

“Effects of Selective Hatha Yoga Practices on Pulmonary Function and Chest Mobility Among Working Police Personnel of Himachal Pradesh: A Quasi-Experimental Study”

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ABSTRACT

Background: Occupational duties among police personnel involve prolonged sedentary postures, irregular shift patterns, and chronic psychophysiological stress, all of which can compromise respiratory efficiency and thoracic mobility over time. Hatha Yoga, incorporating asana, pranayama, and relaxation techniques, has been proposed as a low-cost intervention capable of improving ventilatory function in occupationally exposed adult populations.

Objective: This study examined the effect of a twelve-week selective Hatha Yoga intervention on Peak Expiratory Flow Rate (PEFR) and chest expansion among working police personnel in Himachal Pradesh.

Methods: A quasi-experimental, pre-test post-test control group design was adopted. Eighty police personnel (40 experimental, 40 control), aged 19–58 years, were assigned through purposive sampling. The experimental group undertook a supervised Hatha Yoga protocol comprising asana, pranayama, and relaxation practices for 40 minutes per session, five days per week, over twelve weeks, while the control group continued routine duties without intervention. PEFR was recorded using a peak flow meter and chest expansion using a flexible measuring tape; both were assessed before and after the intervention period. Within-group change was analysed using the paired sample t-test, and post-test differences between groups were analysed using the independent sample t-test.

Results: The experimental group showed a statistically significant increase in PEFR from pre-test to post-test (429.38 ± 55.77 to 436.25 ± 53.21 L/min; $t = -4.775$, $p < 0.001$), whereas the control group showed no change ($t = 0.000$, $p = 1.000$). Chest expansion increased significantly in both groups (experimental: 4.34 ± 0.48 to 4.44 ± 0.48 cm, $t = -5.291$, $p < 0.001$; control: 4.50 ± 0.47 to 4.53 ± 0.45 cm, $t = -2.317$, $p = 0.026$), with a numerically larger mean change in the experimental group. Between-group comparisons at post-test were not statistically significant for either PEFR ($t = -0.529$, $p = 0.598$) or chest expansion ($t = 0.837$, $p = 0.405$).

Conclusion: A twelve-week selective Hatha Yoga intervention produced significant within-group improvement in PEFR and chest expansion among police personnel, though these gains did not translate into a statistically significant between-group advantage over usual duty routine at post-test. The findings support the physiological plausibility of yoga-based respiratory training in occupational health promotion for police personnel, while indicating that longer intervention periods or larger samples may be required to detect between-group effects.

Keywords: Hatha Yoga; Peak Expiratory Flow Rate; chest expansion; police personnel; occupational health; pranayama

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INTRODUCTION

Policing places sustained physical and psychological demands on the personnel who carry it out. Long hours of vehicle patrol, static guard duty, and desk-based administrative work leave police officers with comparatively little built-in opportunity for the kind of movement and controlled breathing that support respiratory conditioning. Recent occupational health research on police forces situates this pattern within a broader picture of elevated cardiovascular and metabolic risk: cross-sectional work comparing police officers with office workers has found that a majority of both groups fall

below recommended cardiorespiratory fitness thresholds, with sedentary duty time identified as a central contributor (Dicks et al., 2023). In the Indian context specifically, a yoga-augmented fitness evaluation among Delhi police personnel documented measurable deficits in baseline pulmonary parameters before intervention, reinforcing that this is not solely a concern reported in Western policing literature (Naulakha et al., 2023).

Hatha Yoga — the integration of postural practice (asana), regulated breathing (pranayama), and structured relaxation — has accumulated a

substantial evidence base as a means of improving pulmonary function in populations ranging from asthmatic patients to healthy working adults. Controlled work combining pranayama with endurance training has produced significant gains in peak expiratory flow among adult patients (Nur et al., 2020), while a six-week yoga training protocol produced significant increases in chest wall expansion alongside respiratory muscle strength in healthy adult subjects (Mongkol, 2016). Mechanistically, regular pranayama practice is understood to recruit and condition both the primary and accessory muscles of respiration, encourage fuller diaphragmatic excursion, and progressively increase the mechanical compliance of the thoracic cage — effects that plausibly extend to occupational groups such as police personnel, whose duty structure otherwise provides little systematic respiratory training (Ankad et al., 2011; Nair et al., 2020).

Yoga-based intervention research conducted directly with police populations remains comparatively sparse, but the studies that exist are instructive. A six-month randomised controlled trial of yoga breathing among German police academy trainees found significant blood pressure reductions and improved resilience in the yoga group, while the untreated control group's physiological and psychological indicators worsened over the same period — a finding that underscores how routine duty alone, without a structured wellness intervention, does not protect against progressive strain in this occupational group (Koch et al., 2022). A pilot Kripalu yoga program delivered to police academy trainees over a small number of sessions likewise reported early signals of reduced tension and fatigue, though its brief duration and absence of a control group limited the strength of its conclusions (Jeter et al., 2013). Beyond direct intervention studies, survey and rehabilitation-planning research on serving police officers — including a large multi-unit survey of Ukrainian police personnel — has consistently identified structured physical and psychological recovery practices as an unmet institutional need (Bondarenko et al., 2021), a picture echoed in Indian research documenting the work-life strain reported by police personnel of Himachal Pradesh specifically (Kaushal & Parmar, 2019).

Review of Literature

The literature bearing on the present study can be organised around three related strands: the general evidence for yoga's effect on pulmonary function and chest mechanics, the more limited evidence specific to police and other occupational populations, and the regional context of police health in Himachal Pradesh.

Evidence for yoga's respiratory effects in general adult populations is comparatively well established and has grown substantially over the past two

decades. A systematic review and meta-analysis of twenty studies concluded that yogic intervention produces significant improvements in pulmonary function and respiratory muscle strength parameters in healthy individuals (Bhagel & Saha, 2021), and a subsequent systematic review of intervention studies reached a similar conclusion regarding yogic exercise and respiratory health indices more broadly (Chahal & Tyagi, 2023). At the level of individual studies, this pooled evidence is well supported: healthy adults practising yoga over an extended period have shown significantly better pulmonary function than sedentary comparison groups (Vedala et al., 2014), and comparative work has found yoga practice to confer respiratory benefits at least comparable to swimming among previously sedentary subjects (Gupta & Sawane, 2012). Structured pranayama practice over twelve weeks has been shown to improve ventilatory function relative to baseline in healthy volunteers (Halder et al., 2012), and combined Hatha yoga and Omkar meditation programs have produced measurable gains in cardiorespiratory performance alongside favourable changes in psychological and neuroendocrine profiles (Harinath et al., 2004). Even brief, single-session pranayama exposure has produced immediate, statistically significant increases in peak expiratory flow rate and other spirometric parameters in healthy adults (Kakkar et al., 2026), and short structured protocols specifically targeting peak expiratory flow rate have replicated this effect (Shilpa & Veena, 2020).

On chest expansion specifically, the evidence is smaller but directionally consistent with the pulmonary function literature. A six-week yoga protocol produced significant increases in chest wall expansion and respiratory muscle strength in healthy female subjects (Mongkol, 2016), a finding that itself drew on earlier Thai research demonstrating that yoga practice increases chest wall expansion and lung volumes in young, healthy adults (Chanavirut et al., 2006). Occupationally exposed but otherwise healthy adults — such as chefs working around cooking fumes — have likewise shown improved chest expansion and breath-holding time following structured yoga and pranayama practice (Nair et al., 2020), and working women engaged in a structured yogic training program have shown significant improvements across physiological variables relevant to respiratory and chest-wall function (Kurwale & Gadkari, 2014). A regional Indian study examining a range of pulmonary parameters — including peak expiratory flow rate and breath-holding time — alongside yoga practice similarly reported significant gains after training (Sharma et al., 2022), and yoga-based regimens have produced measurable pulmonary improvement even in clinical populations with baseline respiratory compromise, such as patients with coronary artery disease (Yadav et al., 2015) and

previously inactive middle-aged adults (Yamamoto-Morimoto et al., 2019). Respiratory muscle strengthening effects of yogic training have also been demonstrated outside the adult population, in a randomised trial of yoga training and detraining among pre-pubertal children (D'Souza & Avadhany, 2014), lending some support to the view that these respiratory adaptations are not confined to a narrow age band, though direct extrapolation from a paediatric sample to working adults should be made cautiously. Foundational work on short-term pranayama and meditation similarly reported measurable improvements in cardiovascular and respiratory function in healthy volunteers, lending further support to the physiological plausibility of the mechanisms invoked here (Ankad et al., 2011). The occupational and police-specific literature, while smaller, converges on two consistent findings. First, police personnel as an occupational group tend to fall below general cardiorespiratory fitness benchmarks, a pattern documented in comparative work against office workers and attributed substantially to the sedentary character of much police duty (Dicks et al., 2023); a fitness-training evaluation among Delhi police personnel that incorporated a structured yoga component similarly identified baseline pulmonary and physiological limitations prior to intervention (Naulakha et al., 2023). Second, where yoga has been trialled specifically with police cohorts, the outcomes assessed have concentrated on cardiovascular and psychological measures rather than respiratory ones: a rigorously designed six-month randomised trial among German police trainees found significant reductions in blood pressure and perceived stress in the yoga group, alongside a corresponding deterioration in these same measures in the untreated control group over the same period (Koch et al., 2022), and a brief Kripalu yoga pilot with police academy trainees reported early, though methodologically limited, improvements in tension and fatigue (Jeter et al., 2013). Neither study measured pulmonary or chest-wall outcomes, leaving this specific respiratory dimension of police occupational health without direct controlled evidence.

Contextual and survey research reinforces the practical relevance of this gap. A large multi-unit survey of Ukrainian police officers identified structured physical and psychological recovery practices as inadequately provided for within existing service conditions (Bondarenko et al., 2021), while research specific to Himachal Pradesh has documented meaningful work-life strain among police personnel of the state, particularly among younger officers (Kaushal & Parmar, 2019). Taken together, this body of work establishes both the physiological plausibility of a Hatha Yoga effect on PEFR and chest expansion, drawn from a broad and largely consistent general and occupational yoga

literature, and the practical and regional relevance of testing that effect directly in a serving Himachal Pradesh police cohort — the gap the present study was designed to close.

Research Gap

Two features of the existing literature, taken together, define the gap the present study addresses. First, while the pulmonary and thoracic benefits of Hatha Yoga have been documented with reasonable consistency in clinical samples, healthy young adults, and occupationally exposed groups such as chefs and asthmatic patients (Nair et al., 2020; Nur et al., 2020; Mongkol, 2016), controlled, repeated-measures evidence specifically isolating Peak Expiratory Flow Rate and chest expansion as outcomes in a serving police cohort is scarce. Second, the small existing body of police-specific yoga research has concentrated overwhelmingly on cardiovascular and psychological outcomes — blood pressure, stress, and resilience (Koch et al., 2022; Jeter et al., 2013) — leaving the respiratory and thoracic-mechanical dimension of police occupational health comparatively underexamined, despite documented baseline pulmonary deficits in this population (Naulakha et al., 2023) and despite police officers' generally lower cardiorespiratory fitness relative to recommended benchmarks (Dicks et al., 2023). A quasi-experimental evaluation with objective, repeated-measures assessment of PEFR and chest expansion in a working police cohort in Himachal Pradesh therefore addresses a specific and currently underserved gap in this literature.

Problem Statement

There is a need to determine whether a structured, time-efficient Hatha Yoga protocol, deliverable within the constraints of police duty schedules, can produce measurable improvement in ventilatory capacity and chest mobility among working police personnel, and whether such improvement is sufficient to distinguish an intervention group from personnel following routine duty alone.

Objectives

1. To assess the effect of a twelve-week selective Hatha Yoga intervention on Peak Expiratory Flow Rate among working police personnel.
2. To assess the effect of the same intervention on chest expansion among working police personnel.
3. To compare post-intervention PEFR and chest expansion between the experimental and control groups.

Hypotheses

H1: Selective Hatha Yoga practices will produce a statistically significant improvement in PEFR among the experimental group compared to pre-test values.

H2: Selective Hatha Yoga practices will produce a statistically significant improvement in chest expansion among the experimental group compared to pre-test values.

H3: Post-test PEFR and chest expansion will differ

significantly between the experimental and control groups.

Materials and Methods

Research Design: A quasi-experimental, pre-test post-test control group design was employed.

Participants and Sampling: Eighty serving police personnel from Police Line Solan, Himachal Pradesh, were recruited through purposive (non-random) sampling and allocated to experimental ($n = 40$) and control ($n = 40$) groups. Participants ranged in age from 19 to 58 years, distributed evenly across four age bands (19–28, 29–38, 39–48, 49–58 years; $n = 20$ per band, 10 per group within each band).

Ethical Approval: The study was conducted following institutional ethical approval (reference: SU/IEC/25/05).

Study Procedure and Yoga Intervention: The experimental group underwent a supervised Hatha Yoga protocol comprising asana, pranayama, and relaxation techniques, conducted for 40 minutes per

session, five days per week, over twelve weeks. The control group continued routine police duties without any structured intervention during this period.

Variables: The present manuscript reports on two physiological variables — Peak Expiratory Flow Rate (PEFR) and chest expansion.

Statistical Analysis: Within-group pre-test to post-test comparisons were performed using the paired sample t -test for both groups separately. Between-group comparisons of post-test scores were performed using the independent sample t -test, with Levene's test used to verify the assumption of homogeneity of variances before interpretation. A p -value of less than 0.05 was considered statistically significant.

Results

Table 1 presents the distribution of participants by study group, and Table 2 presents their distribution by age group.

Table 1. Distribution of Participants According to Study Group

Study Group	Frequency (n)	Percentage (%)
Control Group	40	50.0
Experimental Group	40	50.0
Total	80	100.0

Table 2. Distribution of Participants According to Age Group

Age Group (Years)	Control Group	Experimental Group	Total	Percentage (%)
19–28	10	10	20	25.0
29–38	10	10	20	25.0
39–48	10	10	20	25.0
49–58	10	10	20	25.0
Total	40	40	80	100.0

Peak Expiratory Flow Rate. Table 3 presents the within-group comparison of pre-test and post-test PEFR. The control group showed no change in mean PEFR (429.13 ± 67.03 to 429.13 ± 66.44 L/min; $t = 0.000$, $p = 1.000$). The experimental group showed a statistically significant increase in mean PEFR, from 429.38 ± 55.77 to 436.25 ± 53.21 L/min (mean difference = -6.88 , $t = -4.775$, $p < 0.001$).

Table 3. Comparison of Pre-test and Post-test Peak Expiratory Flow Rate Within the Control and Experimental Groups (Paired Sample t -test)

Group	Pre-test (Mean $\pm$ SD)	Post-test (Mean $\pm$ SD)	Mean Difference	t-value	p-value
Control Group	429.13 ± 67.03	429.13 ± 66.44	0.00	0.000	1.000
Experimental Group	429.38 ± 55.77	436.25 ± 53.21	-6.88	-4.775	<0.001*

*Significant at $p < 0.05$

Table 4 presents the comparison of pre-test and post-test Peak Expiratory Flow Rate (PEFR) within the control and experimental groups. In the control group, the mean PEFR remained unchanged at 429.13 ± 67.03 L/min during the pre-test and 429.13 ± 66.44 L/min at the post-test. The paired sample t -test indicated **no statistically significant difference** ($t = 0.000$, $p = 1.000$).

In the experimental group, the mean PEFR increased from 429.38 ± 55.77 L/min at pre-test to $436.25 \pm$

53.21 L/min at post-test. The paired sample t -test revealed that this increase was **statistically significant** ($t = -4.775$, $p < 0.001$), indicating that the selective Hatha Yoga intervention significantly improved Peak Expiratory Flow Rate among the participants, consistent with earlier reports of improved ventilatory capacity following regular pranayama practice (Ankad et al., 2011).

Mean Pre-test and Post-test Peak Expiratory Flow Rate Scores of the Control and Experimental Groups

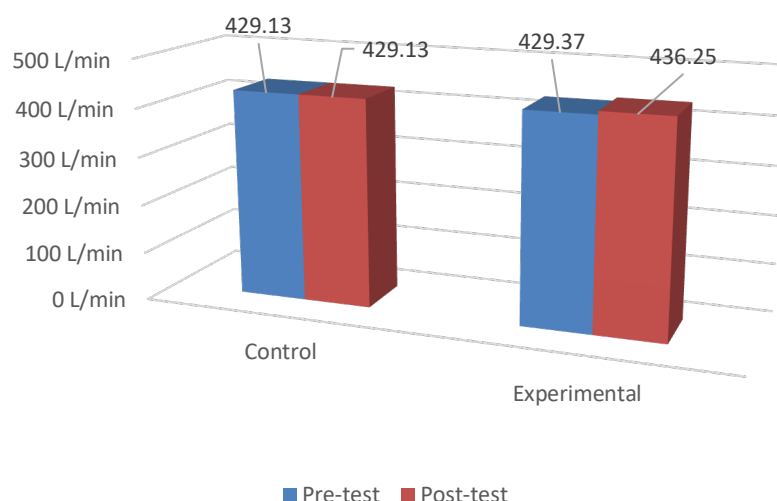


Figure 1: Mean Pre-test and Post-test Peak Expiratory Flow Rate (PEFR) Scores of the Control and Experimental Groups

Interpretation

Figure 1 presents the mean pre-test and post-test Peak Expiratory Flow Rate (PEFR) scores of the control and experimental groups. The control group showed virtually no change in PEFR between the pre-test and post-test assessments. In contrast, the

experimental group demonstrated an increase in post-test PEFR following the selective Hatha Yoga intervention. The graphical findings support the statistical results, indicating improved pulmonary function among the participants who received the yoga intervention.

Table 4. Comparison of Post-test Peak Expiratory Flow Rate Between the Control and Experimental Groups (Independent Sample t-test)

Variable	Control Group (Mean $\pm$ SD)	Experimental Group (Mean $\pm$ SD)	Mean Difference	t-value	p-value
PEFR (L/min)	429.13 $\pm$ 66.44	436.25 $\pm$ 53.21	-7.125	-0.529	0.598

Chest Expansion. Table 5 presents the comparison of post-test Peak Expiratory Flow Rate (PEFR) between the control and experimental groups using the independent sample *t*-test. Levene's test indicated that the assumption of homogeneity of variances was satisfied ($F = 3.833$, $p = 0.054$); therefore, the results corresponding to the equal

variances assumed row were considered for interpretation. The mean post-test PEFR was **429.13 $\pm$ 66.44 L/min** in the control group and **436.25 $\pm$ 53.21 L/min** in the experimental group. Although the experimental group had a higher mean PEFR than the control group, the difference was **not statistically significant** ($t = -0.529$, $p = 0.598$).

Table 5. Comparison of Pre-test and Post-test Chest Expansion Within the Control and Experimental Groups (Paired Sample t-test)

Group	Pre-test (Mean $\pm$ SD)	Post-test (Mean $\pm$ SD)	Mean Difference	t-value	p-value
Control Group	4.50 $\pm$ 0.47	4.53 $\pm$ 0.45	-0.03	-2.317	0.026*
Experimental Group	4.34 $\pm$ 0.48	4.44 $\pm$ 0.48	-0.10	-5.291	<0.001*

*Significant at $p < 0.05$

Table 6 presents the comparison of pre-test and post-test chest expansion within the control and experimental groups. In the control group, the mean chest expansion increased slightly from **4.50 $\pm$ 0.47 cm** at pre-test to **4.53 $\pm$ 0.45 cm** at post-test. The

paired sample *t*-test indicated that this increase was **statistically significant** ($t = -2.317$, $p = 0.026$).

In the experimental group, the mean chest expansion increased from **4.34 $\pm$ 0.48 cm** at pre-test to **4.44 $\pm$ 0.48 cm** at post-test. The paired sample *t*-test

revealed that this improvement was **highly statistically significant** ($t = -5.291$, $p < 0.001$), indicating that the selective Hatha Yoga intervention significantly improved chest expansion among the

participants. Comparable improvements in chest expansion following structured pranayama and yoga practice have been documented in occupationally exposed adult populations.

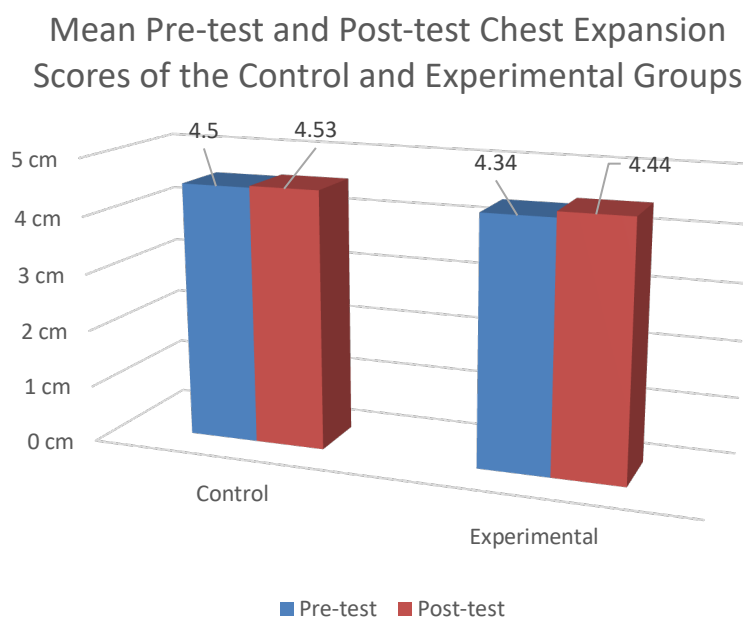


Figure 2: Mean Pre-test and Post-test Chest Expansion Scores of the Control and Experimental Groups

Interpretation

Figure 2 illustrates the mean pre-test and post-test chest expansion scores of the control and experimental groups. The control group exhibited only a marginal increase in chest expansion over the study period, whereas the experimental group

showed a greater improvement following the selective Hatha Yoga intervention. The graphical trend is consistent with the statistical findings, suggesting that the yoga practices enhanced thoracic mobility and respiratory efficiency among the participants.

Table 6. Comparison of Post-test Chest Expansion Between the Control and Experimental Groups (Independent Sample t-test)

Variable	Control Group (Mean $\pm$ SD)	Experimental Group (Mean $\pm$ SD)	Mean Difference	t-value	p-value
Chest Expansion (cm)	4.53 $\pm$ 0.45	4.44 $\pm$ 0.48	0.088	0.837	0.405

Table 6 presents the comparison of post-test chest expansion between the control and experimental groups using the independent sample *t*-test. Levene's test indicated that the assumption of homogeneity of variances was satisfied ($F = 0.130$, $p = 0.719$); therefore, the results corresponding to the equal variances assumed row were considered for interpretation. The mean post-test chest expansion was 4.53 ± 0.45 cm in the control group and 4.44 ± 0.48 cm in the experimental group. The independent sample *t*-test revealed no statistically significant difference between the two groups ($t = 0.837$, $p = 0.405$).

Discussion

The present findings indicate that a twelve-week selective Hatha Yoga intervention produced a statistically significant within-group improvement in PEFR among police personnel who undertook the

practice, while the control group, continuing routine duty alone, showed no measurable change. This pattern is consistent with the proposed mechanism by which regular pranayama practice strengthens the muscles of respiration and enhances lung ventilatory efficiency, a mechanism previously reported in occupational and general adult populations undertaking structured pranayama training (Ankad et al., 2011).

Chest expansion improved significantly in both groups, though the magnitude of improvement was numerically larger in the experimental group. The improvement observed even within the control group may reflect a degree of natural adaptation, measurement learning effect, or residual physical activity inherent to police duty; nonetheless, the more pronounced gain among yoga practitioners aligns with previous evidence that structured pranayama and asana practice enhances thoracic

wall mobility in occupationally exposed adult cohorts (Nair et al., 2020).

Neither PEFR nor chest expansion differed significantly between groups at post-test. This suggests that while the yoga intervention produced a genuine physiological change relative to each participant's own baseline, the magnitude of that change was not large enough, or the sample not large enough, to separate the experimental group from the control group on a between-subjects comparison. This pattern — significant within-group improvement without a corresponding between-group difference — echoes the trajectory reported in the six-month police yoga trial of Koch et al. (2022), where the intervention group's gains were clear against its own baseline even though the study's control comparison told a story mainly of a deteriorating, untreated group rather than a large intervention-versus-control gap. Given that the present intervention ran for twelve weeks against Koch et al.'s six months, a longer protocol or a larger sample may be needed to convert the observed within-group respiratory gains into a statistically detectable between-group advantage.

Practical Implications

These findings suggest that structured Hatha Yoga practice, even within a modest 40-minute daily session, is capable of producing measurable within-individual improvement in respiratory and chest wall function among serving police personnel, supporting its consideration as a low-cost, low-equipment component of occupational wellness programmes for this workforce.

Strengths

The study employed a controlled, repeated-measures design with objective physiological outcome measures and a reasonably balanced sample across a wide adult age range, allowing within-group causal inference regarding the effect of the intervention.

Limitations

Participants were allocated through purposive rather than random sampling, which may introduce selection bias. The absence of a statistically significant between-group difference at post-test may reflect limited statistical power given the sample size, and the twelve-week duration may not have been sufficient to produce a between-group effect of detectable magnitude. Self-selection into duty schedules and lack of blinding of assessors are additional limitations common to applied occupational intervention research of this kind.

Future Recommendations

Future research employing randomised allocation, longer intervention duration, larger sample sizes, and multi-site recruitment across police departments would help clarify whether the observed within-group gains in PEFR and chest expansion can be extended to a detectable between-group effect.

Conclusion

A twelve-week selective Hatha Yoga intervention

produced statistically significant within-group improvement in both Peak Expiratory Flow Rate and chest expansion among working police personnel, supporting the physiological plausibility of yoga-based respiratory training in this occupational group, even though these gains did not reach statistical significance in a direct comparison against a non-intervention control group at post-test.

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