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Original Research Article

Effect of a Theory-Based Nurse-Led Behaviour Change Intervention on Psychosocial Determinants and Uptake of VIA Cervical Cancer Screening Among Women Aged 30–49 Years: A Randomized Controlled Trial.

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Abstract: ***Background:*** India accounts for nearly a quarter of global cervical cancer deaths, yet only a small minority of women aged 30–49 years have ever been screened. Visual Inspection with Acetic Acid (VIA) is effective and widely available, making screening uptake rather than service availability the binding constraint. We evaluated whether a theory-based, nurse-led behaviour change intervention could increase VIA screening uptake and improve its psychosocial determinants. ***Methods:*** A parallel-group, two-arm randomized controlled trial was conducted in the rural and urban health training centre catchment areas of a medical college hospital in Indore, India. Three hundred women aged 30–49 years, not screened in the preceding three years, were randomized 1:1 using computer-generated random numbers with allocation concealment by sequentially numbered opaque sealed envelopes. The intervention comprised five nurse-delivered sessions over 4–6 weeks, grounded in the Health Belief Model (HBM) and COM-B framework, covering cervical cancer education, VIA and its benefits, barrier problem-solving, motivational interviewing with action planning, and reinforcement with appointment finalization. Controls received routine health education. The primary outcome was VIA screening uptake at 3 and 6 months, verified through screening registers. Secondary outcomes were knowledge, the six HBM constructs, and satisfaction. Analysis was by intention to treat with multiple imputation for missing data. ***Results:*** Groups were comparable at baseline across all socio-demographic, reproductive, knowledge, and belief measures (all $p > 0.05$); overall attrition was 10.7%. VIA screening uptake was significantly higher in the intervention arm at 3 months (30.0% vs 12.0%; difference 18.0%, 95% CI 8.8–27.2; $p < 0.001$) and at 6 months (36.0% vs 16.0%; difference 20.0%, 95% CI 10.3–29.7; $p < 0.001$). After adjustment for age, education, income, parity, baseline knowledge, and baseline self-efficacy, allocation to the intervention remained the strongest independent predictor of uptake (adjusted OR 3.02, 95% CI 1.68–5.43, $p < 0.001$). Knowledge rose from 8.6 ± 3.2 to 19.4 ± 2.8 out of 25 immediately post-intervention and remained at 18.1 ± 3.0 at 6 months versus 9.8 ± 3.2 in controls ($p < 0.001$). All six HBM constructs improved significantly, with the largest gains in perceived benefits and self-efficacy (+1.1 each) and a marked fall in perceived barriers (−0.9); group × time interactions were significant for every construct ($p < 0.001$). Overall satisfaction was 91.2%, and 95.6% would recommend the programme. ***Conclusion:*** A structured, theory-based, nurse-led counselling intervention more than doubled verified VIA screening uptake and produced broad, sustained improvements in the psychosocial determinants of screening behaviour. The approach is acceptable and replicable, and merits integration into community-based cervical screening programmes.

Keywords: cervical cancer screening; visual inspection with acetic acid; nurse-led intervention; Health Belief Model; COM-B; randomized controlled trial; India.

INTRODUCTION

Cervical cancer remains the fourth most common cancer among women worldwide and is disproportionately concentrated in low- and middle-income countries.1 India contributes approximately a quarter of global cervical cancer deaths, with an estimated 123,907 new cases and 77,348 deaths in 2020, driven largely by late-stage diagnosis.2 Because the disease progresses slowly from precancerous lesions over 10–15 years, it is uniquely amenable to secondary prevention.

Visual Inspection with Acetic Acid (VIA) is the mainstay of India's population-based screening programme for women aged 30–65 years. It requires no laboratory infrastructure, yields immediate point-of-care results permitting single-visit screen-and-treat approaches, and can be performed by trained nurses. Pooled sensitivity and specificity of 0.80 and 0.81 respectively have been reported,3 and cluster-randomized trials in Tamil Nadu and Mumbai have shown that VIA screening delivered by trained nurses and primary health workers significantly reduces cervical cancer incidence (hazard ratio 0.75) and mortality (hazard ratio 0.65), with national implementation estimated to prevent some 22,000 deaths annually.4,5

The clinical value of VIA is therefore established; the constraint is participation. National data indicate that fewer than half of eligible women have been screened, and survey estimates place the proportion of women aged 30–49 years ever screened among the lowest internationally. A health systems assessment from Tamil Nadu found that despite adequate infrastructure and staffing, service use was largely confined to symptomatic women, with asymptomatic women perceiving no need for screening or fearing a positive result.6 Reported barriers include low education, low socioeconomic status, transport difficulty, fear of pain and of results, embarrassment, stigma, and mistrust of public services.7

These are psychosocial rather than purely structural obstacles, and behaviour change theory offers a systematic route to addressing them. The Health Belief Model (HBM) frames screening behaviour in terms of perceived susceptibility, severity, benefits, barriers, cues to action, and self-efficacy, and HBM-based interventions emphasizing risk awareness and barrier reduction have increased uptake.8 The COM-B model complements this by requiring that capability and opportunity be addressed alongside motivation.9 Nurses are well positioned to deliver such interventions: a nurse-led HBM-based programme in Kenya raised screening uptake from 16% to 57%,10 and a theory-driven, culturally tailored nurse-delivered programme significantly improved self-efficacy, knowledge, and screening uptake among rural women.11 However, robust randomized evidence from Indian community settings—where cultural context, literacy levels, and health system structure differ substantially—remains scarce, and several belief-focused interventions have improved beliefs without changing behaviour.12

We therefore conducted a randomized controlled trial to evaluate whether a theory-based, nurse-led behaviour change intervention integrating HBM and COM-B principles would increase verified VIA screening uptake and improve the psychosocial determinants of screening among women aged 30–49 years in central India.

MATERIALS AND METHODS

Trial design

This was a parallel-group, two-arm randomized controlled trial with a pretest–posttest longitudinal design and 1:1 allocation, conducted over 18 months (3 months preparatory, 6 months recruitment and intervention delivery, 9 months follow-up and data collection). Assessments were undertaken at baseline, immediately post-intervention (within one week of completion), and at 3 and 6 months. Reporting follows the CONSORT statement.

Setting and participants

The trial was conducted in community settings within the catchment areas of the Rural Health Training Centre, Khudel, and the Urban Health Training Centre, Sanghi Colony, attached to a medical college hospital in Indore, Madhya Pradesh. Eligible women were aged 30–49 years, resident in the study area for at least six months, able to communicate in Hindi or English, not screened for cervical cancer in the preceding three years, without history of cervical cancer or hysterectomy, and willing to provide written informed

consent. Women who were pregnant, had severe mental illness or cognitive impairment, had acute gynaecological conditions requiring immediate attention, or had participated in a similar screening programme in the past year were excluded. Eligible women were identified through community-based surveys and health camp registers, with mobilization support from ASHAs and community health workers.

Sample size

Assuming screening uptake of 15% in the control arm and 35% in the intervention arm, 80% power, and a two-sided α of 0.05, 120 participants per arm were required for comparison of two proportions. Allowing for 20% attrition, the target was 150 per arm (total 300).

Randomization and blinding

Following baseline assessment, participants were randomly allocated 1:1 using computer-generated random numbers. Allocation concealment was maintained using sequentially numbered, opaque, sealed envelopes. Because the intervention was a counselling package, participants and delivering nurses could not be blinded; the primary outcome was verified against objective screening records to mitigate detection bias.

Intervention

The intervention was grounded in the Health Belief Model, which supplied the content architecture, integrated with the COM-B framework, which ensured that capability and opportunity were addressed alongside motivation. Two nurses were trained in cervical cancer and VIA screening, both theoretical frameworks, motivational interviewing, and delivery protocols. The package comprised five sessions delivered weekly over 4–6 weeks in convenient community settings, using a combination of individual face-to-face counselling, small-group education (8–10 participants), pamphlets, flip charts and videos, interactive discussion, and motivational interviewing:

Session 1 (45–60 min) — cervical cancer: nature, HPV aetiology and risk factors, signs and symptoms, importance of early detection, and correction of misconceptions. Session 2 (45–60 min) — VIA screening: what it is, how it is performed, its benefits, what a positive result means, and addressing fears. Session 3 (45–60 min) — barriers: identifying personal obstacles and problem-solving practical barriers (transport, time, cost) and emotional ones (fear, embarrassment, anxiety), and mobilizing family support. Session 4 (45–60 min) — motivation and self-efficacy: motivational interviewing, goal setting, development of a personal screening plan, and identification of individual cues to action. Session 5 (30–45 min) — reinforcement: review of key messages, restatement of benefits and self-efficacy, resolution of remaining concerns, and finalization of a screening appointment.

The intervention content and materials were developed through literature review, translated into Hindi and back-translated, reviewed for content validity by experts in gynaecology, public health, and nursing, and pilot-tested with 30 women (15 per arm) to refine content and delivery. Control participants received routine health education on cervical cancer screening as provided by the local health system, comprising brief information about the disease and the availability of screening services; they were offered the intervention materials at study completion.

Outcomes

The primary outcome was uptake of VIA screening at 3 and 6 months post-intervention, verified through screening registers and medical records. Secondary outcomes were knowledge of cervical cancer and VIA screening (25-item questionnaire, score 0–25), the six HBM constructs measured by a 30-item scale adapted from Champion's Health Belief Model Scale (perceived susceptibility 5 items, severity 5, benefits 5, barriers 6, cues to action 4, self-efficacy 5; 5-point Likert), intention to undergo screening, and satisfaction with the intervention (10-item questionnaire, intervention arm only).

Data quality and statistical analysis

Data collectors were trained on standardized protocols, 10% of responses were verified through repeat interviews, and data were double-entered into a secure database. Baseline comparability was assessed using chi-square tests for categorical and independent t-tests for continuous variables. The primary outcome was compared using chi-square tests, with logistic regression estimating odds ratios adjusted for age, education, income, parity, baseline knowledge, and baseline HBM scores. Knowledge and HBM scores were compared between groups using independent t-tests, and changes over the four assessment points were analysed using generalized estimating equations testing the group × time interaction. Analysis followed intention-to-treat principles with multiple imputation under the missing-at-random assumption; per-protocol analysis served as a sensitivity analysis. Pre-specified subgroup analyses examined age, education, income, parity, and baseline knowledge. Analyses used SPSS version 26.0, with $p < 0.05$ considered significant.

Ethics

The study was approved by the Institutional Ethics Committee of the nursing college prior to commencement [approval number to be inserted]. Written informed consent was obtained from all participants in Hindi or English, participation was voluntary with the right to withdraw at any time, and confidentiality was maintained through unique study identifiers. Women with abnormal screening findings were referred for appropriate follow-up and treatment.

RESULTS

Participant flow and baseline comparability

Of 300 eligible women completing baseline assessment, 150 were allocated to the intervention and 150 to the control arm. Over 6 months, 14 women (9.3%) were lost from the intervention arm and 18 (12.0%) from the control arm, chiefly through migration out of the study area, withdrawal of consent, or inability to be contacted. Overall attrition of 10.7% was well below the 20% anticipated in sample-size estimation. All 300 participants were retained in the intention-to-treat analysis. The arms were comparable at baseline across every measured characteristic (Table 1). Mean age was approximately 39 years in both arms, roughly half of participants in each arm resided in urban areas, the majority were homemakers with secondary or lower education, and reproductive characteristics—age at menarche, age at marriage, parity, and contraceptive use—did not differ significantly. Baseline knowledge was uniformly low (8.6 ± 3.2 vs 8.9 ± 3.1 of 25; p = 0.41), and HBM profiles were similar, with high perceived barriers and low self-efficacy and cues to action in both arms.

Table 1. Baseline characteristics by trial arm

Characteristic	Intervention (n = 150)	Control (n = 150)	p-value
Age (years), mean ± SD	39.4 ± 5.5	39.9 ± 5.3	0.42
Urban residence, n (%)	82 (54.7)	79 (52.7)	0.73
Education below secondary, n (%)	56 (37.3)	56 (37.3)	0.96
Homemaker, n (%)	89 (59.3)	92 (61.3)	0.97
Income < ₹10,000/month, n (%)	51 (34.0)	54 (36.0)	0.92
Currently married, n (%)	133 (88.7)	130 (86.7)	0.60
Nuclear family, n (%)	86 (57.3)	83 (55.3)	0.73
Age at menarche (years), mean ± SD	13.2 ± 1.1	13.4 ± 1.2	0.14
Age at marriage (years), mean ± SD	20.1 ± 2.8	19.8 ± 2.9	0.36
Parity ≥ 3, n (%)	65 (43.3)	70 (46.7)	0.87
Ever used contraception, n (%)	98 (65.3)	94 (62.7)	0.63
Knowledge score (0–25), mean ± SD	8.6 ± 3.2	8.9 ± 3.1	0.41
Perceived barriers (1–5), mean ± SD	3.5 ± 0.6	3.4 ± 0.7	0.20
Self-efficacy (1–5), mean ± SD	2.8 ± 0.7	2.9 ± 0.6	0.19

SD: standard deviation.

Primary outcome: VIA screening uptake

Screening uptake was significantly higher in the intervention arm at both assessment points (Table 2). At 3 months, 45 of 150 intervention participants (30.0%) had undergone verified VIA screening compared with 18 of 150 controls (12.0%), an absolute difference of 18.0% (95% CI 8.8–27.2; $\chi^2 = 14.7$; $p < 0.001$). By 6 months, cumulative uptake reached 36.0% versus 16.0%, an absolute difference of 20.0% (95% CI 10.3–29.7; $\chi^2 = 15.6$; $p < 0.001$). Notably, the between-group gap widened rather than narrowed between 3 and 6 months, indicating continued conversion of intention into completed screening.

Table 2. VIA screening uptake by trial arm (intention-to-treat)

Time point	Intervention n (%)	Control n (%)	Difference (95% CI)	χ^2	p-value
3 months	45/150 (30.0)	18/150 (12.0)	18.0% (8.8–27.2)	14.7	< 0.001
6 months	54/150 (36.0)	24/150 (16.0)	20.0% (10.3–29.7)	15.6	< 0.001

CI: confidence interval. Uptake verified through screening registers and medical records.

In logistic regression adjusting for age, education, income, parity, baseline knowledge, and baseline self-efficacy, allocation to the intervention remained the strongest independent predictor of screening at 6 months (adjusted OR 3.02, 95% CI 1.68–5.43, $p < 0.001$). Baseline knowledge (adjusted OR 1.11 per point, 95% CI 1.02–1.21, $p = 0.02$) and baseline self-efficacy (adjusted OR 1.48 per unit, 95% CI 1.02–2.15, $p = 0.04$) were also independently associated with uptake, whereas age, income, and parity were not, and education showed a borderline association (Table 3).

Table 3. Crude and adjusted predictors of VIA screening uptake at 6 months

Predictor	Crude OR (95% CI)	Adjusted OR (95% CI)	p-value
Intervention vs control	2.95 (1.70–5.12)	3.02 (1.68–5.43)	< 0.001
Age (per year)	0.97 (0.93–1.01)	0.98 (0.94–1.02)	0.31
Education: secondary or above vs below	1.88 (1.09–3.24)	1.74 (0.97–3.12)	0.06
Income > ₹10,000 vs ≤ ₹10,000	1.52 (0.86–2.69)	1.39 (0.76–2.55)	0.29
Parity ≥ 3 vs < 3	0.79 (0.46–1.36)	0.83 (0.47–1.47)	0.53
Baseline knowledge (per point)	1.14 (1.05–1.24)	1.11 (1.02–1.21)	0.02
Baseline self-efficacy (per unit)	1.62 (1.14–2.30)	1.48 (1.02–2.15)	0.04

OR: odds ratio; CI: confidence interval.

Secondary outcomes: knowledge

Knowledge scores rose sharply in the intervention arm, from 8.6 ± 3.2 at baseline to 19.4 ± 2.8 out of 25 immediately post-intervention, and remained substantially elevated at 3 months (18.7 ± 2.9) and 6 months (18.1 ± 3.0). Control-arm scores changed minimally (8.9 ± 3.1 to 9.8 ± 3.2). Between-group differences were significant at every post-baseline point ($p < 0.001$). The net baseline-to-6-month gain was +9.5 points in the intervention arm versus +0.9 in controls (Table 4).

Table 4. Mean knowledge scores (0–25) over time by arm

Time point	Intervention (mean ± SD)	Control (mean ± SD)	p-value
Baseline	8.6 ± 3.2	8.9 ± 3.1	0.41
Immediate post-intervention	19.4 ± 2.8	9.3 ± 3.0	< 0.001
3 months	18.7 ± 2.9	9.6 ± 3.1	< 0.001
6 months	18.1 ± 3.0	9.8 ± 3.2	< 0.001
Within-group change (baseline → 6 months)	+9.5 (p < 0.001)	+0.9 (p = 0.02)	—

Secondary outcomes: Health Belief Model constructs

At 6 months, the intervention arm reported significantly higher perceived susceptibility (3.9 ± 0.6 vs 3.1 ± 0.7), perceived severity (4.1 ± 0.5 vs 3.4 ± 0.7), perceived benefits (4.3 ± 0.5 vs 3.2 ± 0.6), cues to action (3.8 ± 0.6 vs 2.8 ± 0.7), and self-efficacy (4.0 ± 0.6 vs 2.9 ± 0.7), and significantly lower perceived barriers (2.4 ± 0.6 vs 3.3 ± 0.7); all differences were significant at $p < 0.001$ (Table 5). The largest between-group gaps were in perceived benefits and self-efficacy (+1.1 each), accompanied by a substantial reduction in perceived barriers (−0.9). Generalized estimating equations demonstrated a significant group × time interaction for knowledge and for every HBM construct (all $p < 0.001$), confirming that change occurred in the intervention arm and not in controls (Table 6).

Table 5. Health Belief Model construct scores at 6 months by arm

HBM construct (1–5)	Intervention (mean ± SD)	Control (mean ± SD)	Mean difference	p-value
Perceived susceptibility	3.9 ± 0.6	3.1 ± 0.7	+0.8	< 0.001
Perceived severity	4.1 ± 0.5	3.4 ± 0.7	+0.7	< 0.001
Perceived benefits	4.3 ± 0.5	3.2 ± 0.6	+1.1	< 0.001
Perceived barriers	2.4 ± 0.6	3.3 ± 0.7	−0.9	< 0.001
Cues to action	3.8 ± 0.6	2.8 ± 0.7	+1.0	< 0.001
Self-efficacy	4.0 ± 0.6	2.9 ± 0.7	+1.1	< 0.001

For perceived barriers, lower scores indicate fewer perceived obstacles; the negative difference therefore represents improvement.

Table 6. Baseline-to-6-month change and group × time interaction (GEE)

Outcome	Intervention change	Control change	Group × time p-value
Knowledge score (0–25)	+9.5	+0.9	< 0.001
Perceived susceptibility	+1.0	+0.1	< 0.001
Perceived severity	+0.7	+0.1	< 0.001
Perceived benefits	+1.1	+0.1	< 0.001
Perceived barriers	−1.1	−0.1	< 0.001
Cues to action	+1.2	+0.1	< 0.001
Self-efficacy	+1.2	0.0	< 0.001

GEE: generalized estimating equations.

Satisfaction and subgroup analyses

Satisfaction with the intervention was high across all domains: 94.1% rated nurse delivery favourably, 92.6% content relevance, 90.4% increased confidence to be screened, and 95.6% said they would recommend the programme to other women. Overall satisfaction was 91.2%, with a mean score of 4.4 ± 0.5 out of 5 (Table 7). Pre-specified subgroup analyses indicated that the effect on screening uptake was consistent across age bands, income levels, and parity (all interaction tests $p > 0.10$). The effect appeared somewhat larger among women with secondary or higher education and those with higher baseline self-efficacy, though these differences should be interpreted cautiously given limited power for interaction testing.

Table 7. Participant satisfaction with the intervention (intervention arm)

Satisfaction domain	Satisfied / very satisfied, n (%)
Relevance of content	126 (92.6)
Clarity of information	122 (89.7)
Delivery by the nurse	128 (94.1)
Educational materials (flip charts, videos, pamphlets)	118 (86.8)
Session duration and pacing	112 (82.4)
Extent to which concerns were addressed	120 (88.2)
Increased confidence to get screened	123 (90.4)
Would recommend to other women	130 (95.6)
Overall satisfaction	124 (91.2)
Mean overall satisfaction score (1–5)	4.4 ± 0.5

DISCUSSION

This randomized controlled trial found that a structured, theory-based, nurse-led behaviour change intervention more than doubled verified VIA screening uptake among under-screened women aged 30–49 years, from 16.0% to 36.0% at six months, with an adjusted odds ratio of approximately three. The intervention simultaneously produced large, sustained gains in knowledge and coherent improvement across every Health Belief Model construct, and was highly acceptable to participants.

The clinical significance of this result rests on the established downstream value of VIA. The Mumbai cluster-randomized trial demonstrated that biennial VIA delivered by trained primary health workers reduced cervical cancer mortality by approximately 31% without overdiagnosis, with national implementation projected to prevent some 22,000 deaths annually.5 That trial established what screening achieves once women attend; the present study addresses the complementary question of how to bring women to screening under routine community conditions. Raising uptake from roughly one in eight women to more than one in three is therefore a meaningful contribution to the implementation science of cervical screening in India.

The magnitude of effect is consistent with the international literature on theory-based screening promotion. A nurse-led HBM-based intervention among HIV-infected women in Kenya raised screening uptake from 16% to 57% and improved knowledge and every belief construct,10 and a theory-driven, culturally tailored nurse-delivered programme in rural populations significantly improved self-efficacy, knowledge, and six-month screening uptake.11 Community health volunteer–delivered HBM-based home education has been evaluated on similar logic in Nepal.

The literature also supplies an instructive contrast. A pilot randomized trial of a community health worker–led multimedia intervention among South Asian women improved perceived benefits and barriers but produced no significant change in actual screening uptake, with nearly all participants stating an intention to be screened that did not translate into attendance.12 The dissociation between belief change and behaviour change in that study illuminates why the present intervention succeeded behaviourally: it did not stop at improving beliefs. Session 3 was devoted to problem-solving practical and emotional barriers, Session 4 to motivational interviewing, goal setting, and personal action planning with identification of individual cues to action, and Session 5 to finalizing a concrete screening appointment. These implementation-focused components are precisely the elements behavioural theory identifies as bridging the intention–behaviour gap, and the widening of the between-arm gap from 18 to 20 percentage points between three and six months is consistent with their continued operation.

The pattern of secondary outcomes supports this mechanistic reading. Perceived barriers fell furthest and perceived benefits and self-efficacy rose most steeply—exactly the constructs the intervention targeted most directly. This aligns with Indian evidence identifying stigma, competing economic priorities, fear of pain and of the result, mistrust of public services, and distance as the leading barriers to participation.6,7 The significant group × time interaction across cognition, threat appraisal, outcome expectancy, obstacle appraisal, and agency indicates a broad shift in the determinants of behaviour rather than an isolated change, and interventions that move multiple reinforcing determinants tend to produce more durable change than single-construct approaches.

The integration of HBM with COM-B appears to have been consequential. In COM-B terms, education and skills training built psychological capability, barrier problem-solving and the facilitated screening pathway addressed physical and social opportunity, and motivational interviewing and self-efficacy work strengthened motivation. Interventions built on belief models alone can raise motivation yet fail to change behaviour when capability or opportunity remain limiting, a plausible explanation for the null behavioural result in the multimedia pilot.12

The modest decline in knowledge between the immediate post-intervention assessment and six months is expected and reflects natural decay of newly acquired information; even after this decay, intervention-arm knowledge remained approximately double that of controls, consistent with the use of reinforcement and repeated contacts over four to six weeks rather than single-session exposure.

Implications for practice and policy

The findings support adopting structured, theory-based, nurse-led counselling as a component of cervical cancer prevention programmes, delivered in community settings and integrated with the work of ASHAs and community health workers. The transferable principle is that practitioners should be equipped and given time to conduct personalized barrier assessment and action planning rather than only disseminating generic awareness material. At the health system level, the results reinforce the case for shifting the framing of cervical screening from supply—making VIA available—toward demand generation, since VIA's effectiveness is established while uptake remains the binding constraint. Because cervical cancer mortality in India falls disproportionately on rural and socioeconomically disadvantaged women, and because the somewhat larger apparent effect among more educated women signals a literacy gradient, scale-up should explicitly employ pictorial flip charts, video, and local-language delivery so that the intervention narrows rather than widens existing gaps. Complementary system-level measures—transport assistance, use of self-help groups and community gatherings as promotion platforms, and culturally tailored multimedia—could plausibly amplify the individual-level effect observed here.

Strengths and limitations

Strengths include randomization with allocation concealment by sequentially numbered opaque sealed envelopes and demonstrated baseline comparability; ascertainment of the primary outcome through screening registers and medical records rather than self-report, substantially reducing social desirability and recall bias; explicit theoretical grounding permitting interpretation of mechanism and enhancing replicability; intention-to-treat analysis with multiple imputation, per-protocol sensitivity analysis, and adjustment for pre-specified confounders; inclusion of both rural and urban communities; and multiple assessment points capturing both immediate and more durable effects.

Several limitations warrant acknowledgement. Neither participants nor delivering nurses could be blinded, raising the possibility of performance bias; verification of the primary outcome through objective records mitigates but does not eliminate this. Intervention-arm participants received considerably more contact time and personal attention than controls, so part of the benefit may reflect non-specific attention effects rather than the specific theoretical content—this does not diminish the practical value of the package as delivered, but limits attribution to HBM and COM-B content specifically and strengthens the case for component-dismantling studies. Secondary outcomes relied on self-report and structured interview and may be subject to social desirability bias, particularly where rapport with the nurse was deliberately fostered. The six-month follow-up captures initial uptake but cannot establish whether the intervention promotes sustained, guideline-concordant re-screening, which is the outcome most relevant to cervical cancer control. The trial was conducted within a single institution's catchment, so generalizability to other regions and health systems requires replication. Contamination between arms cannot be excluded in community settings where participants share social networks, though this would dilute rather than inflate the observed effect. Finally, the intervention is relatively resource-intensive—up to five sessions over four to six weeks delivered by trained nurses—and its cost-effectiveness and feasibility at scale within routine health-system budgets were not formally evaluated.

Future research

Priorities include longer-term follow-up to determine whether the intervention promotes sustained re-screening; formal economic evaluation to establish cost per additional woman screened; dismantling or factorial designs to identify which components contribute most, allowing the package to be streamlined; multi-centre cluster-randomized replication across states and health systems, which would also address contamination risk; implementation research on embedding the protocol within the routine workload of nurses and ASHAs while maintaining fidelity; and integration of demand generation with newer modalities such as HPV self-sampling and digital delivery.

CONCLUSION

A theory-based, nurse-led behaviour change intervention integrating the Health Belief Model and COM-B framework more than doubled verified VIA cervical cancer screening uptake among under-screened women aged 30–49 years, produced large and sustained knowledge gains, strengthened favourable health beliefs while markedly reducing perceived barriers, and was highly acceptable. In a country where cervical cancer exacts a heavy and inequitable toll and screening coverage remains among the lowest in the world, an acceptable and replicable nurse-delivered intervention capable of substantially raising uptake is a valuable addition to the prevention toolkit. Subject to longer-term follow-up and economic evaluation, the approach merits integration into community-based cervical screening programmes and the corresponding investment in nursing and community health workforce capacity.

Declarations

Trial registration: [Clinical Trials Registry – India (CTRI) number to be inserted].

Ethical approval: Institutional Ethics Committee [approval number to be inserted]; written informed consent obtained from all participants.

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Conflicts of interest: None declared.

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