RESEARCH PAPER

Knowledge, Awareness, and Practice of Occupational Health and Safety Among Women Construction Workers: A Review-Based Conceptual Analysis

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ABSTRACT

Construction is one of the few sectors in India where an unskilled woman with no formal schooling can find a day's wage, and that is exactly why so many women end up there. Roughly one in eight construction workers in the country is a woman, and the overwhelming majority of them work without a written contract, without registration under any welfare scheme, and often without knowing that occupational health and safety (OHS) is something they are entitled to ask about. This paper draws together the available literature on OHS knowledge, awareness, training exposure, and safety practice among women in the construction workforce, with particular attention to how the picture differs for women working in India's unorganised sector.

It sets out the scale and nature of the problem, reviews what empirical studies from India and comparable developing-country contexts have found about the gap between what women workers know and what they actually do on site, and identifies where the existing evidence still falls short—particularly the near-absence of validated, gender-disaggregated knowledge-attitude-practice (KAP) instruments built for this population. A conceptual framework is proposed, adapting the Health Belief Model and the KAP model to the specific constraints—low literacy, contractor-mediated employment, domestic double burden, and personal protective equipment (PPE) designed without women's bodies in mind—that shape whether a woman construction worker's safety knowledge, however she came by it, actually translates into safer practice at the worksite. The paper closes by proposing objectives for an empirical study that would test this framework directly among women construction workers in Tamil Nadu.

Keywords: occupational health and safety; women construction workers; knowledge attitude practice; unorganised sector; safety training; India; gender and OHS

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1. Background and Introduction

Walk past any construction site in an Indian city on a weekday morning and the workforce sorts itself, almost without anyone deciding it, along lines of sex. Men are up on the scaffolding, running the mixers, laying brick. Women are carrying headloads of cement, sand, bricks, moving between the mixing pit and the point of use, doing what the industry still quietly classifies as "unskilled" or "helper" work even when it involves lifting loads that would draw comment in almost any other occupation. This division of labour is not incidental to the safety question; it is the safety question. The tasks women are assigned concentrate certain hazards musculoskeletal strain from repetitive lifting and carrying, exposure to cement dust and silica, heat stress from working in direct sun for hours without shade while offering little of the training, supervision, or protective equipment that even token

safety programmes tend to direct toward more visible or more skilled trades.

India's construction sector is the second-largest employer in the country after agriculture, and by most recent estimates it employs upward of fifty million workers, women accounting for somewhere between eleven and fourteen per cent of that workforce depending on the survey and year (International Labour Organization [ILO], Employers' Federation of India, & Confederation of Indian Industry, 2025). What makes this workforce distinctive, and difficult to study, is its informality. An estimated nine in every ten construction workers in India work outside any formal employment relationship no appointment letter, no fixed employer, no enforceable safety obligation attaching to any single party (ILO et al., 2025). Work is arranged through contractors and sub-contractors who compete on price, and safety expenditure is one of the easiest places to cut. Women workers sit at the bottom of this contracting chain more often than men do, in part because they enter the sector with less prior skill certification and less bargaining leverage, and in part because seasonal and circular migration moving from a home village to a work site for the duration of a project disproportionately displaces women from whatever local networks or union presence might otherwise help them push back.

The Government of India's own attempt to count this workforce, the e-Shram portal, had registered close to thirty-two crore unorganised workers by August 2026, and women made up just over fifty-four per cent of all registrations (Ministry of Labour and Employment, 2026). That figure is worth pausing on, because it cuts against a common assumption that informal work is a predominantly male domain. It is not. It is, however, heavily sex-segregated by occupation: women's share of registrations is highest in domestic work, agriculture, and apparel, and lower though still substantial in absolute numbers in construction. Registration on e-Shram is a precondition for accessing accident insurance and several welfare schemes, yet registration alone says nothing about whether a worker has ever received a single hour of safety instruction, or whether she would recognise a heat-stroke warning sign if she saw one in herself or a co-worker.

Occupational health and safety, as a field, has historically been built around a male worker's body and a male worker's job. Standard personal protective equipment gloves, harnesses, respirators, high-visibility vests is sized and shaped according to anthropometric data collected overwhelmingly from men, and the mismatch is not a minor inconvenience. Ill-fitting gloves catch in machinery; oversized harnesses fail to arrest a fall the way they are designed to; boots that do not fit change a worker's gait and raise her risk of a slip or a fall from height (Onyebeke et al., 2016). A pilot study among female construction workers in the United States found that access to properly fitting PPE was the exception rather than the rule, and there is no reason to think the situation is better in an Indian informal-sector context where PPE provision of any kind, fitted or not, is already inconsistent. Safety training programmes carry a parallel bias: they are usually designed, timed, and delivered in ways that assume a worker who can attend a session after the day's wage-earning tasks are done, who is literate enough to follow a handout, and who does not need to leave by a certain hour to collect a child from school or prepare an evening meal. None of these assumptions hold reliably for women in India's construction workforce.

Against this backdrop, the government's Viksit Bharat 2047 vision has set an explicit target of raising women's labour force participation to seventy per cent by the year of India's centenary of independence, a goal reaffirmed in the Union Budget for 2025–26. Achieving that target by simply pulling more women into informal, hazard-dense work such as construction without addressing what they know about the risks they face and whether they are equipped to act on that knowledge would be a hollow version of the ambition. Safety awareness is not a side issue to be handled once female workforce participation has grown; it has to be built into how that growth happens. That is the premise this paper works from, and it is the reason a focused review of what is currently known about OHS knowledge, awareness, and practice among women construction workers is worth doing now.

2. Problem Statement

The problem this paper is concerned with is not simply that women construction workers get hurt on the job though they do, and the injury and morbidity data on this point, thin as it is, is fairly consistent. It is that very little is known, in any systematic or India-specific way, about what these women actually know about the hazards they face, what they believe about their own vulnerability to those hazards, and whether the gap between knowledge and practice when a woman knows a task is risky but performs it unsafely anyway is a matter of ignorance, of unavailable protective equipment, of time and wage pressure, or of something else entirely.

Existing occupational health surveillance in India, such as it is, tends to treat "construction worker" as a single undifferentiated category, or where it does disaggregate by sex, it reports morbidity and injury outcomes without asking the prior question of what the worker knew, or was told, before the injury occurred. An early but still frequently cited study of women construction workers in the unorganised sector found that fifty-six per cent of the women surveyed had suffered a work-related injury that caused them to lose working

days, more than three times the sixteen per cent rate reported among men in the same worksites, and that neither group had access to social security or formal workers' compensation (Lakhani, 2004). More than two decades later, there is little indication that the structural conditions behind that disparity have changed in any fundamental way, even as the scale of the workforce has grown considerably.

The absence of a validated instrument to measure knowledge, attitude, and practice (KAP) specifically calibrated to women construction workers in India compounds the problem. Studies from elsewhere Nepal's hydropower construction sector, for instance, where a KAP survey found that sixty-five per cent of workers demonstrated adequate safety knowledge but only sixty-four per cent translated that into good practice, with education level the strongest predictor of the gap (Shrestha et al., 2025) suggest the knowledge-practice gap is real and measurable, but such instruments have rarely been applied to a specifically female, specifically Indian, specifically informal-sector population. Without that evidence base, safety interventions and training curricula for this workforce are designed on assumption rather than evidence: assumptions about literacy levels, about what women already know, about which hazards concern them most, and about what format of training they would actually be able to attend.

A further dimension of the problem is that "awareness" itself is not a single, uniform thing to measure. A woman may be entirely aware that carrying a heavy headload every day is bad for her back and still have no practical alternative, because refusing the task means losing the day's wage to a co-worker willing to do it. She may know, in general terms, that a hard hat prevents head injury, but never have been issued one, or have been issued one that does not fit and that she has learned to leave on the ground because it slips over her eyes when she bends. The existing literature on OHS in construction rarely separates knowledge (what a worker has been told or has learned), attitude (what she believes about her own risk and her right to protection), and practice (what she does, given the material and economic constraints she is actually working under) as distinct constructs, even though separating them is what makes an intervention possible to design well. This paper treats that separation, and the empirical gap around it, as the central problem worth addressing.

3. Literature Review

3.1 The Scale and Shape of Women's Participation in Construction

The starting point for any review of OHS awareness among women construction workers has to be an honest picture of how many there are and what they actually do. Global bibliometric work on the topic finds that research attention to women's occupational health and safety in construction has grown only slowly, with the United States, South Africa, Australia, and Japan producing the bulk of the published literature a pattern that leaves large gaps for South and Southeast Asian contexts, India included, despite the size of the female construction workforce in this region (see the scientometric review summarized in Bolghanabadi et al., 2024). A recent decade-spanning review of primary-data studies on women's OHS across all sectors, drawing on Scopus and Web of Science records from 2010 to 2021, likewise found that construction-specific, gender-disaggregated primary research remains a minority within an already small literature (Bolghanabadi et al., 2024).

Within India specifically, a science-mapping review of sixty-four Scopus-indexed journal articles on construction workers' health and safety published between 2004 and 2019 found that the dominant themes were safety management, safety climate, safety performance, musculoskeletal disorders, and behaviour-based safety but that almost none of this body of work applied a stated theoretical framework, and gender was not treated as a primary variable in the studies reviewed (Chellappa, Srivastava, & Salve, 2021). That is a telling absence. If the Indian literature on construction OHS has not, for the most part, been built around any explicit behavioural or health theory, then it is not surprising that gender-specific knowledge and awareness which depend on exactly the kind of psychosocial and belief-based constructs that a theoretical framework would surface has received even less attention.

3.2 What Is Known About Knowledge, Attitude, and Practice Gaps

The knowledge-attitude-practice (KAP) model has a long history in public health research as a way of separating what people know from what they believe and from what they actually do, on the reasoning that an intervention aimed at the wrong one of these three will fail even if it succeeds in changing the others (see the general KAP literature summarized in relation to occupational settings). Applied to construction safety, the small number of KAP studies available point consistently to a gap between knowledge and practice rather than a gap in knowledge alone. The cross-sectional study of hydropower construction workers in Nepal referenced above found adequate knowledge in sixty-five per cent of the sample and good safety practice in sixty-four per cent figures close enough to suggest a reasonably tight coupling in that context but it also found that higher educational attainment was independently associated with adequate knowledge (adjusted odds ratio 4.73), which matters directly for a workforce like India's women construction workers, whose literacy rates trail those of male co-workers and of women in most other occupational categories (Shrestha et al., 2025).

Training-effectiveness research from outside the informal-sector context offers a complementary

picture. A frequently cited intervention study among apprentice and journeyman construction trades workers in the United States found that even a single, one-hour hazard-awareness class produced measurable gains in fall-safety and electrical-safety knowledge that persisted three months later, with workers who had less formal education showing lower baseline knowledge but, interestingly, more positive safety attitudes and larger attitude gains after training (Sokas et al., 2009, as widely cited in subsequent construction-safety training reviews). The implication for the present review is double-edged: training does work, even in short, low-cost formats, but its benefits are not guaranteed to reach a workforce whose access to organised training sessions is itself constrained by wage pressure, contractor indifference, and for women particularly domestic responsibilities that compete directly with any time not spent earning.

A broader review of construction safety training methods found that the evaluation of training effectiveness in this sector still relies heavily on self-reported perception measures how workers rate the clarity or usefulness of a session rather than on independently verified changes in knowledge or observed changes in behaviour, and that studies testing interventions specifically with working adults, rather than students in simulated settings, remain a minority (see the systematic literature review of construction safety training methods and evaluation approaches). This matters for any future study of women construction workers in India, because it suggests that even where training programmes exist and are delivered, the evidence for whether they change actual site behaviour as opposed to reported attitudes is thinner than the volume of training-programme literature might suggest.

3.3 Gendered Hazards: PPE Fit, Ergonomics, and Reproductive Health

A distinct strand of the literature documents hazards that are not simply more severe for women but qualitatively different, because they arise from a mismatch between standard safety equipment and women's bodies. The pilot study by Onyebeke et al. (2016) among female construction workers in the United States is among the most direct empirical treatments of this issue: it found that access to properly fitting PPE was inconsistent even in a unionised, formal-sector setting, and that the consequences of ill fit were not cosmetic oversized gloves increase the risk of catching in moving machinery, ill-fitting respirators compromise the seal against airborne contaminants, and gear that is too large creates a tripping hazard in its own right. Subsequent surveys in other developed-country construction sectors have found broadly similar patterns: large-scale surveys of tradeswomen report that a majority struggle to obtain PPE genuinely sized for them, with smaller-sized protective gear and maternity-appropriate safety equipment named as persistent gaps. If this is the state of PPE provision in relatively well-resourced, formally regulated construction industries, the presumption has to be that provision in India's largely unregulated informal sector is considerably worse, even though direct empirical documentation of PPE fit specifically among Indian women construction workers is not yet available in the published literature itself a gap this review returns to below.

Musculoskeletal and ergonomic hazards represent a second gendered dimension. Because women in Indian construction are concentrated in headload-carrying and material-handling tasks rather than mechanised or tool-based trades, they are exposed to sustained spinal and shoulder loading of a kind that ergonomic research consistently associates with chronic low-back pain and related musculoskeletal disorders. A qualitative study using focus group discussions with informal women workers across five occupational categories in Ahmedabad, including construction, found musculoskeletal disorders, respiratory problems, skin irritation, and heat-related illness named repeatedly across every occupational group studied, alongside a socioecological pattern in which women's health knowledge and health-seeking behaviour were shaped as much by household and community-level constraints as by anything happening at the worksite itself (Sheth et al., 2025). That framework the Socioecological Model, which situates individual health knowledge within layers of interpersonal, organisational, community, and policy influence is a useful reminder that a woman's OHS awareness cannot be studied, or improved, purely as an individual cognitive variable, separated from the household and social context she is embedded in.

A third and comparatively under-examined dimension concerns occupational health hazards specific to women's reproductive and maternal health exposure to chemical hazards during pregnancy, the absence of maternity-appropriate protective gear, and the near-total absence, in India's informal construction sector, of any mechanism for temporary work reassignment during pregnancy. International occupational safety bodies have long recommended that reproductive-hazard guidance be built into general construction safety training rather than treated as a specialised add-on, but the available evidence suggests this recommendation has had limited practical uptake even in well-resourced settings, and essentially none in India's informal sector.

3.4 Structural and Institutional Barriers to Safety Awareness

Beyond individual knowledge and equipment, a body of literature mostly from outside India but with clear relevance to the Indian case documents structural barriers that limit whether safety

knowledge, even where it exists, is acted on. Research on occupational health and safety barriers for gender diversity in the Australian construction industry found that women in building trades and earthmoving roles experienced higher rates of injuries resulting in permanent incapacity than their male counterparts, and linked this partly to work pressure, workplace culture, and the reluctance of women workers to report concerns or refuse unsafe tasks in a male-dominated environment where doing so carried a social cost (Hasan & Kamardeen, 2022). The same study found elevated rates of anxiety and depression among female construction workers linked to this pressure, a dimension of occupational health that safety-knowledge research, focused narrowly on physical hazard recognition, tends to leave out entirely.

For India's informal-sector women workers specifically, the contracting structure itself is a barrier. Because most women are engaged through labour contractors rather than directly by the principal employer running the site, responsibility for safety training and equipment provision becomes diffuse the contractor has an incentive to minimise cost, the principal employer can point to the contractor as the responsible party, and the worker has no direct channel to either. Legal and policy analyses of India's construction labour regulation have noted that coverage thresholds in labour law, such as the twenty-worker minimum that determines applicability of certain protections under the Contract Labour (Regulation and Abolition) Act, 1970, systematically exclude much of the small-scale, informal construction work where women are concentrated. A worker's formal right to safety training or equipment, in other words, may not attach to her worksite at all, regardless of what she knows or wants.

Literacy and language present a further structural constraint specific to how safety information is delivered. Safety signage, material safety data sheets, and training materials in the construction sector are overwhelmingly text-based and frequently in a language other than the worker's own, a barrier documented across India's informal workforce more broadly and not unique to construction. Where digital tools have been piloted to reach informal women workers with health and livelihood information, researchers have found that conventional interface design fails to account for lower formal literacy levels, time constraints, and regional language needs, and that tools built with these constraints in mind from the outset perform substantially better than generic ones. The implication for OHS training design is direct: verbal, visual, and peer-delivered formats are likely to reach this population far more effectively than the handout-and-lecture model that most formal safety training still defaults to.

3.5 Social Security, Registration, and the Limits of Policy Coverage

A final strand of the literature examines the welfare and registration architecture that is meant to sit around this workforce, and its limits are directly relevant to safety awareness because registration is often the channel through which safety information, insurance benefits, and welfare-scheme access reach a worker in the first place. The Building and Other Construction Workers (BOCW) Welfare Boards, and in Tamil Nadu the Tamil Nadu Construction Workers Welfare Board specifically, exist to register construction workers and disburse welfare and, in principle, safety-related benefits funded through a cess on construction cost. Coverage has grown substantially Tamil Nadu's board reports registration climbing from a fraction of the estimated workforce to over nineteen lakh workers currently registered — but registration growth alone does not establish that registered women workers have received safety training or understand what protections their registration entitles them to. Audit findings on cess utilisation across states have repeatedly flagged underspending and administrative inefficiency in translating collected funds into services actually reaching workers, which suggests the gap between policy entitlement and worker awareness of that entitlement may be as large as the gap in site-level safety knowledge itself.

Taken as a whole, the literature reviewed here supports three broad conclusions. First, the volume of empirical, India-specific, gender-disaggregated research on OHS knowledge and practice among construction workers is small relative to the size of the workforce it concerns, and smaller still once studies are filtered for a specific focus on women. Second, where comparable KAP research exists mostly outside India it consistently finds a measurable gap between what workers know and what they practice, a gap associated with education level, training exposure, and equipment availability rather than sheer ignorance. Third, the barriers most specific to women PPE that does not fit their bodies, contracting structures that dilute safety accountability, literacy and language mismatches in how safety information is delivered, and a domestic burden that competes directly with any time available for training are documented individually across several literatures but have rarely been brought together into a single framework applied to India's women construction workers as a population in their own right.

4. Research Gap

Three specific gaps emerge from the review above, each of which limits what can currently be said, with evidence, about OHS knowledge, awareness, and practice among women construction workers in India, and Tamil Nadu in particular.

First, there is no widely used, validated KAP instrument built specifically for this population. The

KAP surveys that do exist in the construction-safety literature including the Nepal hydropower study drawn on in this review were developed for general or predominantly male construction workforces in other national contexts, and applying them to Indian women construction workers without adaptation risks measuring the wrong things: questions calibrated to a literate, formally employed, mixed-gender workforce will not capture the specific hazards, barriers, and belief structures relevant to a largely non-literate, informally contracted, female workforce carrying headloads on unregistered sites.

Second, the existing literature treats knowledge, attitude, and practice as though they were separable by survey design but has rarely tested, empirically and specifically for this population, what actually explains the gap between them where one exists. Is a woman who knows a task is hazardous but performs it anyway failing to act because she lacks equipment, because refusing costs her the day's wage, because the social cost of raising a safety concern on a male-dominated site is too high, or because of some combination the existing single-factor studies are not designed to disentangle? Without empirical work that measures knowledge, attitude, and practice as distinct constructs and tests the structural and household-level factors mediating between them, safety interventions are left guessing at which lever to pull.

Third, and connected to the first two, no published study appears to have brought the PPE-fit literature, the contracting-structure and welfare-board literature, and the KAP literature together within a single conceptual framework applied to Indian women construction workers. Each of these strands is well developed on its own terms PPE-fit research in developed-country formal sectors, welfare-board audit research in Indian labour policy, KAP research in cross-sectional occupational health studies elsewhere but they have not been integrated in a way that would let a researcher or a training designer see how a woman's safety knowledge, her access to properly fitting equipment, her contracting arrangement, and her registration status interact to produce (or fail to produce) safe practice on an actual Indian construction site. This paper's proposed conceptual framework, set out in Section 6, is an attempt to begin closing that integration gap, and its objectives, set out in Section 5, are framed as a direct response to it.

5. Objectives

Building on the gaps identified above, this paper proposes the following objectives for an empirical study of OHS knowledge, awareness, and practice among women construction workers, to be conducted among registered and unregistered women construction workers in Tamil Nadu:

1. To assess the current level of occupational health and safety knowledge among women construction workers, across the principal hazard categories relevant to their assigned tasks (manual handling and ergonomic load, heat and weather exposure, dust and respiratory hazards, and site-level physical hazards such as falls and struck-by incidents).
2. To examine attitudes among women construction workers toward occupational risk, protective equipment, and their own entitlement to safety information and training, distinguishing attitude as a construct from measured knowledge.
3. To document actual safety practice at the worksite including PPE use, reporting of hazards or injuries, and participation in any training offered and to identify where practice diverges from stated knowledge or attitude.
4. To identify the structural, contractual, and household-level factors contracting arrangement, welfare board registration status, literacy, and domestic care responsibilities associated with the size of the knowledge-practice gap where one is found.
5. To propose and pilot-test practical, low-literacy, gender-responsive training and communication approaches suited to the constraints this population actually works under, drawing on the conceptual framework developed in Section 6.

6. Conceptual Framework

The framework proposed here adapts two established behavioural models the Health Belief Model (Rosenstock, 1974; Janz & Becker, 1984) and the Knowledge-Attitude-Practice model widely used in public health research to the specific structural conditions documented in the literature review above. Neither model, used alone and unadapted, adequately captures the situation of a woman construction worker in India's informal sector, because both were developed primarily around individual health decision-making, with the implicit assumption that a person who perceives a risk as serious and believes a protective action is effective and available will, other things equal, take that action. For this population, other things are very rarely equal, and the framework needs an explicit layer of structural mediation between belief and behaviour.

The framework has four linked components.

6.1 Knowledge Inputs

The first component is knowledge itself what a woman construction worker has learned about occupational hazards and protective measures, and from what source. Sources realistically available to this population include formal training (rare, and where it exists, often delivered in formats that assume literacy), informal peer or family transmission of safety practice, direct experience of

injury (her own or a co-worker's), and, increasingly, government and NGO outreach delivered through the welfare board registration process or through digital and mobile channels. The framework treats knowledge as multi-sourced and unevenly distributed across hazard types a worker may have strong informal knowledge about heat stress, learned through lived experience, and near-zero knowledge about respiratory hazards from cement dust, which are less immediately visible in their effects.

6.2 Belief and Attitude Mediators

The second component, drawn from the Health Belief Model, comprises the belief structures that determine whether knowledge translates into a perceived need to act: perceived susceptibility (does she believe this hazard could actually affect her), perceived severity (how serious does she judge the consequence to be), perceived benefit of protective action, and perceived barriers to taking it. This is the layer where gendered workplace culture enters directly. A woman who correctly identifies a task as hazardous may still judge the "barrier" of raising a safety concern the risk of being seen as difficult, or of losing preference for future work assignments on a contractor-run site as outweighing the perceived benefit of speaking up, a dynamic documented in the gender-diversity and OHS literature discussed in Section 3.4.

6.3 Structural Mediators

The third component is the layer this paper argues is missing from unadapted applications of either the Health Belief Model or the KAP model to this population: the structural conditions that determine whether a woman who has the knowledge and the motivating belief is actually able to act on it. This includes PPE availability and fit, contracting arrangement and the diffusion of safety responsibility it produces, wage structure (piece-rate versus daily-wage work changes the cost of pausing for a safety measure), welfare board registration status, and household and domestic-care load, which determines how much time and energy remain for training participation outside working hours. These structural mediators are not psychological constructs and cannot be changed by better health communication alone; they require policy, contracting-practice, and equipment-design interventions running alongside any training programme.

6.4 Practice Outcome

The fourth component is observed safety practice PPE use, hazard reporting, participation in training when offered, and health-seeking behaviour following injury or illness which the framework treats as the joint product of knowledge, belief, and structural mediation rather than of knowledge alone. The central empirical claim this framework generates, and which the objectives in Section 5 are designed to test, is that interventions aimed only at the knowledge component (more training, more signage, more awareness campaigns) will show limited effect on practice wherever structural mediators remain unaddressed, and that a measurement approach capable of separating these components is a precondition for designing an intervention that actually works for this specific workforce.

A schematic representation of this framework knowledge inputs flowing into belief and attitude mediators, both filtered through structural mediators before producing observed practice, with feedback from practice and injury experience back into the knowledge base is presented in Figure 1.

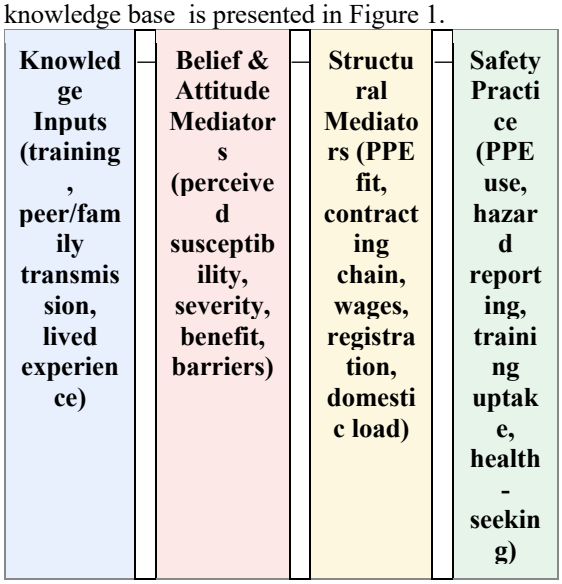


Figure 1. Proposed conceptual framework linking OHS knowledge, belief mediators, structural mediators, and safety practice among women construction workers.

Feedback loop: outcomes of safety practice (an injury, a near-miss, a co-worker's experience) feed back into the knowledge base at the far left, so the framework is cyclical rather than strictly linear in operation over a worker's career.

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