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Training and detraining management of performance measures by Yoga among middle-aged blue-collar men

Research Article

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Abstract

To observe the effect of *yogasanas* and *yoga* breathing maneuvers (YBM) on body flexibility, balance, muscular strength and reaction time on middle aged blue-collar individuals, 8 healthy blue collar, males (age 37±6.2 years) were trained in yoga for 12 weeks. First 6 weeks, they practiced mostly *yogasanas*. From 7th week, progressively the YBM practice increased up to 12th week. Their body flexibility, balance, maximal hand grip strength (HGS) and HGS endurance at 50 % maximal strength for both hands, back -leg strength (BLS), reaction times for both visual (VRT) and auditory (ART) mode, were measured before and at the end of 6th and 12th weeks yoga training. Data was analysed by ANOVA. With more *yogasanas* practice, their body flexibility improved from base line 14.1±4.5 cm to 18.3±4.3 cm ($P<0.001$, magnitude 29.8%) after 6 weeks of yoga training. With proportionately greater YBM practice, still it increased in lower magnitude (9.3%) to 20±4.6 cm ($p<0.001$) after 12 weeks of training. Balance showed similar pattern of changes like flexibility. In VRT, baseline value of 281.4±16.4ms reduced to 271.14±16.1 ms and 251.7±15.4 ms after 6 weeks and 12 weeks respectively, indicating greater reaction time improvement by YBM. ART also showed similar pattern of changes. Left and Right HGS endurance have improved by 19% and 23.1% respectively, after 6 weeks. BLS and HGS improved in small magnitude. Detraining and age related deterioration of body flexibility, balance, reaction time and strength endurance could be controlled by *yogasanas*. YBM have greater positive role in reaction time.

Key Words: Yoga, Aging, Training, Detraining, Performance.

Introduction

Hatha yoga has positive effects on both physical and mental fitness and also useful as therapy to cure disease (1, 2, 3, 4). Yogic training, improves different physical performance components such as muscular strength and endurance (5, 6, 1, 7, 8) body flexibility (9, 10) balance (11) reaction time (12) and aerobic capacity (13, 6). Flexibility, balance and endurance performances of male college athletes were improved by regular yoga training (11). Middle-aged army volunteers showed improvement in muscular strength-endurance with reduced biceps and triceps EMG amplitude after 6 months yoga training (7). In general, different studies found yogic training improved various fitness related parameters, but their magnitude of improvement depend on duration, types and intensity of training. It also varies with age, gender, life style and occupation (14, 15, 10, and 16). In any training situation discontinuity in training is very common and the management of deconditioning is also critical and very important. Middle age is the period, when age related musculo-skeletal degeneration sets in, which affects functional fitness (17). Persons involved in blue-collar jobs, require greater fitness for executing a task in one hand, on the other hand if they come under the middle age group, become more vulnerable to fitness loss. Any practice like yoga, which would help to improve fitness, may be helpful to them. Yogic training includes different training components such as *yogaasanas* (static postures), yoga breathing maneuvers (YBM) and meditation. All of these components, both individually and collectively, may have specific and also integrated effects on different fitness components. Studies on the effect of yoga, on detraining effects of physical fitness components, among middle aged persons, involved in blue collar jobs, are scanty. In this back ground, this study was undertaken on the persons involved in blue collar jobs at their middle age, with a focus on the magnitude of effects of *yogasanas* and YBM, under an especially made yoga protocol, on specific fitness components. It also looked into the possibility of management of age related deterioration in fitness and also on detraining as such on performance by yoga.

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Material and Methods

Subjects

Total 10 healthy middle aged men volunteered in this study, but 2 of them dropped out due to personal problems. The participants had no history of major cardio-pulmonary or metabolic disorders and other history of suffering from any disease, which may affect physical performance. They did not have the habit of smoking and taking alcohol. They also did not have previous experience in *hatha yoga* practice with other factors which may affect performance. All participants were blue-collar workers and were involved in different types of manual works (i.e. sweeping, helping in kitchen activities, gardening, etc.) and stayed in the same place in the main campus. They used to have same standard of diet from a common mess. Prior to this study, subjects were explained the purpose of the study in their mother tongue and their consent for participation in this study was taken. International norms/guideline to conduct the experiments and training on human subjects was followed. Approval of Institutional ethical committee was obtained. Their height (cm), body weight (kg) and fat (%) were measured by body composition analyser (ioi353, Poland) in (Table-1).

Table-1, Physical characteristics, muscular strength and endurance and magnitude of improvement in muscular strength and endurance.

Physical Characteristics					Muscular strength			Strength endurance at 50% maximum strength	
Time	Age (yrs.)	Height (cm)	Weight (kg)	Fat (%)	BLS (kg)	LHGS (kg)	RHGS (kg)	LHGS endurance (Sec)	RHGS endurance (Sec)
Base line	37. 37±6.2	16 169.3±1.9	68.9±4.2	15.6±1.7	108.6±12.3	54.6±4.3	54.8±4.2	7.9±2	7.8±1.7
6th week			68±3.7	15±1.5	109.5±11.3	55.2±3.9	55.7±3.5	9.4±3.1	9.6±1.3
12th week			67.6±3.3	14.8±1.5	109.6±11.2	55.3±3.6	55.8±3.3	8.8±2.9	9.4±1.3
Magnitude of improvement (%) in muscular strength and endurance									
Base line to 6th week					0.8%	1.1%	1.6%	19%	23%
Base line to 12th week					0.9%	1.3%	1.8%	11.4%	18%

Design of experiment and yoga training

All participants practiced yogic exercises in a session of 45 minutes in each day, 6 days per week for 3 months, in the evening. Before yoga practice they performed light loosening exercises for 5 minutes. In yoga training, *yogasanas* (static physical postures) and YBM (*Pranayamas* and *Kriya)* were practiced for 35 minutes. Subsequently, OM chanting and meditation (*Dhyana*) were performed at the end of each session for 5 minutes. The name of the *Yogasanas* as they practiced were: *Makarasana*, *Sukhasana, Shavasana* (Yoga relaxative postures) *Trikonasana*,*Tadasana*, *Saral Bhujangasana*, *Katichakrasana*, *Saral dhanurasana*, *Ardhasalvasana*, *Paschimottanasana*, *Janusirasana*, *Ardha matsyendrsana and Salvaasana*. YBM component included *Kapalbhati* (a *Kriya* in *hatha yogic* parlance); *Anulom vilom*, *Bhastrika*, *Ujjai and Bhramari* (called *pranayamas* in *hatha yogic* parlance)**.** The duration of *yogasana* (static posture) practice was reduced gradually, while the proportion of YBM practice increased throughout the training period. So, only two YBM were introduced in the 1st and 2nd week. From 3rdweek, duration of those YBM practice increased along with one more new YBM. Thereafter, it was introduced in each week up to 6th week as per the ability of the subjects, along with the reduced practice time for *yogasanas*. Up to 6th week, they devoted maximum 17 minutes for YBM (including rest pauses in relaxative postures like *sukhasana* or *shavasana*) and minimum 18 minutes for *yogasanas,* which also included various relaxative *yogasanas* like *Shavasana*, *Makarasana* and *Sukhasana.* The duration of *yogasana* practice gradually reduced from the 7th week onwards to the 10th week, when maximum duration of YBM practice was for 20 minutes, while minimum duration of *yogasana* practices was only 15 minutes including relaxative *yogasanas*. Last 2 weeks (i.e.11th and 12th week) they practiced only YBM with relaxative *yogasanas,* while maintaining the duration of loosening exercises, OM chanting and meditation same as they practiced from the initial days of training.

Recording of different parameters

Recordings body flexibility (cm) and balance (Sec), back-leg strength (BLS), left hand grip strength (LHGS) and right hand grip strength (RHGS) in kg, Left hand grip strength endurance (LHGS endurance) and Right hand grip strength endurance (RHGS endurance) in seconds , Visual reaction time (VRT) and Auditory reaction time (ART) in milliseconds (ms) were taken. All parameters were taken before the commencement of training, at the end of the 6th week and 12th week of training. Body flexibility was measured by sit and reach test (Johnson and Nelson, 1969). Static Balance was measured by Stork stand test (Johnson and Nelson, 1969). Both hand grip strength and strength endurance were measured by handgrip dynamometer (Baseline, USA). BLS was measured by back leg strength dynamometer (Baseline, USA). Both ART and VRT were measured by a reaction time

measurement system manufactured by Education Emporium Sales, Kolkata.

To measure flexibility 'sit and reach test box' was used. Subject followed sit and reach test procedure (18). Subject sat on the floor with the legs extended, both knees locked and soles of the feet were placed against the 'sit and reach test box' with one hand on top of the other. Then he slowly reached towards the toes. The individual tried to reach maximum distance and held the position for at least one to two seconds while distance (cm) was recorded. No jerky movement was allowed. The best reading in centimeter was recorded from three trials.

Static balance of the whole body was measured by Stork balance stand test (18). Volunteers were removed shoes and stand on one leg. The position of the non-supporting foot was against the inside knee of the standing leg and then placed the hands on the hip. The stop watch was started when the heel of the standing leg was up from the floor. The stop watch was stopped, if any condition occurs. The conditions were: hands come off the hip, supporting foot swivelled or moved in any direction and heel of the standing foot touched the floor. The time was recorded in seconds. There were three trials and best score was noted.

While measuring BLS, subject stood in 30° lumbar flexion. Then he pulled the handle of dynamometer as much as possible without bending the knees and recording was taken. Every volunteer performed three trials with a rest of one minute between each trial and the best reading was noted (18).

To measure right and left HGS, hand grip dynamometer was used. Subject stood with the elbow fully extended and keeping both hands by the side of the body. Then he applied maximal grip force while holding firmly the dynamometer by one hand. The dynamometer displayed the peak force from the trial. Every volunteer performed three trials with a rest of one minute between each trial and best reading was noted (18). Same procedure was followed for both right and left hand.

The handgrip dynamometer was used to measure hand grip strength endurance of both hands. Before the final trial, all volunteers participated in a demo trial. The subject stood with the elbow fully extended and keeping both hands by the side of the body. Then he applied 50% of maximum strength on the presser and maintained it constant by looking at its display and the stopwatch was started for time recording. When the indicator of the handgrip dynamometer deflected, the endurance time was noted after stopping the watch. Every volunteer performed 1 trial on each hand and they have taken the rest for 10 minutes between the first and second trials.

Both ART and VRT were measured by reaction timer instrument, which had built in four digits chronoscope with least count of 1/1000 sec. i.e. 1 millisecond. Green light stimulus and high frequency beep stimulus were selected for recording VRT and ART respectively. Once the subject got familiarized with the instrument, the final reading was taken. For each of ART and VRT, three readings were recorded from auto-display. The average of three readings for each of the parameter were taken. Before the experimenter pressed the respective push button to trigger auditory and visual stimulus, subjects were alerted about impending signal to come and they were ready by keeping their index finger of the dominant hand just above the push button to indicate the response. As soon as the stimulus was perceived by the subjects, they were asked to respond by pressing the response button. For each subject the lowest reading was taken as the value for the reaction time task. The experiments were performed in a room temperature varying from 25 to 28 °C.

Statistical Analysis

Purposive sampling was adopted and normality of continuous variables was evaluated by Shapiro-Wilk test. Data were summarized using means and standard deviation (SD). The means obtained from different data sets were compared by one way repeated measures of analysis of variance test (ANOVA), followed by Bonferroni test. Significance level was set at $p<0.05$. Data was analysed with SPSS v.210 (SPSS Inc, Chicago, Illinois, USA).

Results:

Fig: 1

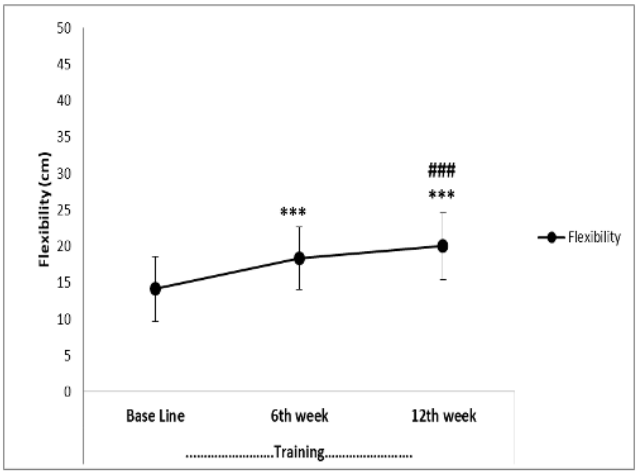

Fig: 2

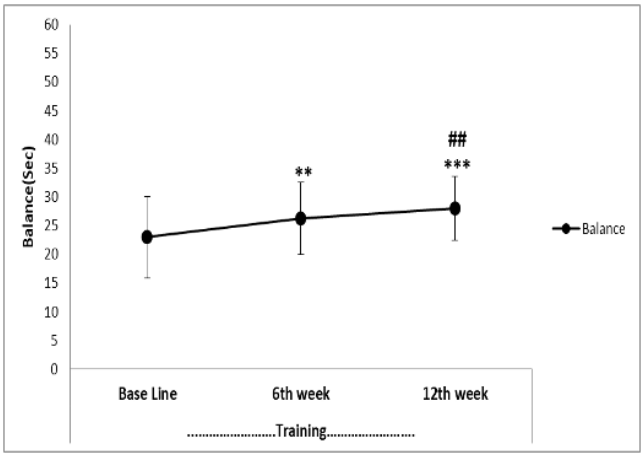

Fig-1 and 2 are showing changes in flexibility and balance at baseline, at 6th week and 12th week end of training. Filled circles represent mean ± SEM. Both

flexibility and balance are significantly improved throughout the training period. * denotes significance of difference from base line to 6th week and 12th week. # denotes significant difference between 6th week and 12th week. *** denotes p<0.001, ### denotes p<0.001.

Fig: 3

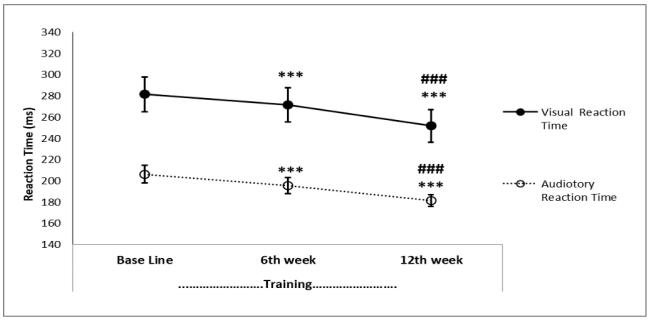

Fig. 3 showing changes in value of Auditory and Visual Reaction Time of baseline, at 6th week and 12th week end of training. Open circles and dotted line represent mean ± SEM for auditory reaction time and filled circles and straight line represents visual reaction time respectively. Both ART and VRT have significantly improved. * denotes significance of difference from base line to 6th week and 12th week. # denotes significant difference between 6th week and 12th week. *** denotes p<0.001, ### denotes p<0.001

In this study, the pre-training baseline mean value of flexibility was 14.1±4.5 cm. After 6 weeks of yoga training with more *yogasanas* practice, it increased with high significance to 18.3±4.3 cm (p<0.001). At the 12th week end, it further increased to 20±4.6 cm. with high significance (p<0.001). The magnitude of improvement from baseline to 6th-week end was 29.8%, while it was 9.3% in the case of 6th-week to 12th-week end (Fig: 1). An almost similar pattern of changes due to *yogasanas* practice were found in balance (Fig: 2). Mean baseline value of balance was 23±7.1 Sec. It increased to 26.3± 6.3 Sec (p<0.01) at the 6th week end and 28±5.6 Sec. at the 12th week end (p<0.01). The magnitude of changes in this parameter at 6th and 12th week end were 14% and 6.7% respectively. The magnitude of improvement pattern in strength (BLS, LHGS & RHGS) and strength endurance (Left and Right hand) were greater in 1st half of the training (from baseline to 6th week end) compared to the 2nd half of the training (from 6th week to 12th week end) (Table-1). In visual reaction time (VRT), baseline mean value was 281.4±16.4 ms. At 6th week and 12th week end it reduced with high statistically significance (p<0.001) to 271.14±16.1 ms. and 251.7±15.4 ms. respectively. The magnitude of improvement in VRT was greater (7.3%) in 2nd half of the training compared to 1st half (3.6%) of the training, when more time devoted in YBM. A similar pattern of changes in ART were observed with high statistical significance at the 6th and 12th week end, where magnitudes of the improvement were 5.1% and 7.3% respectively (Fig: 3).

Discussion

In general, yoga has helped in the health promotion in all the recorded parameters in yoga training program. The greater magnitude of improvement in body flexibility and balance in the 1st half of training, from 1st week to 6th week, are due to the practice of greater amount of *yogasanas*. The previous studies on yoga training have indicated the potential role of *yogasanas* in this direction (9, 10, and 11). The improvement in VRT and ART during this period, though it is in lesser magnitude, may be attributed to *yogasanas* as it has been shown by Malathi and Parulkar (19), among young college students. In the 2nd half of the training (7th week to 12th week end) the magnitude of improvement in body flexibility and balance were comparatively less due to limited amount of *yogasana* practice, but reaction times have shown comparatively greater improvement (greater reduction in mean values) with greater amount of YBM practice during this period. The pattern of changes in both muscular strength and strength endurance are similar to the body flexibility and balance in both first and second half of yoga training, though it is statistically not significant. The study reveals that YBM have additional role in counteracting the detraining effects of flexibility, balance, reaction time, muscular strength and strength endurance. This can be attributed to its effect on the brain (20, 21) and also other psychophysiological effects in general (22, 23, 19). Though aging per se has deteriorated the mean values of all the parameters in these middle aged blue collar men except maximal muscular strength as compared to younger subjects as reported by others (24, 25) and also by us (our unpublished observation), the effect of yoga training as a whole and also specific effect of *yogasana* and YBM remained almost same with slight differences in magnitudes. Thus, it shows the possibility of yoga practices could be beneficial to reduce the age related deterioration of performance.

In this study design, we could find out the effect of *yogasanas* and YBM separately as well as their interactions in different points of time and also the possibility of the management of detraining effects, when more YBM are practiced instead of *yogasanas* in the 2nd half of 3 months yoga training. The different components of yoga like *yogasana* and YBM may have potential role in both physical and psychophysiological aspects in health promotion for general public, the diseased, as well as in sports training also. To the best of our knowledge, no study has used this type of approach while exploring the utility of yoga training.

The detail discussions on the individual parameters are given below:

Flexibility

Flexibility depends on muscle stretching ability and mobility of joints. During *yogasana* practice muscle stretch and relax repetitively and blood circulation increases in the muscle. In the final position of a yoga posture, the holding for a period of >20 sec improves the strength of the connective tissue. The breath control

is being recognised as some of the most important element to get better response in the muscle (26). In this study, the subjects have practiced *Janusirasana,* which may help to improve the strength of spinal muscles along with hip flexors and hamstrings. Another *yogasana* i.e. *Trikonasana* acts on the muscles of chest, hips and hamstrings and thus may have role in body flexibility. Significant increase in flexibility after an eight weeks yoga intervention has been reported earlier (3). In a study (26) on the effect of 12 weeks yoga intervention on shoulder and hip range of motion in adult females, a significant increase in flexibility of hip flexion and extension, hip abduction and shoulder flexion have been found. Similarly, another study (2) has shown significant improvement in the range of motion of neck, shoulder, trunk, hip and knee among young men after yoga training for five months, three times per week for one hour per day. Flexibility reduces due to aging (27, 24). Chapman, et al. (27) has shown the joint stiffness among older age group (63 to 88 years) is greater than younger age groups (15 to19 years). Another study (24) measured spinal mobility of women aged 20 to 84 years in six age groups indicating that spinal mobility decreases with aging. We have seen much greater improvement in these parameters among younger age group of subjects practising yoga under similar protocol (our unpublished observation). This has got the supporting evidence in the study of (27).

Balance

The sensorimotor control systems for maintaining balance in human depends on the sensory inputs as received by the brain from sensory organs i.e. from eyes, vestibular organs in the inner ear, muscles and joints. The integrated results of various sensory inputs get transmitted through brain stem by nerve impulses to the muscles of various regions of the body, which control the movement of eyes, head, neck, trunk, and legs. Thus, an individual can efficiently maintain balance. Polsgrove, Eggleston and Lockyer (11) have reported biweekly yoga practice for 10 weeks improves body balance of male college athletes. Krishnamurthy & Telles (28) have reported that older people after practicing yoga for 75 minutes daily, for 6 days in a week for 6 months, have shown significant improvement in balance, gait and mobility, but their counterpart under same age group, have been unable to attain same improvement in these parameters without yoga training. Concha-Cisternas (25) have shown that aging causes morpho-physiological changes, which include reduction in number and size of muscle fibre, loss of muscle strength that causing greater risk of falls.

In this study muscular strength and flexibility have improved which might have both direct and indirect influence to improve balance. Raghuraj & Telles (21) have indicated that YBM practice improves balance due to positive effect of diaphragmatic breathing on brain and better neural recruitment and function at the mesencephalic region. Ray, et al. (7); Lau and Woo (1); Rathod and Jiwtode (29) have found yoga practice improves muscle strength-endurance which may be responsible for delayed fatigue, as it takes place in antigravity muscles as a result of alternating recruitment of different groups of motor units during muscle contraction. This also indicates possible well-co-ordinated reciprocal action of synergic and antagonistic muscles which has been brought about through the practice of *yogasanas* with its slow and steady movement to achieve final static postures.

Muscular Strength and Muscular Endurance

Yogasanas are mainly isometric type of exercise. It helps to improve muscular strength as it is found in any resistive exercise. *Yogasana* training has helped to improve muscular strength, though to a lesser extent, by better neural drive from brain involving both the mechanisms of recruitment and rate coding of muscle contraction to achieve greater force. During *yogasana* practice in final position, holding the posture for a period of >20 secs. with controlled breathing is being recognised as some of the most important element to get better response in the muscle. Improved muscle strength-endurance by yoga practice (1, 7, and 29) may be responsible for this as it may happen due to delayed fatigue. Ray, et al. (7) have reported that yoga exercises help in significant improvement in endurance time with decreased biceps and triceps muscle EMG amplitude, indicating better recruitment of muscles fibres, in the sense of economic use of it in execution of a task, among yoga practitioners. They also noted the delay in onset of fatigue. In this study LHGS endurance and RHGS endurance have improved by 19% and 23.1% respectively by yoga practice, in spite of maximal muscular strength in both hands have improved in very lower magnitude (only 1.3% to 1.8%). So, the effect of *yogasanas* is more in muscular strength endurance than in maximal muscular strength. This might have been possible by efficient muscle fibre recruitment, better muscle blood flow and better management of anaerobic metabolites like lactic acid and oxidative stress. Many of these have been indicated by Ray et al. (7) while reporting the muscular strength endurance by yoga. Aging per se increases the oxidative stress of a person, but yogic practices help in balancing it by shifting it more to antioxidant activity with better oxidative stress management (30). All our study participants are blue-collar workers and have been attached in different types of manual works requiring better local muscular strength. So they have greater muscular strength at the base line itself as compared to younger age group (as reported in other studies). So, possibly greater duration and intensity of yoga training could have brought about more improvement in maximal strength.

Visual and Auditory Reaction Time

Reaction time depends on afferent sensory neural processing speed with respect to specific sensory cue, central neural processing of it, to trigger the appropriate specific task. This is also true for the execution of a task, which depends on efferent motor conduction speed. This ultimately helps a person to complete the task (here pressing the button) as quick as possible. Studies of Takroo, et al. (31) have shown improvement in motor and sensory conduction of median nerve and

positive changes in visual evoked potential activity along with improved ART and VRT by yoga practices. The studies of Malhotra, et al. (32) also have indicated improvement in motor nerve conduction velocity after yoga practice. There are also studies showing improvement in auditory evoked potential after practicing YBM indicating better auditory neural processing (33). Our study also showed magnitude of improved of VRT and ART is greater in second half of training due to more YBM practice. Even by yoga practice, the middle aged persons in our study could not achieve the magnitude of improvement as is possible through yoga among younger age group as found by us (our unpublished observation) and also by others (24,25). Another study (34) has reported that reaction time in signal detection task in different age groups; older group has lesser response speed than younger groups because of aging related decline in speed of neural process.

YBM counteracting detraining effects of muscular strength, flexibility and balance

Training and detraining effects depend on training load. It is an important factor of physical training which is determined by on FITT formula (Frequency, Intensity, Types and Time). In this study after 6th week, duration of *yogasanas* practice gradually reduced but YBM practice time was increased. For this reason, after 12th week the magnitude of improvement of flexibility, balance, strength and strength endurance are less but there is no decline. It has been found (35) that *pranayama* training decreases sympathetic activity, resulting in mental relaxation and a relative decrease in autonomic arousal with decreasing force fluctuations during isometric contraction with improvement in HGS and HGS-endurance. During some of the YBM practice, specific pattern of using the fingers called *Mudras* in yogic parlance may have also effect, as this has also been reported to have influenced HGS (29). In our study, during the 2nd half of yoga training, the expected detraining effect with deterioration in various parameters in absence of *yogasana* practice, has not been found fully in all parameters, possibly due to the greater duration of YBM practice. Further studies may reveal detail mechanisms in this regard.

Conclusion

Yogasana practice helps in the improvement of body flexibility, balance, muscular strength endurance and reaction time. Its detraining effects may be controlled by YBM practice among middle aged persons. YBM have another possibility to improve reaction time. The deterioration of the capacity of those physical fitness components, which gets affected due to aging may be arrested and regained by *yoga*. To develop physical fitness in different age groups one needs to follow different yogic protocols considering training duration, intensity and types. Many investigations reported that YBM and *yoga* as such have famous psychophysiological effects. This may have application in physical training programme and sports, whenever detraining takes place due to any condition like periodization of training as well as during recuperative phase of patients with sports related injuries or any reason, when physical training involving the use of different body parts is not possible due to disability.

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