) consist of 10 people (50%) each. The average weight and height of the participant were 64.65 kg and 164.15 cm. Most participants' body mass index (BMI) falls under the overweight category (BMI 23-24.9). The baseline characteristics of the participants are presented in TABLE 1.

Participants' flexibility was categorized into average and below-average ranges following the guidelines issued within the Senior Fitness Test protocol developed by Rikli and Jones.<sup>14</sup> The range is developed based on sex and aged, with normal flexibility defined as the middle 50% of the population. A score above the range was considered as above average for their age and those below the range as below average. The characteristics of the participants' flexibility are presented in TABLE 2.

It was seen that in the pre-intervention, 10 (50%) of participants had upper limb flexibility in the average range, and 17 (85%) participants had lower limb flexibility in the average range. In the post-intervention results, an increase for upper (70%) and lower limb flexibility (95%) compared to the pre-intervention was observed

A significant difference between the pre-and post-intervention mean values of upper limb flexibility was observed ( $t = -4.02$ ;  $p < 0.001$ ). Similar results were also found for lower limb flexibility, which showed a significant difference between the pre-and post-intervention ( $t = 3.824$ ;  $p = 0.014$ ). The results are presented in TABLE 3.

TABLE 1. Baseline characteristics of participants

| Variables                              | Mean $\pm$ SD     | Frequency [n (%)] |
|--|-------------------|-------------------|
| Age (y.o.)                             | 59.25 $\pm$ 6.98  |                   |
| • Pre-elderly (45-59)                  |                   | 10 (50)           |
| • Elderly ( $\geq$ 60)                 |                   | 10 (50)           |
| Sex                                    |                   |                   |
| • Male                                 |                   | 11 (55)           |
| • Female                               |                   | 9 (45)            |
| Weight (kg)                            | 64.65 $\pm$ 10.26 |                   |
| Height (cm)                            | 164.15 $\pm$ 8.06 |                   |
| • Body mass index (kg/m <sup>2</sup> ) | 23.93 $\pm$ 3.09  |                   |
| • Underweight (<18.5)                  |                   | 1 (5)             |
| • Normal (18.5-22.9)                   |                   | 5 (25)            |
| • Overweight (23-24.9)                 |                   | 8 (40)            |
| • Obesity I (25-29.9)                  |                   | 5 (25)            |
| • Obesity II (30-35)                   |                   | 1 (5)             |

TABLE 2. Pre-post change in flexibility characteristic

| Variables                      | Frequency        |                   |
|--------------------------------|------------------|-------------------|
|                                | Pre-intervention | Post-intervention |
| Upper limb flexibility [n (%)] |                  |                   |
| • Average                      | 10 (50)          | 14 (70)           |
| • Below average                | 10 (50)          | 6 (30)            |
| Lower limb flexibility [n (%)] |                  |                   |
| • Average                      | 17 (85)          | 19 (95)           |
| • Below average                | 3 (15)           | 1 (5)             |

TABLE 3. Pre-post change in flexibility measurements

| Variables                           | Pre-intervention | Post-intervention | $\Delta$ | p      |
|-------------------------------------|------------------|-------------------|----------|--------|
| Upper limb flexibility <sup>a</sup> | -15.30           | -9.56             | 5.74     | <0.001 |
| Lower limb flexibility <sup>b</sup> | 0.53             | 6.06              | 5.53     | <0.001 |

Note: <sup>a</sup>Paired t-test; <sup>b</sup>Wilcoxon signed rank test

## DISCUSSION

This study demonstrates that there is a very significant increase in the flexibility of the upper and lower limbs in the pre-elderly and elderly groups after practicing Surya Namaskar for

8 wk. Previous studies regarding the effect of yoga on increasing flexibility in the elderly also reported.<sup>17-19</sup> However, research explicitly examining the effect of Surya Namaskar on flexibility in pre-elderly and elderly is limited. Bhaskar *et al.*<sup>19</sup> involved 30 male participants aged



60-65 yr in the Surya Namaskar practice for 12 wk. The duration of the practice was longer compared to this study. The study showed an increase in lower limb flexibility (using the sit and reach test) of  $1.43 \pm 0.568$  cm.<sup>19</sup> Another study by Kulkarni *et al.*<sup>20</sup> with a cross-sectional design, which included male participants aged 30-50 yr who regularly practiced yoga and Surya Namaskar for 6 mo, also found a significant increase in flexibility.

Other studies regarding the effect of Surya Namaskar in increasing flexibility has also been reported in different age groups. Jakhotia *et al.*<sup>12</sup> reported that practicing Surya Namaskar for 8 wk in obese women aged 20-40 yr could also increase flexibility. The ability of Surya Namaskar to increase flexibility significantly in a short period was even shown by Nishi *et al.*<sup>21</sup> All the studies listed above only demonstrated an increase in lower limb flexibility. However, they did not examine the effect on upper limb flexibility with the back scratch test.

Two studies investigated yoga's effect on upper limb flexibility using the back-scratch test method. Petric *et al.*<sup>22</sup> reported an increase of  $1.3 \pm 1.5$  cm after 8 wk of practicing Hatha yoga. The study was conducted on 9 female participants with an average age of  $23.8 \pm 2.9$  yr. Van Puymbroeck *et al.*<sup>23</sup> conducted another study of Hatha exercises with 8 participants aged 59 yr with a duration of 2.5 hr per wk for 8 wk. The results of the back scratch test showed an increase in upper limb flexibility of 1.3 cm, and the chair sit and reach test showed an increase in lower limb flexibility of 0.92 cm.<sup>23</sup> However, these did not specifically use Surya Namaskar in their practice.

The results of this study are aligned with the general theory, which states that increased flexibility is closely related to increased elasticity and extensibility of the ligaments and muscles that make up the joint area, despite age.<sup>7,9</sup> In general, yoga encourages gradual stretching of the muscles and connective tissue around

the bones and joints. Regular stretching increases the length and number of sarcomeres, the contractile elements of the muscle cell, thus lengthening the muscle fibers.<sup>9,17</sup> The series of yoga movements accompanied by static stretching in certain poses and dynamic stretching movements encourage joint areas to achieve their maximum ROM.<sup>21-23</sup> Static stretching is found to cause mechanical stimulation, which induces the release of nitric oxide (NO) and mechanical growth factor secretion (MGF) by skeletal muscle, which is crucial in regulating the addition of sarcomeres.<sup>17</sup> These processes will increase muscle strength, joint mobility, and soft tissue flexibility, improve posture, and trigger synovial fluid lubrication of the articular cartilage.<sup>22</sup>

Surya Namaskar consists of 12 series of poses combining the components of flexion, extension, hyperextension, abduction, adduction, and rotation of the joints of the spine and extremities in its core movement.<sup>6,19,24</sup> Moreover, the kinematical observation of Surya Namaskar by Mullerpatan *et al.*<sup>25</sup> showed that the graceful sequence of poses that move the spine and lower extremity joints are largely symmetrical movements, which, achieve a near-complete ROM, and thus, would be very effective in stretching muscles and soft tissue. Furthermore, it will gradually increase the elasticity and extensibility of the joint area components and allow for increased flexibility.<sup>21,23</sup> Additionally, Mullerpatan *et al.*<sup>25</sup> also noted that the time taken to achieve each pose, along with the transition to the next pose, was fairly well distributed, ensuring that loads were not sustained on one joint for a prolonged duration. To sum up, the observations proved that Surya Namaskar is effective in increasing flexibility while also preventing exercise-related injury caused by prolonged loads sustained by single joints, which would be ideally suited to older demographics.

## CONCLUSION

In conclusion, practicing Surya Namaskar for 8 wk significantly enhanced the flexibility of both upper and lower extremities in the pre-elderly and elderly groups. A reduction in the gap is observed in this study as measured by the back-scratch test and chair sit-and-reach test, representing flexibility in the upper and lower limbs, respectively. This study suggests that Surya Namaskar stands as a beneficial physical activity for the pre-elderly and elderly population to optimize flexibility and subsequently improve the quality of life.

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