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Age-Related Susceptibility to Urinary Tract Infection Among Circumcised and Uncircumcised Preschool Boys in Jembrana, Bali, Indonesia: A Retrospective Analysis

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Abstract: Urinary tract infection (UTI) is a frequent bacterial infection in children. In Indonesia, the interaction between age-specific susceptibility and circumcision status in preschool boys remains underexplored. This study analyzed age-related susceptibility to UTI among circumcised and uncircumcised boys aged two to five years at Negara General Hospital, Jembrana, Bali. A retrospective cross-sectional study was conducted using medical records from 2016 to 2022. Eighty male patients meeting the inclusion criteria were analyzed. The relationships between age, circumcision, and UTI were assessed using the Chi-square test ($p < 0.05$). The overall prevalence of UTIs was 31.3%. Uncircumcised boys had a significantly higher infection rate (46.9%) compared to circumcised boys (6.5%). While age alone did not show a statistically independent effect, infection frequency was highest in uncircumcised boys aged 2–3 years and declined in older preschoolers as circumcision rates increased. Circumcision confers a significant protective effect against UTI in preschool boys. The data suggest that susceptibility decreases with age, primarily due to the protective benefits of circumcision and developmental maturation. Early circumcision combined with hygiene education is recommended.

Keywords: Age factors; Circumcision; Preschool children; Susceptibility; Urinary tract infection

INTRODUCTION

Urinary tract infection (UTI) remains one of the most common bacterial infections in childhood and continues to represent a significant cause of morbidity worldwide[1]. Globally, UTIs occur in approximately 3–8% of children, with a higher risk among younger age groups due to physiological and behavioral factors that predispose them to bacterial colonization of the urinary tract[2]. The susceptibility in younger children, particularly those below five years of age, is influenced by anatomical immaturity, incomplete bladder control, and dependence on caregivers for personal hygiene[3]. Studies have consistently shown that children under two years are the most vulnerable to severe infections, while preschool-aged children remain at risk of recurrent infections due to hygiene-related factors[4].

The role of circumcision as a preventive factor against UTI has been recognized in both global and regional studies[2]. The removal of the preputial foreskin decreases periurethral bacterial colonization, thereby reducing infection risk in boys[5]. However, the degree of this protective effect may not be constant throughout early childhood. It is suggested that as boys age, improvements in personal hygiene, immune system maturation, and behavioral independence may further modulate susceptibility to infection[6]. While numerous meta-analyses have confirmed the protective benefit of circumcision in infants[3], fewer studies have examined whether this effect varies across narrower preschool age intervals.

In the Indonesian context, pediatric UTI continues to be a significant clinical problem[4]. Regional data suggest high burdens in specific pediatric cohorts. For instance, a study in Central Java reported that UTI cases frequently occurred in children aged one to five years, indicating this age group is a primary contributor to morbidity[8]. Similarly, in East Java, data from Dr. Soetomo Hospital revealed a high prevalence of UTI in

toddlers, often complicated by antibiotic resistance[7]. Meanwhile, research in Bali found that Escherichia coli was the dominant pathogen in pediatric patients, closely linked to local demographic factors[6]. Despite these findings across the archipelago, specific data on the interaction between age and circumcision in the rural districts of Bali, such as Jembrana, remain underreported.

MATERIAL AND METHOD

Study Design and Setting

This research employed an analytic observational design with a cross-sectional approach. The study was conducted at Negara General Hospital, Jembrana, Bali, using medical record data collected between 2016 and 2022. This design was selected to simultaneously observe exposure variables (circumcision status and age) and the outcome variable (occurrence of UTI) within a defined population.

Population and Sample

The study population consisted of male patients with pediatric aged 2 to 5 years who were admitted to the pediatric, surgical, or emergency departments. The population selection followed the standard definition for generalization areas in quantitative research. A sample size of 80 subjects was calculated using the Snedecor and Cochran formula for cross-sectional studies (95% confidence level, 10% margin of error). A consecutive sampling technique was employed, using a quota method, to recruit subjects who met the inclusion criteria sequentially from the medical registry until the required sample size was achieved.

Inclusion and Exclusion Criteria

Inclusion criteria were male children aged two to five years with complete medical records regarding circumcision status and UTI diagnosis. Meanwhile, exclusion criteria included immunocompromised conditions (e.g., HIV/AIDS, tuberculosis) and congenital anatomical abnormalities (e.g., hypospadias, epispadias) to avoid confounding factors.

Data Analysis

Data were analyzed using SPSS version 25. Descriptive statistics summarized variable distribution, while the Chi-square test was used to assess the association between circumcision status and UTI incidence, with statistical significance set at $p < 0.05$. The study utilized pediatric admission registry data specific to the local setting.

Ethical Considerations

Ethical approval was granted by the Ethics Committee of the Faculty of Medicine, University of Surabaya (No. 152/KE/VI/2023). The study adhered to the Declaration of Helsinki regarding research involving human subjects.

RESULT

A total of 80 medical records of male preschool children aged two to five years met the inclusion criteria. All subjects had complete documentation regarding circumcision status and urinary tract infection (UTI) diagnosis.

Table 1. Baseline Characteristics of Preschool Boys (n=80)

Characteristic	2 years	Frequency (n)	Percentage (%)
Age	2 years	8	10.0
	3 years	14	17.5
	4 years	26	32.5
	5 years	32	40
Circumcision Status	Uncircumcised	49	61.3
	Circumcised	31	38.8
UTI Diagnosis	Negative	55	68.8
	Positive	25	31.3

Table 1 summarizes the demographic and clinical characteristics of the subjects. The highest proportion of patients was five years old (40.0%). The majority of the study population was uncircumcised (61.3%). Regarding clinical outcomes, 31.3% of the subjects were diagnosed with a urinary tract infection.

Table 2. Age-Specific Distribution of Circumcision Status

Age (years)	Circumcised	Uncircumcised	Total
2 years	8	10.0	8
3 years	14	17.5	14
4 years	26	32.5	26
5 years	32	40	32
Total	31 (38.8%)	49 (61.3%)	80

Table 2 details the distribution of circumcision by age. The frequency of circumcision increased with age, with the highest proportion of circumcised boys found in the five-year-old group (22.5%).

Table 3. UTI Prevalence by Age

Age (years)	UTI Positive	UTI Negative	Total
2 years	2 (2.5%)	6 (7.5%)	8
3 years	3 (3.8%)	11 (13.8%)	14
4 years	10 (12.5%)	16 (20.0%)	26
5 years	10 (12.5%)	22 (27.5%)	32
Total	25 (31.3%)	55 (68.8%)	80

As indicated in Table 3, the absolute number of UTI-positive cases was higher in children aged four and five years, corresponding to the larger sample size in these age groups.

Table 4. Cross-tabulation of UTI Occurrence by Circumcision Status

UTI Status	Circumcised	Uncircumcised	Total
UTI Positive	2	23	25
UTI Negative	29	26	55
Total	31	49	80

Table 4 displays the cross-tabulation of infection status. Children who were not circumcised had a markedly higher frequency of UTI (n = 23) compared to those who were circumcised (n = 2).

Table 5. Chi-square Analysis of Circumcision and UTI

Test	Circumcised	Uncircumcised	Total
Pearson Chi-square	2	14.478	< 0.001
Continuity correction	29	12.664	< 0.001
Likelihood ratio	16.798	1	< 0.001

The statistical analysis in Table 5 reveals a significant relationship between circumcision status and the occurrence of UTIs ($p < 0.001$). The calculated prevalence ratio indicated that circumcision reduced the risk of UTI by more than 90% in this cohort.

DISCUSSION

The results of this study demonstrated that uncircumcised preschool boys had a significantly higher rate of UTI (46.9%) compared to circumcised boys (6.5%), with statistical analysis confirming a strong association ($p < 0.001$). These findings suggest that circumcision status, rather than age alone, was the primary determinant of infection risk. The observed decline in infection prevalence in older boys appears to correspond with the higher frequency of circumcision at later preschool ages. This suggests that both biological and behavioral factors may synergistically contribute to reduced infection risk.

Quantitative analysis of this study's data revealed a stark risk differential. The calculated Odds Ratio (OR) for uncircumcised boys developing UTI in this cohort was 12.3 (95% CI: 2.7–56.1), indicating that they are over twelve times more likely to develop an infection compared to their circumcised peers. This finding is

notably higher than the summary OR of 3.65 reported in global meta-analyses for lifetime risk[3] but aligns more closely with the infant-specific risk ratios observed in high-prevalence populations[2]. When compared to regional data, such as a study in Surabaya which reported high bacterial burden in uncircumcised populations[7], the high OR in this study suggests that in rural settings like Jembrana—where access to clean water and sanitation may be more variable—the protective "hygienic advantage" of circumcision becomes clinically critical.

Theoretically, the strong association between uncircumcised status and UTI is attributed to the preputial environment. The foreskin's inner mucosa harbors a moist, warm niche conducive to the colonization of uropathogenic Escherichia coli and bacterial adherence[3,4]. This biological mechanism is consistent with local microbiological data from Sanglah Hospital in Bali, which identified Escherichia coli as the dominant pathogen in pediatric UTI cases[6]. During the early preschool years, the urethral immune defense is still developing, which increases the likelihood that colonization will progress to an ascending infection.

Regarding age-related susceptibility, infection rates were observed to be highest among toddlers aged two to three years. This finding is consistent with the "window of vulnerability" hypothesis, where younger children possess incomplete bladder control and depend heavily on caregivers for hygiene[4]. As children age, epithelial maturation and improved hygiene independence reduce bacterial exposure. In this study, the decline in UTI cases after age four coincided with a sharp increase in circumcision prevalence, reinforcing the concept that the "protective effect of age" is heavily mediated by the timing of circumcision.

When compared to other Indonesian data, this study's findings are highly consistent with regional patterns. The high infection rate in uncircumcised toddlers mirrors findings in Central Java, where the highest UTI prevalence also occurred in the early childhood age group[8]. This similarity highlights that UTI remains a persistent burden in the Indonesian pediatric population, likely influenced by local environmental factors. Data from the Jembrana District Health Profile indicate that while sanitation access is improving, gaps persist in rural areas which may amplify the risk for uncircumcised boys living in such environments[14].

Socio-economic factors and hygiene education also play a critical role. Previous reviews emphasize that poor hygiene practices are a primary driver of recurrent infections in preschool children[12]. In the Indonesian context, national consensus guidelines highlight the necessity of proper genital hygiene to prevent ascending infections[13]. The high rate of infection observed in uncircumcised boys in this study underscores the need for targeted parental education regarding foreskin hygiene if circumcision is delayed.

The implications of this study support the importance of early intervention. While cultural norms in Bali often delay circumcision until late preschool or early school age, this study's data show that the highest risk occurred earlier (ages 2–3). Therefore, performing circumcision closer to infancy or toddlerhood could prevent a significant number of infections. This supports the global recommendation that the health benefits of early male circumcision outweigh the risks[2,3].

CONCLUSION

This study demonstrates that age-related susceptibility to urinary tract infection (UTI) among preschool boys in Jembrana, Bali, is strongly influenced by circumcision status. The highest vulnerability was observed in uncircumcised boys aged two to three years. As boys age, the risk of infection declines, a trend that corresponds with increased circumcision rates and the process of developmental maturation. Hence, early circumcision, combined with hygiene education as recommended by national guidelines[13], is advisable to reduce the burden of UTI in this population.

ETHICAL CONSIDERATIONS

This study has been approved by the Ethical Committee of the University of Surabaya (No. 152/KE/VI/2023, June 15, 2023), in accordance with the Declaration of Helsinki.

This article is based on secondary analysis of data previously reported in the *Calyptra Journal (2023, Vol. 12, No. 1)*, focusing on a different analytical objective and interpretation.

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This article presents a new analytical interpretation derived from the same anonymized dataset as a prior publication in *Calyptra Journal (Vol. 12 No. 1, 2023)*. The current study explores a different research objective focusing on age-related susceptibility patterns. Ethical approval remains valid under reference number 152/KE/VI/2023.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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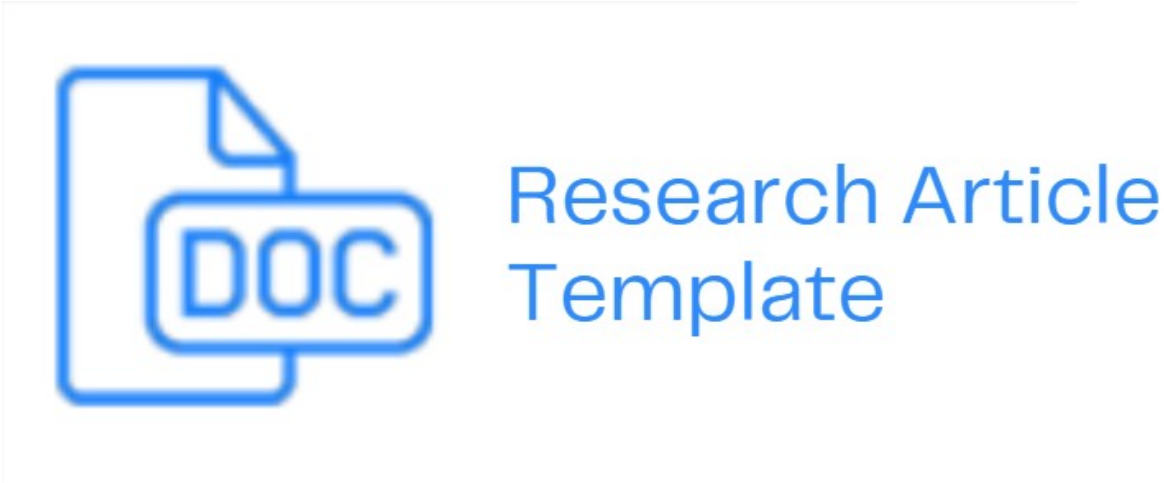

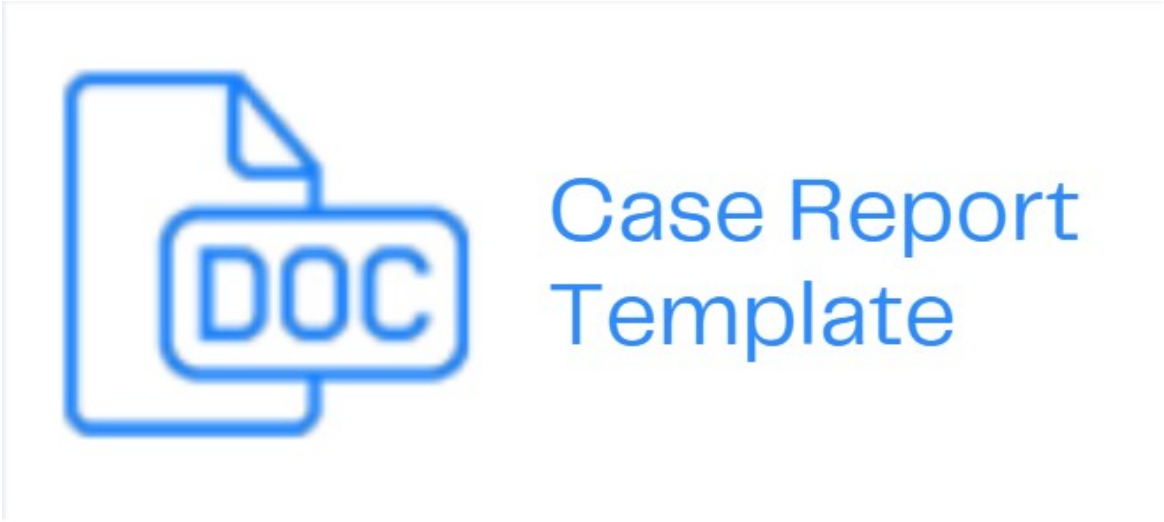

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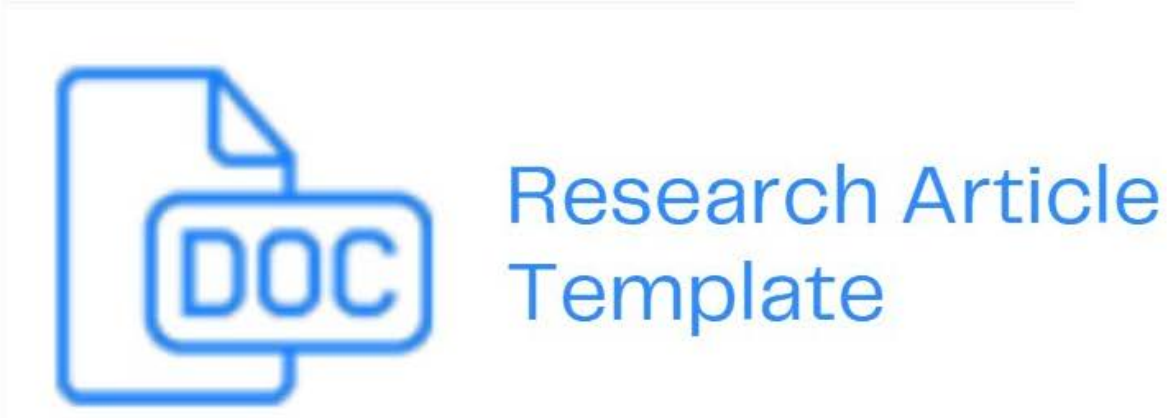

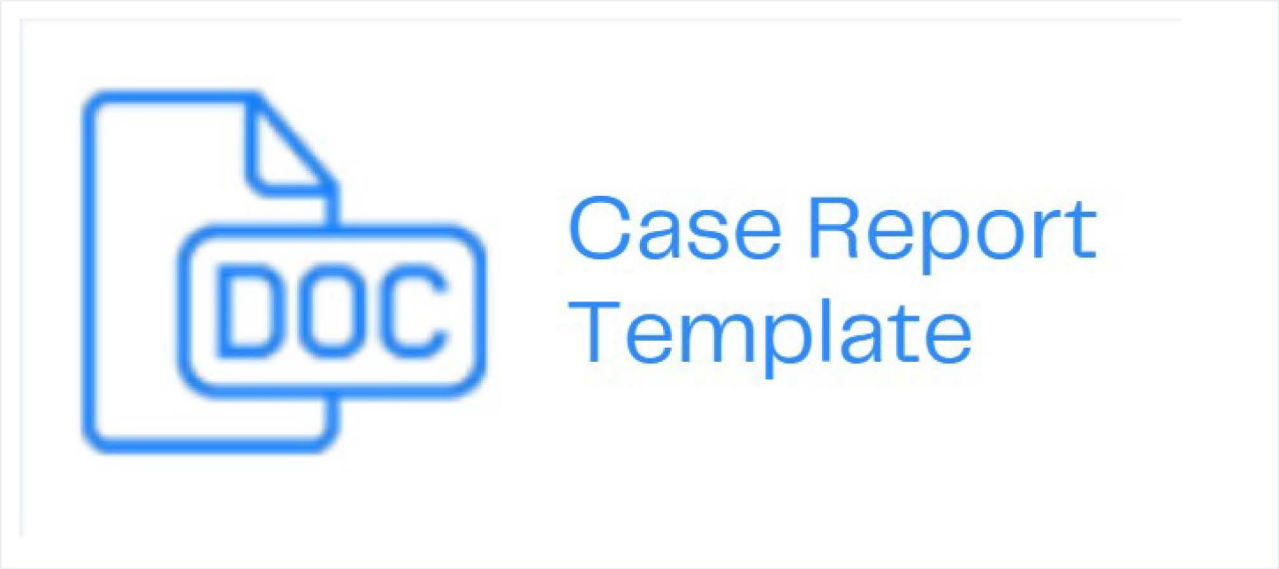

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