Hernia (2025) 29:162
https://doi.org/10.1007/s10029-025-03351-6

ORIGINAL ARTICLE

Ventral hernia is a chronic disease: a systematic review of long-term outcomes beyond 5 years

Brody A. Smith[1] · **Zachary Malaussena**[1] · **Rahul Mhaskar**[1,2] · **Salvatore Docimo Jr.**[1,3]

Received: 6 February 2025 / Accepted: 21 April 2025

Abstract

Purpose To systematically evaluate the long-term outcomes of ventral hernia repair (VHR) and reassess its classification as a definitive surgical intervention. This review synthesizes evidence on postoperative complications including recurrence, chronic pain, and patient-reported outcomes to characterize the long-term burden of VHR and its impact on patient management. This study underscores the necessity of prolonged postoperative surveillance to accurately assess surgical efficacy and inform evidence-based follow-up trategies.

Methods A systematic review was conducted in accordance with PRISMA guidelines, searching PubMed, Embase, and Web of Science for studies with a mean or median follow-up of ≥5 years. Eligible studies reported outcomes including recurrence, reoperation, mesh infection, chronic pain, and quality of life. A random-effects meta-analysis was performed using STATA MP 18 to pool event rates for each outcome. Results: Among 2,721 patients followed for ≥5 years, 13% (95% CI: 9–17%) experienced recurrence. Long-term complications included seroma in 11% (95% CI: 6–17%, n = 1,778) and reoperation in 8% (95% CI: 5–11%, n = 1,833) of patients. Patient-reported outcomes, including chronic pain, were collected, with 15% (95% CI: 8–23%, n = 1,220) reporting its occurrence.

Conclusion This systematic review evaluates the complexity of ventral hernia repair and proposes conceptual realignment in managing ventral hernias, viewing them through the lens of chronic disease to align treatment goals with long-term patient outcomes. The data suggests that ventral hernias exhibit characteristics of a chronic condition, requiring sustained medical oversight and potential reinterventions for chronic pain, recurrence, and other quality-of-life complications

Keywords Ventral hernia · Long-term outcomes · Patient-reported outcomes · Quality of life · Chronic disease

Introduction

The prevalence of ventral (e.g., primary and incisional) hernias constitutes a significant component of the healthcare system, with approximately 350,000 surgeries performed annually in the United States [1]. One of the most common and concerning complications of ventral hernia repair (VHR) is postoperative recurrence [2]. The rate of recurrence varies significantly depending on the technique used, defect size and location, patient comorbidities, mesh utilization, infection, and physical activity, among other factors [3]. Recurrence after VHR has been estimated to be as high as 40% with mesh repair and 70% without mesh repair at 5 years postoperatively [4]. A significant percentage of these recurrences lead to reoperation and decreased quality of life, for patients who experience years of chronic pain, discomfort, and impaired activities of daily living [5]. Hernia recurrence often necessitates repeat surgical interventions, increasing the risk of complications such as infection, longer recovery times, and additional healthcare costs [6].

The psychological burden of living with a recurrent hernia can also lead to anxiety and decreased patient satisfaction [7]. Thus, patient-recorded outcomes (PRO) are important measurements historically missing from the literature on hernia repair. Several PRO questionnaires that measure quality of life (QoL) have been validated specifically for

✉ Brody A. Smith
brodysmith@usf.edu

[1] University of South Florida Morsani College of Medicine, 560 Channelside Drive Tampa, Tampa, FL 33602, USA

[2] Department of Medical Education, University of South Florida Morsani College of Medicine, Tampa, USA

[3] Department of Surgery, University of South Florida Morsani College of Medicine, Tampa, USA

Published online: 08 May 2025

hernia patients, including the Abdominal Hernia-Q (AHQ), HerQLes, EuraHS, and the Carolinas Comfort Scale (CCS) [8–11]. These tools can quantitatively assess patients' long-term satisfaction with hernia repairs, complementing standard objective data points such as reoperation rates and healthcare expenditures.

The current body of literature maintains an inadequate focus on genuine long-term outcomes following ventral hernia repair. Many studies report long-term outcomes for only a few years postoperatively; however, this time frame does not capture the full scope of potential complications [12]. A period of five or more years postoperatively may provide a better opportunity to observe the potential long-term implications on patient health and overall quality of life. Delayed complications associated with mesh reinforcement often contribute to significant morbidity. Common issues, such as chronic pain potentially resulting from nerve entrapment or inflammatory responses to the mesh material, may persist long-term and negatively impact patient quality of life [13]. Though less frequent, mesh-related infections are challenging to manage and sometimes require mesh explantation [14]. Furthermore, the presence of mesh can lead to adhesion formation with surrounding tissues, increasing the risk of bowel obstruction or enterocutaneous fistula over time [15].

Patients undergoing ventral hernia repair frequently expect that a single surgical intervention will resolve their condition, yet the high recurrence rates reported in the literature suggest that such expectations may be overly optimistic [16]. Recognizing the multifaceted and persistent nature of these risks, this systematic review seeks to reframe ventral hernia not as a simple condition to be resolved by a single procedure, but rather as a chronic disease state associated with the possibility of long-term complications and the requirement of expectant recurrences.

Methods

This systematic review follows all updated guidelines of the 2020 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement [17]. Relevant procedural elements have been documented and accessible as part of our internal review process, ensuring adherence to the recognized standards of transparency and methodological rigor throughout this project. This study was determined to be exempt from institutional review board oversight as it is a systematic review of existing literature and does not involve human subjects research, patient participation, or access to protected health information.

Eligibility criteria

Before beginning our literature search, strict inclusion and exclusion criteria for populations, interventions, outcomes, and study designs were predefined. Studies were included in this review if they had been conducted on adult humans receiving surgical treatment for all ventral hernia types (e.g., primary and incisional) using laparoscopic, open, robotic, transversus abdominus release, suture, and/or mesh repair techniques. Long-term follow-up data from patients at a mean or median time $\geq$ 5 years was also required for inclusion. The primary outcome of interest was the recurrence rate after hernia repair, with data on additional secondary, long-term complications also collected. Randomized and non-randomized controlled trials, cohort studies, case-control studies, and observational studies were all eligible for inclusion. Exclusion criteria eliminated studies on repairs of inguinal, femoral, hiatal, diaphragmatic, obturator, lumbar, perineal, sciatic, and gluteal hernia. Also excluded were studies not reporting any of the outcomes of interest, conference abstracts, case studies, case series, editorials, commentaries, and review papers. Our search intended to focus on studies reporting QoL outcomes reflected in the search terms, but potential studies were not excluded for the lack of a QoL outcome measurement. Papers with a mean or median follow-up time of less than 5 years are excluded from this review.

Search strategy

The search for published studies in all languages with no date range exclusion was conducted in August of 2024. Three databases were searched, including PubMed, EMBASE, and Web of Science with all returned studies exported to a secondary data management software tool [18]. The search strategy was designed to be exhaustive, incorporating a wide array of terms pertaining to intervention type, PRO measures, long-term complications, and follow-up duration. For instance, the PubMed search included terms such as ("ventral hernia" OR "ventral hernia repair" OR "abdominal wall reconstruction") AND ("quality of life" OR "patient-reported outcomes" OR "functional status") AND ("chronic pain" OR "recurrence" OR "complications") AND ("long-term follow-up" OR "extended follow-up" OR "5-year outcomes"). This selection represents only a fraction of the terms used, as numerous additional keywords and variations were employed to ensure comprehensive coverage of the literature. This search strategy prioritizes objective measures of postoperative complications while also identifying publications with PROs, which are essential for capturing the full scope of long-term quality of life in patients following ventral hernia repair. Including PROs allows for a

comprehensive evaluation that reflects not only clinical success but also the patient's perspective on recovery and daily well-being.

Study selection

The study selection process involved a rigorous multi-step approach to ensure an unbiased review. An independent screening of titles and abstracts was first conducted by two reviewers (B.S., Z.M.) to identify studies potentially meeting the inclusion criteria. Any discrepancies between reviewers regarding study eligibility were resolved through discussion. A third reviewer was consulted to decide if a consensus could not be reached (S.D.). Next, full-text articles of the selected studies were retrieved and assessed for eligibility based on the predefined inclusion and exclusion criteria. Studies that did not meet any of the exclusion criteria were included in the final selection stage. Throughout the process, detailed records have been kept, including reasons for exclusion at each stage, to ensure transparency.

Data collection

Two reviewers (B.S., Z.M.) independently extracted data from the selected studies using a piloted form to collect key information such as author, year of publication, study design, hernia type, repair technique, mesh characteristics, sample size, and patient demographics. Outcome data was also collected, including recurrence (%), reoperation (%), follow-up time, delayed healing (%), seroma (%), chronic pain (%), surgical site infection (SSI), and subjective quality of life measurements (QoL). Data were extracted based on the patients reported in each study, as outcomes for patients lost to follow-up cannot be reliably ascertained. If available, the outcomes of these lost patients may have altered the percentages of each reported outcome.

Statistical methods

The number of events for each outcome variable and the total number of patients were pooled using a single-arm meta-analysis of proportions with a random-effects restricted maximum likelihood model. Results are reported as proportion and 95% confidence intervals (95% CIs). Subgroups by length of follow-up time were also analyzed. Meta-analysis was completed with STATA MP 18.

Results

Our initial search identified 547 unique studies that were exported to a secondary data management platform for screening and extraction. Deduplication removed 187 entries, resulting in 360 records eligible for preliminary screening. Preliminary screening involved the assessment of abstracts and titles using the predefined PICOS criteria. During screening, studies were excluded for several reasons. 232 records were removed for evaluating procedures unrelated to ventral hernia repair, such as inguinal or hiatal hernia interventions. Additionally, 62 studies were excluded due to insufficient follow-up duration, as they did not report a mean or median follow-up period of at least 5 years. Furthermore, 39 studies were removed due to inappropriate study designs, including case reports, narrative reviews, and editorials. Publication types deemed unsuitable, such as non-original research and conference abstracts, excluded five more records. Finally, 1 study focusing on a pediatric population was excluded, as it did not meet the inclusion criteria targeting adults.

The remaining 23 articles identified from the initial database search advanced to full-text review, assessed against the same predefined inclusion and exclusion criteria. At this stage, six additional studies were removed for meeting one or more exclusion criteria, leaving 17 papers from the original search that satisfied all inclusion criteria. To enhance the comprehensiveness of the review, vertical citation searching was employed for the 17 included studies. This process yielded five additional papers that met the inclusion criteria. These studies were not retrieved in the original database search due to potential limitations in indexing, differences in terminology, or evolving publication patterns. With the integration of vertical citation searching, our final dataset comprised 22 studies, providing a more robust and comprehensive foundation for analysis. A summary of this process can be found in Fig. 1.

For data collection and analysis, studies comparing two distinct interventions, such as laparoscopic versus open repair or suture versus mesh repair, were stratified into separate subgroups. Each intervention was treated as an independent cohort to allow for a more precise analysis of outcomes associated with specific techniques. This approach ensured that the data could be analyzed in a way that accounted for each intervention's unique characteristics and results while minimizing potential confounding effects that could arise from direct comparisons within the same study. Across the 22 studies analyzed in this review, data from 2,721 patients was extracted. A summary of all the study characteristics included can be found in Table 1.

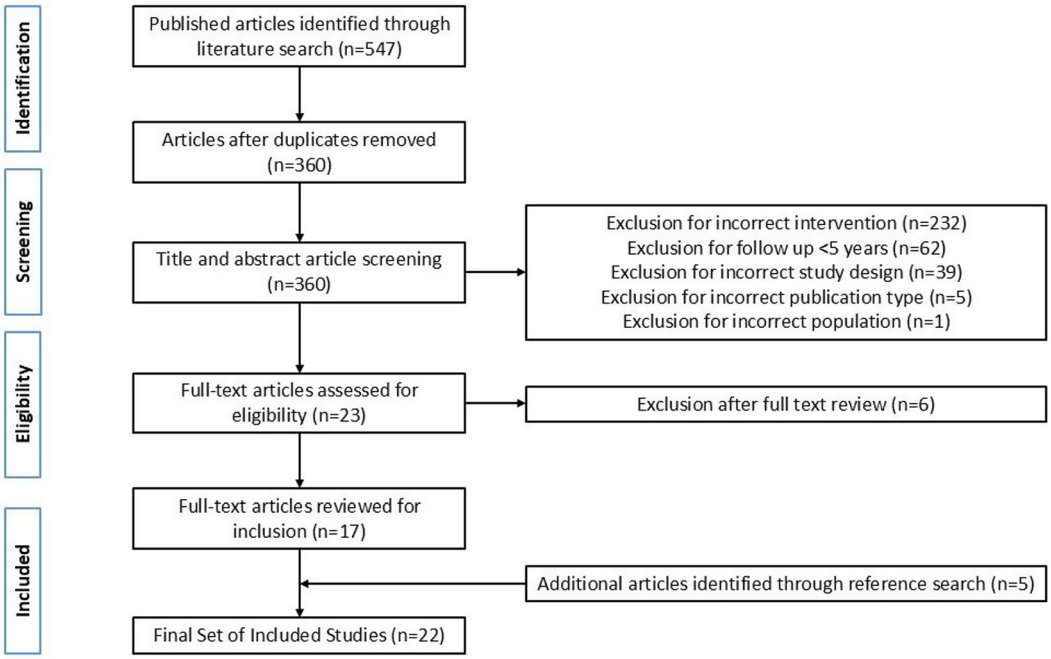

Fig. 1 PRISMA Flow diagram

Recurrence

As shown in Tables 2 and 26 groups, comprising 2721 patients, were included in the analysis. The overall pooled proportion of patients experiencing ventral hernia recurrence at any time was 13% (95% CI = 9-17%). Stratification by follow-up duration revealed the following trends: among three groups with a follow-up of 5 years or less, the pooled recurrence proportion was 13% (95% CI = 6-22%). For 15 groups with a follow-up duration of 5-7.49 years, the proportion was slightly higher at 15% (95% CI = 9-23%). In contrast, four groups with follow-up durations between 7.5 and 10 years reported a lower pooled recurrence proportion of 5% (95% CI = 2-8%). Finally, four groups with follow-up periods exceeding 10 years observed a recurrence proportion of 11% (95% CI = 7-17%). There was significant heterogeneity ($I^2 = 88.67\%$) among the assorted studies.

Reoperation

The analysis included 19 groups, comprising a total of 1833 patients, as detailed in Table 2. The overall pooled proportion of patients who underwent reoperation at any time was 8% (95% CI: 5-11%). Reoperation procedures included additional hernia repair, mesh explantation, decompressive laparotomy, necrotic tissue debridement, and other surgical interventions. Stratification by follow-up duration revealed the following trends: for the 2 groups with follow-up durations of 5 years or less, the pooled reoperation proportion was 12% (95% CI: 6-19%). In contrast, for the 13 groups with follow-up periods between 5 and 7.49 years, the pooled reoperation proportion was lower, at 8% (95% CI: 4-13%). Among the 2 groups with follow-up durations between 7.5 and 10 years, the pooled reoperation proportion further decreased to 2% (95% CI: 0-9%). Lastly, for the 2 groups with follow-up periods exceeding 10 years, the reoperation proportion was 8% (95% CI: 1-18%). There was significant heterogeneity ($I^2 = 79.57\%$) among the various studies.

Seroma

The analysis included 15 groups, comprising a total of 1778 patients, as detailed in Table 2. The overall pooled proportion of patients who developed seroma at any time was 11% (95% CI: 6-17%). Stratification by follow-up duration revealed the following trends: for the 3 groups with follow-up durations of 5 years or less, the pooled seroma proportion was 21% (95% CI: 7-40%). In contrast, for the 7 groups with follow-up periods between 5 and 7.49 years, the pooled seroma proportion was lower, at 7% (95% CI: 2-15%). Among the 3 groups with follow-up durations between 7.5 and 10 years, the pooled seroma proportion was 8% (95% CI: 5-12%). Lastly, for the 2 groups with follow-up periods exceeding 10 years, the seroma proportion was 13% (95% CI: 0-56%). There was significant heterogeneity ($I^2 = 92.70\%$) among the various studies.

Table 1 Characteristics of included studies. PC = Primary closure, ePTFE = Expanded polytetrafluoroethylene, PVDF = polyvinylidene fluoride, EIOM = erlangen inlay onlay mesh, IPOM = intraperitoneal onlay mesh, AAS = activities assessment scale, VAS = visual analog scale, TAR = transversus abdominis release, P4BH = Poly-4-hydroxybutyrate. Follow-up reported in years (y)

Name	Technique	Mesh Type	QoL Survey	Total Patients	Follow-up (y)
Arer el. al. [19]	PC + Retromuscular	Polypropylene	n/a	132	Mean = 7.58 Range = 1.67–9.33
Asencio et al. [20]	Open + lap	Composite Mesh (Polypropylene + ePTFE)	EuraHS-QoL	85	Median = 12.88 IQR = 5.98–13.8
Ayik et al. [21]	EIOM	Polypropylene	n/a	163	Mean = 5.83 Range = 1.5-15.83
Bueno-Lledo et al. [22]	Onlay	polypropylene + PVDF	n/a	368	Median 5.13 IQR = 4.25–5.92
Burger (A) et al. [23]	PC	Suture	n/a	97	Median = 6.25
Burger (B) et al. [23]	Retrorectus	Polypropylene	n/a	84	Median = 6.75
Dalenbäck et al. [24]	PC + Mesh	Polypropylene	n/a	144	Mean = 5.83 Median = 4.83 Range = 2.25–11.83
Dhanani et al. [25]	Sublay + Underlay	Synthetic + Biologic	AAS	78	Median = 5.3 IQR = 3.2–5.6
Gomez-Menchero et al. [26]	IPOM	Composite (ePTFE + Polypropylene + PVDF)	Pain VAS	58	Mean = 5
Hiekkaranta (A) et al. [27]	IPOM	Composite	SF-36	65	Mean = 7.25 IQR = 5.42–9.58
Hiekkaranta (B) et al. [27]	Open + IPOM	Composite	SF-36	60	Mean = 7.25 IQR = 5.42–8.42
Juvany et al. [28]	PC + Onlay	Polypropylene	in house	76	Median = 5.33 IQR = 5-6.33
Karlsson et al. [29]	Sublay	Synthetic	in house	271	Median = 11.1 IQR = 5.9–15.1
Kurzer et al. [30]	Sublay	Polypropylene	n/a	125	Mean = 7.92 Median = 7 Range = 3.83-14
Ladurner (A) et al. [31]	Sublay	Polypropylene	SF-36	12	Mean = 9.33
Ladurner (B) et al. [31]	Sublay	Composite Mesh (Polypropylene + ePTFE)	SF-36	12	Mean = 6.25
Lavanchy et al. [32]	IPOM lap + IPOM open	polyester + PVDF + polypropylene	n/a	184	Mean = 5.5
Messa et al. [33]	TAR	P4HB	HerQLes / AHQ	29	Median = 5.11 IQR = 3.64–5.94
Mills et al. [34]	EIOM	Polypropylene	n/a	93	Median = 12 IQR = 11–13
O'Dwyer et al. [35]	IPOM	Polyester	n/a	32	Mean = 8.67 IQR = 7.67–9.67
Rogmark et al. [36]	Retromuscular	Polypropylene	SF-36	217	Mean = 11.42
Roth et al. [37]	Retromuscular + onlay	P4HB	CCS	121	Mean = 5
Stodolski (A) et al. [38]	Retromuscular	Polypropylene	n/a	41	Median = 5.25 Range = 0.25–9.924
Stodolski (B) et al. [38]	Retromuscular	Polypropylene	n/a	74	Median = 4.67 Range = 0.08–9.67
Talwar et al. [39]	Retromuscular + onlay	P4HB	HerQLes / AHQ	51	Median = 5.16 IQR = 4.82–5.55
Yu et al. [40]	Retrorectus	Absorbable Synthetic	n/a	49	Mean = 5.2 Range = 0.06–8.74

Chronic pain

The analysis included 12 groups, comprising a total of 1220 patients, as detailed in Table 2. The overall pooled proportion of patients who developed chronic pain at any time was 15% (95% CI: 8-23%). Stratification by follow-up duration revealed the following trends: for the 1 group with a follow-up duration of 5 years or less, the pooled chronic pain proportion was 7% (95% CI: 2-15%). In contrast, for the 6 groups with follow-up periods between 5 and 7.49 years, the pooled chronic pain proportion was higher, at 15% (95% CI: 5-27%). Among the 3 groups with follow-up durations

Table 2 Meta-analysis of included studies using the random-effects REML model. Results are stratified by range of mean or median follow-up time. Aggregate data without stratification by follow-up duration are displayed in the bottom row for each outcome. "Groups" include complete study populations in addition to cohorts separated based on technique or intervention as previously described. Forest plots are available in the supplemental figures

Outcome	Number of groups	Number of events	Number of patients	Pooled proportion of patients experiencing outcome	95% confidence interval	Heterogeneity (I^2)
Recurrence						
≤5 years	3	38	253	0.13	0.06–0.22	70.45%
5-7.49 years	15	234	1501	0.15	0.09–0.23	91.18%
7.5–10 years	4	18	301	0.05	0.02–0.08	7.57%
>10 years	4	73	666	0.11	0.07–0.17	70.85%
Overall	26	363	2721	0.13	0.09–0.17	88.67%
Reoperation						
≤5 years	2	24	195	0.12	0.06–0.19	47.29%
5-7.49 years	13	103	1292	0.08	0.04–0.13	83.66%
7.5–10 years	2	1	44	0.02	0.00-0.09	0.00%
>10 years	2	20	302	0.08	0.01–0.18	84.86%
Overall	19	148	1833	0.08	0.05–0.11	79.57%
Seroma						
≤5 years	3	49	253	0.21	0.07–0.40	90.28%
5-7.49 years	7	99	872	0.07	0.02–0.15	90.60%
7.5–10 years	3	24	289	0.08	0.05–0.12	4.78%
>10 years	2	90	364	0.13	0.00-0.56	98.48%
Overall	15	262	1778	0.11	0.06–0.17	92.70%
Chronic Pain						
≤5 years	1	4	58	0.07	0.02–0.15	n/a
5-7.49 years	6	83	629	0.15	0.05–0.27	92.01%
7.5–10 years	3	14	169	0.1	0.02–0.20	54.95%
>10 years	2	124	364	0.24	0.01–0.63	97.84%
Overall	12	225	1220	0.15	0.08–0.23	91.47%
Mesh Infection						
≤5 years	2	6	195	0.02	0.00-0.16	91.56%
5-7.49 years	7	22	833	0.02	0.01–0.04	60.27%
7.5–10 years	1	2	125	0.02	0.00-0.05	n/a
>10 years	2	3	310	0.01	0.00-0.03	32.15%
Overall	12	33	1463	0.02	0.00-0.03	69.54%

between 7.5 and 10 years, the pooled chronic pain proportion was 10% (95% CI: 2-20%). Lastly, for the 2 groups with follow-up periods exceeding 10 years, the chronic pain proportion was 24% (95% CI: 1-63%). There was significant heterogeneity (I^2 = 91.47%) among the various studies. Surveys used for PRO measures included HerQLes, AAS, AHQ, EuraHS, SF-36, CCS, and a pain VAS. Pain scores were inconsistently reported across studies, with assessment intervals varying from daily or weekly evaluations to monthly measurements.

Mesh infection

The analysis included 12 groups, comprising a total of 1463 patients, as detailed in Table 2. The overall pooled proportion of patients who developed mesh infection at any time was 2% (95% CI: 0-3%). Stratification by follow-up duration showed relatively consistent proportions across the groups: for the 2 groups with follow-up durations of 5 years or less, the pooled mesh infection proportion was 2% (95% CI: 0-16%). For the 7 groups with follow-up periods between 5 and 7.49 years, the pooled mesh infection proportion was 2% (95% CI: 1-4%). Among the 1 group with follow-up durations between 7.5 and 10 years, the mesh infection proportion was 2% (95% CI: 0-5%). Lastly, for the 2 groups with follow-up periods exceeding 10 years, the mesh infection proportion was 1% (95% CI: 0-3%). There was significant heterogeneity (I^2 = 69.54%) among the various studies.

Discussion

Ventral hernia repair remains a complicated issue for many patients. As previously discussed, a one-time repair in which a patient experiences no complications or long-term

adverse effects may not be providing reasonable expectations to patients. This study synthesizes long-term outcome data beyond 5 years from the existing literature, challenging the notion of ventral hernia repair as a single, definitive intervention and highlighting the need for extended follow-up to address the chronic nature of hernia pathology. While some patients undergoing ventral hernia repair may not experience any short-term complications and go a lifetime without recurrence or requiring reoperation, expectations should still be clear regarding the potential for long-term implications requiring medical or surgical intervention.

The definition of "chronic disease" is subject to interpretation, as various health agencies hold differing views on what conditions qualify for this classification. Even within the U.S. Department of Health and Human Services, definitions of chronic diseases differ, with notable discrepancies between agencies such as the Centers for Medicare and Medicaid Services and the Centers for Disease Control and Prevention [41]. Despite these differences, there are common elements recognized by most institutions. Chronic diseases are typically characterized by prolonged onset, gradual progression, and persistence over months or years, necessitating ongoing medical management [42]. They are frequently attributed to genetic, environmental, and behavioral factors. While conditions such as chronic obstructive pulmonary disease (COPD), diabetes, and cardiovascular disease are frequently cited as examples, there is variation in which diseases are universally included within this category [43]. Based on the findings of this review, we propose that ventral hernia should be considered a form of chronic disease.

Reoperation

One major concern for patients undergoing VHR is the potential for reoperation. This review reports an overall reoperation rate of 8% across 1833 patients (Table 2). The indications for reoperation include hernia recurrence, wound complications, and chronic mesh complications, such as ongoing inflammation or infection, which may contribute to fibrosis, impaired tissue integration, or recurrent pain syndromes. These conditions significantly complicate subsequent management and increase the risk of surgical morbidity, including adhesions and enterocutaneous fistulas, while prolonging the recovery process and negatively affecting patient-reported outcomes. While mesh infection rates are typically low, they may require long-term antibiotics or mesh explantation, putting the patient at further risk of infection and bowel or wound complications. Pooled analysis of the studies included in this review revealed an overall mesh infection rate of 2% in 1463 patients (Table 2). The data in Table 2 is divided into groups based on their mean or median follow-up period.

Chronic pain

Chronic pain is a prevalent postoperative concern following VHR, and its assessment necessitates patient-reported outcome measures due to its inherently subjective nature. Ten of our included studies included quality-of-life questionnaires that evaluated chronic pain. The pooled proportion of patients who report chronic pain in this analysis is 0.15 (Table 2). When stratifying by follow-up duration, the pooled proportion of patients who experience chronic pain was greatest in the studies with longer follow-up periods (0.24 in studies with at least 10-year follow-up). While it is true that these patients may have experienced difficulty with pain management in a shorter follow-up period, the longer follow-up time may increase the chance of identifying patients suffering from chronic pain. Assessment intervals of chronic pain ranged from daily to weekly or monthly evaluations, reflecting inconsistencies in data collection methodologies among the included studies. Furthermore, not all studies provided an explicit definition of chronic pain, contributing to heterogeneity in outcome measurement and limiting direct comparability. Burger et al. revealed chronic pain was reported in 39% of patients after a median of 6.25 years of follow-up [23]. Karlson et al. reported chronic pain in 42.7% of patients after a median of 11.1 years of follow-up [29]. In addition to the mere presence of pain, the severity and frequency of pain are notably relevant. Rogmark et al. described in their study that 14.5% of their patients reported daily pain, while 72% reported experiencing monthly pain [36]. This data and other quality-of-life metrics (such as functional status, cosmetics, and patient satisfaction) should be utilized when counseling patients and setting appropriate expectations before surgery.

Recurrence

Hernia recurrence is the most common reason for patients to undergo reoperation. Recurrence rates after ventral hernia repair vary widely based on hernia characteristics (size, location), patient characteristics (body habitus, comorbidities), and repair technique. Many studies look at recurrence with other complications in the immediate postoperative period, days to months after surgery. This review includes studies with mean or median follow-up equal to or greater than 5 years, providing a better understanding of long-term recurrence risk. Our pooled analysis revealed an overall recurrence rate of 13% in 2721 patients compiled from 26 groups of patients (Table 2). When stratifying by follow-up duration, several trends emerge. For the three groups with

a follow-up limited to 5 years, the pooled proportion of patients experiencing recurrence was 0.13 (95% CI = 0.06–0.22), indicating that the risk of recurrence at approximately 5 years is consistent with the overall rate. In the 15 groups with mean or median follow-up durations between 5 and 7.49 years, the pooled proportion slightly increased to 0.15 (95% CI = 0.09–0.23), suggesting a marginally higher risk of recurrence during this mid-range follow-up period. However, among the four groups with follow-up durations between 7.5 and 10 years, the pooled proportion notably decreased to 0.05 (95% CI = 0.02–0.08), indicating that the risk of recurrence is lower after 7.5 years. Finally, the four groups with follow-up periods exceeding 10 years observed a pooled proportion of 0.11 (95% CI = 0.07–0.17), indicating that the risk of recurrence stabilizes or slightly reverts to levels observed in the 5-year follow-up subgroup. Although some of these recurrences could have been captured in a shorter follow-up period, long-term follow-up provides a higher chance of identifying recurrences and establishing a true recurrence rate, which may help counsel patients.

Despite these trends, the results should be interpreted with caution due to heterogeneity among the included studies. Some studies revealed recurrence rates as low as 0–4% [21, 30, 31]. Other studies reported recurrence rates of over 30% in patients who received mesh [23, 28]. Burger et al. reported recurrence rates of over 50% in patients who did not receive mesh [23]. Juvany et al. noted that half of their recurrences occurred after 3 years post-operation, emphasizing the importance of long-term follow-up [28]. These late recurrences are often underreported in the literature due to insufficient follow-up duration. This high level of variability suggests that factors other than follow-up duration, such as patient characteristics, surgical techniques, and study designs, may contribute to the observed differences in recurrence rates. The heterogeneity highlights the need for further investigation into the sources of variation and emphasizes the importance of standardizing follow-up periods and definitions of recurrence in future studies.

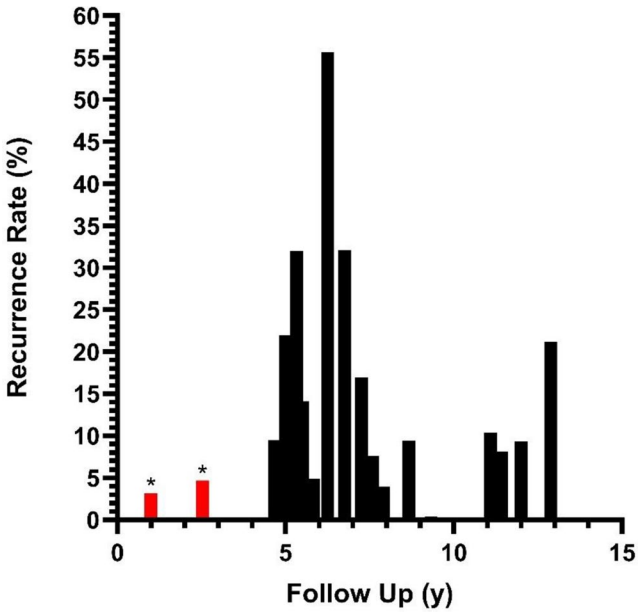

Fig. 2 Recurrence rates after ventral hernia repair with greater than 5 years of follow-up. Each bar in the graph represents an individual study or subgroup, with the recurrence rate in percentage representing the height of each bar (y-axis). On the x-axis is the mean or median follow-up time for each cohort. The red bars denoted with a (*) provide some context for studies with recurrence rates reported at a follow-up duration of < 5 years and are not a comprehensive review of the short-term data

Hernia as a chronic disease

The literature on short-term outcomes often presents a more favorable view of VHR as a single, definitive treatment. This is primarily due to the lower recurrence rates typically reported in studies with shorter follow-up periods. For instance, a recent multicenter study of 1,018 patients with a mean follow-up of 2.53 years reported a recurrence rate of just 4.7% [44]. A meta-analysis of the Rives-Stoppa technique reported a 12-month recurrence of only 3.2% across 12,440 patients [45]. The comparison of short-term data derived from substantially larger cohorts, relative to the long-term studies included in this review, is illustrated in Fig. 2. Such data can be misleading, as it fails to capture the full scope of recurrence, particularly after several years. The thousands of patients included in these short-term studies may have experienced additional complications beyond the 1 or 2 years of follow-up, potentially leading to underestimating the long-term burden associated with hernia recurrence. Long-term data, including follow-up durations of 5 years or more, offer a more comprehensive understanding of hernia recurrence patterns, revealing the persistence of the condition and the need for continued medical management or additional interventions. Thus, for a more accurate assessment of VHR's sustained efficacy, it is critical to consider long-term outcomes, which provide a more complete picture of the recurrence risk and its implications for patient care.

The reporting of hernia recurrence in the literature varies considerably, with different definitions and assessment methods employed across studies. Some studies define recurrence based on anatomical findings, such as imaging or intraoperative observations, regardless of whether the patient is symptomatic. In these cases, a recurrence is identified purely by the physical presence of a defect in the abdominal wall. Other studies rely on self-reported recurrence, where patients describe symptoms like bulging, pain, or discomfort at the site of the previous repair. This method, however, depends on the patient's perception and

willingness to report these symptoms, presenting a potential for underreporting. Some studies define recurrence based on clinical diagnosis, where a healthcare professional confirms the presence of a recurrence through physical examination. This approach emphasizes the role of clinician assessment in determining recurrence, particularly in cases where imaging or patient-reported symptoms may be inconclusive. Another critical factor influencing the outcomes of VHR is the size of the recurrence. The extent of the recurrence has implications for both symptom severity and the potential for reoperation, yet this variable is inconsistently reported across studies, leading to challenges in comparing outcomes. The lack of standardized definitions and reporting methods underscores the need for a more uniform approach to hernia recurrence in the literature, particularly when evaluating long-term outcomes and quality of life after VHR.

Limitations

Despite following the PRISMA guidelines for systematic reviews to ensure methodological rigor, the current study is limited by the quality of included studies. As demonstrated in Table 2, the heterogeneity of several groups included in this review are high when calculated using the I^2 statistic. This is likely due to variations in surgical techniques, patient characteristics, loss to follow up over prolonged durations. Long-term follow-up studies often have a high attrition rate due to a variety of factors related to prolonged patient engagement which was seen in several of the studies included in this review. For instance, Arer et al. initiated their study with a cohort of 132 patients undergoing ventral hernia repair (VHR); however, only 41.6% of the cohort remained available for long-term follow-up, representing a substantial attrition rate that could impact the validity and generalizability of the findings [19]. The reasons for losing over half the study participants to follow-up remain unknown, raising the possibility that additional long-term complications may have occurred in these patients and potentially leading them to seek care from providers outside the research group.

The methods used to assess long-term outcomes in the included studies were highly variable, including phone or mailed questionnaires, retrospective chart reviews, and clinical visits with the operating surgeon. This heterogeneity in follow-up approaches presents a challenge, as each method is associated with varying response rates, leading to the potential for considerable bias in the reporting of outcomes. Specifically, studies utilizing mail questionnaires or requests for clinical visits may face lower response rates, especially when patients are less motivated to respond, while those based on repeated phone calls may have a different patient pool, skewing the data.

Moreover, long-term follow-up is not part of the standard care for patients undergoing VHR, further compounding the difficulty in maintaining robust follow-up across extended periods of time. As a result, the response rate to follow-up data collection is likely to be less than optimal, which could affect the reliability of long-term outcome reporting. Additionally, the composition of the follow-up groups across different time points (e.g., 5, 5–7, and 10 years) may not be uniform, further complicating the interpretation of results. For instance, patients lost to follow-up or those who dropped out of the study for various reasons could lead to significant differences in the baseline characteristics and outcomes of the groups. This variability in group composition may help explain some of the discrepancies observed between the various follow-up time periods. It is possible that these differences are not solely attributable to the length of follow-up but rather to the inherent variability in the composition of patients at different time points, underscoring the importance of considering patient retention and attrition in future studies.

This review employed a comprehensive search strategy to identify relevant publications, aiming to capture both the objective long-term complications associated with VHR and the subjective patient experiences assessed through patient-reported outcome measures. Consequently, the search terms and methodology were designed to address these dual objectives. However, this approach may have inadvertently excluded studies that focused solely on either objective clinical outcomes or PRO measures, particularly if their titles or abstracts did not explicitly align with both aspects. As a result, there is a limitation in the publications reviewed for eligibility, with some relevant studies potentially omitted due to the specificity of the search criteria. Once retrieved from the databases, papers were not excluded for the lack of one of these criteria, as defined in the methods section. However, the search terms may have excluded some papers that could have provided additional data points. This limitation underscores the challenge of balancing specificity and inclusivity in systematic reviews addressing multifaceted research questions.

Many studies included in this review report substantial loss to follow-up, which presents a significant challenge in accurately assessing long-term outcomes. Some of these patients may have never experienced issues or felt the need to follow-up. In contrast, others may have sought care for VHR complications from different providers, potentially leading to inconsistent data collection and incomplete tracking of clinical outcomes. The number of patients completing long-term follow-up is illustrated in Fig. 3. While there are a few cohorts with a couple hundred patients or more, this sample size is relatively small compared to the thousands of patients reported in the literature on short-term outcomes.

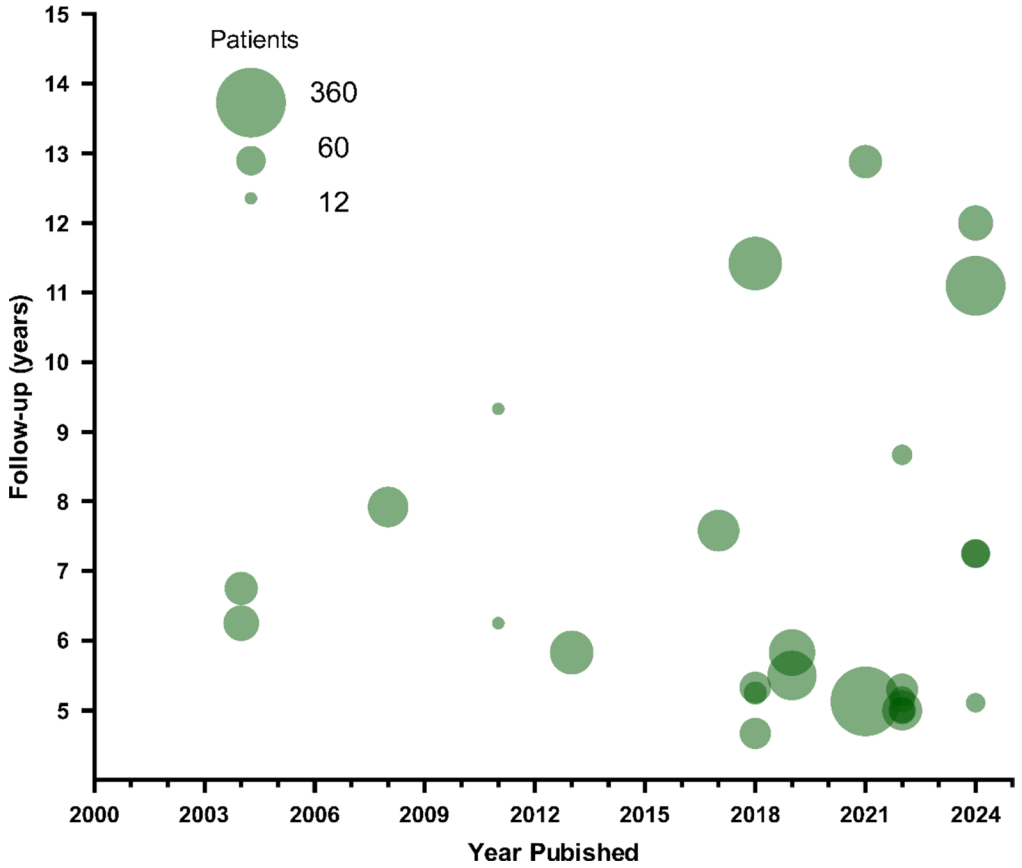

Fig. 3 Schematic representation of the current literature published on long-term VHR outcomes. Each bubble corresponds to an individual study or subgroup separated previously. Bubble size corresponds to the sample size, with larger bubbles indicating studies with more patients (legend top left: 360, 60, and 12 patients). The y-axis represents the mean or median follow-up duration in years, while the x-axis shows the year of publication of each study

Many patients reporting favorable outcomes in short-term studies may have subsequently developed late recurrences, chronic pain, or other adverse PROs, which are not captured in these analyses. Thus, the ability to capture the true long-term complications associated with VHR is limited by these studies' sample size and attrition rate.

Conclusion

This systematic review and meta-analysis underscores the complexity of ventral hernia repair. It proposes reframing the condition as a long-term therapeutic challenge rather than a disease with a one-time surgical solution. By analyzing studies with a minimum follow-up period of five years, the findings highlight significant variability in recurrence rates, influenced by patient and hernia characteristics, surgical techniques, and the use of mesh. Late recurrences, often underreported in shorter follow-up studies, emphasize the need for long-term surveillance to accurately assess VHR outcomes. The data suggest that ventral hernias exhibit characteristics of a chronic condition, requiring sustained medical oversight and potential reinterventions for chronic pain, recurrence, and other quality-of-life complications. Standardizing definitions of recurrence and follow-up protocols with large hernia centers and databases will be crucial for advancing clinical understanding and optimizing patient care. This review proposes conceptual realignment in managing ventral hernias, viewing them through the lens of chronic disease to align treatment goals with long-term patient outcomes.

Declarations

Conflict of interest S.D. has received a speaker honorarium from Medtronic, BD, and Boston Scientific. B.S., Z.M., R.M., declare that they have no conflict of interest.

References

1. Ahmed A, Gandhi S, Ganam S, Diab AF, Mhaskar R, Sujka J et al (2024) Ventral hernia repair using bioresorbable

poly-4-hydroxybutyrate mesh in clean and contaminated surgical fields: a systematic review and meta-analysis. Hernia 28(2):575–584. https://doi.org/10.1007/s10029-023-02951-4
2. Lindmark M, Lowenmark T, Strigard K, Gunnarsson U (2022) Major complications and mortality after ventral hernia repair: an eleven-year Swedish nationwide cohort study. BMC Surg 22(1):426. https://doi.org/10.1186/s12893-022-01873-9
3. Parker SG, Mallett S, Quinn L, Wood CPJ, Boulton RW, Jamshaid S et al (2021) Identifying predictors of ventral hernia recurrence: systematic review and meta-analysis. BJS Open 5(2). https://doi.org/10.1093/bjsopen/zraa071
4. Bhardwaj P, Huayllani MT, Olson MA, Janis JE (2024) Year-Over-Year ventral hernia recurrence rates and risk factors. JAMA Surg 159(6):651–658. https://doi.org/10.1001/jamasurg.2024.0233
5. Lee TJ, Ulisney KL, Choudhuri AK, Swiger JL, Gibeily GJ (2019) Understanding the patient perspective after ventral hernia repair. Hernia 23(5):995–1001. https://doi.org/10.1007/s10029-019-02015-6
6. Davila DG, Parikh N, Frelich MJ, Goldblatt MI (2016) The increased cost of ventral hernia recurrence: a cost analysis. Hernia 20(6):811–817. https://doi.org/10.1007/s10029-016-1515-5
7. Liang MK, Clapp M, Li LT, Berger RL, Hicks SC, Awad S (2013) Patient satisfaction, chronic pain, and functional status following laparoscopic ventral hernia repair. World J Surg 37(3):530–537. https://doi.org/10.1007/s00268-012-1873-9
8. Heniford BT, Walters AL, Lincourt AE, Novitsky YW, Hope WW, Kercher KW (2008) Comparison of generic versus specific quality-of-life scales for mesh hernia repairs. J Am Coll Surg 206(4):638–644. https://doi.org/10.1016/j.jamcollsurg.2007.11.025
9. Krpata DM, Schmotzer BJ, Flocke S, Jin J, Blatnik JA, Ermlich B et al (2012) Design and initial implementation of HerQLes: a hernia-related quality-of-life survey to assess abdominal wall function. J Am Coll Surg 215(5):635–642. https://doi.org/10.1016/j.jamcollsurg.2012.06.412
10. Muysoms F, Campanelli G, Champault GG, DeBeaux AC, Dietz UA, Jeekel J et al (2012) EuraHS: the development of an international online platform for registration and outcome measurement of ventral abdominal wall hernia repair. Hernia 16(3):239–250. https://doi.org/10.1007/s10029-012-0912-7
11. Mauch JT, Enriquez FA, Shea JA, Barg FK, Rhemtulla IA, Broach RB et al (2020) The abdominal Hernia-Q: development, psychometric evaluation, and prospective testing. Ann Surg 271(5):949–957. https://doi.org/10.1097/SLA.0000000000003144
12. Mercoli H, Tzedakis S, D'Urso A, Nedelcu M, Memeo R, Meyer N et al (2017) Postoperative complications as an independent risk factor for recurrence after laparoscopic ventral hernia repair: a prospective study of 417 patients with long-term follow-up. Surg Endosc 31(3):1469–1477. https://doi.org/10.1007/s00464-016-5140-2
13. Seid AS, Amos E (1994) Entrapment neuropathy in laparoscopic herniorrhaphy. Surg Endosc 8(9):1050–1053. https://doi.org/10.1007/BF00705717
14. Wilson RB, Farooque Y (2022) Risks and prevention of surgical site infection after hernia mesh repair and the predictive utility of ACS-NSQIP. J Gastrointest Surg 26(4):950–964. https://doi.org/10.1007/s11605-022-05248-6
15. Leber GE, Garb JL, Alexander AI, Reed WP (1998) Long-term complications associated with prosthetic repair of incisional hernias. Arch Surg 133(4):378–382. https://doi.org/10.1001/archsurg.133.4.378
16. Casson CA, Kushner BS, Holden TR, Majumder A, Blatnik JA, Holden SE (2024) Patient expectations and decisional regret in the management of ventral hernias. Surg Endosc. https://doi.org/10.1007/s00464-024-11318-4
17. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD et al (2021) The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 372:n71. https://doi.org/10.1136/bmj.n71
18. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A (2016) Rayyan-a web and mobile app for systematic reviews. Syst Rev 5(1):210. https://doi.org/10.1186/s13643-016-0384-4
19. Arer IM, Yabanoglu H, Aytac HO, Ezer A, Caliskan K (2017) Long-term results of retromuscular hernia repair: a single center experience. Pan Afr Med J 27:132. https://doi.org/10.11604/pamj.2017.27.132.9367
20. Asencio F, Carbó J, Ferri R, Peiró S, Aguiló J, Torrijo I et al (2021) Laparoscopic versus open incisional hernia repair: Long-Term Follow-up results of a randomized clinical trial. World J Surg 45(9):2734–2741. https://doi.org/10.1007/s00268-021-06164-7
21. Ayik N, Klein P, Grutzmann R, Demir R (2019) Long-term outcome of incisional hernia repairs using the Erlangen inlay onlay mesh (EIOM) technique. J Surg Res 243:14–22. https://doi.org/10.1016/j.jss.2019.04.045
22. Bueno-Lledo J, Bonafe-Diana S, Carbonell-Tatay F, Torregrosa-Gallud A, Pous-Serrano S (2021) Component separation and large incisional hernia: predictive factors of recurrence. Hernia 25(6):1593–1600. https://doi.org/10.1007/s10029-021-02489-3
23. Burger JW, Luijendijk RW, Hop WC, Halm JA, Verdaasdonk EG, Jeekel J (2004) Long-term follow-up of a randomized controlled trial of suture versus mesh repair of incisional hernia. vol 4. United States
24. Dalenbäck J, Andersson C, Ribokas D, Rimbäck G (2013) Long-term follow-up after elective adult umbilical hernia repair: low recurrence rates also after non-mesh repairs. Hernia 17(4):493–497. https://doi.org/10.1007/s10029-012-0988-0
25. Dhanani NH, Saucedo B, Olavarria OA, Bernardi K, Holihan JL, Ko TC et al (2022) Is expectant management warranted in patients with ventral hernias and co-morbidities? A prospective, 5 year follow-up, patient-centered study. Am J Surg.224(1 Pt A):96–9. https://doi.org/10.1016/j.amjsurg.2022.02.065
26. Gomez-Menchero J, Balla A, Fernandez Carazo A, Morales-Conde S (2022) Primary closure of the midline abdominal wall defect during laparoscopic ventral hernia repair: analysis of risk factors for failure and outcomes at 5 years follow-up. Surg Endosc 36(12):9064–9071. https://doi.org/10.1007/s00464-022-09374-9
27. Hiekkaranta JM, Ahonen M, Mäkäräinen E, Saarnio J, Pinta T, Vironen J et al (2024) Laparoscopic versus hybrid approach for treatment of incisional ventral hernia: a 5-10-year follow-up of the randomized controlled multicenter study. Hernia: J Hernias Abdom Wall Surg 28(1):191–197. https://doi.org/10.1007/s10029-023-02849-1
28. Juvany M, Hoyuela C, Carvajal F, Trias M, Martrat A, Ardid J (2018) Long-term follow-up (at 5 years) of midline incisional hernia repairs using a primary closure and prosthetic onlay technique: recurrence and quality of life. Hernia 22(2):319–324. https://doi.org/10.1007/s10029-018-1730-3
29. Karlsson S, Björklund I, Burman A, Israelsson LA, Cengiz Y (2024) Long-term follow-up after incisional hernia repair: dynamics of recurrence and patient-reported outcome. World J Surg. https://doi.org/10.1002/wjs.12294
30. Kurzer M, Kark A, Selouk S, Belsham P (2008) Open mesh repair of incisional hernia using a sublay technique: Long-term follow-up. World J Surg 32(1):31–36. https://doi.org/10.1007/s00268-007-9118-z
31. Ladurner R, Chiapponi C, Linhuber Q, Mussack T (2011) Long term outcome and quality of life after open incisional hernia

repair - light versus heavy weight meshes. BMC Surg 11 Doi. https://doi.org/10.1186/1471-2482-11-25
32. Lavanchy JL, Buff SE, Kohler A, Candinas D, Beldi G (2019) Long-term results of laparoscopic versus open intraperitoneal onlay mesh incisional hernia repair: a propensity score-matched analysis. Surg Endosc 33(1):225–233. https://doi.org/10.1007/s00464-018-6298-6
33. Messa CA, Amro C, Niu EF, Habarth-Morales TE, Talwar AA, Thrippleton S et al (2024) Transversus abdominis release with biosynthetic mesh for large ventral hernia repair: a 5-year analysis of clinical outcomes and quality of life. Hernia: J Hernias Abdom Wall Surg 28(3):789–801. https://doi.org/10.1007/s10029-023-02889-7
34. Mills JMZ, Luscombe GM, Hugh TJ (2024) Long-term patient-reported outcome measures (PROMs) after primary ventral or small midline incisional hernia repair. ANZ J Surg. https://doi.org/10.1111/ans.19153
35. O'Dwyer PJ, Chew C, Qandeel H (2022) Long term outcome and elasticity of a polyester mesh used for laparoscopic ventral hernia repair. Hernia 26(2):489–493. https://doi.org/10.1007/s10029-021-02486-6
36. Rogmark P, Smedberg S, Montgomery A (2018) Long-Term Follow-Up of retromuscular incisional hernia repairs: recurrence and quality of life. World J Surg 42(4):974–980. https://doi.org/10.1007/s00268-017-4268-0
37. Roth JS, Anthone GJ, Selzer DJ, Poulose BK, Pierce RA, Bittner JG et al (2022) Long-Term, prospective, multicenter study of Poly-4-Hydroxybutyrate mesh (Phasix mesh) for hernia repair in cohort at risk for complication: 60-Month Follow-Up. J Am Coll Surg 235(6):894–904. https://doi.org/10.1097/XCS.0000000000000363
38. Stodolski M, Papadakis M, Zirngibl H, Ambe PC (2018) Risk of recurrence following mesh associated incisional hernia repair using the retromuscular technique in patients with relevant medical conditions. Asian J Surg 41(6):562–568. https://doi.org/10.1016/j.asjsur.2018.01.005
39. Talwar AA, Perry NJ, McAuliffe PB, Desai AA, Thrippleton S, Broach RB, Fischer JP (2022) Shifting the goalpost in ventral hernia care: 5-year outcomes after ventral hernia repair with Poly-4-hydroxybutyrate mesh. Hernia: J Hernias Abdom Wall Surg 26(6):1635–1643. https://doi.org/10.1007/s10029-022-02674-y
40. Yu JF, Goldblatt HE, Alter-Troilo K, Hetzel E, Goldblatt MI (2022) Long-term outcome of absorbable synthetic mesh in clean ventral hernia repairs. Surg Endosc 36(7):5144–5148. https://doi.org/10.1007/s00464-021-08885-1
41. Bernell S, Howard SW (2016) Use your words carefully: what is a chronic disease?? Front Public Health 4:159. https://doi.org/10.3389/fpubh.2016.00159
42. Goodman RA, Posner SF, Huang ES, Parekh AK, Koh HK (2013) Defining and measuring chronic conditions: imperatives for research, policy, program, and practice. Prev Chronic Dis 10:E66. https://doi.org/10.5888/pcd10.120239
43. Hacker K (2024) The burden of chronic disease. Mayo Clin Proc Innov Qual Outcomes 8(1):112–119. https://doi.org/10.1016/j.mayocpiqo.2023.08.005
44. Piccoli M, Pecchini F, Vetrone G, Linguerri R, Sarro G, Rivolta U et al (2022) Predictive factors of recurrence for laparoscopic repair of primary and incisional ventral hernias with single mesh from a multicenter study. Sci Rep 12(1):4215. https://doi.org/10.1038/s41598-022-08024-3
45. Hartog F, Sneiders D, Darwish EF, Yurtkap Y, Menon AG, Muysoms FE et al (2022) Favorable outcomes after Retro-Rectus (Rives-Stoppa) mesh repair as treatment for noncomplex ventral abdominal wall hernia, a systematic review and Meta-analysis. Ann Surg 276(1):55–65. https://doi.org/10.1097/SLA.0000000000005422