

## The Association between Post-Operative Complications of Circumcision and Body Mass Index in Pediatric Population at a Tertiary Centre in the Maldives

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**Abstract:** The purpose of this study is to examine the association between post-operative complications of circumcisions and body mass index. The study selected 143 who registered in IGMH (a public hospital) for routine ritual normal circumcision starting from 1st July 2022 to 31st of July 2022. The post-operative complication of circumcision includes bleeding and swellings and are considered dependent variables. The data was collected using simple random probability sampling from the sampling strata. The independent variables include weight, height and Body Mass Index of children. The data was collected based on clinical, and children complain complications. The data was analysed using Pearson's correlation, paired sample t-test and multiple linear regression techniques via SPSS version 22. The correlation analysis showed that there is a significantly positive association between bleedings and Body Mass Index in both cases of child complaints and clinical findings of bleedings. In terms of height of children, there was a significantly negative association between height of children and bleeding (clinical findings). The paired sample T-test showed that child complained swelling is more compared to clinical findings and such differences are significant. This means children complain swellings are critical complication of circumcision. In terms of multiple linear regressions, it was found that height and Body Mass Index has significantly positive influence on post-operative complication of circumcision in terms of bleeding (clinical findings). However, body weight itself was found to have a significantly negative impact on the post-operative complication of circumcision in terms of bleeding (clinical findings). Therefore, it is concluded that increasing the Body Mass Index of children will causes to increase the post-operative complication of circumcision in terms of bleeding. Also, it was concluded that increasing height of the children could cause more complication after circumcisions. The implications of the findings were discussed. This study adds value to the current theoretical frameworks by establishing BMI as key determinants of bleeding as a post-operative complication of circumcisions. Also, this study contributes to new knowledge in terms of establishing the relationship between BMI and post-operative complications, particularly in Maldivian context.

**Keywords:** Post-operative Complications, Body Mass Index, Body weight, Height.

### INTRODUCTION

Ritual male circumcision is one of the most common surgeries carried out in the pediatric population since ancient times. It is carried out for religious, cultural or for pathological conditions (Arslan, Kalkan, Yazgan, Ünüvar & Şahin, 2013; Brook, 2016; Douglas, Maluleke, Manyapelo & Pinkney-Atkinson, 2018). In Muslim and Jewish populations, it is mandatory to undergo circumcision due to religious reasons. In the Maldivian context children usually undergo circumcision before they attain puberty.

The American Academy of Pediatrics found that the health benefits outweigh the risks of newborns undergoing circumcision, but the benefits are not good enough to warrant universal circumcision for all boys (Brook, 2016). It has been reported that complications related to circumcision are as low as 0.2% (Christakis, Harvey, Zerr, Feudtner, *et al.*, 2000) and as high as 12.6% (Kim, Koyle, Chua, *et al.*, 2019). Bleeding is the most common complication which has been reported (Prabhakaran, Ljuhar, Coleman & Nataraja, 2018; Shabanzadeh, Clausen, Maigaard & Fode, 2021). The other complications which have been reported include infections, adhesions, inadequate/excessive skin removal, and meatal stenosis. Rarely amputation or death may occur (Kim, *et al.*, 2019).

It has been observed in various studies that obesity is related to complications such as preputial adhesions and buried penis requiring re-surgery for correction (Fahmy, 2019; Storm, Baxter, Koff & Alpert, 2011). The patients requiring suturing for bleeding significantly increased in patients with weight >5.1 kg (Douglas, *et al.*, 2018).

Various techniques have been used for circumcision. These include plastibell, gomco clamp, mogen clamp, dorsal slit, and freehand method (Prabhakaran, *et al.*, 2018). In the Maldives, the medical practitioners or surgeons have been using the bone cutter method and plastibell for circumcisions.

As there are very few studies done in the Maldives, it is quite pertinent for us to conduct research to find out the relation between obesity and complications following circumcision so that we are able to bring about necessary changes to our clinical practice to make it safer for these children undergoing circumcision. It will also enable us to provide accurate information to the parents regarding the expected complications which might arise from circumcision. Therefore, the following research objectives are developed

- (1) To examine the impact of the weight of circumcised boy on the post-operative complication of circumcision
- (2) To examine the impact of height of circumcised boy on the post-operative complication of circumcision
- (3) To examine the body mass index (BMI) on the post-operative complication of circumcision

## LITERATURE REVIEW

**The Prepuce:** The prepuce mainly arises from two components at the junction between the glans and the shaft of the penis. The first one is the dartos fascia of the shaft and the second one is the glans stroma. It grows as a solid glanulopreputial lamella in an outward direction (Hadidi, 2022). On the other hand, the formation of the median ventral part of the prepuce is formed essentially from the distal proliferation of the median raphe (Glenister, 1956).

In the early stages of the prepuce development, the epithelium covering the deep aspect of the preputial fold is fused with the epithelium covering the glans. Later on, the breaking down of the epithelial layer between the preputial fold and the glans gives rise to the cylindrical prepuce (Hadidi, 2022).

The prepuce is a unique organ with a unique structure, despite how delicate it is, it is able to withstand frictional trauma along with the whole life. The outer surface of the prepuce is not well demarcated from the remaining of the penile skin, yet in a flaccid penis, it can be recognized by the coronal ridge projection. Normal Prepuce is a conical structure that has two layers, the first is the outer skin which is folded distally at the preputial meatus, and the second is the inner layer of mucous membrane which is folded sagittally at the ventral surface of the glans to be attached to the wings of glans and form the frenulum (Fahmy, 2020).

The outer epithelium of the prepuce consists of stratified squamous keratinized epithelium with melanocytes in the basal layers. The outer layer of the prepuce contains a few sebaceous and sweat glands (Barreto, Caballero & Cubilla, 1997; (Shabanzadeh, *et al.*, 2021). The inner layer of the prepuce is formed of mucosal epithelium which is the same as the mucosal epithelium covering the glans penis and both consist of variably keratinized squamous epithelium which is devoid of hair follicles, sweat, sebaceous glands, and melanocytes (Fahmy, 2020).

**Circumcision:** Circumcision is one of the most performed surgical procedures in the world and it is performed for both medical and traditional purposes with a rate of 30% to 34% (Mu, Fan, Liu & Zhu, 2020). In addition to the traditional and religious purposes of circumcision, there are a lot of indications for circumcision including, Phimosi which is an acquired or congenital constriction of the prepuce with the inability of the foreskin to be completely retractable, Paraphimosis which happens when the prepuce is unable to be pulled back over the glans after retraction leading to a tight constricting band, Balanoposthitis which is erythema and oedema of both the prepuce and the glans, balanitis which is inflammation of the glans, and recurrent attacks of urinary tract infection (Hohlfeld, Ebrahim, Zaki Shaik & Kredo, 2021).

There are several techniques used for circumcision either using conventional surgical dissection or using circumcision devices, irrespective to the technique of circumcision the surgical base is the same which includes crushing the foreskin at the proposed location, obtaining hemostasis then the foreskin is either excised or allowed to slough off by ischemic necrosis and the crushed edges are sutured, glued, or even left to heal (Alanis & Lucidi, 2004).

The most commonly used circumcision devices are the Mogen clamp, the Plastibell device and the Gomco clamp. The devices are further classified into ligature devices which allow the prepuce to slough off by ischemic necrosis with no suturing needed or crush devices which provide crushing hemostasis then the foreskin is excised, and the edges are sutured. The dissection techniques using sharp dissection, cautery, or ligation of bleeding vessels followed by suturing of the edges. The types of dissection techniques include the traditional forceps-guided technique, the inner ring-outer ring technique, and the dorsal slit technique (Hohlfeld, Ebrahim, Shaik & Kredo, 2022)

Although circumcision is a very common surgery as with any surgical procedure, it is not free of complications. There are lots of studies with varying complication rates. The reported incidence varies from less than 3% and up to 30%, but a systematic review estimates it to be 0% to 16% with a median of 2% (Shabanzadeh, *et al.*, 2021). At this point, we can assume an average of 4% of children have complications following circumcision similar to other studies (Shabanzadeh, *et al.*, 2021).

These complications are divided into early and late. Early complications include bleeding, infection, glans necrosis and amputation, delayed/early slippage of circumcision devices, and very rarely death. Late complications include inadequate skin removal, cosmetic issues, inclusion cysts, adhesions and skin bridges, suture sinus tracts, ventral curvature, secondary buried penis and phimosis, urethrocutaneous fistulae, and meatal stenosis (Coran, Adzick, Krummel, *et al.*, 2012; Krill, Palmer & Palmer, 2011). Commonest among them are bleeding, infection, partial penile/glans amputation, preputial stenosis, meatal stenosis, trapped/buried/concealed penis, urethrocutaneous fistula, insufficient foreskin removal redundant foreskin (Auvert, Taljaard, Lagarde, *et al.*, 2006; Shabanzadeh, *et al.*, 2021). Some of these complications are minor and easily treated such as bleeding and infection; others, however, require additional surgery to correct the complication such as trapped penis and unsatisfactory cosmetic results. Inadequate circumcision, or excess foreskin, is a fairly common indication for referral to a pediatric Urologist (Fahmy, 2019).

Many factors are assumed for different complications including anatomical variations like penoscrotal webbing, suprapubic fat pads and obesity, neonates and prematurity, and different surgical techniques and surgeon's experience (Bode, Ikhisemojie & Ademuyiwa, 2010; Fahmy, 2019; Storm, *et al.*, 2011). A study has found these complications are more often in children circumcised at age 2-18 years as compared to those circumcised as infants but there is no significant difference in type of surgery (Shabanzadeh, *et al.*, 2021). Similarly, another

study found not much difference in complications using different circumcision devices compared to surgical techniques (Hohlfeld, *et al.*, 2021).

Obesity, in general, and excessive suprapubic fat, in particular, have a worse effect in male circumcision, with an increased incidence of post-circumcision bleeding as an early complication and penile adhesions with a hidden penis as a late complication (Olson, 2023). Increased weight for length percentile in male infants before and after circumcision may be significantly associated with webbed penile adhesions and hidden penis. So, it is advisable to postpone circumcision in overweight children if there is a chance for weight reduction; otherwise, special precautions should be taken, such as proper haemostasis, meticulous suturing of the circumcised edges and proper follow-up (Storm, *et al.*, 2011). Similarly, a concealed penis can result from overzealous removal of shaft skin coupled with a prominent suprapubic fat pad resulting in healing within the fat pad. Another consequence of this configuration is secondary phimosis from the progressive closure of the skin over the glans penis (Spilotros & Ambruso, 2022). Preputial adhesion often results from a prominent suprapubic fat pad. Williams, *et al.* reported that 63% of patients presenting for circumcision revision were found to have prominent suprapubic fat pads (Williams, Richardson & Bukowski, 2000).

**REVIEW OF PAST RESEARCH**

A suitable amount of research on complications arise due to the circumcision is available in the public domains. Some of these studies are summarized below:

**Table 1:** Review of past literature

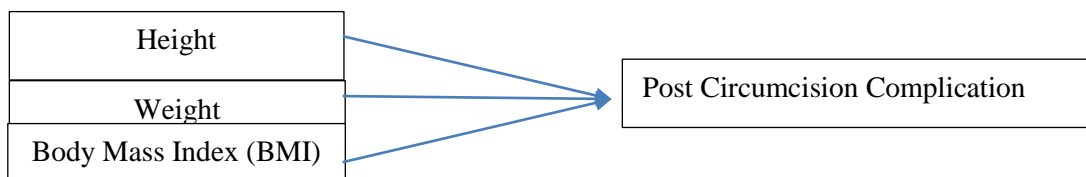
Author	Findings	Context
Fahmy (2019)	Circumcision can result in complications, and the most common early (intra-operative) complications tend to be minor and treatable, such as minor bleeding, swelling. Serious complications may occur during or immediately after the procedure, including death from excess bleeding, severe urethral injuries and complete or partial amputation of the entire penis or the glans. Postoperative complications include formation of a skin bridge between the penile shaft and the glans, infection, urinary retention, meatal ulcer, fistulas and other rare complication. Loss of penile sensitivity, sexual dysfunction and psychic impaction are considered as remote complications	NA
Menahem (1981).	Five seriously ill infants were referred with complications arising from ritual circumcision performed by non-physicians.	Australia

	Four infants developed systemic infections; in three of them, including one with early meningitis, there was septicemia. The common predisposing factor was an excessively tight dressing over an infected penile wound, leading to urinary retention, urinary tract infection and septicemia. In the fifth infant, the glans had been partially amputated and required a suture; a second dressing tightly applied to control the bleeding was removed without subsequent problems	
Alzubaidi, Hahn, Gellhaus and Erickson (2019).	Patients with a buried penis had a higher body mass index ( $46.53 \pm 10.6$ vs $31.48 \pm 5.63$ kg/m <sup>2</sup> , $p < 0.0001$ ) and underwent fewer inguinal lymph node dissections (20% vs 58%, $p = 0.05$ ) than patients without a buried penis, but had similar rates of higher stage (2-4) presentation. a buried penis and higher body mass index affect presentation, clinical management, surgical outcomes	University of Iowa Hospitals, USA
Storm, et al., (2011).	We evaluated 51 patients with penile adhesions and hidden penis after newborn circumcision and compared them to 33 age matched controls. Boys with hidden penis had a statistically higher weight for length percentile at birth and at urological evaluation. However, in boys with penile skin bridges there was no statistical difference in the weight for length percentile at either time.	USA
Ferhatoglu, Kartal and Gurkan (2019).	The mean age of the patients was $93.57 \pm 40.12$ (2-248) months. The mean follow-up time was $16.32 \pm 9.24$ (2-35) months. Sixteen patients had bleeding, four patients had a penile hematoma, and 108 patients had penile edema. There is no statistically significant difference in the penile edema occurrence according to the weight of the patients ( $p=0.58$ ).	Bursa State Hospital, Turkey

The BMI (body mass index) was studied in association with circumcisions. However, based on the studies listed in the above tables, it suggested that there was very limited research done to examine the impact of BMI on post circumcision complications, particularly clinical and self-reported complications are not emphasized. One of the earliest studies was done by Menahem (1981) in Australia. The research emphasis on examining the complications of circumcisions rather than relating to BMI. The complications reported included bleeding, penile infection, urinary tract infection and septicemia (Menahem, 1981). Also, in 2011, a study was carried out using 51 male patients in USA about circumcision complications in association with body weight. They found that body weight has a statistically significant association with the hidden penis (Storm, et al., 2011). However, they found that boys with a penile skin bridge there was no statistical

difference in the weight for length percentile at either time (Storm, et al., 2011). More recently, studies focused on examining the post complication of circumcision. A study done by Fahmy (2019) indicated that post circumcision related complication includes death from excess bleeding, severe urethral injuries and complete or partial amputation of the entire penis or the glans. Similarly, another study indicated that patient with hidden penis has a higher BMI, which causes to undergo fewer inguinal lymph node dissections than patients without a buried penis (Alzubaidi, et al., 2019). However, it was found that there is no statistically significant difference in the penile edema occurrence according to the weight of the patients (Ferhatoglu, et al., 2019) self-reported complication of circumcision.

Therefore, the following conceptual framework is developed



**Figure 1: Conceptual Framework**

### Height and Post Circumcision Complication

As earlier mentioned, there is very few research done to examine the body height and its causal relations with post circumcision complications such as bleeding or swelling. It was found that the body height of the boys has significantly positive impact on bleeding due to the circumcisions (Ferhatoglu, *et al.*, 2019). Another study found that the height of the boys has a significant effect on post complications of circumcision such as intraoperative blood loss and incision healing time (Li, Ang, Chen, Gai, Xu, You, & Hou, 2022). Also, studies that were conducted examine the success and failure rate of surgery in relation to many health problems. One of the studies indicated that the successful surgery carried out among the shorter group of people are significantly higher compared to group of taller people (She, Liu, Wang, Ou, Liang & Lei, 2021). Another study found that height of individuals is associated with knee surgical success (Liu, Balkwill, Banks, Cooper, Green & Beral, 2007). As discussed, it can be clearly indicated that increasing height is positively associated with post-surgical outcomes as well as complications. Therefore, the following hypotheses were formulated:

H1: *There is a significant relationship between the body height of the child and post circumcision complications*

### Weight and Post Circumcision Complication

The body mass or weight is found to have significant relation with post circumcision complication such as bleeding (Jiang, Fu, Guo, *et al.*, 2021). Also, a study found that there is no significant difference between lighter or heavier children in terms of post circumcision outcomes such as bleedings (Nicassio, Klamer & Fuchs, *et al.*, 2022). It was found that children older than 3 months and heavier than 5.1 kg increases the unplanned visits to hospitals due to the post circumcisions' complications (Nicassio, *et al.*, 2022). The doctor's intervention is much more required to the children who are heavier than those who are lighter among the young children (Nicassio, *et al.*, 2022). Another study found that boys with hidden penis had a statistically higher weight for length percentile at birth and at urological evaluation (Storm, *et al.*, 2011). Also, it was found that those children who have a weight that exceeds 5.1 kg has high risk of bleeding requiring sutures and long-term complications (Kim, *et al.*, 2019). Therefore, the following hypothesis was developed

H2: *Increasing body weight has a significantly positive impact on post circumcision complications.*

### Body Mass Index (BMI) and Circumcision Complication

In general, the increased body mass index (BMI) will cause complications to arise after surgery (Sabzi & Faraji, 2016). This study found that BMI was significantly associated with prolonged intubation time (Sabzi & Faraji, 2016). Another study carried out to examine the impact of BMI on post-surgical complications in terms of visceral surgery has shown that no surgical complication after surgery in association with overweight patients with spinal deformity surgery (Hashimoto, Yoshii, Sakai, *et al.*, 2022). Similarly, it was found that BMI was inversely associated with tumor size and tumor depth (Feng, Zheng, Guo, *et al.*, 2018). In contrast, it was found that patients with higher BMI had more postoperative complication such as anastomotic leakage and cardiovascular diseases, but less incidence of chylous leakage (Zhang, Yang, Luo, *et al.*, 2013). Similarly, Feng, *et al.*, (2018) found that higher BMI was associated with increased blood loss and operation time and decreases the number of retrieved lymph nodes. Also, low BMI is associated with decreased rate of postoperative fever and decreases survival (Feng, *et al.*, 2018). Obesity and BMI have an adverse impact on certain surgical related, health related and long-term surgical outcomes (Flippin, Harris, Paxton, *et al.*, 2017). The study indicated that increasing BMI has associated with medical burden of surgical outcomes (Flippin, *et al.*, 2017). Furthermore, BMI is considered as a factor that can be used to determine the post-surgical complication of prolonged air drainage, and hemorrhage in patients for whom resection is planned due to lung cancer (Evcil, Önal & Özkan, 2023). Moreover, those who have a higher BMI were found to have experienced more post-surgical complication related to circumcision (Storm, *et al.*, 2011). Therefore, the following hypothesis was developed

H3: *Increasing body mass index (BMI) has a significantly positive impact on post circumcision complications.*

## METHODOLOGY

### Research Design

This study is a quantitative observational study. As the focus of the study is to correlate the occurrence of post circumcision complications and body mass index (BMI) of those children, this design will

help to observe the occurrence of different types of complications including skin bridge formation between the glans penis and the skin, fibrosis, and scar formation of the circumcised area. The quantitative method used has helped the researchers to calculate the percentage of the occurrence of these complications among the study sample. Similarly, it has facilitated calculating the correlation of these percentages with the BMIs of the study sample.

**Study setting and Participants**

The study was conducted at the Department of Surgery in Indira Gandhi Memorial Hospital (IGMH). The sampling procedure for this quantitative observational study was decided as follows:

**1- Inclusion Criteria**

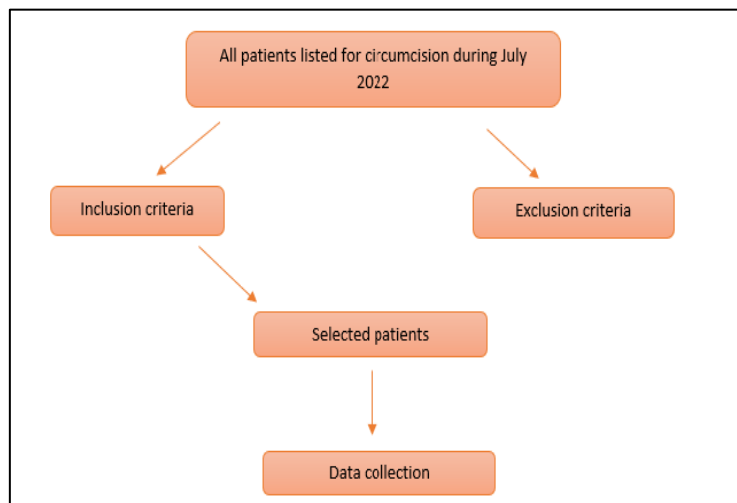
1. All who registered in IGMH for routine ritual normal circumcision during the school holiday period starting from 1<sup>st</sup> July 2022 and ending on 31<sup>st</sup> of July 2022 will be offered to participate in the study.

2. Children of those parents who give consent for participation in the study will be recruited and registered.
3. Age > 2 years and < 12 years

As the study was an observational study, all participants were operated in a standard unified method even though different surgeons have operated on the study samples.

**2- Exclusion Criteria**

1. Children of those parents who refused to give consent for participation
2. Children who have concomitant other medical conditions including different types of Hypospadias, Inguinal hernia, Hydrocele, Previous history of Circumcision, and other conditions
3. Those who are scheduled for other surgical procedures in the same setting.
4. Those who were lost to follow-up
5. Those who went to other centres for a second opinion



**Figure 2:** Participant recruitment and data collection

**Sample Size**

This is a prospective study with data collection of the children who are listed for circumcision camp that will be conducted by IGMH in July 2022. A sample of 143 participants were included in this study.

As this is a prevalence study, the following simple formula would be used for calculating the adequate sample size for this study.

$$n = \frac{Z^2 P (1 - P)}{d^2}$$

Where n is the sample size, Z is the statistic corresponding to the level of confidence, P is expected prevalence (that can be obtained from the same studies or a pilot study conducted by the researchers), and d is precision (corresponding to effect size).

Based on the 5.1% prevalence of complications (Thorup, Thorup & Ifaoui, 2013) sample size for this study is 75. As the prevalence percentage varies in different contexts and no similar study was conducted in the Maldives, the sample size was further calculated based on statistical power analysis for a correlation test that will be used to analyze the association between BMI and post-

operative complications of circumcision. Using the G\*Power for correlation: bivariate normal model, the minimum sample size for this study is 143

participants. However, the final sample used in this study is 143 participants or cases.

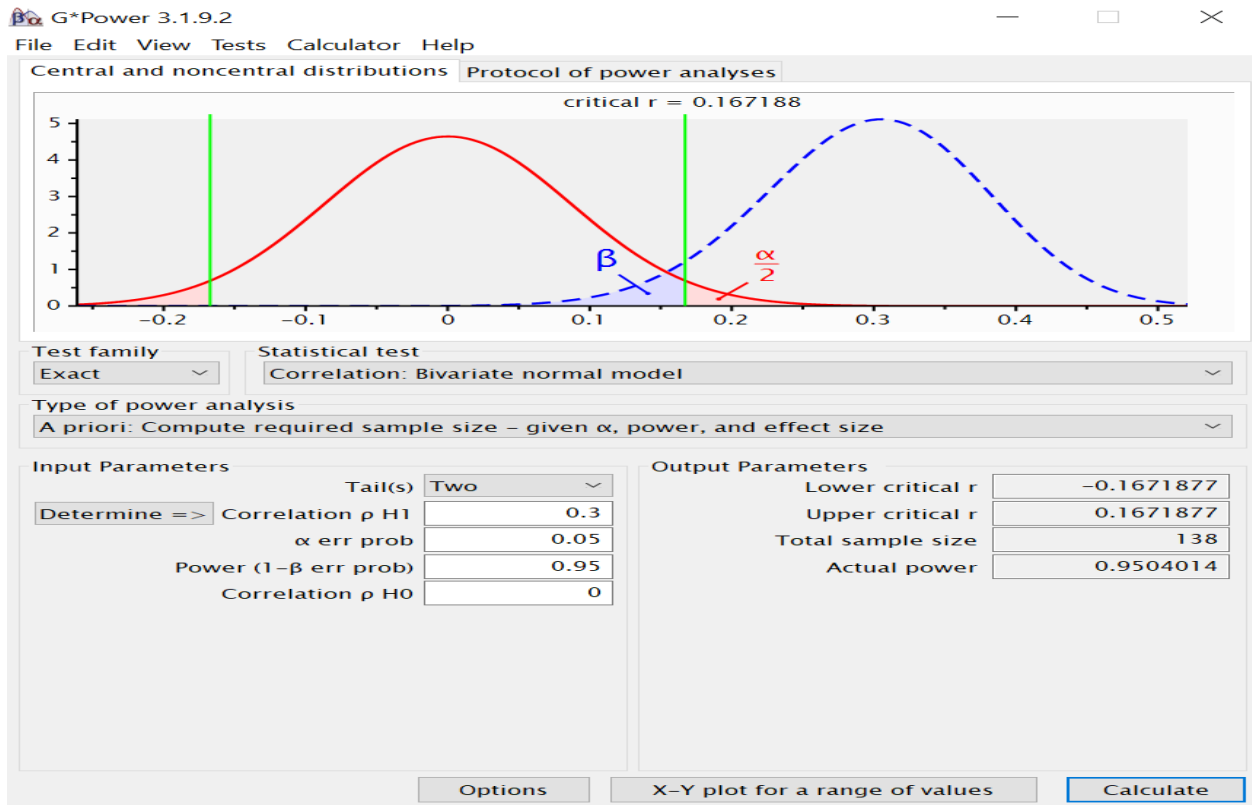


Figure 3: Sample size calculation for correlation analysis using G\*Power

**The Circumcision Procedure**

In order to unify the surgical procedure which will be performed by different surgeons from the department of surgery, we suggested a unified method of normal traditional method of circumcision in the following way.

1. After the induction of anesthesia cleaning and draping will be done
2. The surgeon will release the frenulum using bipolar cautery and return the glans penis and skin to their normal resting position
3. Using a sterile skin marker, a line will be drawn 1 cm distal to the coronal groove of the head of the penis
4. Using 2 straight arteries, one applied at the 6 o'clock position of the tip of the prepuce and the other one will be applied at the 12 o'clock position and the assistant will elevate the skin upwards.
5. Under direct vision, a bone cutter will be applied at the level of the previously drawn line and cut the skin using the number 10 blade
6. Hemostasis will be attained using bipolar cautery and sutures will be applied

approximating skin and membranous layer using 4-0 rapid Vicryl on the following way

- a. First, take a bite at the frenula area at 6 o'clock position and a second bite at 12 o'clock position on the dorsum of the penis and both stitches are held with artery forceps to give tension on the foreskin which leads to an equal approximation of the skin
- b. Take another two bites on each side of the penis
7. Dressing applied using paraffin gauze over the suture line and normal gauze stripe applied over the paraffine gauze and Micropore tape will be applied to fix the dressing.

**Instruments and Materials**

The data collection is divided into two tiers, using quantitative methods as given below:

An adapted survey questionnaire will be administered to the participants of the study in several locations.

1. Questionnaire at the time of the procedure in Operation Theater (OT), where all demographic data, anthropometric measurement, procedure, and Anesthesia details are recorded

2. Questionnaire at the time of discharge from the hospital, where details about the immediate postoperative period are documented, especially about the dressing
3. Questionnaire at the time of follow-up on 3<sup>rd</sup> postoperative day, where details about circumcision area are recorded and dressing removal details are documented
4. Questionnaire on 30<sup>th</sup> postoperative day follow-up by a video call from researchers, where the outcome of the circumcision is documented, and any complications have been noted since 3<sup>rd</sup> POD
5. Questionnaire for any visit to ER or OPD for any complication

All data collected will be entered to a secure online database. Only the research team members will have access to the database. The information collected will be handled confidentially and anonymously. Following data collection prior to analysis any information which can identify the patient will be removed and anonymised.

#### Data Analysis

The data obtained will be organized and cleaned before starting data analysis. The data will be analyzed using the Statistical Package for Social Sciences (SPSS) 27.0. A suitable non-linear correlation statistical test will be used to identify the correlation between the occurrence of post-circumcision complications and the body mass index (BMI) of children who were circumcised. Research objectives two and three will be answered using descriptive statistics of frequency, percentage, mean and standard deviation.

#### Definition of Terms

Definitions of important terminologies used in the research are given below:

##### 1. Postoperative Complications

The complications in this study are defined as any complication that occurs after circumcision. These complications are divided into early and late. Early complications include bleeding, infection, glans necrosis and amputation, delayed/early slippage of circumcision devices; etc. Late complications include inadequate skin removal, cosmetic issues, inclusion cysts, adhesions and skin bridges, suture sinus tracts, ventral curvature, secondary buried penis and phimosis, urethro-cutaneous fistulae, and meatal stenosis. If any complications occur, they will be noted in the immediate post-operative period before discharge, post-operative day 3 and postoperative day 30.

##### 2. Body Mass Index:

It is defined as a person's weight in kilograms divided by the square of his height in meters (kg/m<sup>2</sup>). It is commonly used to determine childhood weight status.

##### 3. Circumcision:

In this study, Circumcision refers to the procedure performed by a qualified surgeon to remove part of the foreskin of the penis, performed to fulfil the request for ritual circumcision.

##### 4. Pediatric Population:

For the purpose of this study, the pediatric population definition was taken from guidelines for pediatric experts for advisory panels for the United States Department of Health and Food and Drug Administration. That is the childhood is from 2 to 12 years of age.

## DELIMITATIONS AND LIMITATIONS OF THE STUDY

As it is a single centre experience, our findings may not be eligible to drive definitive conclusions on the study objectives. Though the technical steps of the procedure are unified, the procedure will be performed by different surgical teams on different days and variations are expected in many steps. Also, the management of patients postoperatively is not unified as the patient is discharged from the hospital within a few hours after the procedure.

## SIGNIFICANCE OF THE STUDY

This study will examine the association between postoperative complications of circumcision and Body Mass Index (BMI). Also, it will identify and document the types of complications that occur following circumcision and the study will analyse these complications specifically those that required other procedures to correct complications that occurred after routine ritual circumcision performed in a tertiary level hospital by a qualified surgery team.

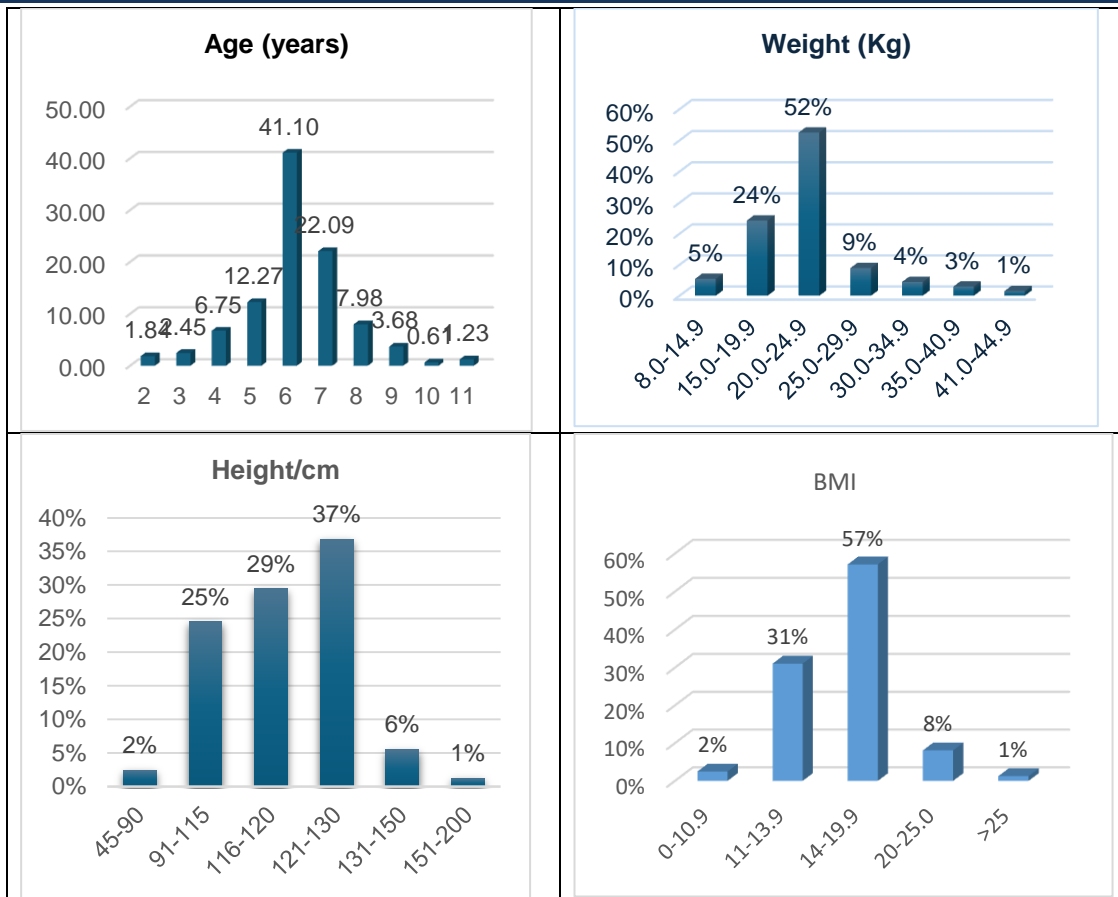
## FINDING AND ANALYSIS

This section involves discussion of the demographic profile of the participants, analysis of descriptive statistical analysis, correlation, paired-sample t-test and regression analysis

### Demographic Analysis

The demographic aspects such as age, weight, height and body mass index (BMI) were analysed as illustrated below.





**Figure 4:** Demographic profile of participants

The age group ranges from 2 to 11 years. 41.1% of respondents among the 138 respondents is 6 years old followed by 7 years old who represents 22.09% of the sample. 12.27% of sample represents 5 years old males. This shows that most parents prefer to circumcise their children from the age between 5 years to 7 years. This represents an accumulated percentage of 75.5% of sample included in the study.

In terms of the weight of the circumcised sample, 52% of the participants have a weight ranged between 20 to 24.9 kilograms, followed by age group that ranged from 15 to 19.9 kilograms. Most of the children’s circumcised weight falls between 15 kilograms and 25.0kilogram, representing 85% of the participants included in the sample.

In terms of height of the circumcised boys, 37% of participants has a height that ranged between 121 to 130 centimeters followed by 29% of the

participants has a height that ranges between 116 and 120 centimeters, followed by 25% of participants who have a height between 91-115 centimeters. This shows that most of the participants have a height between 91 and 130 centimeters.

In terms of body mass index (BMI), 57% of participants have a BMI value that ranged between 14 and 19.9, while 31% of participants have a BMI that ranged between 11 to 13.9. Generally, the BMI used to assess the body weight matches the body height. It was reported that BMI of 18.5 to 24.9 is considered as normal, while BMI of 25 to 29.9 is considered as overweight and BMI of 30 or higher is considered as obese (Mohajan & Mohajan, 2023). This means most of the circumcised boys are at normal weight.

**Descriptive Statistical Analysis**

**Table 2:** Descriptive Statistics

	N	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Weight( kg)	143	22.1671	6.27233	.906	.203	1.099	.403
BMI	143	16.0212	6.70003	8.648	.203	91.546	.403
CC-Bleeding	143	1.049	.2165	4.225	.203	16.078	.403

CC-Swelling	143	1.245	.4315	1.200	.203	-.568	.403
CF-Bleeding	143	1.035	.1843	5.117	.203	24.527	.403
CF-Swelling	143	1.154	.3621	1.939	.203	1.785	.403
Valid N (listwise)	143						

Overall, the mean values are low. This mean among the selected sample group, the complication observed indicated that the complication in terms of bleeding and swelling are not very critical. The above table suggested that mean values are highly reliable as standard deviation are below 0.5. Generally, any mean values that is associated with a standard deviation below 0.9 is considered acceptable (Andrade, 2020).

**Paired Sample T-Test**

The paired sample t-test, sometimes called the dependent sample t-test, is a statistical procedure used to determine whether the mean difference between two sets of observations is zero. In a paired sample t-test, each subject or entity is measured twice, resulting in pairs of observations.

**Table 3: Paired Samples Test**

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	CC-Bleeding - CF-Bleeding	.0140	.1178	.0099	-.0055	.0335	1.419	142	.158
Pair 2	CC-Swelling - CF-Swelling	.0909	.3119	.0261	.0393	.1425	3.485	142	.001

The table above indicated that there is a significant difference of bleeding among the observed similar clinical and child complaint complications of swelling. This means child complaint complications in terms of swelling are reported more frequently than clinical findings. This could be because of the difference in time of the reporting and observation.

Correlation analysis shows whether there is an association between two variables. The association should be significant. This means the correlation (r) value must be associated with a significant value of 0.05 or 0.01 (Hazarika, Saikia, Boruah & Nath, 2021). Values between 0.3 and 0.7 (0.3 and -0.7) indicate a moderate positive (negative) linear relationship through a fuzzy-firm linear rule (Hazarika, et al., 2021)

**Correlation Analysis**

**Table 4: Correlations**

	Weight( kg)	Height (cm)	BMI	CC-Bleeding	CC-Swelling	CF-Bleeding	CF-Swelling
Weight( kg)	1						
Height (cm)	.611**	1					
BMI	.325**	-.385**	1				
CC-Bleeding	-.127	-.164	.248**	1			
CC-Swelling	.041	.110	-.049	.022	1		
CF-Bleeding	-.137	-.231**	.317**	.839**	.069	1	
CF-Swelling	.012	.121	-.063	.083	.704**	.130	1

\*\* . Correlation is significant at the 0.01 level (2-tailed).

The correlation analysis showed that there is a relationship between BMI and Bleeding. However, height and bleeding have a negative relationship. This means if the height increases, the bleeding

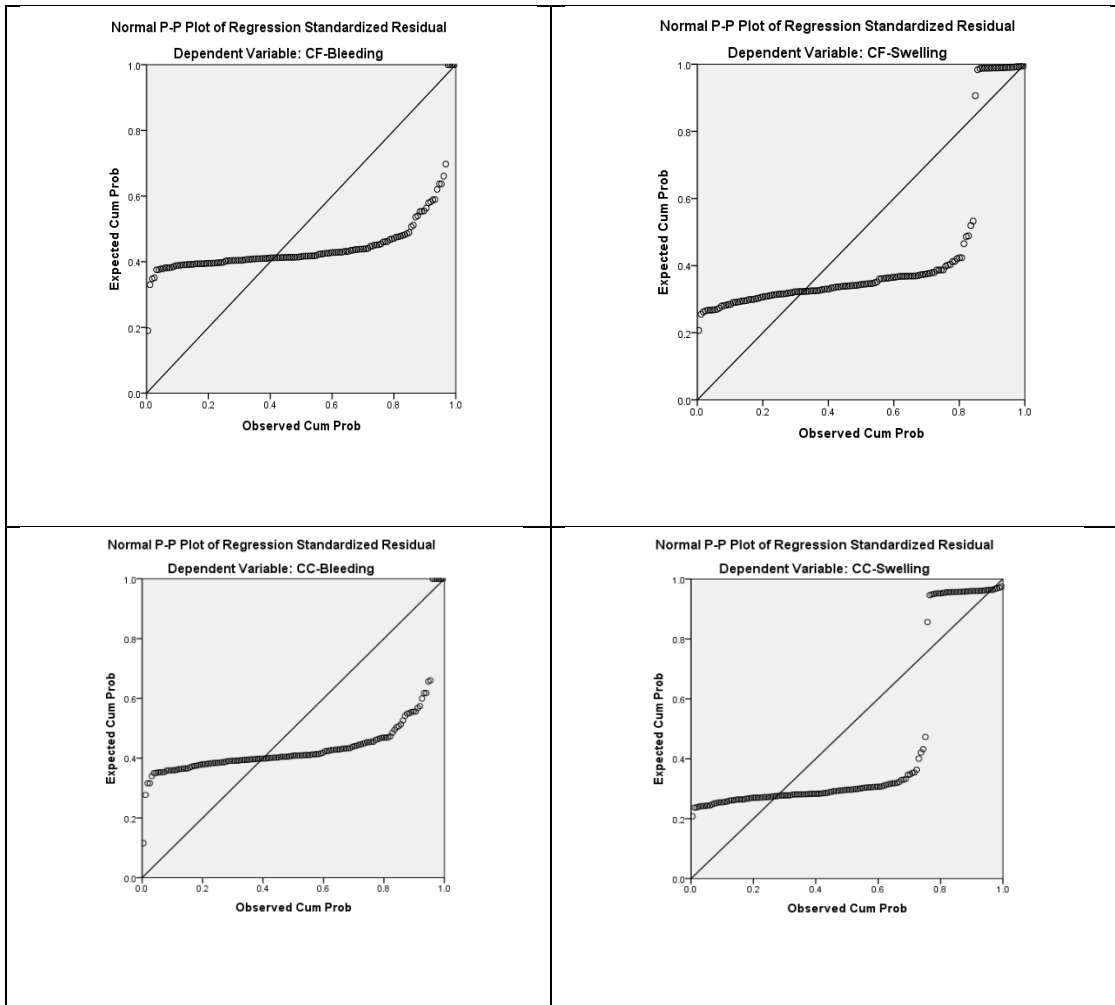
decreases. However, among the child complaints, the height and bleedings do not have any significant association or relationship. This is because height and clinical bleeding’s correlation

coefficient (r) values of negative 0.231 is associated with a significant value of 0.01. When the correlation between two variables are negative and significant, if one value goes up, the other value goes down (Hazarika, et al., 2021). Therefore, when height goes up, the bleeding reported in clinics is expected to increase.

**Regression Analysis**

The general rule is made with the assumption that if the overall pattern follows approximately a

straight line, then the data follow the assumed probability distribution, and if the overall pattern has curvature or shelves, then the data have skewed behaviour and therefore they do not follow the assumed (Howard, 2022). The below figures indicate that there is a very weak linear relationship between independent and dependent variables, or the data distribution is not normally distributed.



**Figure 5:** the linear relationship

**Predictive Model (1)**

**Table 5:** Model Summary<sup>b</sup>

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.444 <sup>a</sup>	.197	.180	.1669	.197	11.380	3	139	.000	1.571
a. Predictors: (Constant), BMI, Weight( kg), Height (cm)										
b. Dependent Variable: CF-Bleeding										

The model is not a good fit model as the adjusted R-Square value is below 0.60. the model has a

very poor fit in terms of determining the complications of bleeding. It only explains 18%

variation of bleeding. However, the overall model is significant to predict the outcomes as significant of F change is below 0.05. Also, the overall model

indicates that there are no autocorrelations since Durbin-Watson values are within the range of -2 to 2 (1.571).

**Table 6: Coefficients<sup>a</sup>**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.473	.243		1.945	.054		
	Height (cm)	.005	.002	.362	2.358	.020	.245	4.076
	Weight(kg)	-.017	.004	-.566	-3.784	.000	.258	3.880
	BMI	.018	.004	.640	4.989	.000	.350	2.854

a. Dependent Variable: CF-Bleeding

The table above showed that the standard  $\beta$ -coefficient values are associated with p-values that are less than 0.05, suggesting all the independent variables has significant effects on bleeding after circumcision.

The height itself has a significantly positive influences on bleeding (CF). This means when height of the boy increases by 1 unit (cm), will causes to increase bleeding by 0.362 units.

However, when weight (kg) of the boy has significantly negative influence on bleeding. This means every unit increase in weight will causes to decrease bleeding by 0.566 units. The overall BMI has a significantly positive influence on bleeding. This means every unit increase in BMI index, the bleeding will increase by 0.640 units. Therefore, the empirical model to predict the bleeding is as follows:

$$\text{Bleeding} = \alpha + \beta(\text{height}) + \beta_1(\text{weight}) + \beta_2(\text{BMI}) \text{-----}(1)$$

$$\text{Bleeding} = 0.473 + 0.362(\text{height}) - 0.566(\text{weight}) + 0.640(\text{BMI}) \text{-----}(1)$$

**Table 7: Model Summary<sup>b</sup>**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
2	.390 <sup>a</sup>	.152	.134	.2015	.152	8.320	3	139	.000	1.747

a. Predictors: (Constant), BMI, Weight( kg), Height (cm)

b. Dependent Variable: CC-Bleeding

The model is not a good fit model as the adjusted R-Square value is below 0.60. the model has a very poor fit in terms of determining the complications of bleeding. It only explains 13.4% variation of bleeding. However, the overall model

is significant to predict the outcomes as significant of F change is below 0.05. Also the overall model indicates that there is no autocorrelations since Durbin-Watson values are within the range of -2 to 2 (1.747).

**Table 8:** β-Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
2	(Constant)	.302	.294		1.028	.306	
	Height (cm)	.007	.003	.417	2.648	.009	.245
	Weight(kg)	-.020	.005	-.575	-3.741	.000	.258
	BMI	.019	.004	.596	4.514	.000	.350

a. Dependent Variable: CC-Bleeding

The table above showed that the standard β-coefficient values are associated with p-values that are less than 0.05, suggesting all the independent variables has significant effects on bleeding after circumcision.

The height itself has a significantly positive influences on bleeding (CF). This means when height of the boy increases by 1 unit (cm), will causes to increase bleeding by 0.417 units.

$$\text{Bleeding} = \alpha + \beta_3(\text{height}) + \beta_4(\text{weight}) + \beta_5(\text{BMI}) \text{-----}(2)$$

$$\text{Bleeding} = 0.302 + 0.417(\text{height}) - 0.575(\text{weight}) + 0.596(\text{BMI}) \text{-----}(2)$$

**DISCUSSION AND CONCLUSION**

This study aimed to achieve three objectives: (1) to examine the impact of weight on post-operative complication of circumcision, (2) to examine the impact of height on post-operative complication of circumcisions, and finally (3) to examine the impact of body mass index (BMI) on post-operative complication of circumcisions.

In terms of height of the circumcised boys, there is a significantly negative association between heigh and post-operative complication of circumcision such as bleeding. However, the current study found that the height of the boys has a significantly positive impact on the post-operative circumcision complications such as bleeding. Therefore, H1 is accepted. This finding is similar to most of the past literature. A study done by Ferhatoglu, *et al.* (2019) shows that the height of the boys has significantly positive impact on bleeding due to the circumcisions. Another study done by Li, *et al.*, (2022) found that the height of the boys has a significant effect on post complication of circumcision such as intraoperative blood loss and incision healing time. One of the studies indicated that the successful surgery carried out among the shorter group of people is significantly higher compared to group of taller people (She, *et al.*, 2021). Furthermore, past studies found that the height of individuals is associated with post-

However, when weight (kg) of the boy has significantly negative influence on bleeding. This means every unit increase in weight will causes to decrease bleeding by 0.575 units. The overall BMI has a significantly positive influence on bleeding. This means every unit increase in BMI index, the bleeding will increase by 0.596 units. Therefore, the empirical model to predict the bleeding is as follows:

surgical success (Liu, *et al.*, 2007). Therefore, it can be concluded that increasing height will causes to increase the chances of post-operative complication of circumcision such as bleeding.

In terms of weight, the current study found that there is no significant relationship with the post-operative complication of circumcisions. This means that the current study indicated that the weight of the boy has little or no significant role in terms of the number of complications, particularly regarding the swelling or bleeding reported by clinical findings or child complaint reports. However, based on the clinical findings reported, it indicated that the weight of the circumcised boys has a significantly negative impact on the post-operative complication of bleeding. This means if the weight of the circumcised boy is high, the post-operative complication of bleeding will be reduced. This is similar to some studies such as Nicassio, *et al.*, (2022) found that there is no significant difference between lighter or heavier children in terms of post circumcision outcomes such as bleeding. However, studies such as Jian, *et al.*, (2021) found a significant relationship with body weight and post operative circumcision complications, which is different from the finding of the current study. Also, studies such as Nicassio, *et al.*, (2022) indicated that children older than 3 months and heavier than 5.1 kg

increase the unplanned visits to hospitals due to the post circumcisions' complications. The doctor's intervention is much more required to the children who are heavier than those who are lighter among the young children (Nicassio, *et al.*, 2022). Another study found that boys with hidden penis had a statistically higher weight for length percentile at birth and at urological evaluation (Storm, *et al.*, 2011). Also, it was found that those children who have a weight that exceeds 5.1 kg have high risk of bleeding requiring sutures and long-term complications (Kim, *et al.*, 2019). Despite the finding of the current study indicated that increasing weight reduces the post complication of circumcision, particularly bleeding, most of the past studies indicated increasing weight will cause post-operative circumcision complication such as bleeding. This means even if H2 is rejected, most of the available literature opposes the finding of the current study. However, based on the findings of the current study, it is concluded that increasing weight will cause decrease the post-operative circumcision complications.

In terms of body mass index (BMI), the current study found that there is a significant association between post-operative complication of circumcision such as bleeding. This means if the BMI value increase, it will causes to increase bleeding that are reported by clinical findings as well as child complains. Similarly, the current study found that BMI has a significantly positive impact on bleeding as post-operative complication of circumcision as child complains reports along with clinical findings reported. Therefore, H3 is accepted. This finding of the study is very similar to previous studies such as Sabzi and Faraji (2016) as they found BMI causes post-operative complication of surgery. However, studies such as Hashimoto, *et al.*, (2022) findings are aligned with the current study results. They found that that no surgical complications after surgery in association with overweight patients with spinal deformity surgery. Also, studies done by Feng, *et al.*, (2018) found increasing BMI causes to decrease post-surgical complications. These findings are quite contrary to the findings of the current study. Alternatively, studies done by Zhang, *et al.*, (2013) and Feng, *et al.*, (2018) indicated that BMI has positively significant association with implications such as anastomotic leakage and cardiovascular diseases, but less incidence of chylous leakage, increased blood loss and operation time as well as decreases number of retrieved lymph nodes.

Furthermore, studies such as Flippin, *et al.*, (2017) argued aligned with findings of the current study stating that obesity and BMI have an adverse impact on certain surgical related, health related and long-term surgical outcomes such as medical burden. Some studies even argued that BMI can be used to determine post-surgical complication of prolonged air drainage, and hemorrhage in patients for whom resection is planned due to lung cancer (Evcil, *et al.*, 2023). Moreover, those who have a higher BMI are expected to experience more post-surgical complications related to circumcision (Storm, *et al.*, 2011). Therefore, it is concluded that increased BMI values associated with child's body will cause post-operative surgical circumcision complication such as bleeding.

## IMPLICATIONS

Overweight or obesity is a critical factor that increases BMI, which imposes a significant risk on the success or failure of surgery. The current study indicated that most of the circumcised children participated in this study has a normal weight. The findings of the study has various implications:

- (1) Key determinants of post-operative complications: This study confirmed that height, weight and BMI are key determinants of post-operative circumcision complications such as bleeding. Most of the studies focused on only BMI. However, this study confirmed the individual impact of height, weight and BMI on post-operative complications.
- (2) New insight into the current literature: The finding of the study provides new insight into the existing literature related to the post-operative complications, particularly circumcisions. This study has established the fact that BMI plays a key role in success or failure of circumcision operations
- (3) Contextual contributions: This study could be the first study in its nature carried out in Maldivians context. This is another contribution that could help the practitioners to consider enhancing their consultancy or guide the surgical process, particularly circumcisions.
- (4) Awareness programs: The findings of the study will help the medical practitioners to take additional measures to prevent such complication prior to the circumcision through awareness programs or through effective consultation programs.
- (5) Guidebook: the findings of the study could be useful to prevent post-operative complication,

particularly bleeding of a high BMI value associated child prior to the surgery (circumcision)

## LIMITATION AND FUTURE RESEARCH DIRECTION

Some of the limitation of the research includes

- (1) Data collection: More emphasis should be given to collect detail of the complication rather than just reporting 'yes', or 'no' to indicate the complication. Information such as how much blood or time or period of complication could be useful.
- (2) Sample size: The sample size should be increased from 143 to a larger sample such as 500 to 600.
- (3) Generalization: Data should be taken from all the hospitals and around the islands of the country. This will enable researchers to generalize the findings across the country.
- (4) A mixed method could help the researchers to provide more meaningful insight while interpreting the collected data. This will enable or facilitate guide the circumcision process more precisely.

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