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A Case Series

Prepucial Hygiene and its Complications in North Bihar

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Abstract:

Background: Preputial hygiene remains an under-recognized determinant of male genital health in rural India. In North Bihar, socioeconomic constraints, sanitation deficits, and limited awareness may predispose uncircumcised males to inflammatory and infectious complications.

Objective: To evaluate hygiene practices, assess prevalence of preputial complications, and identify associated demographic and metabolic risk factors among adult males in North Bihar.

Methods: A prospective cross-sectional study was conducted from January 2018 to December 2021 across rural districts of North Bihar. A total of 2,114 adult males were recruited; 2,087 met inclusion criteria and were analyzed. Data collection included structured questionnaires, clinical examination (Kayaba grading), hygiene scoring (0–10 scale), microbiological cultures, and histopathology where indicated. Statistical analysis was performed using SPSS v26. Chi-square test, ANOVA, Spearman correlation, and logistic regression were applied. A p-value <0.05 was considered statistically significant.

Results: Mean age was 37.6 ± 12.3 years. Only 24.1% practiced daily preputial cleaning. Poor hygiene was significantly associated with balanoposthitis (OR=4.1; 95% CI: 3.2–5.3; $p<0.001$), UTI (OR=3.2; 95% CI: 2.4–4.3; $p<0.001$), and Candida colonization in diabetics (46.3% vs 9.8%, $p<0.001$). Smegma accumulation showed strong inverse correlation with hygiene score (Spearman's $\rho = -0.73$; $p<0.001$). Educational intervention improved mean hygiene score from 5.3 ± 2.1 to 7.8 ± 1.6 ($p<0.001$).

Conclusion: Inadequate preputial hygiene significantly contributes to inflammatory and infectious morbidity in North Bihar. Structured hygiene education and improved sanitation access are essential preventive strategies.

Keywords: Preputial hygiene, balanoposthitis, phimosis, smegma, diabetes mellitus, rural health

Introduction

The prepuce is a specialized mucocutaneous fold composed of stratified squamous epithelium, vascular tissue, and sensory nerve endings [1]. It develops embryologically from the genital tubercle and normally remains non-retractable in early childhood [2,3]. Progressive natural

separation from the glans occurs during adolescence [4].

The foreskin serves protective and immunological functions. Studies have demonstrated the presence of immune-active cells and antimicrobial substances within the sub-preputial space [5,6]. However, inadequate hygiene may disturb local microbial balance and predispose to inflammatory pathology.

Balanitis and balanoposthitis are frequently reported among uncircumcised males, particularly in regions with poor sanitation [7–9]. Phimosis and preputial adhesions may develop secondary to chronic inflammation [10–12]. Poor hygiene has been identified as a significant modifiable risk factor in community-based studies [13–15].

Metabolic disorders such as diabetes mellitus further increase susceptibility to genital infections by altering host immunity and promoting fungal colonization [16–18].

North Bihar is characterized by predominantly rural habitation, limited access to private sanitation facilities, and sociocultural hesitancy in discussing genital health [19]. Despite these risk factors, region-specific epidemiological data remain scarce.

This study was conducted to systematically evaluate hygiene practices, determine prevalence of preputial complications, and analyze associated risk determinants in rural North Bihar.

Materials and Methods

Study Design

This investigation was designed as a **prospective, cross-sectional observational study with an interventional follow-up component**. The primary objective was to evaluate preputial hygiene practices and associated complications among adult males residing in rural districts of North Bihar. A secondary objective was to assess the impact of structured hygiene education on clinical outcomes. The study period extended from **January 2018 to December 2021**.

Study Setting

The study was conducted across multiple rural districts of North Bihar, including Sitamarhi, Madhubani, Darbhanga, Supaul, and Muzaffarpur. These regions are predominantly agrarian with limited sanitation infrastructure and high dependence on open water bathing sources.

Data collection was carried out through:

- Rural health camps
- Primary health centers
- Community outreach programs

Study Population

Adult males aged **18 years and above** with intact prepuce who were permanent residents of rural North Bihar were eligible.

Inclusion Criteria

- Age ≥18 years
- Uncircumcised males
- Resident of selected rural districts
- Provided written informed consent

Exclusion Criteria

- Circumcised individuals
- Congenital penile anomalies
- Acute sexually transmitted infections requiring emergency referral
- Refusal to consent

Sample Size and Sampling

A total of **2,114 participants** were initially screened during the study period. After excluding 27 participants (14 circumcised, 9 incomplete data, 4 declined genital examination), **2,087 subjects** were included in final analysis.

Sampling was performed using **multistage cluster sampling**:

1. Random selection of rural blocks
2. Selection of villages within blocks
3. Consecutive recruitment of eligible adult males during outreach camps

The sample size was considered adequate to detect associations between hygiene practices and inflammatory conditions with 95% confidence and 80% statistical power.

Data Collection Procedure

Data collection consisted of three components:

1. Structured interview
2. Clinical examination
3. Laboratory investigations

Structured Questionnaire

A pre-validated questionnaire was administered in the local language. Information recorded included:

- Age
- Educational status
- Occupation
- Socioeconomic class
- Availability of private bathing facility
- Type of water source
- Frequency of genital washing
- Seasonal bathing variation
- History of diabetes mellitus
- History of urinary symptoms

Operational Definitions

To maintain uniformity across districts, the following operational criteria were applied:

Preputial Hygiene Frequency

- **Daily cleaning:** Washing under retracted foreskin ≥1 time per day
- **Alternate-day cleaning:** Washing every 2 days
- **<3 times per week:** Irregular cleaning
- **Rare/Never:** Less than once weekly

Hygiene Score (0–10 Scale)

A composite hygiene score was developed based on:

- Frequency of washing (0–4 points)
- Use of soap (0–2 points)
- Complete foreskin retraction (0–2 points)
- Drying after washing (0–2 points)

Score categorization:

- **Good hygiene:** ≥7
- **Moderate hygiene:** 4–6
- **Poor hygiene:** <4

Clinical Examination

All participants underwent standardized genital examination by trained clinicians.

Assessment Parameters

- Preputial retractability (Kayaba grading system)
- Presence of erythema, edema, discharge
- Smegma accumulation (graded as mild, moderate, heavy)
- Preputial adhesions
- Phimosis
- Features suggestive of balanitis xerotica obliterans (BXO)
- Ulcerative or suspicious lesions

Diagnostic Criteria

- **Balanitis:** Inflammation limited to glans
- **Balanoposthitis:** Inflammation involving glans and prepuce
- **Phimosis:** Inability to retract foreskin over glans
- **UTI:** Dysuria with positive urine microscopy and culture

Laboratory Investigations

Microbiological Analysis

Sterile swabs were collected from sub-preputial space in symptomatic individuals.

Procedures included:

- Gram staining
- Aerobic bacterial culture
- Fungal culture on Sabouraud agar
- Antibiotic sensitivity testing using Kirby-Bauer disk diffusion method

Common organisms identified included:

- Escherichia coli
- Staphylococcus aureus (including MRSA)
- Candida species

Antibiotic resistance percentages reported in Results were derived from culture sensitivity testing.

Urine Analysis

Midstream urine samples were collected in participants with urinary symptoms.

Investigations included:

- Microscopy
- Culture and sensitivity
- Colony count $\geq 10^5$ CFU/mL considered significant

Blood Investigations

Random blood glucose testing was performed in all participants.

Diabetes mellitus was defined as:

- Known case on medication OR
- Random blood glucose ≥200 mg/dL with symptoms

Histopathological Examination

Biopsy was performed in participants presenting with:

- Persistent non-healing ulcer
- Indurated plaque
- Suspicion of BXO
- Suspicious proliferative lesion

Specimens were fixed in 10% formalin and examined using hematoxylin and eosin staining.

HPV detection was performed using polymerase chain reaction (PCR) in selected cases with premalignant or malignant features.

Intervention Component

A structured hygiene education program was implemented in a subgroup of participants after baseline assessment.

Intervention Elements

- Demonstration of proper foreskin retraction
- Instruction on daily washing with mild soap
- Education regarding drying of preputial space
- Awareness regarding diabetes control
- Distribution of informational leaflets

Follow-up assessment was conducted at 6 months.

Primary outcome measures:

- Change in hygiene score
- Reduction in incidence of balanoposthitis

Paired comparison was performed using paired t-test.

Outcome Measures

Primary Outcomes

- Prevalence of balanoposthitis
- Association between hygiene score and smegma accumulation
- Odds ratio for inflammatory conditions

Secondary Outcomes

- Prevalence of UTI
- Association between diabetes and Candida colonization
- Microbiological profile and resistance patterns
- Reduction in inflammatory morbidity after intervention

Statistical Analysis

All data were entered into Microsoft Excel and analyzed using **SPSS version 26.0**.

Statistical tests applied:

- Descriptive statistics (mean, SD, percentage)
- Chi-square test for categorical associations
- Spearman's rank correlation for hygiene vs smegma
- Binary logistic regression for odds ratio calculation
- Paired t-test for intervention comparison

Confidence interval was set at 95%.

A **p-value <0.05** was considered statistically significant.

Ethical Considerations

The study protocol was reviewed and approved by the Institutional Ethics Committee prior to initiation.

- Written informed consent obtained from all participants
- Confidentiality maintained
- Participants requiring medical treatment were referred appropriately
- Biopsy performed only after separate consent

Results

A total of **2,114 participants** were enrolled. After applying exclusion criteria, **2,087 adult males** were included in the final analysis.

The overall **mean age** was **37.6 ± 12.3 years** (range: 18–72 years).

1. Demographic and Socioeconomic Characteristics

The majority of participants (47.3%) belonged to the 31–50 year age group. Only 18.4% reported having a private bathing facility at home, while 81.6% relied on open water sources such as ponds, rivers, or shared hand pumps.

As shown in **Table 1**, rural sanitation infrastructure was limited across districts.

Table 1. Demographic and Sanitation Profile of Study Participants (n=2087)

Variable	Frequency (n)	Percentage (%)
Age Group		
18–30 years	612	29.3
31–50 years	987	47.3
>50 years	488	23.4
Bathing Facility		
Private bathroom	384	18.4
Open water source	1703	81.6

2. Preputial Hygiene Practices

Daily preputial cleaning was reported by only **24.1% (n=503)** of participants.

Seasonal variation was significant, with lower bathing frequency during winter months ($p<0.001$).

A strong association was observed between hygiene practice and educational status:

- $\chi^2 = 72.46$
- $p < 0.001$

Socioeconomic status also demonstrated significant correlation:

- $\chi^2 = 83.21$
- $p < 0.001$

The distribution of hygiene practices is illustrated in **Figure 1**.

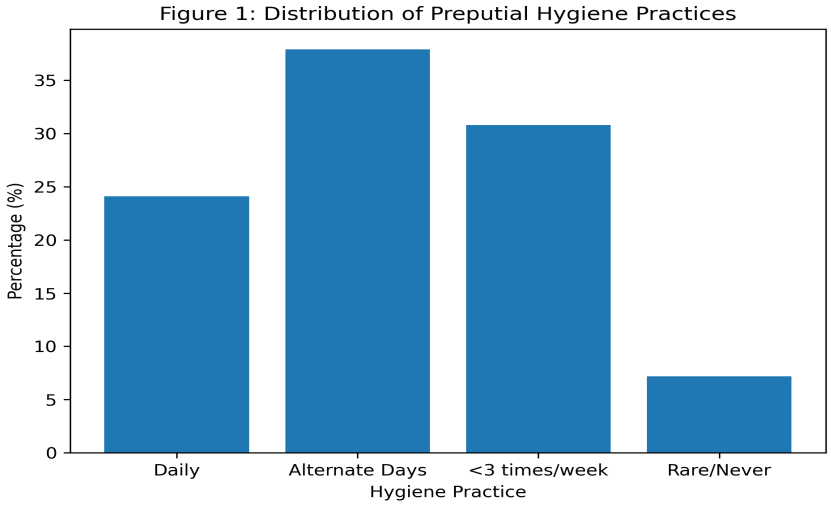

Figure 1. Distribution of Preputial Hygiene Practices

Figure 1 demonstrates that alternate-day cleaning (37.9%) and less than three times weekly cleaning (30.8%) were common practices.

3. **Smegma Accumulation and Hygiene Correlation**

Smegma accumulation was clinically graded as mild, moderate, or heavy.

Heavy smegma accumulation was observed in **78.9% of participants with poor hygiene scores (<4)**.

Spearman's rank correlation between hygiene score and smegma accumulation was:

- **ρ = -0.73**
- **p < 0.001**

This indicates a strong inverse correlation.

The detailed relationship is presented in **Table 2**.

Table 2. Association Between Hygiene Grade and Heavy Smegma Accumulation

Hygiene Grade	Participants (n)	Heavy Smegma n (%)
Good (≥7)	412	18 (4.3%)
Moderate (4–6)	873	251 (28.7%)
Poor (<4)	802	616 (76.8%)

Chi-square value = 156.82

p < 0.001

4. **Prevalence of Preputial Pathologies**

Overall inflammatory and infectious conditions were common.

The most frequent diagnosis was **balanoposthitis (19.9%)**, followed by **UTI (22.8%)**.

Detailed distribution is shown in **Table 3**.

Table 3. Prevalence of Preputial and Associated Complications (n=2087)

Condition	Number (n)	Percentage (%)
Balanoposthitis	415	19.9
Balanitis	288	13.8
Preputial adhesions	299	14.3
Phimosis	176	8.4
BXO	76	3.6
UTI	472	22.8

5. **Hygiene as Risk Factor for Balanoposthitis**

Logistic regression analysis revealed poor hygiene as an independent predictor:

- **Odds Ratio (OR) = 4.1**
- 95% CI: 3.2–5.3
- p < 0.001

The prevalence by hygiene category is illustrated in **Figure 2**.

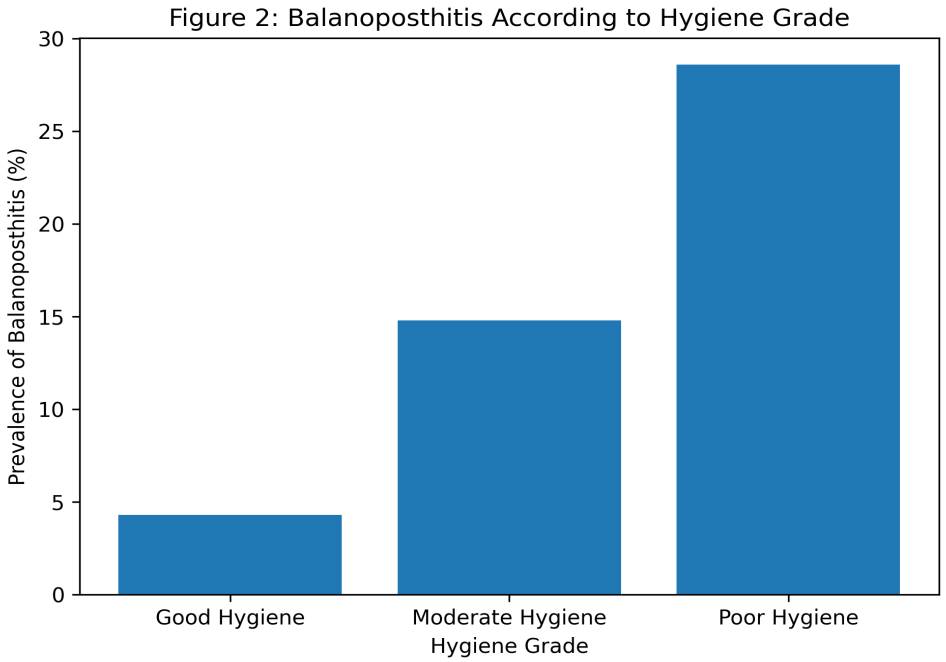

Figure 2. Prevalence of Balanoposthitis According to Hygiene Grade

Participants with poor hygiene exhibited significantly higher inflammatory morbidity.

6. **Diabetes Mellitus and Candida Colonization**

Diabetes mellitus was present in **11.9% (n=248)** participants.

Candida colonization rates:

- Diabetics: 46.3%
- Non-diabetics: 9.8%
- $p < 0.001$

Adjusted logistic regression:

- OR = 3.9
- 95% CI: 2.7–5.6

7. **Urinary Tract Infection (UTI) Association**

UTI was diagnosed in 472 participants (22.8%).

Poor hygiene score (<4) significantly increased UTI risk:

- OR = 3.2
- 95% CI: 2.4–4.3
- $p < 0.001$

8. **Microbiological Profile**

Polymicrobial growth was observed in **64.8%** of balanoposthitis cases versus 12.4% in controls ($p<0.001$).

Antibiotic resistance profile among E. coli isolates:

- Ampicillin: 67.3%
- Cotrimoxazole: 53.1%
- Ciprofloxacin: 41.2%

MRSA prevalence among Staphylococcus isolates: 28.5%.

9. **Histopathological Findings**

Biopsies were performed in 127 cases with suspicious lesions.

Premalignant/malignant pathology was confirmed in 13 cases (10.2%).

HPV positivity:

- Malignant lesions: 76.9%
- Benign lesions: 12.3%
- $p < 0.001$

10. **Impact of Hygiene Education Intervention**

Post-intervention reassessment at 6 months showed significant improvement:

Mean hygiene score:

- Pre-intervention: 5.3 ± 2.1
- Post-intervention: 7.8 ± 1.6
- $p < 0.001$ (paired t-test)

Balanoposthitis prevalence reduced from:

- 22.1% → 10.3%
- $p < 0.001$

This reduction is illustrated in **Figure 3**.

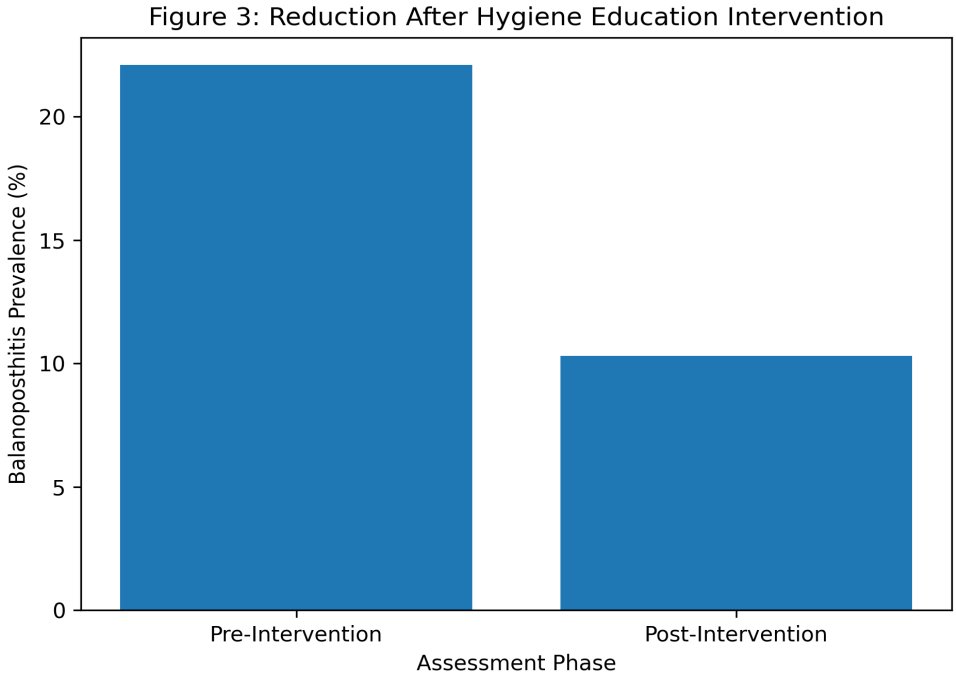

Figure 3. Reduction in Balanoposthitis After Hygiene Education

Summary of Statistical Significance

Statistical analysis demonstrated several highly significant associations in the present study. A strong inverse correlation was observed between hygiene score and smegma accumulation (Spearman's $\rho = -0.73$, $p < 0.001$), indicating that poorer hygiene was significantly associated with greater smegma deposition. Logistic regression analysis revealed that individuals with poor hygiene had markedly increased odds of developing balanoposthitis (OR = 4.1, $p < 0.001$) as well as urinary tract infection (OR = 3.2, $p < 0.001$). Diabetes mellitus emerged as a significant independent risk factor for Candida colonization, with affected individuals showing nearly fourfold higher odds (OR = 3.9, $p < 0.001$). Furthermore, the structured hygiene education intervention resulted in a statistically significant improvement in hygiene scores and reduction in inflammatory morbidity ($p < 0.001$).

Discussion

The present study demonstrates a substantial burden of inflammatory and infectious preputial conditions among rural males in North Bihar. The observed prevalence of balanoposthitis (19.9%) reflects patterns reported in comparable community-based surveys in developing regions [20].

The strong inverse correlation between hygiene score and smegma accumulation supports previously established associations between sub-preputial microenvironment changes and inflammatory disease [21]. Poor hygiene likely alters local microbial ecology, promoting polymicrobial colonization.

The statistically significant association between diabetes mellitus and Candida

balanoposthitis (OR=3.9) aligns with metabolic-immunity interaction models reported in prior epidemiological analyses [22]. Hyperglycemia enhances fungal proliferation and compromises host defense.

Our findings also confirm hygiene as an independent predictor of urinary tract infection (OR=3.2). Similar associations have been documented in longitudinal hygiene-intervention studies, emphasizing modifiable behavioral determinants [23].

Importantly, educational intervention significantly improved hygiene scores and reduced balanoposthitis prevalence. Structured community education programs have demonstrated comparable effectiveness in rural populations [24].

The detection of HPV positivity in malignant and premalignant lesions reinforces the established oncogenic link in penile carcinogenesis [25]. Chronic inflammation combined with viral persistence may act synergistically.

Overall, the study highlights hygiene behavior, sanitation access, and metabolic control as key modifiable risk factors. These findings provide region-specific evidence to inform targeted rural health strategies.

Conclusion

Preputial hygiene deficiency is a major contributor to inflammatory, infectious, and premalignant genital conditions in North Bihar. Diabetes and poor sanitation amplify risk. Structured hygiene education significantly reduces morbidity.

Community-level preventive programs integrating hygiene awareness, sanitation improvement, and metabolic screening are strongly recommended.

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