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Review Article

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Unravelling Port Site Hernia: Insights from a 15-Year Global Study on Incidence and Prevention Strategies

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Abstract

Background: Laparoscopic surgery has become a novel approach for numerous surgical interventions. This is because of its minimally invasive nature. However, it has found to be correlated with certain complications including port-site hernia (PSH), leading to significant morbidity. ***Aim and Objective:*** This systematic review and meta-analysis aimed to answer the question:" What are the primary risk factors and effective management interventions correlated with the incidence of port-site hernia (PSH) post laparoscopic surgery and how do these factors vary across different surgical approaches and populations?". ***Methods:*** A comprehensive literature search was conducted across PubMed, Embase, and Scopus from 2011 to 2024. A total of 11 studies were finally selected from 18196 studies with a total of 40248 patients. ***Results:*** The overall incidence of PSH was reported as 2.08% across our studies. The key risk factors identified included trocar size, port location, and patient-related comorbidities like obesity, hypertension, and diabetes. A high PSH incidence (%) was noted for comorbidities followed by inadequate closure of the port and umbilical port placement. ***Conclusion:*** - PSH is a significant complication of laparoscopic surgery. Numerous factors influence its incidence rates. Correct trocar selection and fascial closure are suitable preventive measures to reduce the risk of PSH.

Keywords: ***Port-site hernia, laparoscopic surgery, incidence, systematic review, meta-analyses.***

Introduction

Laparoscopic surgery has made much advancement in the field of surgery providing various benefits like decreasing post-operative pain and recovery time and scarring. This has become the gold standard in numerous surgical procedures like appendectomy, cholecystectomy, and hernia repairs. However, it has complications. One among them is port-site(PSH) leading to morbidity and bowel obstruction leading to mortality if untreated. It is defined as an incisional hernia at the trocar insertion site post-laparoscopic surgery. The term trocar is derived from the French term "Trios" wherein "Tro" means three and "Car" means edge. In the mid-18th century, urologists used trocars to drain fluids from the body (Pulle et al, 2015). Nowadays, a wide range of precision-engineered laparoscopic trocars are available in a variety of sizes and designs. The modern trocars comprise components such as a cannula, seal, and obturator which prevent slipping from the abdominal cavity maintaining optimal air pressure during laparoscopic procedure. The latest innovation is an optical obturator trocar that consists of a crystal at the distal end of the obturator through which a zero-degree laparoscope is introduced to transmit real-time images (Mishra RK, 2021). The first case of PSH after laparoscopic cholecystectomy was first reported in 1991 (Shih SL et al, 2020). The PSH incidence was reported as an overall of 2.08% in our systematic review and meta-analyses. Variability is caused by factors like size of the trocar, obesity observed in patients, port closure technique, and other patient-related conditions. The anatomical position and the inherent weakness of the umbilical port are attributed to PSH. So also, the junction of the umbilical pillar/ umbilical stalk with linea alba is the thinnest part of the abdominal wall which is also prone to PSH. Therefore, most of surgeons prefer to use the supra-umbilical or infra-umbilical region of the abdominal wall (Wani AA et al, 2021). PSH is a preventable complication involving a host of factors like the selection of the appropriate trocar size and designing the tip of the trocar, a disposable trocar with a shielded spring-like mechanism, meticulous closure of the fascia avoiding unnecessary extension of the incision, use of non-absorbable suture for larger port, repair of para-umbilical hernia or other defects if present at the time of the surgery (Razak O A et al, 2023). Deflation of the pneumoperitoneum prior to port removal is essential so that the omentum and intestines are not drawn into a fascial defect (Perrotta G, 2021). The selection of the port site is equally important. Trocar placed away from the midline is considered less prone to PSH due to overlapping of the muscles and fascia Persichetti P et al, 2022).

With this systematic review and meta-analysis, we aimed to provide a comprehensive port-site hernia (PSH) incidence and the risk factors associated with it to improve the understanding related to this field and the prevention strategies in laparoscopic surgery. By utilizing data from various studies we sought to analyze and identify effective management interventions that could decrease the occurrence of PSH, hence enhancing patient outcomes and reinforcing the efficacy and safety of laparoscopic procedures.

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Methodology

This systematic review and meta-analyses followed the Preferred Reporting Item for Systematic Review and Meta-Analyses (PRISMA) guidelines (**Figure 1 a**) (Page MJ et al, 2021). The risk of bias was also analyzed (**Figure 1 b**).

Literature search

A comprehensive literature search was done to find out studies published between 2011 to 2024 on the incidence of PSH. Electronic database search was done in PubMed, Embase and Scopus using the keywords "port-site hernia", "incidence" and "laparoscopic surgery".

Inclusion criteria

The inclusion criteria were:

- Prospective, long-term, retrospective, cross-sectional studies and systematic reviews reporting port-site hernia incidence post-laparoscopic surgery
- Studies including adult patients aged above 18 years who underwent any kind of laparoscopic surgery comprising of but not limited to appendectomy, cholecystectomy, and bariatric procedures
- Studies including a sample size of at least 50 patients to ensure data sufficiency for analysis
- Studies encompassing minimum follow-up data of at least 3 months after the surgery to evaluate the occurrence of PSH
- Cases available with complete data for the incidence of PSH.
- Studies published in English

Exclusion criteria

- Studies conducted on animals and any other non-human subjects
- Case reports.
- Studies having insufficient data regarding the incidence of PSH, the risk factors associated with it and management approaches
- Studies published in languages other than English

No ethical approval was required because the study conducted was a systematic review and meta-analyses and did not include any patient data. Studies from 2011 to 2025 were selected for the review and analyses.

Data extraction and analysis

The eligibility of the article based on criteria search was completed by 2 authors (A.R.K. and S.H.) and the full text of the studies was analysed by using Microsoft Excel 2016. The two authors assessed the methodology and the quality of the articles by using the New Castle Ottawa assessment scale (Norris JM et al, 2021). Finally, a total of 11 studies met the quality of assessment. The data shows different studies from different parts of the world from various countries namely India, Pakistan, Australia, Italy, China, USA, Netherlands, Switzerland and Ghana. The first author with year, country of study, study design, sample characteristics and PSH incidence were all tabulated (Table 1). Forest graph was plotted (Figure 2). The data was analysed using the SPSS software version 28. R Studio was used for graph preparations.

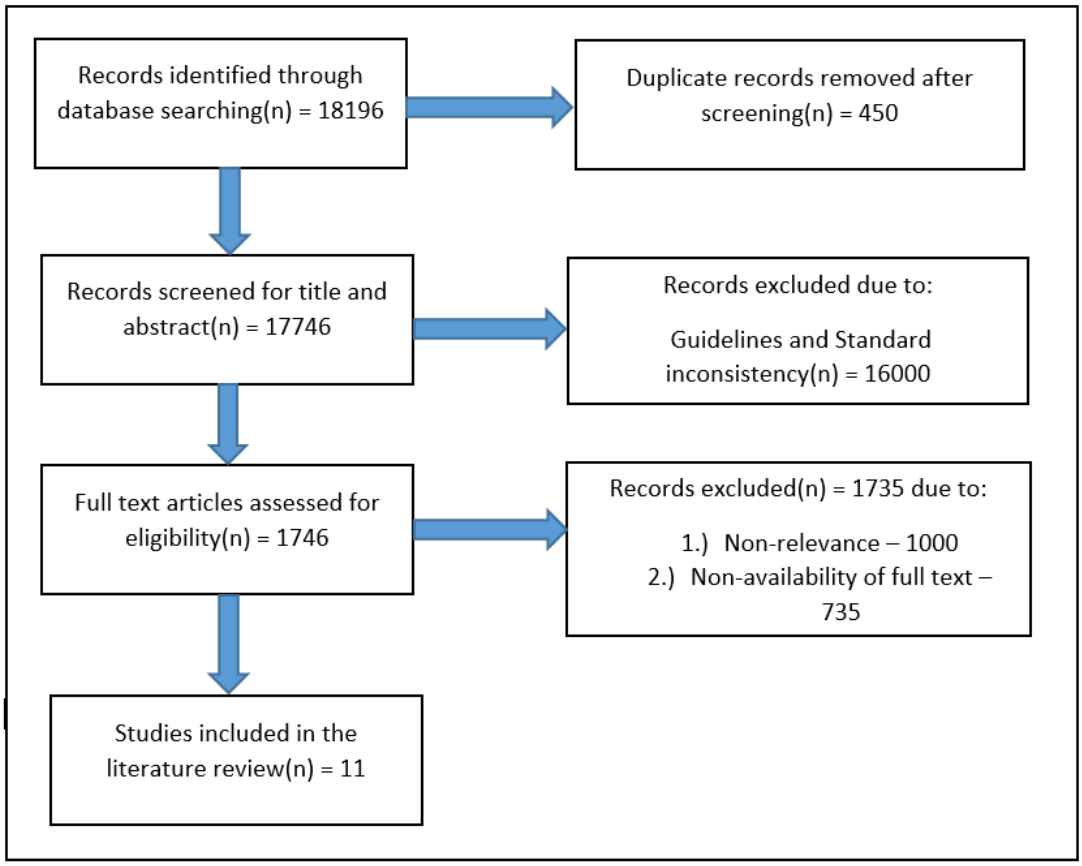

Figure 1 a): Flow chart for systematic review and meta analyses on incidence of PSH

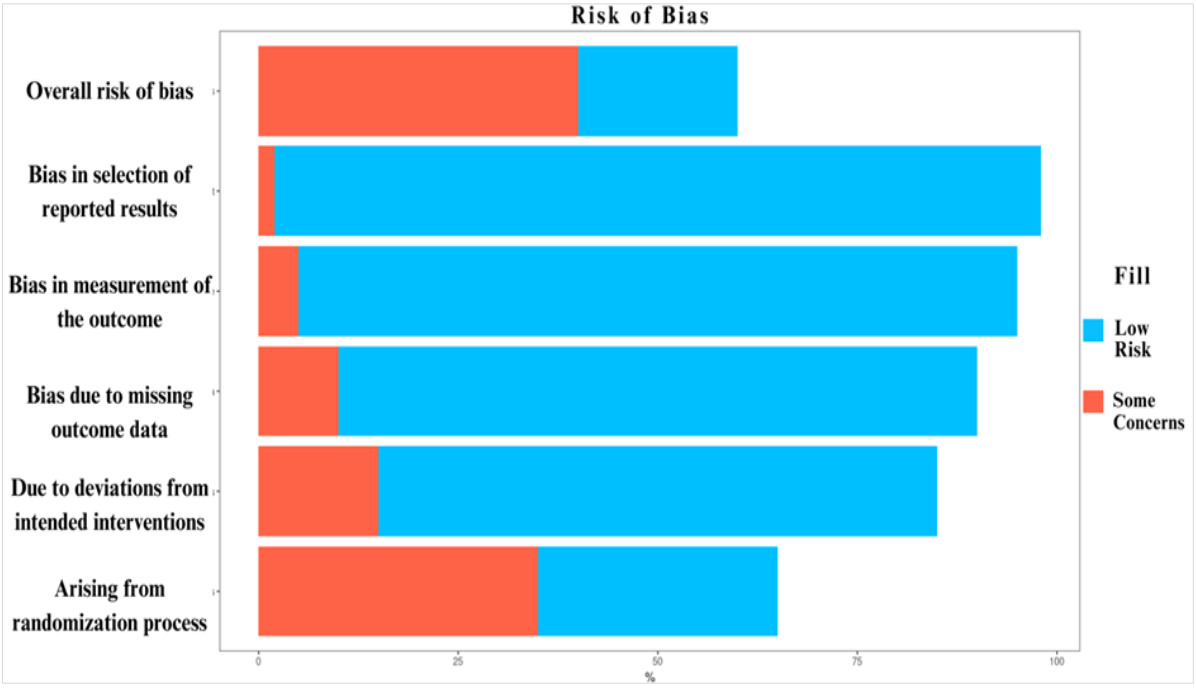

Figure 1 b) Risk bias chart

Results

Screening flow

According to the search strategy set in advance, a total of 18196 articles were retrieved in the target database (Figure 1). Then 450 duplicate articles were removed. The remaining 16000 articles that didn't meet the eligibility criteria were removed from 17746 articles by reading the titles and abstracts. Finally, 11 articles were determined to be included in the analysis after excluding 1735 articles from 1746 records during the full-text screening phase. A total of 40248 subjects were studied.

Funnel's test and egger's test

To assess the risk of publication bias, funnel plot analysis, and Egger's test were conducted (Egger M et al, 1997). The funnel plot was asymmetrical indicating publication bias (Figure 3). The Egger's test showed a p-value < 0.001 indicating publication bias.

Meta-analysis of the incidence of PSH revealed extremely significant heterogeneity (I2 = 99.314%).

The pooled prevalence for forest plot for PSH incidence across various studies was noted as 0.02(0.01,0.03).

The bubble meta regression plot depicted a negative linear association between sample size and the proportion of PSH incidence (Figure 4). The R2 value came out to be 0.257 showing a moderate correlation. The regression line equation y = 0x + 0.0259 indicated that the PSH incidence proportion reduced by roughly 0.0259% for every unit increase in sample size.

The overall PSH incidence (%) according to various factors was analyzed and tabulated (**Table 2 and Figure 5**).

Table 1: Study characteristics author wise

S. No	Author Name (Year)	Country of Study	Study Design	Sample Size	PSH incidence (%)
1	Memon et al (2011)	Pakistan	Prospective	1492	2.14
2	Karthik et al (2013)	India	Prospective	570	3
3	Liot et al (2017)	Switzerland	Long term study	226	0.02
4	Zhang et al (2019)	China	Prospective	1000	1.5
5	Gutierrez et al (2020)	USA	Review	18533	0.104
6	de Beaux et al (2021)	Australia	Prospective	300	1
7	Restaino et al (2022)	Italy	Retrospective	500	4
8	Buckley III et al (2023)	USA	Case Series	50	6
9	Agaba et al (2023)	Ghana	Cross-sectional	200	2.5
10	Pulle et al (2024)	India	Review	15000	0.5
11	Bodegraven et al(2025)	Netherlands	Retrospective	2377	2.1

Table 2: Overall PSH incidence (%) noted across studies according to factors

Factors	PSH Incidence(%)
Trocar Size	2.32
Trocar Design	0.5
Inadequate Closure	4.75
Umbilical port placement	4.5
Various comorbidities	6

Table 3: Merits and gaps of each study

S No	Author Name (Year)	Merits	Gaps
1	Memon et al (2011)	Large sample size	Due to the single-centre study, generalizability was limited
2	Karthik et al (2013)	Stress on fascial closure method	Generalizability limited due to single-centre study
3	Liot et al (2017)	Long-term follow-up	Small sample size
4	Zhang et al (2019)	Fair sample size	Subjected to a single institution
5	Gutierrez et al (2020)	Detailed multiple study	Inadequate original data
6	de Beaux et al (2021)	Trocar type impact on PSH incidence depicted	Inadequate patient demographics data observed
7	Restaino et al (2022)	Certain PSH risks noted	Selection bias observed
8	Buckley III et al (2023)	Vivid insights into PSH incidence reported	Small sample size
9	Agaba et al (2023)	Vivid assessment was possible due to cross sectional nature of the study	Long-term follow-up was lacking
10	Pulle et al (2024)	The need for comprehensive guidelines was stressed upon	Potential bias
11	Bodegraven et al (2025)	Detailed umbilical port data	Bias due to the retrospective nature of the study

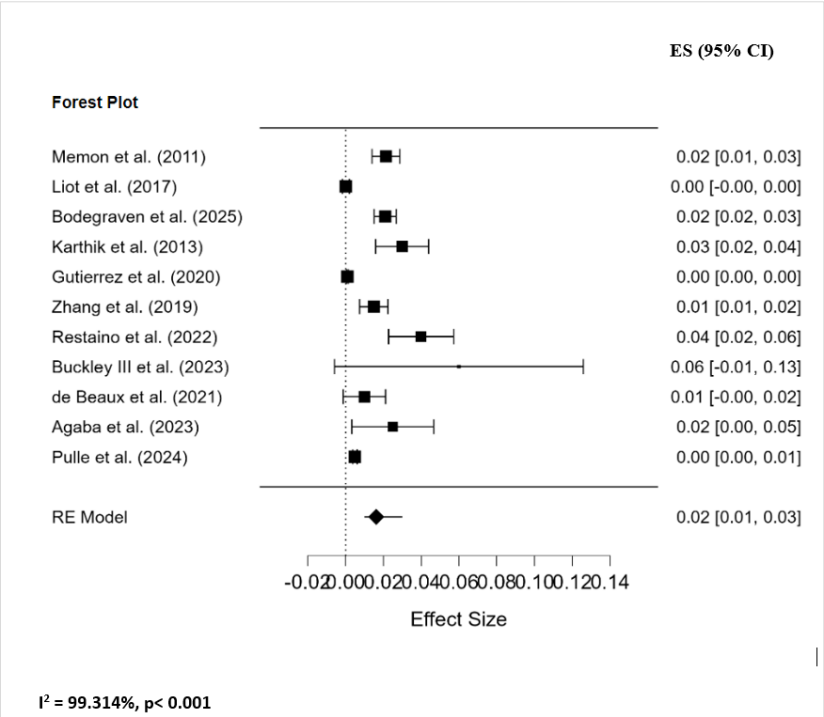

Figure 2: Forest plot for systematic review and meta-analyses on incidence of PSH

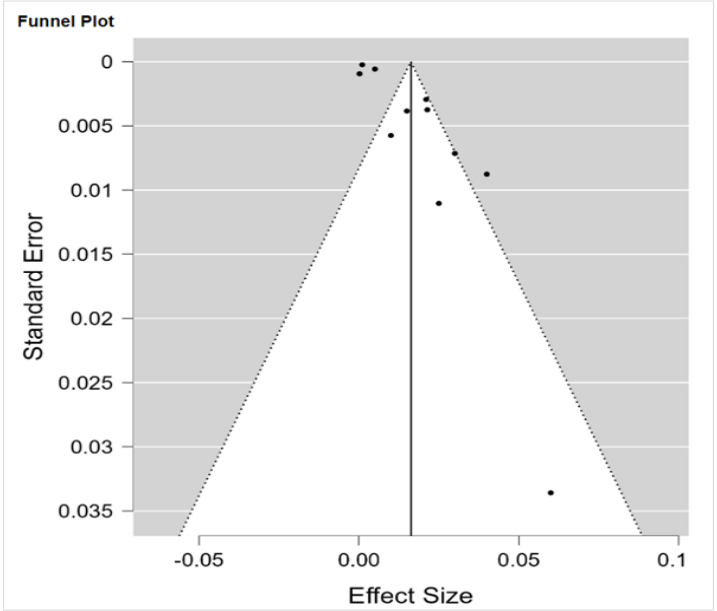

Figure 3: Funnel plot for systematic review and meta anaylses on incidence of PSH

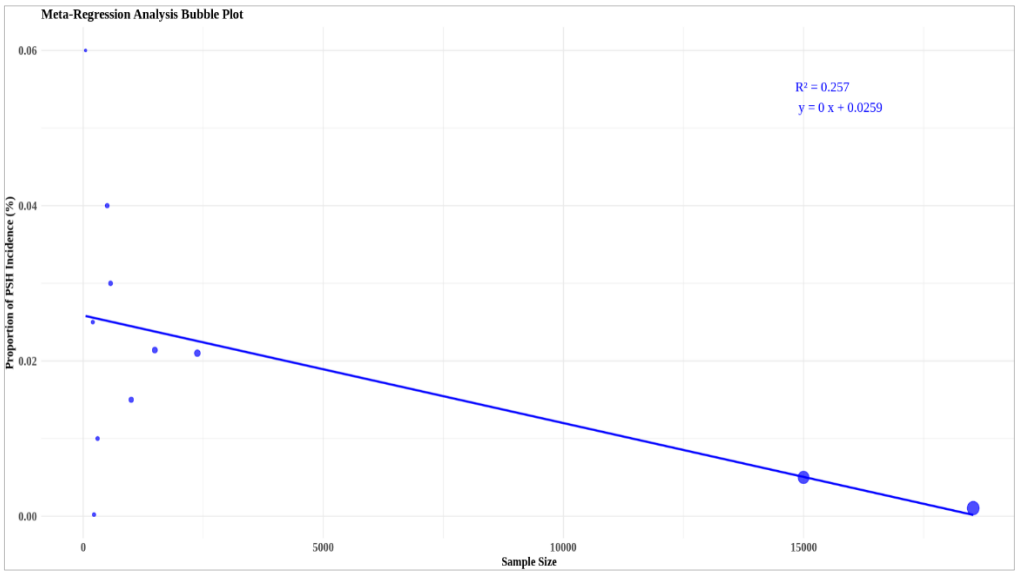

Figure 4: Bubble meta regression analyses for PSH incidence

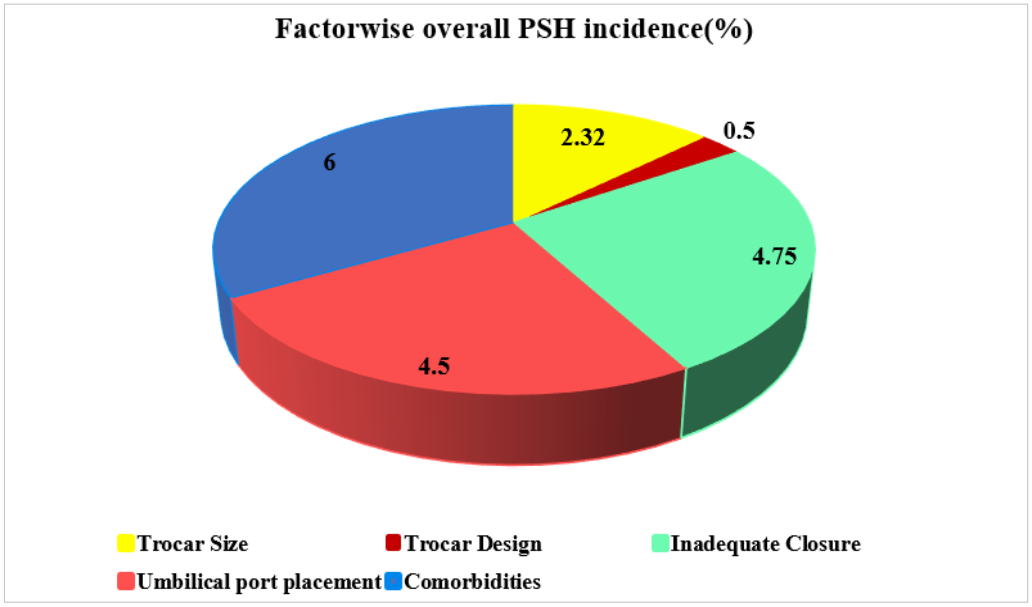

Figure 5: Overall PSH incidence (%) factor wise

Discussion

Two studies stressed the point that the trocar size diameter (>10 mm) showed a higher incidence of PSH namely 2.14% and 2.5% respectively (Memon MR et al, 2011; Zhang L et al, 2024). The same thing was noted in another study of ours (Karthik S et al, 2013). This was supported by another author (Ahlqvist S et al, 2022).

Shielded trocar designs proved effective (PSH incidence: 0.5%) when compared to standard designs as stated by an author of our study (de Beaux AC, East B, 2022). This was further depicted in another study (Tayar S et al, 2022).

Three studies indicated the significance of meticulous fascial closure of the port (Karthik S et al, 2013; Restaino S et al, 2024; Agaba EA et al, 2014). One of the authors said inadequate closure led to a PSH incidence of 4.5% (Agaba EA et al, Karthik S et al, 2013). Another author reported a PSH incidence of 5% with inadequate closure (Pulle MV et al, 2015) Further adequate closure led to a reduction in PSH by 1%. (Pulle MV et al, 2015). The third out of the three authors supported this finding by reporting a PSH incidence of 2% for an adequate closure approach (Restaino S et al, 2024). This was further corroborated by another author (Vineet K et al, 2023).

Umbilical port placement showed a vulnerable anatomical site for PSH. This was noted by two authors (Zhang L et al, 2024; Bodegraven EA et al, 2025). The incidence of PSH was reported as 4.5% when compared to an incidence of 1.2% for lateral placement as stated by an author of our study (Bodegraven EA et al, 2025). This was elucidated by another author Cunnigaiper ND et al, 2010).

Various comorbidities were reported with obesity (40%), hypertension (25%), and diabetes (20%) leading to PSH incidence of 6% as stated by an author (Buckley III FP et al, 2014). Another author from our study found 35% of obese patients with a PSH incidence of 6% (Restaino S et al, 2024). Yet another author depicted 25% of diabetic patients with comorbidities leading to high PSH risk (Agaba EA et al, 2014). This was reported by another author (Hisham AA et al, 2024).

Two of the authors from our study reported that geographic variations affect PSH incidences by throwing light on demographics, healthcare systems across various regions and local practices and their impact on outcomes. The author from Switzerland demonstrated a striking low incidence of 0.02% over five years in a

study involving 226 patients attributed to high surgical standard and stringent training protocols along with healthcare systems focusing primarily on safety of patients (Liot E et al, 2017). Another author's study from our review in contrast reported a PSH incidence of 1.5% suggesting impact of trocar size (>10 mm) and the significance of meticulous closure techniques (Zhang L et al, 2024). This was depicted by another study (Chandrasekharam VV et al, 2021).

Two authors highlighted the need for standardized training techniques and surgeon experience with certain tools (Pulle MV et al, 2015; de Beaux AC, East B, 2022). This was highlighted by another author (Kshirsagar VV et al, 2024).

Other techniques to prevent hernia while closure using fascial closure device, suitable suture material and Deschamps needle can be employed (De Alwis D et al, 2021).

The strengths and weaknesses for authors of various studies were tabulated (Table 3).

Conclusion

The aim of reducing the incidence of PSH to zero needs detailed study with the involvement of surgeons, industries, and researchers working on further development with emphasis on prevention to ensure that the novel method of laparoscopy is acceptable by the general public. With the evaluation of data from various studies considered in our meta-analyses and systematic review, we aimed to depict the importance of preventive approaches by providing a comprehensive overview of PSH along with effective management strategies to reduce this complication.

Strengths and limitations

Our study consisted of robust data with a considerable amount of subjects over a time span of 15 years. However, high heterogeneity was noted leading to publication bias attributed to studies from different regions and the chronological factor.

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Conflicts of interests

The authors report no conflict of interest.

Author contributions

Conceptualization and methodology, A.R.K., A.S., and S.H..; Formal analysis, S.H., and J.H.; Visualization and writing – original draft A.R.K., A.S., S.H.; Writing – review and editing, A.S., A.R.K., S.H. and J.H. All authors have read and agreed to the final version of the manuscript.

Ethical approval

Not Required because the study conducted was a systematic review and meta analysis and past year studies published within a span of 15 years that is from 2011 to 2025 were selected for the review and analyses. No patient data was required since it was not a retrospective study.

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