

ORIGINAL RESEARCH

Respiratory Symptom Composite, Individual Characteristics, and Area PM10 Measurements among Makassar Flour Mill Workers

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ABSTRACT

Introduction: This study described an unvalidated respiratory symptom composite, individual characteristics, and concurrent spirometric screening among flour mill workers in Makassar, with short-duration area PM10 measurements providing descriptive workplace context.

Methods: The cross-sectional study was conducted in December 2025. Archived aggregate tables included data for 87 workers; complete participation and source-data completeness could not be verified. The primary outcome was a study-specific, unvalidated 12-item composite using a $\geq 50\%$ affirmative-response threshold. Crude prevalence ratios (PRs) and odds ratios (ORs) with nominal 95% confidence intervals (CIs) were reconstructed from categorical counts. Ten 10-minute area PM10 measurements were summarized separately. The unverifiable adjusted model was removed.

Results: The composite threshold was met by 49/87 workers (56.3%). Crude PRs were 1.61 (95% CI 1.08–2.40) for the respiratory history composite, 2.44 (1.65–3.62) for service >5 years, and 2.62 (1.60–4.31) for former or current smoking versus never smoking. PPE use had a PR of 1.47 (0.996–2.180), and the exercise composite had a PR of 1.04 (0.72–1.52). Abnormal spirometric screening co-occurred with a higher composite-positive proportion (PR 2.56; 1.39–4.73), without implying a predictive relationship. PM10 ranged from 5 to 902 $\mu\text{g}/\text{m}^3$. Estimates were unadjusted and CIs did not account for possible work-area clustering.

Conclusion: Recorded individual characteristics differed in their crude association with the unvalidated symptom composite. These findings do not establish respiratory disease prevalence, independent determinants, or causation. Area measurements cannot establish individual PM10–symptom associations or regulatory compliance. The findings identify priorities for better-documented exposure assessment and respiratory surveillance.

Keywords: Flour Mill Workers; PM10; Respiratory Symptom Composite; Cross-Sectional Study; Spirometric Screening

INTRODUCTION

Flour milling can release airborne organic dust during cleaning, milling, handling, and packaging. Studies in flour mill workforces have documented respiratory symptoms and reduced spirometric indices, supporting occupational respiratory health as a relevant surveillance concern (1–4). A systematic review found lower pulmonary function measures among flour-exposed workers, while also identifying substantial heterogeneity and limitations in the underlying studies (5). These findings provide occupational context but do not establish exposure effects in every workplace. Flour dust contains multiple components capable of eliciting allergic and nonallergic responses, so a nonspecific symptom score cannot be equated with sensitization or baker's asthma (6,7). Research in bakery employees and trainee bakers has assessed allergen sensitization alongside respiratory outcomes, illustrating the value of keeping these constructs distinct (8,9).

Interpretation depends on what was measured. Self-reported symptoms, spirometric measurements, and airborne particle concentrations describe different aspects of respiratory health and the work environment. A study of textile workers used documented respirable-dust sampling and lung function testing (10); its exposure fraction and outcome definitions cannot be transferred directly to a short area PM10 assessment. Inhalable, respirable, and PM10 fractions are not interchangeable, and unit conversion alone does not make their sampling conventions or averaging periods equivalent (11). Spirometric classifications also require documented measurement quality and appropriate reference-based interpretation (12,13).

Individual characteristics can be associated with respiratory health without constituting independent causes. Smoking is relevant to the interpretation of occupational particle exposure; literature on impaired particle clearance provides a biological rationale, but an interaction cannot be assumed in a dataset that does not measure it (14). Service duration may be related to age and job assignment. Reported PPE use may follow symptoms or reflect dustier tasks, while a respiratory history composite may overlap with the symptom outcome. These possibilities require explicit consideration when interpreting cross-sectional comparisons.

The conceptual framework separates workplace context, individual characteristics, and concurrent health measures. Area PM10 provides environmental context only. Smoking, service duration, exercise, respiratory history, and PPE use are recorded characteristics for exploratory crude comparisons. Age, sex, work area, previous occupational exposure, and smoking intensity are potential confounders; height and reference-equation inputs are relevant to spirometric interpretation. Respiratory history could indicate susceptibility, but its timing is unknown. PPE could lie between workplace exposure and inhaled dose, or be adopted after symptoms; these alternative pathways cannot be distinguished. The symptom composite is the primary descriptive outcome, and spirometric screening is a separate concurrent measure, not an established causal predictor or mediator in this study.

The contextual gap is the limited characterization of the archived symptom composite and its distribution across recorded individual characteristics in this Seaside production workforce. The study contributes a transparent description of those distributions, together with exploratory area PM10 measurements. It does not resolve an individual exposure–symptom relationship. The objectives were to describe the study-specific symptom composite and spirometric screening categories, estimate crude associations between recorded individual characteristics and composite status, and summarize the 10 available area PM10 readings at PT Eastern Pearl Flour Mills, Makassar.

METHODS

Research type and study period

This analytical cross-sectional study involved workers in the Seaside production section of PT Eastern Pearl Flour Mills, Makassar. The reported data-collection period was December 2025. Exact recruitment, questionnaire, spirometry, and dust-measurement dates, their sequence, and whether procedures occurred on the same days or shifts were not documented in the records available for this revision. Temporal comparability and precedence therefore cannot be established. The present analyses reconstruct descriptive and crude comparisons from archived aggregate tables; they are not a reanalysis of verified individual-level records. The STROBE reporting framework identifies the participant selection, measurement, bias, and missing-data information needed to appraise observational studies; citing it does not establish that the unavailable study procedures met those requirements (15).

Population and sample

The original study described a census (total-sampling) approach targeting Seaside production workers. The number 87 represents the archived analytic sample as tabulated, rather than confirmed complete participation by all eligible workers. Beyond employment in the Seaside production section, detailed eligibility criteria, exclusion criteria, and the sampling-frame roster were unavailable. The numbers of workers invited, consenting, declining, excluded, absent, or unable to complete acceptable spirometry—and the reasons for these outcomes—could not be recovered from the available documents. A response rate and a verified participant-flow diagram therefore cannot be reported.

Table 2 distinguishes the denominators present in the aggregate tables from unverified missingness in the source records. Each categorical cross-tabulation totals 87, but this arithmetic does not demonstrate that the same 87 individuals had complete observations for every measure or that item-level responses were complete. Source-level missingness, exclusions, and any original imputation or complete-case rules remain unknown. No individual-level data were imputed for the present calculations. The reported census approach explains the intended study size; no prospective precision or power calculation was documented, and retrospective power is not inferred from statistical significance. Missing-data methods require

information and assumptions about the missingness process; the available aggregate totals cannot establish these assumptions or support a defensible individual-level imputation model (16).

Data collection procedures

Area PM10 measurements

The available record reports DustTrak measurements lasting 10 minutes at each of 10 named locations, with one reported PM10 value per location in $\mu\text{g}/\text{m}^3$. The device model, calibration factor, zero check, size-selective inlet, flow setting, sampling height, measurement times, task and ventilation conditions, repeated-reading schedule, and rule used to summarize readings were unavailable. These missing details prevent independent verification of the PM10 configuration and measurement reproducibility. Values are therefore presented as reported exploratory area readings rather than as verified full-shift personal exposure estimates.

The earlier analysis assigned area readings to workers, but the worker-to-location linkage and time spent in different areas could not be checked. No individual PM10 exposure was assigned in the revised analysis. Worker-group PM10 means and medians, the worker-level Mann–Whitney test, and the compliant/noncompliant dust classification were removed. Numerically, 5–902 $\mu\text{g}/\text{m}^3$ equals 0.005–0.902 mg/m^3 ; this conversion changes only units, not particle fraction or averaging time. Neither total-dust nor respirable-dust limits nor full-shift limits can be used to classify these short PM10 readings without a justified matching assessment. No occupational exposure-limit comparison or compliance determination was made (11).

Questionnaire measures

The primary outcome is an unvalidated, study-specific respiratory symptom composite based on 12 yes/no items and an original threshold of $\geq 50\%$ affirmative responses. Under a complete 12-item administration, that rule corresponds to at least six affirmative responses. Item wording, source instrument, recall period, translation procedures, validation and reliability evidence, and the empirical rationale for the threshold were unavailable. The item-level scoring implementation and handling of unanswered items could not be verified. Consequently, the archived positive/negative classification was retained without claiming that it diagnoses respiratory disease, measures chronic symptoms, or identifies every worker with any symptom. A negative composite does not establish the absence of symptoms. Methodological guidance distinguishes content validity, reliability, and other measurement properties; a numerical threshold alone does not demonstrate these properties (17,18).

The exercise composite used six yes/no items and a $\geq 50\%$ threshold; the respiratory history composite used 14 items and the same threshold. For complete questionnaires, these correspond to at least three and seven affirmative answers, respectively. Neither threshold was newly validated. Exercise frequency, intensity, duration, and recall period were unavailable, so the categories are described by the recorded score threshold rather than as verified routine exercise. The history composite is not a clinically confirmed prior diagnosis and could classify a person with a single important respiratory condition as below the threshold. Former and current smokers were combined in the archived category; separate status, amount, duration, and pack-years were unavailable. PPE use indicates reported mask use, with no verified type, fit, consistency, exposure-specific suitability, or observation protocol. Table 1 records these definitions and limits.

Spirometric screening

The original screening rule classified results as normal when percent-predicted forced vital capacity (FVC) was $\geq 75\%$ and the forced expiratory volume in one second/FVC ratio (FEV1/FVC) was $\geq 75\%$; other results were classified as abnormal. Device model, calibration and quality-control records, operator training, pretest conditions, number of maneuvers, acceptability and repeatability criteria, reference equations, predicted-value inputs, and contraindication handling were unavailable. Individual measurements and flow-volume curves were not available to reclassify participants. The original binary categories are retained solely as unverified study-specific screening categories.

ATS/ERS measurement and interpretation standards provide a basis for quality-assured spirometry and reference-based classification (12,13). They are not evidence that the procedures in this study met those standards or that fixed 75% thresholds are diagnostically valid. Obstructive, restrictive, and mixed disorders are not assigned from the archived binary labels; a reduced FVC alone does not confirm restriction. Spirometry remains a separate concurrent health measure and is excluded from any causal or multivariable prediction of the symptom composite. Reference-equation research illustrates the role of age-dependent normal limits, while occupational spirometry standards emphasize documented testing quality and longitudinal comparison when repeat measurements are available (19,20).

Table 1. Operational definitions and limits of interpretation

Measure	Recorded definition or rule	Role in this analysis	Interpretation limit
Symptom composite	12 yes/no items; $\geq 50\%$ affirmative = positive; $< 50\%$ = negative.	Primary outcome.	Unvalidated; items, recall period and missing-item rules unavailable. Negative does not mean symptom-free.
Exercise composite	6 yes/no items; $\geq 50\%$ versus $< 50\%$ affirmative.	Crude individual-characteristic comparison.	No verified frequency, intensity, duration, or validated cutoff.
Respiratory history composite	14 yes/no items; $\geq 50\%$ versus $< 50\%$ affirmative.	Crude individual-characteristic comparison.	Not a clinical diagnosis; timing and construct overlap unknown.
Service duration	> 5 versus ≤ 5 years, retained from original categorization.	Crude occupational-characteristic comparison.	No continuous tenure or historical dust dose; cutoff not newly validated.

Measure	Recorded definition or rule	Role in this analysis	Interpretation limit
PPE use	Reported use versus no use of a mask at work.	Crude individual-characteristic comparison.	No verified respirator type, fit, consistency, or observation method.
Smoking	Recorded former or current versus never smoking.	Crude individual-characteristic comparison.	Former and current smokers cannot be separated; pack-years unavailable.
Spirometric screening	Normal if FVC $\geq 75\%$ predicted and FEV1/FVC $\geq 75\%$; otherwise abnormal.	Concurrent screening only.	Quality and reference inputs unverified; not diagnostic or a causal predictor.
Area PM10	One reported 10-minute DustTrak value at each of 10 locations; $\mu\text{g}/\text{m}^3$.	Environmental description only.	Model, calibration, PM10 configuration, and personal linkage unverified.

All questionnaire thresholds above reproduce archived study rules; they are not newly established clinical or psychometric standards. The service-duration cutoff is retained for consistency with the tabulated data as a descriptive grouping, not a validated biological threshold. Dichotomizing continuous service duration also sacrifices information and limits evaluation of the shape of an association (21).

Table 2. Participant counts and variable-specific data availability

Stage or variable	Count documented in aggregate records	What remains unverified
Eligible, invited, and consenting workers	Not separately documented	Eligibility roster, participation rate and recruitment flow.
Excluded or nonparticipating workers; failed spirometry	Not separately documented	Numbers, reasons and handling of contraindications or unacceptable tests.
Archived analytic sample	87	Complete participation and completeness of linked individual records.
Symptom composite	49 positive + 38 negative = 87	Item-level missingness and source-level exclusions unknown.
Exercise composite	47 below + 40 at/above threshold = 87	Variable-specific source missingness and scoring exclusions unknown.
Respiratory history composite	45 at/above + 42 below threshold = 87	Variable-specific source missingness and scoring exclusions unknown.
Service duration	36 > 5 years + 51 ≤ 5 years = 87	Variable-specific source missingness unknown.
PPE use	45 use + 42 no use = 87	Variable-specific source missingness unknown.
Smoking category	47 former or current + 40 never = 87	Variable-specific source missingness unknown.
Spirometric screening	58 abnormal + 29 normal = 87	Source missingness, failed tests, and quality exclusions unknown.
Area PM10	10 locations with one reported value each	Additional readings, repeated samples, and worker linkage unknown.

Data analysis

The original analysis reportedly used SPSS, but its syntax, software version, individual-level dataset, and model matrix were unavailable. For this revision, categorical totals and percentages were checked against each reported 2×2 table. Composite-positive status was the event (1), and composite-negative status was the reference outcome (0). Crude PRs were calculated directly as the positive proportion in the comparison group divided by that in the specified reference group. Crude prevalence ORs were also reconstructed to retain comparability with the earlier report. Because 56.3% of the archived sample met the composite threshold, PRs are emphasized to avoid interpreting an OR as a prevalence or risk ratio (22). These calculations use aggregate counts and do not constitute an adjusted individual-level reanalysis.

For each comparison, a and b denote positive and negative counts in the comparison group, while c and d denote positive and negative counts in the reference group. The crude OR is ad/bc , and its log standard error is the square root of $1/a + 1/b + 1/c + 1/d$. The crude PR is $[a/(a+b)]/[c/(c+d)]$, and its log standard error is the square root of $1/a - 1/(a+b) + 1/c - 1/(c+d)$. Each nominal 95% CI was obtained by exponentiating the log estimate plus or minus 1.96 standard errors. No zero-cell correction was needed. Reference groups are explicit in Table 4. No new p values, significance-based variable selection, or rankings of “dominant” factors are used.

These conventional intervals assume independent observations and do not account for possible correlation among workers in the same area. They are exploratory uncertainty summaries conditional on the reported counts, not population-representative or cluster-adjusted intervals. Work-area identifiers and joint covariate data were unavailable, preventing cluster-adjusted estimates, age–tenure correlation or collinearity checks, confounder adjustment, and sensitivity analyses for alternative questionnaire thresholds. Multiple comparisons were exploratory and no multiplicity adjustment was applied. An intended census does not remove these measurement and inferential limitations. Confidence intervals are interpreted alongside these design and measurement limitations, rather than as a binary certificate of the presence or absence of an association (23).

The original adjusted regression estimates, including the PPE coefficient, were removed because event/reference coding and model construction could not be verified. No adjusted ORs or PRs are reported. Spirometric screening is presented only as a separate concurrent cross-tabulation. Classification accuracy and the Hosmer–Lemeshow output were also removed because the revised objective is not prediction and the underlying model is unverifiable. PM10 is described only for the 10 locations, without worker-level testing, a between-symptom-group effect estimate, or a confidence interval for an exposure–symptom association.

Ethical approval

This research was conducted after ethical approval was obtained from the Health Research Ethics Committee of the Faculty of Public Health, Hasanuddin University (approval number 2230/UN4.14.1/TP.01.02/2025). All participants received information about the purpose, procedures, benefits, and potential risks of the research before data collection. Those who agreed to participate were asked to sign an informed consent form. Participant identities and data were kept confidential, and all data were used only for research purposes.

RESULTS

Archived sample and outcome distribution

The aggregate records represented 87 workers, of whom 49 (56.3%) were composite-positive and 38 (43.7%) composite-negative. These proportions describe the unvalidated study-specific symptom classification, not the prevalence of clinically confirmed respiratory disease or of any respiratory symptom. The categorical tables included 47 workers below the exercise threshold, 45 at or above the history threshold, 36 with service >5 years, 45 reporting PPE use, and 47 in the combined former-or-current smoking category. Spirometric screening was recorded as abnormal for 58 (66.7%) and normal for 29 (33.3%). Table 2 reports the limits of denominator verification.

Descriptive area PM10 measurements

Table 3. Reported short-duration area PM10 measurements

Point	Location	Reported PM10 (µg/m ³)
1	Supply Store	21
2	Packaging Material	5
3	Pelletizing Area	56
4	Maintenance Mechanic	902
5	Warehouse	22
6	HSE Office	20
7	Packing Area	890
8	Milling Area	836
9	Wheat Silo	10
10	Jetty Ship	15

One 10-minute measurement was reported per location. These are area readings, not independent personal measurements or full-shift time-weighted averages. Reported PM10 ranged from 5 to 902 µg/m³. The highest readings were recorded at Maintenance Mechanic (902), Packing Area (890), and Milling Area (836); the lowest was recorded at Packaging Material (5). The observations identify locations for repeat assessment but do not demonstrate chronic personal exposure, noncompliance, or a PM10–symptom association.

Crude comparisons and concurrent screening

Table 4. Symptom composite status and reconstructed crude comparisons

Characteristic and category	Total n	Positive (%)	n	Negative n	Crude PR (95% CI)	Crude OR (95% CI)
Exercise composite	47	27 (57.4)	20		1.04 (0.72–1.52)	1.10 (0.47–2.58)
Below threshold						
At or above threshold (reference)	40	22 (55.0)	18		1.00	1.00
Respiratory history composite	45	31 (68.9)	14		1.61 (1.08–2.40)	2.95 (1.23–7.11)
At or above threshold						
Below threshold (reference)	42	18 (42.9)	24		1.00	1.00
Service duration	36	31 (86.1)	5		2.44 (1.65–3.62)	11.37 (3.76–34.33)
<5 years (reference)	51	18 (35.3)	33		1.00	1.00
Reported PPE use	45	30 (66.7)	15		1.47 (0.996–2.180)	2.42 (1.02–5.77)
No use (reference)	42	19 (45.2)	23		1.00	1.00
Smoking category	47	37 (78.7)	10		2.62 (1.60–4.31)	8.63 (3.27–22.83)
Former or current						
Never (reference)	40	12 (30.0)	28		1.00	1.00
Spirometric screening	58	41 (70.7)	17		2.56 (1.39–4.73)	6.33 (2.35–17.06)
Abnormal						
Normal (reference)	29	8 (27.6)	21		1.00	1.00

Positive = meeting the ≥50% threshold of the unvalidated 12-item symptom composite; negative = below that threshold, not necessarily symptom-free. Percentages use each row total. Every comparison totals 87; source missingness remains unknown as detailed in Table 2. All estimates are unadjusted and CIs are nominal, without work-area clustering adjustment. The PPE PR limits retain three decimals to show that the interval includes 1. Spirometric screening is a concurrent cross-tabulation only and is not interpreted as an exposure or independent determinant. PR, prevalence ratio; OR, prevalence odds ratio; CI, confidence interval.

Composite positivity was 68.9% versus 42.9% across the history-composite categories (PR 1.61; 95% CI 1.08–2.40), 86.1% versus 35.3% for service >5 versus ≤5 years (PR 2.44; 1.65–3.62), and 78.7% versus 30.0% for former or current versus

never smoking (PR 2.62; 1.60–4.31). These are crude differences in the archived sample. They cannot be attributed independently to the characteristics because joint confounding and work-area clustering were not addressed. For reported PPE use, composite positivity was 66.7% versus 45.2% among nonusers, giving a PR of 1.47 (95% CI 0.996–2.180) and an OR of 2.42 (1.02–5.77). The point estimate is above 1, but the PR interval includes 1; the result is therefore described as imprecise rather than as evidence of a harmful or protective PPE effect. Exercise-composite groups had similar positivity (57.4% versus 55.0%; PR 1.04; 0.72–1.52).

Composite positivity co-occurred with abnormal spirometric screening in 41/58 workers (70.7%), compared with 8/29 (27.6%) in the normal-screening category (PR 2.56; 95% CI 1.39–4.73). This comparison describes two contemporaneous classifications and does not validate either measure, establish a temporal pathway, or demonstrate diagnostic accuracy.

DISCUSSION

Meaning of the primary outcome and comparison with earlier studies

The main finding is that 49 of the 87 tabulated workers met the study-specific symptom-composite threshold, with variation across several recorded characteristics. The appropriate interpretation concerns an unvalidated questionnaire classification. Without the original items, recall period, and threshold justification, its clinical meaning and comparability with other symptom instruments remain uncertain. The 56.3% proportion must not be relabeled as confirmed respiratory disease, impaired lung function, chronic symptoms, or the proportion with any symptom. Established questionnaire-evaluation criteria reinforce the need to document item content and measurement properties before assigning clinical meaning to a composite score ([17,18](#)). Lagiso and colleagues reported chronic respiratory symptoms in 56.6% of flour mill workers using a different, explicitly described questionnaire definition ([1](#)). Despite the numerical similarity, their estimate and the present 56.3% composite-positive proportion do not measure an established identical construct. The Addis Ababa study also examined chronic respiratory symptoms in flour mill workers ([2](#)). These studies support the relevance of respiratory surveillance in flour processing, but they cannot validate the present cutoff. The systematic review of pulmonary function among flour mill workers concerned objective spirometric indices and noted limitations in study quality and heterogeneity ([5](#)); it should not be used to equate this symptom composite with physiological impairment. Comparative studies by Demeke and Haile and by Mekonnen and colleagues likewise used explicitly described symptom assessments; they provide occupational context rather than validation of the current 12-item threshold ([3,4](#)).

What the area measurements can support

The 10 reported area readings show substantial variation across sampled locations. Maintenance, packing, and milling merit more detailed exposure characterization, but a short measurement at a location cannot stand in for every worker's inhaled dose over a shift or employment history. No worker-level dust effect or null association can be concluded because the revised analysis does not test that relationship. The removal of worker-group PM10 means and medians also prevents an unverified area assignment from being interpreted as an individual exposure gradient.

An improved assessment would document the particle fraction, device and calibration, sampling location and duration, tasks, ventilation, repeated measurements across shifts, and personal breathing-zone sampling where appropriate. The measurement fraction and averaging period would then need to match the intended interpretation ([11](#)). The respirable-dust protocol in the Myanmar textile study illustrates a different documented sampling strategy ([10](#)), not a threshold that can be applied to these PM10 readings. Unknown temporal and spatial variability could attenuate or distort an exposure association; its direction cannot be quantified here. Page and colleagues combined personal breathing-zone and general-area measurements of inhalable flour dust with allergen assessments, demonstrating a more specific exposure-characterization strategy than a single unlinked area reading ([8](#)).

Individual characteristics and uncertainty

The history composite showed a crude PR of 1.61, but both history and symptom classifications derive from self-report. The history threshold could miss an individual with one clinically important condition, and overlapping items or a shared reporting tendency could inflate their association. The timing of any underlying disease relative to work exposure or present symptoms is unknown. This finding therefore cannot establish prior disease as an independent determinant.

The tenure comparison showed a PR of 2.44, whereas its prevalence OR was 11.37. The contrast illustrates why the OR must not be described as an elevenfold prevalence or risk increase when the outcome is common ([22](#)). Studies in flour and textile workforces have also examined service duration ([1,10](#)), but differences in outcomes and adjustment prevent direct comparison of effect magnitudes. Age, job assignment, past exposures, and selection into continued employment could explain part of the present difference; the latter is a recognized concern in occupational epidemiology ([24](#)). Historical dust levels and age–tenure correlations were unavailable, so tenure is not interpreted as measured cumulative dose.

Reported PPE use had an imprecise crude PR of 1.47. Different nominal intervals for the PR and OR can straddle the null differently because the measures and their log-scale approximations differ; this is not a basis for choosing a preferred significance result ([23](#)). More symptomatic workers may adopt masks, and more exposed jobs may require them, but these are untested alternatives. Mask type, fit, and consistency were not established. The earlier adjusted PPE coefficient was removed because its event/reference coding and model matrix could not be verified; no coding explanation or protective adjusted effect is claimed.

The combined former or current smoking group had a crude PR of 2.62. Literature provides a biological rationale for smoking to affect particle clearance ([14](#)), but this study did not measure that mechanism or test interaction with flour dust. Combining

former and current smokers obscures differences in dose and cessation; cessation after illness may also affect interpretation. Pack-years, passive exposure, and joint confounder data were unavailable. The association is therefore exploratory and not an estimate of an independent smoking effect.

The exercise-composite comparison was imprecise (PR 1.04; 95% CI 0.72–1.52). Its categories do not represent a verified activity dose, and symptoms may themselves influence activity. The estimate cannot establish that exercise is ineffective, protective, or equivalent between groups (23). Interpretation is restricted to the recorded composite categories.

Concurrent spirometric screening

The symptom composite and abnormal spirometric screening co-occurred more often than the composite and normal screening. Because both were contemporaneous health measures, spirometry was not used as an independent explanatory variable in an adjusted symptom model. The absence of raw values, maneuver-quality documentation, and reference inputs prevents confirmation of physiological impairment or reclassification into obstructive, restrictive, or mixed patterns. Technical standards are cited to explain the missing requirements, not to certify the archived tests (12,13,20). A normal archived screening label likewise does not exclude disease.

Limitations and generalizability

Several limitations determine the scope of inference. Cross-sectional timing does not establish temporality and allows reverse causation for PPE and exercise. Unknown recruitment and exclusion counts prevent assessment of nonparticipation and failed-test bias. A healthy-worker survivor effect could reduce the observed burden if less healthy workers left employment, while selective participation could bias estimates in either direction (24). Equal aggregate denominators do not prove complete linked data; unrecorded missingness or exclusions could also change the estimates.

Unvalidated questionnaire cutoffs, missing recall periods, and unverified spirometry may misclassify both the outcome and comparison variables. Differential reporting or overlap between history and symptoms could increase associations, whereas other misclassification could weaken or otherwise distort them. These directions cannot be assumed without validation data. Confounding by age, sex, work area, previous exposure, and smoking intensity remains unresolved (15). Conventional CIs may be too narrow if workers within areas are positively correlated, and the exploratory multiple comparisons may include chance findings. Several estimates remain imprecise even before accounting for these additional uncertainties.

The data concern one company and an incompletely documented analytic sample. They do not support extrapolation to all flour mill workers, regulatory compliance findings, or a predictive risk model. The main contribution is a transparent reconstruction of tabulated associations and a description of available area readings. Recovery of the original questionnaires, participant records, measurement logs, and individual-level dataset would be required to investigate the unresolved measurement and analytic issues; wording changes alone cannot repair those limitations. If adequate individual-level records are recovered, direct ratio-estimation approaches, including appropriately specified log-binomial or robust Poisson models, could be considered for adjusted analyses; these methods cannot reconstruct absent covariates or correct an unvalidated outcome (22,25).

Implications for workplace assessment

Workplace action should prioritize documented assessment of dust generation and engineering controls at dusty tasks, supported by suitable respiratory protection and worker training. A review of baker's asthma prevention supports combining exposure control, worker education, exposure monitoring, and medical surveillance (26). A simulation study in bakery workers examined how prevention strategies may differ in their long-term impact; those modeled benefits should not be treated as observed effects in this workforce (27). Respiratory surveillance should use clearly defined symptom questions and quality-assured spirometry, with clinical follow-up when indicated (12,13,20). Smoking-cessation support can complement exposure control. These are preventive priorities informed by occupational evidence, not interventions whose effectiveness was demonstrated by this study.

CONCLUSION

In the archived tables for 87 Seaside production workers, 49 (56.3%) met an unvalidated respiratory symptom-composite threshold. Respiratory history, service duration, and recorded smoking showed higher crude composite-positive proportions in their comparison groups; PPE and exercise estimates were imprecise. Spirometric screening was a separate concurrent measure. None of these comparisons establishes independent determinants, causation, or clinical disease prevalence. The 10 short area PM10 readings provide environmental context only, without a worker-level exposure–symptom or compliance conclusion. Better-documented exposure assessment, validated symptom measurement, and quality-assured respiratory surveillance are needed.

DECLARATIONS

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