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Improving worker conditions in Brick kilns in Bangladesh

Submission date
02/10/2025

Recruitment status
No longer recruiting

Registration date
12/12/2025

Overall study status
Completed

Last Edited
16/07/2026

Condition category
Injury, Occupational Diseases, Poisoning

[_] Prospectively registered
[_] Protocol
[X] Statistical analysis plan
[_] Results
[_] Individual participant data
[X] Record updated in last year

Plain English summary of protocol
Background and study aims
Bangladesh's ~7,000 brick kilns contribute substantially to air pollution, responsible for 11% of the country's particulate matter, 22% of black carbon, and 17% of total annual CO2 emissions. In our earlier work, we developed an intervention, Zigzag 2.0 (ZZK2.0), an intervention offering kiln owners and operators low-cost training and technical support in kiln management and insulation. In a trial with 276 kilns in Khulna Division, 65% adopted the two most important components. Adoption led to 24% less coal use per 100,000 bricks, with 21% reductions in both CO_2 and PM2.5 emissions. At the request of the Ministry of Environment, Forest and Climate Change, icddr,b scaled the intervention across 1000 kilns in 2023-25.

Yet, brick kiln workers represent a particularly vulnerable population. Our past study also delivered information to owners on the importance of incentivising workers to adopt the technical practices, but it was found that owners did not take up these suggestions. A recent study also showed that about 70% workers reported a lack of personal protective equipment (PPE), exposing them to risk of burns, head injuries, eye irritation, and smoke inhalation. Most lack formal contracts and endure 12- to 16-hour shifts near 800°C chambers, often without shaded rest areas or safe water. Many are seasonal migrants trapped in debt-bondage arrangements, often bringing their entire families, resulting in a high child labor prevalence, estimated at 70% of kilns. These harsh work conditions cause highly elevated risks of dehydration, heat exhaustion, long-term health complications, and even death. At the same time, heat-related illness may lead to productivity losses for owners. Other trafficking indicators reported less commonly by workers include wage or benefits withholding.

The study aims to: 1. Measure uptake of different workplace improvement components and improvements in workplace infrastructure and practices (PPE availability, shaded rest areas, safe drinking water access, breaks during heat periods); 2. Evaluate impact on worker-reported occupational injuries, health outcomes, wage withholding and labor trafficking indicators, and well-being; and 3. Assess changes in physiological heat strain indicators (core body temperature, heart rate variability, hydration status).

Who can participate?
Brick kilns (owners) and kiln workers in Bangladesh.

What does the study involve?
The study will involve 200 brick kilns, which will be randomly assigned to either the intervention group (120 kilns) or the control group (20 kilns), with each kiln treated as a separate unit in the randomization process. The study will be implemented across Jashore, Jhenaidah and Satkhira in kilns where icddr,b has established working relationships through previous interventions. Eligible kilns are those that adopted the ZZK2.0 technical intervention in past projects with icddr, b. Intervention kilns will get an integrated training on worker conditions and improvements, as well as a refresher on the ZZK2.0 technical methods. Implementation teams will support kiln owners with planning and implementing the improvements in their kilns through the brick season. Control groups will only be surveyed at baseline and endline.

What are the possible benefits and risks of participating?
The possible benefits of participating are improvements in worker health and well-being, improved living and working conditions, improved occupational safety, and a reduction in workplace injuries, both for participants and other workers on participating brick kilns. If such benefits are associated with the intervention, a long-term benefit is that these practices may be scaled to other brick kilns in Bangladesh (or even across South Asia) to improve the health and well-being of kiln workers outside the study sample.

It is acknowledged that introducing changes to workplace practices and employment relationships carries potential risks, including the possibility of unintended negative consequences for workers, such as strained relationships with owners, reduced work opportunities, or retaliation. Risk mitigation measures include confidential reporting mechanisms for workers to raise concerns about negative impacts, regular monitoring by field staff trained to identify signs of adverse effects, established protocols for responding to reports of retaliation or harm, and a process for withdrawing kilns from the intervention if serious harms are identified.

Where is the study run from?
The study will be conducted in Bangladesh, where the implementing organization (icddr,b) will be running fieldwork. The study is collaboratively supervised by researchers at icddr,b, Stanford University (CA, USA), and University of Michigan (MI, USA).

When is the study starting and how long is it expected to run for?
November 2025 to May 2026

Who is funding the study?
Stanford University, USA

Who is the main contact?
Grant Miller, ngmiller@stanford.edu

Contact information

Type(s)
Public, Scientific, Principal investigator

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Protocol serial number
AEARCTR-0016904

Study information

Scientific Title
Improving worker conditions in brick kilns: a randomized controlled trial in Bangladesh

Study objectives
1. Measure uptake of different workplace improvement components and improvements in workplace infrastructure and practices (PPE availability, shaded rest areas, safe drinking water access, breaks during heat periods)
2. Evaluate impact on worker-reported occupational injuries, health outcomes, wage withholding and labor trafficking indicators, and well-being.
3. Assess changes in physiological heat strain indicators (core body temperature, heart rate variability, hydration status).

Ethics approval required
Ethics approval required

Ethics approval(s)
1. Approved 07/12/2025, Ethical Review Committee of icddr,b (Ethical Review Committee, IRB Secretariat, Research Administration, CMS International Centre for Diarrhoeal Disease Research, icddr,b, GPO Box 128, Dhaka, 1000, Bangladesh; +880-2-9827084; jilanimsa@gmail.com), ref: PR-25-020

2. Approved 12/08/2025, Administrative Panel on Human Subjects in Non-Medical Research (Stanford University, Stanford, CA 94305, United States of America; +1 (650) 725-0650; irbnonmed@stanford.edu), ref: 83207

Primary study design
Interventional

Study design
Cluster randomized controlled trial

Study type(s)
Other

Health condition(s) or problem(s) studied
Heat stress, occupational safety (including workplace injuries), poor living and working conditions, indicators of labor exploitation.

Interventions
This study is a randomized controlled trial in 200 kilns (120 intervention and 20 control) with brick kilns as the unit of randomization. The study will be implemented across Jashore, Jhenaidah and Satkhira in kilns where icddr,b has established working relationships through previous interventions. Eligible kilns are those that adopted the ZZK2.0 technical intervention in past projects with icddr,b. Intervention kilns will get an integrated training on worker conditions and improvements, as well as a refresher on the ZZK2.0 technical methods. Implementation teams will support kiln owners with planning and implementing the improvements in their kilns through the brick season. Control groups will only be surveyed at baseline and endline.

Owners in kilns in the intervention arm will receive an integrated ZZK2.0+ training, which includes a Zigzag 2.0 refresher training combined with a worker condition improvement (WCI) package designed to enhance occupational safety, improve payment practices, and improve living conditions for kiln workers. The WCI package, finalised during our pilot, is structured around five components: (1) provision of personal protective equipment (PPE) and occupational safety measures, (2) timely wage payment monitoring, (3) improvements to workplace and living conditions, (4) heat mitigation strategies, and (5) child labor awareness and prevention.

PPE and occupational safety
The intervention will encourage owners to provide basic safety gear to workers in high-risk roles, including firemen, unloaders, coal crushers, and loaders. Protective equipment includes work boots, gloves, head protection, goggles, cooling towels, masks, and sun caps, all sourced from local markets to ensure availability, sustainability and affordability. First aid kits and oral rehydration salts should also be provided for immediate management of minor injuries and heat-related illnesses. Implementation will be accompanied by systems for procurement support,

action planning, monitoring, replacement scheduling, and troubleshooting for owners and workers to support consistent availability and use.

Timely wage payment monitoring
To address the widespread problem of wage delays and deductions, owners and their managers will be encouraged to establish a monitoring system for timely payments. This will include promoting weekly record-keeping by managers and sardars, monthly owner–worker discussion meetings, random spot checks by project staff, and standardized monitoring forms. Transparency can be enhanced by promoting publicly posting payment schedules at kilns. Communication and grievance systems will be established through structured meetings and anonymous reporting channels (e.g our project hotline). Owners will be instructed to work with sardars to encourage timely payments and support fair practices.

Improved living and working conditions
Kilns will be encouraged to construct resting sheds with seating and drinking water provision. These structures will be strategically placed to maximize shade and serve as designated rest areas. Sanitation conditions will be improved through handwashing stations, soap provision, and toilet maintenance. Where feasible, fans will be installed to enhance cooling. Technical guidance will be provided for design and placement, with inspections to ensure proper use and maintenance throughout the season.

Heat Mitigation
Workers will receive training on recognizing symptoms of heat stress, hydration protocols, safe work–rest cycles, and emergency response procedures. Practical demonstrations will cover correct PPE use in hot environments, cooling techniques, and first aid basics. Training will be delivered through group sessions with illustrated posters in Bengali and reinforced by managers through short reminders during peak heat months. Sardars will receive targeted training on supporting work–rest cycles, and families living on-site will receive basic awareness messages to extend protection beyond the workplace.

Child Labor Awareness and Prevention
The intervention will also receive information to prevent child labor at kilns. Owners and sardars will be encouraged to collect and verify identity documents (National ID, birth certificate) for all workers. Awareness sessions for parents will be conducted twice per season, focusing on child rights and educational opportunities. Kilns will be encouraged to establish clear penalties for non-compliance, and referral systems will connect children to local education providers.

The primary outcome measures involve:
1. Personal Protective Equipment (PPE) Index
2. Workplace conditions
3. Timeliness of wages
4. Labor trafficking indicators
5.Heat stress

1. Personal Protective Equipment (PPE): We use principal components analysis (PCA) to calculate a continuous PPE index for each worker, using a set of 9 indicators taking a value of 1 if a given worker reports access to a given PPE item (cooling towels, gloves, helmets, head coverings, boots, goggles, masks, first aid support, oral rehydration salt (ORS)), and zero otherwise. Our study is powered at 80% to observe a minimum decline of 0.29 in a PPE index computed using previous season data (standardized effect size of 0.27), with a relatively high ICC of 0.24.
2. Workplace conditions: We use principal components analysis (PCA) to calculate a continuous index reflecting the quality of working conditions each worker reports. Components include

sanitation conditions, access to rest areas, cooling sheds, and amenities in living quarters. Our study is powered at 80% to observe a minimum decline of 0.44 in a working conditions index computed using previous season data (standardized effect size of 0.28), given a high leval of intracluster correlation (ICC = 0.39).
3. Timeliness of wages: For each kiln, timeliness of wages is measured using share of workers reporting on-time payment during the preceding 3 months of work (or since the beginning of the season, if shorter than 3 months). Although available data for the timeliness of wages is limited, we estimate a minimum detectable effect size of 7.15 percentage points in the probability of timely pay (a standardized effect size of .22 relative to baseline), given a relatively high ICC of 0.32.
4. Labor trafficking indicators: Conditions contributing to labor trafficking are measured using a standarized set of indicators developed by the United States Department of State Trafficking in Persons Office. The standard tool consists of 39 total indicators (4 extremely strong indicators, 14 strong indicators, and 21 medium indicators) for conditions related to labor trafficking determination. Our survey focuses on a subset of 17 of these indicators deemed culturally appropriate and relevant to the intervention. Our primary outcome is then computed as a continuous measure of the total number of indicators experienced (weighting medium indicators at 0.66). Previous surveys collecting similar data show that our study is powered to detect declines of 0.342 trafficking indicators (an 18% decline; standardized effect size of 0.26) with 80% power at a 5% confidence level.
5. Heat stress: We measure heat stress following standard clinical practice using maximum heart rate, skin temperature, and urine specific gravity. Our study is powered at 80% to observe a minimum decline of 5.43BPM in maximum heart rate (standardized effect size of 0.34), 0.49° in skin temperature (standardized effect size of 0.301), and 0.0022 in USG (standardized effect size of 0.337), assuming a relatively high intracluster correlation of .3 (estimated using data on outcomes related to work conditions measured in a preceding study of the same kilns).

The secondary outcome measures involve:
Respiratory outcomes: Respiratory health will be assessed through worker-reported symptoms (cough, shortness of breath, chest tightness, wheezing) using structured recall periods of 2 days, 1 week, and 2 weeks prior to survey administration. Symptoms will be scored using frequency categories (none, mild, moderate, severe) and functional impact on work activities. Given the seasonal nature of brick kiln operations and potential recall bias with longer time periods, the 2-day and 1-week windows will serve as primary respiratory endpoints. Based on occupational health studies in similar dusty work environments, we estimate our study has 80% power to detect a 15-20% reduction in moderate-to-severe respiratory symptom reporting (standardized effect size of approximately 0.25), assuming an intracluster correlation similar to our other worker-reported outcomes (ICC ≈ 0.30).

Injuries: Workplace injuries will be measured using worker recall of incidents occurring in the past 2 weeks, categorized by type (cuts, burns, falls, crushing injuries), body part affected, and severity (required stopping work, sought medical care, lost work days). The 2-week recall period balances accuracy of reporting with sufficient observation time to capture injury events. Our sample size provides 80% power to detect a reduction of approximately 8-12 percentage points in injury incidence (standardized effect size of 0.22-0.28), based on baseline injury rates observed in comparable brick manufacturing settings and assuming moderate intracluster correlation (ICC ≈ 0.25).

Intervention Type
Behavioural

Primary outcome(s)

The following primary outcome measures are assessed at baseline (approximately mid-November 2025) and at endline (approximately mid-march to end of April 2026):
1. Access to a given PPE item (cooling towels, gloves, helmets, head coverings, boots, goggles, masks, first aid support, oral rehydration salt (ORS)) measured using the Personal Protective Equipment (PPE) Index
2. Workplace conditions measured using data collected from worker reports, including sanitation conditions, access to rest areas, cooling sheds, and amenities in living quarters
3. Timeliness of wages measured using the proportion of workers reporting on-time payment during the preceding 3 months of work (or since the beginning of the season, if shorter than 3 months)
4. Labor trafficking indicators measured using a standarized set of indicators developed by the United States Department of State Trafficking in Persons Office
5. Heat stress measured using the following standard clinical practice to record maximum heart rate, skin temperature, and urine specific gravity

Key secondary outcome(s)
The following secondary outcome measures are assessed using worker-reported health outcomes :
1. Respiratory health will be measured using worker-reported symptoms (cough, shortness of breath, chest tightness, wheezing) using structured recall periods of 2 days, 1 week, and 2 weeks prior to survey administration
2. Workplace injuries will be measured using worker recall of incidents occurring in the past 2 weeks, categorized by type (cuts, burns, falls, crushing injuries), body part affected, and severity (required stopping work, sought medical care, lost work days)

Completion date
05/05/2026

Eligibility

Key inclusion criteria
1. Brick kilns (employers, the level of clustering) are included based on prior participation in a study with our team to improve the energy efficiency of their operation. To be included in the current study, a brick kiln must have previously adopted the technical intervention that improved the energy efficiency of operations.
2. At eachkiln, five adult workers will be randomly selected across the main job categories at brick kilns: firemen, molders, loaders, and unloaders, yielding a study population of one thousand workers.

Participant type(s)
Employee

Healthy volunteers allowed
No

Age group
Mixed

Lower age limit
18 Years

Upper age limit
65 Years

Sex
All

Total final enrolment
1000

Key exclusion criteria
1. Kilns that do not plan to operate in the upcoming season or that did not previously adopt the technical intervention
2. Workers who decline to participate (and are replaced with a randomly selected worker in the same job category)

Date of first enrolment
15/11/2025

Date of final enrolment
31/12/2025

Locations

Countries of recruitment
Bangladesh

Study participating centre
icddr,b
68, Shaheed Tajuddin Ahmed Sarani
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1212

Sponsor information

Organisation
Stanford University

ROR
https://ror.org/00f54p054

Funder(s)

Funder type
University/education

Funder Name
Stanford University

Alternative Name(s)
Stanford, Leland Stanford Junior University, SU

Funding Body Type
Government organisation

Funding Body Subtype
Universities (academic only)

Location
United States of America

Results and Publications

Individual participant data (IPD) sharing plan
The datasets generated during and/or analyzed during the current study will be available upon request from Nina Brooks (ninarb@umich.edu).

• The type of data that will be shared: survey data
• Timing for availability: after study completion, anonymization, and upon request.
• Whether consent from participants was required and obtained: consent from participants will be obtained; participants will be informed that de-identified data may be shared with other researchers and that aggregated data will be reported in publications.
• Comments on data anonymization: data will be de-identified prior to sharing with any interested parties
• Any ethical or legal restrictions: N/A

IPD sharing plan summary
Available on request

Study outputs

Output type	Details	Date created	Date added	Peer reviewed?	Patient-facing?
Other files		30/03/2026	16/07/2026	No	No
Other files		30/03/2026	16/07/2026	No	No
Statistical Analysis Plan		19/03/2026	20/03/2026	No	No
Statistical Analysis Plan		30/03/2026	31/03/2026	No	No
Statistical Analysis Plan		20/03/2026	31/03/2026	No	No