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Original Article

Body Mass Index as a Determinant of Inguinal Hernia Type: A Clinical Analysis

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Abstract

Background: Inguinal hernias are among the most frequent conditions encountered surgically worldwide. It is hypothesized that body mass index (BMI) is involved in the occurrence and distribution pattern of types of hernias, yet the relationship is debated. ***Objectives:*** This study sought to establish the relationship between the type of inguinal hernia and BMI and determine the significance of age and sex as covariates. The research question addressed was: Does BMI strongly predict the occurrence of direct inguinal hernia against the occurrence of indirect inguinal hernia in adults? ***Methods:*** An observational retrospective study was carried out between January 2024 and September 2025 at Karuna Medical College, located at Vilayodi, Chittur, Palakkad. The research signed up a total of 54 adult patients with unilateral inguinal hernia. The demographic and anthropometric information was extracted from medical records and then entered into Microsoft Excel 2016 and statistical analysis was carried out using R Studio. Analytical methods applied included descriptive statistics, the Mann–Whitney U test, chi-square test, Spearman correlation, and logistic regression analysis. ***Results:*** Cohort age was 56.84 ± 14.84 years and BMI was 24.41 ± 3.08 kg/m². Direct hernia was dominant (55.56%) over indirect hernia (44.44%). Significant difference in BMI was observed between direct and indirect hernia groups (p=0.0281). Logistic regression established BMI as an independent correlate of direct hernia (OR=1.29, 95% CI: 1.04–1.59, p=0.0205). No significant correlation was noted between type of hernia and age and sex. ***Conclusion:*** Increased BMI was strongly associated with direct inguinal hernia, and it suggests broader body weight distribution as a probable dominant factor amongst patients for this subtype. These findings highlight the importance of considering the BMI for risk stratification and preoperative evaluation of patients with hernias. Large-scale, multicentric studies are recommended for strengthening the evidence.

Keywords: ***inguinal hernia, body mass index, direct hernia, indirect hernia, retrospective study, logistic regression, risk factors*.**

Introduction

The inguinal hernia is universally agreed upon as one of the most frequent conditions encountered in general surgical practice and as having a considerable impact on morbidity and the global health system. Despite the widespread prevalence of the disorder, the overall contributing causes of presentation with variable types of hernias remain of appreciable clinical and research significance. Direct and indirect inguinal hernias present with variable anatomical locations of origin and the respective risk factors; however, the clear-cut role of anthropometric parameters, including body mass index (BMI), is poorly defined.

The global rise in overweight and obese individuals has reawakened enthusiasm regarding body mass index (BMI) and its application in regard to abdominal wall integrity and the development of hernias. Due to its established nature as an indicator of body composition, BMI was found to correlate with increased intra-abdominal pressure, changes in connective tissue metabolism, and mechanical strain on the abdominal wall. These factors cumulatively have the potential not only to influence development but also categorization of inguinal hernias. An understanding of this relationship is of heightened importance, considering the increasing surgical complexity and postoperative risk as it pertains to increasing BMI. Inasmuch as obesity is described as a predictive factor for multiple types of hernias, the exact implication of BMI on certain types of inguinal hernias (direct and indirect) is worthy of further study (Li et al., 2024). Background research validated BMI as an independent predictive factor for post-abortion hernia repair complication, with differing thresholds advocated in a quest for optimizing surgical performance (Liu et al., 2022) (Mabeza et al., 2023). Regardless, the exact impact of BMI in regard to prevalence rates and recurrence rates for direct and indirect inguinal hernias remains yet undeterminable (Abebe et al., 2022). Even while obesity is so frequently described as a risk factor contributing towards an attenuated risk of inguinal hernia, what correlation there is between multiple measurements of what it means to be obese and inguinal

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hernia continues to remain uncertain (Shi H et al., 2025). Epidemiological trends also suggest that age and sex may differently influence incidence rates for hernias, with conditions disproportionately higher in males and older ages. Regardless, the extent with which demographic considerations interact with BMI to differently influence inguinal hernia type remains uncertain. Prior research communicated inconsistent conclusions, supporting the need for systematic analysis as it pertains to wider clinical populations.

This research was thus undertaken against such a backdrop, in a bid to determine the correlation of body mass index with inguinal hernia type in a retrospective cohort study. The research question formulated was thus: "Is raised body mass index independently associated with direct inguinal hernia compared with indirect inguinal hernia among adult patients?" The question is posited at a time when interplay between escalating prevalence of obesity and surgical outcomes is of clinical and public health significance. In an attempt to answer the question, the study tries to fill the gap required for risk stratification, preoperative planning, and preventive measure planning among patients presenting with inguinal hernia.

Methodology

Study Design and Setting

This investigation was conducted as a retrospective observational study in the Department of General Surgery, Karuna Medical College, Vilayodi, Chittur, Palakkad, Kerala, India. The study period extended from January 2024 to September 2025, during which medical records of patients who underwent evaluation and operative management for inguinal hernia were systematically reviewed.

Sample Size

A total of 54 patients fulfilled the eligibility criteria and were included in the final analysis.

Eligibility Criteria

Inclusion criteria

- Adult patients aged 18 years and above.
- Patients diagnosed with unilateral inguinal hernia.
- Both direct and indirect inguinal hernia types.
- Patients who underwent elective operative repair during the study period.
- Complete demographic, anthropometric, and clinical documentation available.

Exclusion criteria

- Recurrent inguinal hernia.
- Bilateral inguinal hernias.
- Femoral, obturator, or other abdominal wall hernias.
- Complicated or strangulated hernias requiring emergency surgery.
- Pediatric patients (<18 years).
- Incomplete medical records.
- Patients with systemic illnesses or cachexia that could independently alter BMI.

Data Extraction and Synthesis

Data were collected retrospectively from case files and electronic hospital records. Two independent reviewers extracted the data and cross-verified for accuracy. Extracted data included age, sex, height, weight, BMI, and hernia type. All data were anonymized, coded, and entered into Microsoft Excel version 2016 for organization. Statistical analysis and graphical presentations were carried out using R Studio.

Variables

Independent variables: Age, gender, weight, height, BMI (continuous and categorical).

Dependent variable: Type of inguinal hernia (direct vs. indirect).

Outcomes

Primary outcome

- To assess the association between BMI and type of inguinal hernia
- To determine whether BMI is an independent predictor of direct hernia after adjusting for age and gender using logistic regression.

Secondary outcomes

- To evaluate the association between age and type of hernia using appropriate non-parametric tests.
- To determine the association between gender and type of hernia.
- To analyze correlations between continuous variables (age, height, weight, BMI) using Spearman correlation.
- To assess differences in distribution of BMI categories (underweight, normal, overweight) across hernia types.
- To perform multivariate regression modeling for predictive analysis of hernia type.
- To generate descriptive and graphical summaries for characterizing the study population.

Statistical Analysis

The continuous variables are defined using their mean, standard deviation, median, interquartile range, and minimum and maximum. Categorical variables are summarized in counts and percentages. Shapiro–Wilk test is applied in testing the normality of distribution. For comparing groups of continuous variables, the Mann–Whitney U test and Kruskal–Wallis test are applied. Chi-square test and Fisher's exact test are applied in determining the relationships between categorical variables. Spearman's correlation coefficient is used in the analysis of continuous variables. Logistic regression analysis is performed in determining independent predictors of direct hernia and the odds ratios (OR) and 95% confidence intervals (CI) are provided. A p-value of less than 0.05 is taken as statistically significant.

Results

A total of 54 individuals were incorporated into the current analysis. The average age of the study cohort was 56.84 ± 14.84 years (median: 59.50; range: 6.50–83.00). The mean body weight of the participants was 63.83 ± 11.11 kg (median: 65.00; range: 45.00–82.00), while the average height was recorded at 160.98 ± 8.13 cm (median: 162.00; range: 142.00–171.00). The average body mass index (BMI) calculated was 24.41 ± 3.08 kg/m² (median: 24.22; range: 18.50–29.10). These summary statistics are detailed in Table 1.

When classified according to type of hernia, direct inguinal hernia was noted in 30 patients (55.56%), and indirect inguinal hernia was noted in 24 patients (44.44%). Direct hernia patients recorded a higher mean value of BMI (25.18 ± 3.41) compared with patients with an indirect type of hernia (23.46 ± 2.34). Age distribution was raised somewhat in direct hernia patients (mean:

59.20 ± 13.06 years) relative to patients with an indirect type (mean: 53.90 ± 16.61 years). Table 2 gives descriptive statistics on a group-wise scale.

With regard to categorical variable, nearly all patients (94.44%) were males, and females represented just 5.56% of patients. Normal weight was observed in 57.41%, overweight in 40.74%, and underweight in 1.85% of patients. Categorical distribution is given in Table 3.

The Shapiro–Wilk test established that the age was in an approximately normal distribution ($p = 0.0871$), while weight ($p = 0.0071$), height ($p = 0.0015$), and BMI ($p = 0.0158$) significantly differed from normality and thus required non-parametric statistical testing (Table 4).

Inferential analysis did not show any significant difference in age ($p = 0.3604$), weight ($p = 0.3759$), and height ($p = 0.3727$) between direct and indirect hernial groups. However, patients with direct hernia significantly had a higher BMI compared with patients with indirect hernia (Mann–Whitney U = 486.50, $p = 0.0281$). No correlation was found between type of hernia and sex (Fisher's exact $p = 1.0000$). Conversely, there was correlation between type of hernia and BMI category (Chi-square = 14.76, $p = 0.0006$) (Table 5).

Spearman's correlation analysis (Table 6) indicated a strong positive correlation between weight and BMI ($\rho = 0.81$) and a moderate positive correlation between weight and height ($\rho = 0.68$). Age showed weak negative correlations with weight ($\rho = –0.28$) and BMI ($\rho = –0.19$).

Logistic regression was performed with type of hernia as the outcome variable (direct = 1, indirect = 0). In univariable analysis, BMI was strongly associated with direct hernia (OR = 1.21, 95% CI = 1.00–1.47, $p = 0.0445$) but age and gender did not predict. In multivariable analysis, BMI was an independent significant predictor (OR = 1.29, 95% CI = 1.04–1.59, $p = 0.0205$) but age trended towards significance (OR = 1.04, 95% CI = 1.00–1.09, $p = 0.0650$). Gender was not significant (OR = 0.33, 95% CI = 0.01–7.41, $p = 0.4832$) (Table 7).

In combination, these outcomes indicate that higher BMI is significantly associated with direct hernia, and sex and age are not statistically significantly associated with type of hernia.

Table 1: Overall Descriptive Statistics for Continuous Variables (n = 54)

Variable	Mean ± SD	Median	IQR (Q1–Q3)	Min	Max
Age (years)	56.84 ± 14.84	59.50	46.50–66.75	6.50	83.00
Weight (kg)	63.83 ± 11.11	65.00	55.00–70.00	45.00	82.00
Height (cm)	160.98 ± 8.13	162.00	155.00–168.00	142.00	171.00
BMI (kg/m²)	24.41 ± 3.08	24.22	22.08–27.23	18.50	29.10

Table 2: Group-wise Descriptive Statistics by Type of Hernia

Variable	*Direct Hernia (n=30)*	*Indirect Hernia (n=24)*
Age (years)	59.20 ± 13.06; median 59.50; IQR 49.50–69.75; range 32.00–83.00	53.90 ± 16.61; median 59.00; IQR 41.75–65.00; range 6.50–83.00
Weight (kg)	65.33 ± 11.85; median 65.50; IQR 55.75–78.00; range 45.00–82.00	61.96 ± 10.05; median 62.00; IQR 55.00–70.00; range 45.00–79.00
Height (cm)	160.17 ± 8.06; median 161.00; IQR 153.25–167.75; range 142.00–171.00	162.00 ± 8.28; median 163.50; IQR 155.00–170.00; range 142.00–171.00
BMI (kg/m²)	25.18 ± 3.41; median 26.70; IQR 21.33–27.79; range 18.98–29.10	23.46 ± 2.34; median 24.17; IQR 22.23–24.27; range 18.50–29.02

Table 3: Distribution of Categorical Variables (n = 54)

Variable	Category	n (%)
Gender	Male	51 (94.44%)
	Female	3 (5.56%)
Type of Hernia	Direct	30 (55.56%)
	Indirect	24 (44.44%)
BMI Category	Normal	31 (57.41%)
	Overweight	22 (40.74%)
	Underweight	1 (1.85%)

Table 4: Shapiro–Wilk Test for Normality of Continuous Variables

Variable	*p-value*	*Interpretation*
Age	0.0871	Normal ($p > 0.05$)
Weight	0.0071	Non-normal ($p < 0.05$)
Height	0.0015	Non-normal ($p < 0.05$)
BMI	0.0158	Non-normal ($p < 0.05$)

Table 5: Inferential Test Results by Type of Hernia

Variable	*Test*	*Statistic*	*p-value*	*Significance*
Age	Mann–Whitney U	413.00	0.3604	NS
Weight	Mann–Whitney U	411.00	0.3759	NS
Height	Mann–Whitney U	308.50	0.3727	NS
BMI	Mann–Whitney U	486.50	0.0281	*Significant*
Gender	Fisher's exact	–	1.0000	NS
BMI Category	Chi-square	14.76	0.0006	*Significant*

Table 6: Spearman Correlation Matrix for Continuous Variables

Variable	Age	Weight	Height	BMI
Age	1.00	–0.28	–0.25	–0.19
Weight	–0.28	1.00	0.68	0.81
Height	–0.25	0.68	1.00	0.16
BMI	–0.19	0.81	0.16	1.00

Table 7: Logistic Regression Analysis for Predictors of Direct Hernia

Predictor	OR	95% CI	p-value
Univariate Analysis			
Age (years)	1.03	0.99–1.07	0.1968
BMI (kg/m²)	1.21	1.00–1.47	0.0445*
Gender (M vs. F)	0.61	0.05–7.15	0.6928
Multivariate Analysis			
Age (years)	1.04	1.00–1.09	0.0650
BMI (kg/m²)	1.29	1.04–1.59	0.0205*
Gender (M vs. F)	0.33	0.01–7.41	0.4832

**OR = Odds Ratio; CI = Confidence Interval; p < 0.05 considered statistically significant.*

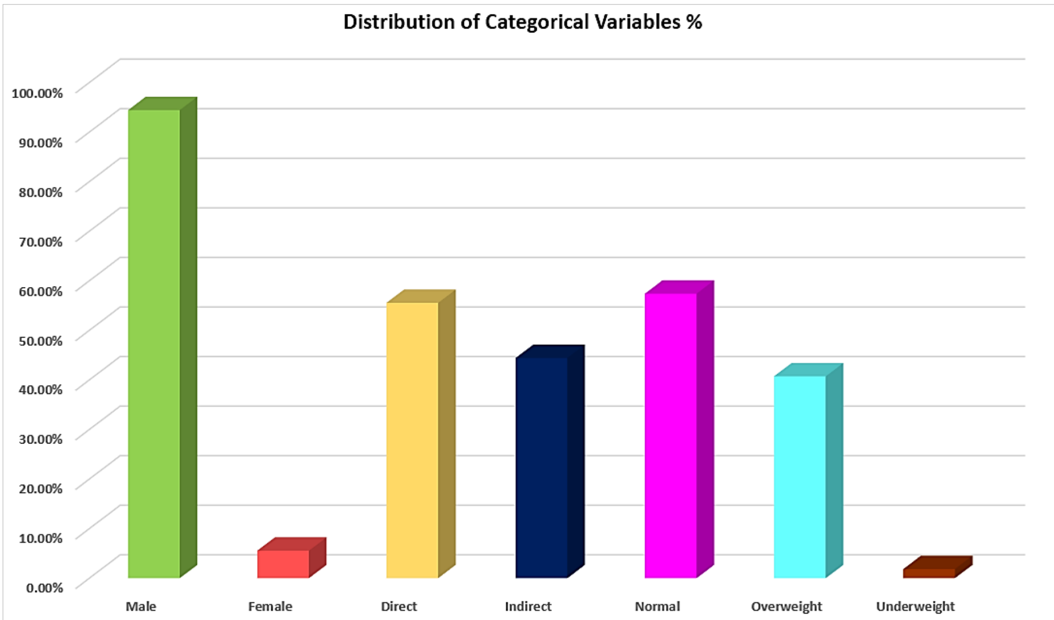

Figure 1: Distribution of categorical variables %

Discussion

The current study examined the correlation between body mass index (BMI) and inguinal hernial classification in a sample population of 54 patients. The research established that BMI was significantly elevated in direct hernial patients as opposed to patients with indirect hernial conditions. The correlation was maintained after adjustment for age and sex in a multivariate analysis of odds, thereby providing evidence of BMI as an independent predictive variable for direct hernia. The discovery is of particular significance considering the established negative correlation between increased BMI and occurrence of inguinal hernias among general outpatient patients (Hemberg et al., 2021).

The descriptive statistics reflected a mean Body Mass Index (BMI) of 24.41 ± 3.08 in the study population, which reflected an elevated mean BMI among patients with direct hernia (25.18 ± 3.41) as opposed to their counterparts with indirect hernia (23.46 ± 2.34). The Mann–Whitney U test confirmed a statistically significant difference in the distribution of the BMIs between the two groups (p=0.0281). Similarly, categorical analysis using BMI classifications reflected a strong correlation with the type of hernia as reflected in the chi-square test (χ^2=14.76, p=0.0006). Logistic regression analysis also reinforced the correlation, whereby each step increase in BMI reflected an elevated risk of direct hernia (OR=1.21, 95% CI=1.00–1.47, p=0.0445 in univariable analysis; OR=1.29, 95% CI=1.04–1.59, p=0.0205 in multivariable analysis). These results suggest an intricate relationship between adiposity and the pathogenesis of hernias, whereby increased BMI, and indeed especially in the overweight and obese ranges, may differentially affect certain phenotypes of inguinal hernias (Rosca R et al, 2023). In another study, it was observed that most patients with inguinal hernias repaired surgically were non-obese and that the complications occurred less in obese patients (Shrestha S, Upadhyay PK; 2021). In yet another study, it was concluded that abnormal BMI was linked with an elevated number of inguinal hernias across sexes. It was further reflected that abnormal BMI in males reveals an elevated risk of inguinal hernia occurrence over that of lesser BMI, and that unilateral occurrence of inguinal hernias occurring on the right is greater over bilateral occurrence. Lastly, males are overrepresented over females (Melwani R et al, 2020). Another study established a noteworthy correlation between body mass index (BMI) and complicated development of hernias, with the study recognizing obese patients presenting with hernias as being 7.2 times more vulnerable to complication of hernias compared with non obese patients (Bharata B, Triarta G, 2020).

Conversely, age was not significantly different between direct and indirect hernia groups (Mann–Whitney U p=0.3604). Even though the mean age of patients with direct hernia (59.20 ± 13.06 years) was somewhat higher in comparison with patients with an indirect hernia (53.90 ± 16.61 years) patients, it was not significantly different. In addition, a logistic regression analysis was not able to establish age as an independent predictor; however, there was a trend for significance in the multivariable model (OR=1.04, 95% CI=1.00–1.09, p=0.0650). It is apparent that non-chronological changes such as metabolic changes and anatomical changes with an increase in BMI may play an even greater role in the pathogenesis of direct inguinal hernias (Zelicha et al., 2024). It was also observed that obese patients are not significantly increased in risk of outcomes compared with non-obese veterans with open inguinal hernia repair, and the optimal method of inguinal hernia repair for obese patients must be established based upon the preference and ability of the surgeon (Huerta S et al., 2021).

Gender distribution of the cohort was significantly skewed, males contributing 94.44% of study population. No significant difference was found in hernia type distribution based on gender (Fisher's exact test p=1.0000) and logistic regression did not find gender as an independent variable predicting type of hernia. Small number of females (n=3) precluded further conclusions with regard to this subgroup. Females presenting with primary inguinal hernia repair pre-operatively manifested with more risk factors for inguinal hernia compared with males. There was no greater incidence of bilaterality and noteworthy genetic predisposition among females evidenced with regard to noted family history of hernias. There was no correlation between age, sex, number of deliveries and number of hernial defects encountered. We encourage awareness of inguinal hernias presenting in females and report new data that quantify sex-based differences and sex-based inguinal hernia predispositions (Pivo S et al, 2023). Repair of inguinal hernia is significantly positively associated with non-Hispanic white race/ethnicity, advanced age, male sex, greater physical activity, alcohol intake and tobacco consumption (in women alone); and inversely with obese and overweigh status. (Cowan B et al, 2023). Increased age, female sex, increasing body mass index, white race, chronic pulmonary disease, diabetes, drug abuse, peripheral vascular disease, and bilateral procedures, all corresponded with an elevated reoperation risk after inguinal hernial repair. These potential predictors may become targets for optimization protocols before undergoing elective inguinal hernial repair with an objective to decrease reoperation risk (Park CL et al, 2023).

The correlation analysis revealed strong positive correlations between weight and body mass index (BMI) (ρ=0.81) and between weight and height (ρ=0.68). In contrast, a weak negative correlation was found between age and BMI (ρ=-0.19) and suggested that in this sample, greater age was not associated with an increase in BMI.

These final results thus identify BMI as the one variable that was consistently and significantly linked with type of hernia. Neither age nor sex was significantly linked. These conclusions lend credence to the hypothesis that body habitus, as reflected in body mass measurements via the body mass index is an even greater determining factor in type of hernia compared with demographic variables in the study population.

Finally, the present research detected considerable and independent correlations between elevated BMI and direct inguinal hernia according to sex and age. These outcomes suggest that BMI is an informative anthropometrical indicator for consideration in the evaluation of hernial risk profiles, where sex and age are less predictive indicators in such a population.

Conclusion

In the present retrospective analysis of 54 patients, BMI was an independent and significant predictor of direct inguinal hernia, and there was no such correlation with age and gender. These findings indicate body composition, and not demographic data alone, might have an imperative role in the pathogenesis of types of hernias. Clinically, there is an impetus for the integration of BMI assessment in preoperative work-up and surgical decision-making, especially in higher-risk patients for direct hernia. Multicentric prospective studies with larger samples are required in the future for confirmation of these observations, modeling with predictive value, and understanding biological mechanisms correlating adiposity with the development of hernias. With the advancement in surgical and imaging technologies, individually customized intervention and preventive intervention on an early basis with stratification according to BMI might have noteworthy value in improving patient outcomes and also optimizing the use of available surgical practice resources.

Strengths and Limitations

The merits of the analysis are the use of the right non-parametric tests based on non-normal distribution of data and the usage of logistic regression in determining independent predictors. We need, however, to mention some of the deficiencies. The relatively small sample size, specifically the poor representation of female patients, makes it difficult to generalize conclusions regarding gender. Moreover, variables including comorbid conditions, work activity, and lifestyle, potential ones determining the development of hernias, never featured in the dataset.

Declarations

Ethical Approval

The ethical approval was obtained already from the Institute of Karuna Medical College Hospital.

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Conflicts of Interests

The authors report no conflict of interest.

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Article Category

Retrospective study

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