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ASSOCIATION OF HEALTH CARE ACCESS, LIFESTYLE, AND OCCUPATIONAL ENVIRONMENT WITH INFERTILITY RISK IN THE AGRICULTURAL REGION OF JEMBER

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ABSTRACT

Background: Infertility is a growing reproductive health problem in Indonesia. The Global Cancer Observatory (2020) reported 61,103 new cases related to women's reproductive health. In Jember Regency, the prevalence of infertility reaches 15%, while coverage of reproductive health examinations is only 30% among rural women of reproductive age. **Method**: An analytic case–control study was conducted among 115 respondents (29 cases; 86 controls). Three predictor constructs were built as composite indices: health care access, screening services, service quality, distance, travel time, cost), lifestyle (smoking, alcohol use, diet, physical activity, hygiene, sanitation), and occupational environment (chemical exposure, working hours, personal protective equipment use). Logistic regression was applied ($\alpha = 0.05$). **Result**: The logistic model was significant ($\chi^2 = 59.709$, df = 3, $p < 0.001$) with Nagelkerke $R^2 = 0.439$. Classification performance was good (accuracy = 0.740; sensitivity = 0.735; specificity = 0.744) and AUC = 0.836. The Hosmer–Lemeshow test indicated good fit ($\chi^2 = 9.810$, df = 8, $p = 0.279$). All three constructs showed protective and significant associations with infertility risk: Access_index (B = −0.728; OR = 0.483; p = 0.0037), Lifestyle_index (B = −1.330; OR = 0.264; $p < 0.001$), and Work_index (B = −1.296; OR = 0.274; $p < 0.001$). The effect of Access_index was relatively smaller, consistent with the minimal contribution of distance and travel time within the access construct. **Conclusion**: Health care access, lifestyle, and occupational environment are significantly associated with infertility risk, with lifestyle and occupational factors showing the dominant effects. Policy recommendations should prioritize health-promoting lifestyles, strengthening occupational safety and health (OSH) and PPE adherence, and expanding JKN/screening with improvements in service quality and affordability—rather than focusing solely on geographic barriers.

Keywords: infertility, health care access, lifestyle, occupational environment, agriculture

INTRODUCTION

Infertility is a global reproductive health problem that affects women's quality of life and family relationships; identifying its risk factors is essential to improve the chances of conception and prevent secondary infertility (Alghamdi et al., 2023; Naser et al., 2024). Globally, the burden of reproductive diseases remains high; the Global Cancer Observatory (GLOBOCAN) reported 61,103 new cases related to women's reproductive health and 234,511 cancer deaths in Indonesia in 2020, underscoring the urgency of prevention and management (WHO, 2020). On the other hand, although more than 20 fertility clinics provide advanced Assisted Reproductive Technology (ART), utilization in Indonesia remains low—about 2,627 in vitro fertilization (IVF) cycles per year—lower than Vietnam (≈6,000 cycles) and Singapore (≈2,500 cycles). This low uptake is exacerbated by service distribution concentrated in major cities on Java Island and limited literacy and information in rural communities (Alghamdi et al., 2023; Naser et al., 2024; WHO, 2020).

Access to infertility diagnosis and treatment is also hindered by economic and geographic barriers and by low health literacy among women, particularly in areas with limited health infrastructure. In agricultural/rural regions, infertility services are often concentrated in urban referral centers, so long travel distances, limited availability of specialists, and additional indirect costs can delay diagnostic workups and treatment initiation (Harris et al., 2017; Brodeur et al., 2022). Differences in service quality contribute to disparities in outcomes; for example, marginalized groups frequently experience delays in diagnosis or intervention due to services that do not meet clinical standards (Karanth et al., 2019; Gupta et al., 2023). These conditions indicate that infertility is influenced not only by medical factors but is also closely linked to the health care system and to the social–economic determinants of health.

In East Java Province—especially Jember Regency—infertility is a serious concern, with an estimated prevalence of 15%, while coverage of reproductive health examinations is only about 30% among rural women of reproductive age (Jember Health Office, 2024). Inadequate health insurance coverage further worsens the situation, as reflected in the concept of underinsurance, which leads to delays in diagnosis and treatment even among populations with formal coverage (Smith et al., 2022).

Beyond structural barriers, infertility risk in agrarian settings is also shaped by lifestyle patterns and work-related routines that are common in farming communities. In many agricultural regions, daily activities are characterized by heavy physical workload, early-start and prolonged working hours, limited opportunities for rest, and irregular meal patterns; these conditions can be accompanied by unbalanced diets and low adherence to personal protective equipment (PPE), particularly during pesticide handling, which together may compromise reproductive health (Istriningsih et al., 2022). The key problem is that these "lifestyle" factors are not purely individual choices but are often constrained by seasonal work demands, economic pressure, and the local occupational environment. Theoretically, the Health Care Access Model by Penchansky and Thomas emphasizes five dimensions—affordability, availability, accessibility, accommodation, and acceptability—which in practice are often unequal in farming communities, limiting preventive counseling, early risk detection, and timely referral for infertility-related complaints (Gupta et al., 2023).and the occupational environment in agrarian settings also

contribute to infertility risk. Exposure to pesticides, long working hours, insufficient rest, low adherence to personal protective equipment (PPE), and unbalanced diets are important factors affecting the reproductive health of farming communities (Istriningsih et al., 2022). Theoretically, the Health Care Access Model by Penchansky and Thomas emphasizes five dimensions—affordability, availability, accessibility, accommodation, and acceptability—which in practice are often unequal in farming communities (Gupta et al., 2023).

Prevention and management of infertility risk in farming populations require a multifactorial approach integrating health care access, lifestyle, and occupational environment, so that support for couples of reproductive age under the National Health Insurance (JKN) can be better targeted (Clarke et al., 2022; Anggraeni et al., 2024). In line with this framework, the present study aims to analyze the effects of health care access, lifestyle, and occupational environment on infertility risk in the agricultural region of Jember Regency, with the expectation that the effect of access will be relatively smaller than that of lifestyle and occupational factors because geographic barriers (distance/travel time) contribute minimally.

METHOD

This study employed a quantitative analytic observational case–control design to assess the effects of health care access, lifestyle, and the occupational environment on infertility risk among farming communities in Jember Regency. The study population comprised all couples of reproductive age residing in agricultural areas. The sample included 115 respondents with a 1:3 ratio—29 cases (women of reproductive age not achieving pregnancy after ≥12 months of regular unprotected intercourse) and 86 controls (women of reproductive age without a history of infertility). Multistage random sampling was applied: nine of the 31 subdistricts (~30%) were selected at random, followed by random selection of villages and respondents within each selected subdistrict based on eligibility criteria and informed consent. Primary data were collected through structured questionnaires and field observations, while secondary data were obtained from the Jember District Health Office and health facility records.

Independent variables were operationalized as three composite index constructs derived from measurable indicators: (1) Access_index (active National Health Insurance [JKN], availability of screening services, service quality, distance, travel time, and service cost); (2) Lifestyle_index (smoking, alcohol use, diet, physical activity, hygiene, and sanitation); and (3) Work_index (chemical exposure, working hours, and personal protective equipment [PPE] use). Each indicator was standardized using a z-score transformation to place all measures on a comparable scale and to minimize the influence of differing units and distributions across variables. The direction of effect was harmonized so that indicators reflecting protective or beneficial conditions were coded as positive values, whereas indicators reflecting harmful or adverse conditions were coded as negative values, ensuring that higher index scores consistently indicated more favorable conditions. To construct each composite index, standardized indicators were aggregated following a predefined weighting scheme informed by theoretical rationale and the local agrarian context. Specifically, distance and travel time were assigned smaller weights within the Access_index to reflect their relatively minor contribution compared with non-spatial components such as JKN activation, screening availability, service quality, and service cost, which are expected to exert a stronger and more direct influence on timely utilization of infertility-related services and continuity of care.

The primary analysis used binary logistic regression with Infertility (0 = no, 1 = yes) as the outcome and Access_index, Lifestyle_index, and Work_index as predictors. Model adequacy and performance were evaluated using the Omnibus/Likelihood-Ratio χ^2, Nagelkerke pseudo-R^2, the Hosmer–Lemeshow goodness-of-fit test, classification accuracy, sensitivity, and specificity at a 0.50 threshold, as well as the Area Under the ROC Curve (AUC) for discrimination. Descriptive statistics and bivariable tests (chi-square/t-tests, as appropriate) were conducted for preliminary exploration. All analyses were performed in SPSS with a significance level of $\alpha = 0.05$. This study received ethical approval from the Health Research Ethics Committee, Faculty of Dentistry, University of Jember (No. 3355/UN25.8/KEPK/DL/2025).

RESULT

Table 1. Respondent Characteristics

Characteristic	Cases (n=29)	Controls (n=86)	Total (N=115)
Age (mean ± SD), years	35.1 ± 4.8	32.3 ± 5.1	33.0 ± 5.1
Marital duration (median [IQR]), years	8 [5–11]	6 [4–9]	7 [4–10]
Education ≥ senior high school, n (%)	13 (44.8%)	48 (55.8%)	61 (53.0%)
Agricultural occupation, n (%)	22 (75.9%)	56 (65.1%)	78 (67.8%)
Body mass index (mean ± SD), kg/m²	25.2 ± 3.6	23.8 ± 3.4	24.2 ± 3.5
Active National Health Insurance (JKN), n (%)	16 (55.2%)	58 (67.4%)	74 (64.3%)
Ever screened for fertility, n (%)	17 (58.6%)	67 (77.9%)	84 (73.0%)

Descriptive analysis indicated that baseline characteristics were broadly comparable between cases (n = 29) and controls (n = 86), with more pronounced variation on the indicators forming the three principal constructs: health care access, lifestyle, and occupational environment (Table 1). In bivariate tests, most lifestyle indicators (e.g., smoking, diet, physical activity) and occupational indicators (chemical exposure, PPE adherence) were associated with infertility risk in the expected directions, whereas distance and travel time—components of the access construct—showed weak or non-significant associations. In the multivariate analysis, the logistic regression model with three main predictors (Access_index, Lifestyle_index, Work_index) was significant overall ($\chi^2 = 59.709$, df = 3, $p < 0.001$) and yielded a Nagelkerke $R^2 = 0.439$, indicating adequate explanatory power (Tables 2 and 3). All three constructs were protective and statistically significant: Access_index (B = −0.728; OR = 0.483; p = 0.0037), Lifestyle_index (B = −1.330; OR = 0.264; $p < 0.001$), and Work_index (B = −1.296; OR = 0.274; $p < 0.001$) (Table 2); the magnitude of these effects is visualized in the forest plot (Figure 2). Classification performance was good (accuracy 0.740; sensitivity 0.735; specificity 0.744), with strong discriminative ability on the ROC curve (Figure 1; AUC consistent with Table 3). The Hosmer–Lemeshow test indicated good fit ($\chi^2 = 9.810$, df = 8, p = 0.279), and the decile-based calibration curve lay close to the line of equality between predicted and observed outcomes (Figure 3; Table 5). Substantively, the access effect was smaller than the lifestyle and occupational effects, consistent with the minimal contribution of distance and travel time within the access construct compared with non-spatial components (active JKN, screening, service quality, and affordability).

Table 2. Logistic regression results

Variable	B	SE	Wald	Sig.	Exp(B)	95% CI Exp(B)
Intercept	−0,240	0,205	1,375	0,2410	0,786	0,526 – 1,175
Access_index	−0,728	0,251	8,435	0,0037	0,483	0,295 – 0,789
Lifestyle_index	−1,330	0,272	23,846	<0,001	0,264	0,155 – 0,451
Work_index	−1,296	0,313	17,168	<0,001	0,274	0,148 – 0,505

Table 3. Model adequacy and performance

Measure	Value
−2 Log Likelihood (null)	206.636
−2 Log Likelihood (model)	146.926
χ^2 (LR), df, p	59.709, 3, <0.001
Nagelkerke R^2	0.439
AUC (ROC)	0.836

Table 4. Classification metrics (threshold = 0.50)

Metric	Value
Accuracy	0.740
Sensitivity	0.735
Specificity	0.744
PPV (Precision)	0.704
NPV	0.772

Table 5. Hosmer–Lemeshow test (g = 10)

Measure	Value
χ^2 (df = 8)	9.810
p-value	0.279
Interpretation	Good fit

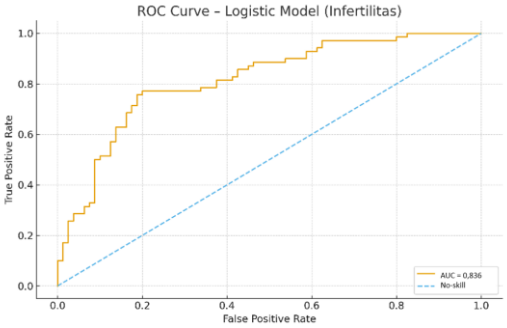

Figure 1. ROC curve

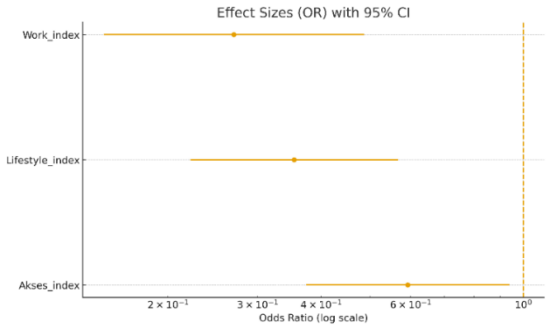

Figure 2. Forest plor-OR(95%CI)

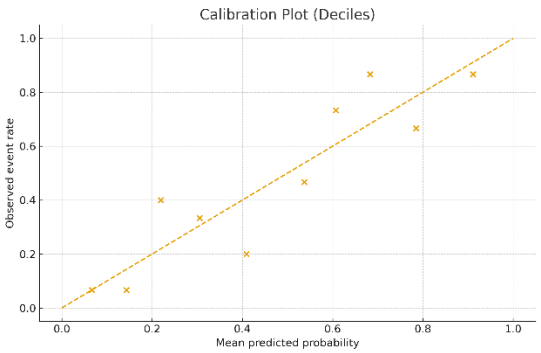

Figure 3. Calibration plot

DISCUSSION

The main findings of this study affirm that infertility risk in agrarian communities is significantly influenced by three constructs—health care access, lifestyle, and occupational environment—with protective effects for all three (OR < 1), albeit with different magnitudes: the effects of the Lifestyle_index and Work_index are stronger than that of the Access_index. Logistic regression indicated a significant overall model (χ^2 = 59.709; $p < 0.001$) with adequate explanatory power (Nagelkerke R^2 = 0.439), good discrimination (AUC = 0.836), acceptable goodness-of-fit (Hosmer–Lemeshow χ^2 = 9.810; $p = 0.279$), and balanced classification performance (accuracy 0.740; sensitivity 0.735; specificity 0.744) (see Tables 2–5, Figures 1–3). Substantively, this pattern supports the view that infertility is multifactorial, shaped not only by clinical factors but also by behavioral determinants and work context that influence the likelihood of conception and the maintenance of reproductive function (Alghamdi et al., 2023; Naser et al., 2024).

For access, the smaller effect of the Access_index (B = −0.728; OR = 0.483; $p = 0.0037$) reflects that non-spatial barriers—such as affordability, participation in JKN (national health insurance), service quality, and screening coverage—are more decisive than distance and travel time, which contribute minimally within this construct. However, in agricultural regions, fertility-related services and specialist care are often concentrated in urban referral centers, and limited local availability means patients may still face repeated travel and substantial indirect costs (transportation, time off work), which can delay help-seeking even when distance itself is not the dominant component of the index (Harris et al., 2017; Brodeur et al., 2022). This aligns with the Penchansky & Thomas framework on five access dimensions (affordability, availability, accessibility, accommodation, acceptability), which are often imbalanced in farming communities (Gupta et al., 2023). Moreover, underinsurance—even among populations with formal coverage—can delay diagnosis and treatment, worsening reproductive outcomes (Smith et al., 2022). At a macro level, the globally reported burden of reproductive disease further underscores the urgency of system improvement and early prevention (WHO, 2020).

For lifestyle, the Lifestyle_index shows the strongest protective effect (B = −1.330; OR = 0.264; $p < 0.001$). This is consistent with evidence that smoking and alcohol increase risk, whereas healthier diet, physical activity, hygiene, and sanitation are associated with improved reproductive function (Alghamdi et al., 2023; Naser et al., 2024). In agricultural regions, however, "lifestyle" risk is often structurally shaped by farming routines and living conditions: seasonal and long working days may lead to irregular meals and suboptimal dietary diversity despite living in food-producing areas, while limited household WASH conditions can increase reproductive-tract infection risk that may indirectly compromise fertility (Mehraban & Ickowitz, 2021; Baker et al., 2017). Policywise, these findings support prioritizing health-promoting lifestyle interventions and community-based education so that couples of reproductive age derive optimal benefits in the JKN era (Clarke et al., 2022; Anggraeni et al., 2024).

For the occupational environment, the Work_index is also significant (B = −1.296; OR = 0.274; $p < 0.001$). Agrarian settings expose women to pesticides/chemicals, long working hours, and suboptimal PPE adherence, factors documented to be associated with reproductive disorders (Istriningsih et al., 2022). Accordingly, strengthening occupational

safety and health (OSH) in agriculture—substitution/limits on exposure, engineering/administrative controls, PPE, and oversight of working hours—represents a key intervention pathway, alongside improving chemical-risk literacy within farming households.

Methodologically, assembling indicators into three composite indices enables more stable capture of latent constructs in the model. Good calibration (Figure 3) and a high AUC (Figure 1) support the predictive validity of the findings, while the forest plot (Figure 2) clearly displays the hierarchy of effects (Lifestyle ≈ Work > Access). Even so, causal interpretation warrants caution given the observational design; potential information bias (e.g., self-reported behaviors), residual confounding (clinical reproductive variables not fully captured), and limited generalizability to similar agrarian communities remain important limitations. Enhancing the measurement of non-spatial access indicators (actual costs, experienced service quality), employing biomarker-based assessments of chemical exposure, and conducting longitudinal studies are recommended to strengthen inference (Karanth et al., 2019; Gupta et al., 2023; Istriningsih et al., 2022).

Practically, program implications include: (i) cost subsidies and expansion of JKN for essential fertility services; (ii) expansion of screening and improvement of primary reproductive care quality; (iii) targeted lifestyle interventions (smoking/alcohol cessation, nutrition, physical activity, hygiene); and (iv) measurable OSH in agriculture and PPE adherence. This policy mix aligns with the literature and may help close utilization gaps that have been concentrated in urban centers (Alghamdi et al., 2023; Naser et al., 2024; Clarke et al., 2022; Anggraeni et al., 2024; WHO, 2020).

CONCLUSION

This study confirms that health care access, lifestyle, and occupational environment are significantly associated with infertility risk in agrarian communities. The magnitude of effects indicates the dominance of behavioral factors and work context over access barriers, with geographic constraints being relatively less decisive. Within the access construct, non-spatial components—health insurance enrollment, screening coverage, service quality, and affordability—are more relevant than distance and travel time, while lifestyle and occupational factors exhibit the dominant effects and non-spatial access components matter more than geographic barriers.

Practically, policy priorities should focus on behavior-change interventions (smoking and alcohol cessation, improved nutrition, increased physical activity, and strengthened hygienic practices), strengthening occupational safety and health in the agricultural sector (control of chemical exposure, management of working hours, and adherence to personal protective equipment), and expanding insurance and screening alongside improvements in quality and affordability of services at the primary care level. Going forward, longitudinal research with more precise exposure measurement, implementation evaluation in primary care, and cost-effectiveness analysis are needed to strengthen causal inference and optimize resource allocation for at-risk rural populations.

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