



## OPEN ACCESS

## \*CORRESPONDENCE

Mia Weiss,  
✉ Mia.Weiss@abd.com

RECEIVED 10 February 2026

REVISED 13 April 2026

ACCEPTED 28 April 2026

PUBLISHED 11 May 2026

## CITATION

Weiss M, Gürcan H, Aronitz E, Gareer H and Fischer JP (2026) Health-related quality of life outcomes of bioabsorbable Phasix Mesh versus permanent synthetic mesh following open ventral hernia repair: a systematic literature review and narrative synthesis.

*J. Abdom. Wall Surg.* 5:16382.

doi: 10.3389/jaws.2026.16382

## COPYRIGHT

© 2026 Weiss, Gürcan, Aronitz, Gareer and Fischer. This is an open-access article distributed under the terms of the [Creative Commons Attribution License \(CC BY\)](#).

The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

# Health-related quality of life outcomes of bioabsorbable Phasix Mesh versus permanent synthetic mesh following open ventral hernia repair: a systematic literature review and narrative synthesis

Mia Weiss <sup>1\*</sup>, Hakan Gürcan<sup>1</sup>, Elise Aronitz <sup>2</sup>,  
Haytham Gareer<sup>1</sup> and John P. Fischer<sup>3</sup>

<sup>1</sup>Becton, Dickinson and Company, Franklin Lakes, NJ, United States, <sup>2</sup>EVERSANA, Burlington, ON, Canada, <sup>3</sup>Division of Plastic Surgery, University of Pennsylvania Health System, Philadelphia, PA, United States

**Background:** A hernia occurs when an organ or tissue protrudes through a weak spot in the surrounding muscle or connective tissue. The presence of a hernia, its surgical management, and the associated postoperative complications can substantially influence patient health-related quality of life (HRQoL). Ventral hernias often require mesh repair to reduce recurrence. While permanent synthetic meshes have historically been the standard of care, they have been associated with complications such as infection and chronic pain. As a result, patients are increasingly requesting alternatives, leading to growing interest in bioabsorbable meshes such as Phasix™ Mesh. This systematic literature review uses narrative synthesis to summarize reported HRQoL outcomes following open ventral hernia repair with Phasix™ Mesh or permanent synthetic mesh.

**Methods:** Searches were conducted across multiple databases (i.e., MEDLINE®, Embase, Cochrane Central, and Cochrane Reviews) from 2013 to August 2024 using a peer-reviewed strategy. The primary outcome of the review was HRQoL, reported using the hernia-related quality of life survey (HerQLes).

**Results:** Seven records of six independent studies met the inclusion criteria; four on Phasix™ Mesh and three on permanent synthetic mesh. Most studies were retrospective, with follow-up durations ranging from 12 to 66 months. A narrative synthesis was performed to summarize study design, patient characteristics, and HerQLes outcomes. Both mesh types showed improvements in HerQLes scores postoperatively. At the longest follow-up, the mean HerQLes postoperative scores were 75.25 for Phasix™ Mesh studies and 75.56 for permanent synthetic mesh studies. Quality of studies were moderate to high based on the Newcastle-Ottawa scale, supporting the reliability of findings.

**Conclusion:** This study found that postoperative HerQLes scores improved with both Phasix™ Mesh and permanent synthetic meshes following open, ventral hernia repair. Single-arm studies of Phasix™ Mesh reported improvements in HerQLes scores up to 60 months post-surgery, including complex hernia cases. Early improvements in HerQLes scores were reported in permanent synthetic

mesh studies, with reduced scores observed at the longest follow-up time points. Future large-scale, rigorously designed comparative studies are needed to confirm these findings, given no direct comparative studies are available.

#### KEYWORDS

permanent synthetic mesh, Phasix Mesh, poly-4-hydroxybutyrate, quality of life, ventral hernia repair

## Introduction

A hernia is a medical condition where an organ, tissue, or structure in the body protrudes through a weak spot or opening in the surrounding muscle or connective tissue that usually holds it in place [1]. In 2019, more than 45 million (32.53 million prevalent and 13.02 million incident) cases of various abdominal hernias, such as inguinal, femoral, and abdominal, were recorded globally [2]. Ventral hernias account for an estimated 611,000 repairs annually in the United States of America (USA) [3], resulting in a cost of more than \$3.2 billion annually to the USA [4]. This number is projected to grow due to rising risk factors such as an aging population, increasing obesity rates, and a higher incidence of abdominal surgeries unrelated to hernias [5].

Recurrence rates following hernia repair vary significantly depending on the type of hernia, with recurrence of ventral hernia repair occurring in 7.9%–25% of cases [6, 7]. These recurrences, along with complications, such as infections and other surgical site issues, can negatively affect patient outcomes and contribute to rising healthcare costs [8].

The presence of a hernia, its surgical management, and the associated postoperative complications can substantially influence patient health-related quality of life (HRQoL) [9]. The presence of a hernia may adversely affect various aspects of daily living, including sexual function, physical activity, and dietary habits, thereby impacting psychological wellbeing and social interactions [10]. Surgical intervention, particularly hernia repair, has been shown to improve patient outcomes [11]. Hernia repair is a technically demanding procedure that necessitates precise surgical execution to achieve optimal outcomes and enhance patient HRQoL [12]. Common surgical techniques include open, laparoscopic, and robotic approaches [13, 14].

The use of mesh has become the gold standard in surgical hernia repair due to its lower recurrence and reoperation rates compared to suture repair [15]. The first dedicated surgical mesh for hernia repair was introduced in 1955, which was composed of permanent synthetic non-degradable materials such as polyester, polypropylene, and expanded polytetrafluoroethylene [16]. Permanent synthetic meshes are valued for their mechanical strength and cost-effectiveness compared to biologic alternatives [17]. However, their use is not without the risk of complications, which may include chronic inflammation, low elasticity, infection, fistula formation, and persistent pain [14, 16]. Bioabsorbable mesh, is an alternative option constructed from non-permanent polymers such as poly-4-hydroxybutyrate (P4HB), which are gradually absorbed by the body [18]. In hernia repair, bioabsorbable meshes have demonstrated promising results compared to alternative meshes [18–21]. Bioabsorbable meshes offer the potential to mitigate long-term mesh related complications [18, 22].

Phasix™ Mesh (BD, Warwick, Rhode Island, USA) is a notable example of a bioabsorbable mesh, featuring an open monofilament scaffold composed entirely of P4HB [23]. This mesh is designed to degrade over 12–18 months into natural metabolites found in human tissues and recognized by the body, which can be eliminated through hydrolysis [24]. Many studies have supported the clinical efficacy and safety of Phasix™ Mesh, highlighting its ability to promote healthy tissue ingrowth and provoke a favorable host immune response [23, 25–28]. Preclinical and *in vitro* investigations have shown that Phasix™ Mesh facilitates rapid incorporation into host tissue and stimulates an early anti-inflammatory macrophage response, which is critical for effective tissue remodeling [29]. Phasix™ Mesh also provides long-term mechanical strength, more than twice that of other bioabsorbable meshes [24].

Recently, patient-reported outcomes (PROs) have become increasingly important in evaluating the effectiveness of hernia repair procedures [12]. While traditional clinical outcomes such as recurrence rates and surgical complications remain essential, they fail to fully capture the patient's perspective [30]. Incorporating HRQoL tools that are tailored specifically for hernia can provide valuable insights into aspects such as physical, emotional, and social wellbeing, allowing for a more comprehensive evaluation of treatment success [31]. Although two recent systematic literature reviews (SLRs) have examined the clinical outcomes for Phasix™ Mesh [28, 32], there remains a notable paucity of studies summarizing the evidence on HRQoL. In this study, an SLR was conducted to identify studies reporting HRQoL outcomes for patients that underwent open, ventral hernia repair with permanent synthetic mesh or Phasix™ Mesh. HRQoL outcomes generated using the hernia-related quality of life survey (HerQLes) were described herein via narrative synthesis.

## Materials and methods

This review was conducted following the guidelines outlined in the Cochrane Handbook for Systematic Reviews of Interventions and adhered to the standards set by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement [33, 34]. The SLR protocol was not registered.

## Databases searched

All searches were conducted by a health librarian/medical information specialist. Using the Ovid® search interface, the following electronic databases were searched for studies reporting clinical and HRQoL outcomes: MEDLINE® and Epub Ahead of Print, In-Process, In-Data-Review & Other Non-Indexed Citations, Daily and Versions, Embase (1974–2024), EBM Reviews - Cochrane

TABLE 1 PICOS framework.

Items	Inclusion criteria	Exclusion criteria
Population	Human adults ( $\geq 18$ years) undergoing open <sup>a</sup> ventral hernia repair (primary ventral hernias: umbilical, epigastric, lumbar, spigelian, ventral; secondary ventral hernias: incisional, parastomal)	Patients under the age of 18 years old, those with inguinal hernia, and those undergoing laparoscopic or robotic-assisted surgeries
Intervention	Phasix™ Mesh (also known as P4HB mesh or poly-4-hydroxybutyrate mesh)	Any other (non-Phasix™ Mesh) bioabsorbable or biosynthetic meshes
Comparator	Synthetic (permanent) mesh	Biologic mesh
Outcome(s)	Any clinical <sup>b</sup> or HRQoL measure including, but not limited to: hernia-related quality of life survey (HerQLeS); European registry of abdominal wall hernias quality of life (EuraHS QoL); Carolinas comfort scale (CCS); abdominal hernia questionnaire (AHQ) <sup>c</sup>	Any non-HRQoL outcome
Study design	Clinical trials (randomized, non-randomized), single-arm studies, retrospective or prospective clinical studies, cohort studies, conference abstracts (past 2 years)	<i>In-vitro</i> studies, animal studies, and opinion/narrative pieces, case series, case reports, SLRs, meta-analyses, narrative reviews, editorials
Location	NA	NA
Language	English <sup>d</sup>	Non-English
Date limit	2013 onwards	Prior to 2013 <sup>e</sup>

<sup>a</sup>If the study methods did not specify whether open, laparoscopic, or robotic-assisted surgical technique was used, it was assumed to be open surgery and included in the SLR.

<sup>b</sup>PICOS criteria included outcomes for both clinical and HRQoL outcomes; however, only HRQoL outcomes were of interest for this study.

<sup>c</sup>Search captured all clinical outcomes to minimize the risk of losing evidence; however, only those reporting the HRQoL outcomes were included in this study.

<sup>d</sup>Search captured all languages, but non-English citations were excluded during screening.

<sup>e</sup>Aligned with the publication of the first Phasix™ Mesh studies [23, 24].

Abbreviations: AHQ, abdominal hernia questionnaire; CCS, Carolinas comfort scale; EuraHS QoL, European registry of abdominal wall hernias quality of life; HerQLeS, hernia-related quality of life survey; HRQoL, health-related quality of life; NA, not applicable; P4HB, poly-4-hydroxybutyrate; PICOS, population, intervention, comparator, outcome, and study design; SLR, systematic literature review.

Central Register of Controlled Trials (1991-present), and EBM Reviews - Cochrane Database of Systematic Reviews (2005-present). Searches were performed on 1 August 2024. Search results were limited to records that were published after 2013 to align with the publication of the first Phasix™ Mesh studies [23, 24]. The full search strategy is provided in [Supplementary Material 1](#).

## Inclusion and exclusion criteria

Studies were included if they reported clinical or HRQoL outcomes for patients undergoing open ventral hernia repair using either Phasix™ Mesh or permanent synthetic mesh. The predefined PICOS criteria are outlined in [Table 1](#). If the study methods did not specify whether open, laparoscopic, or robotic-assisted surgical technique was used, it was assumed to be open surgery and included in the SLR. Studies that did not fulfill the inclusion criteria were excluded, with the reasons for exclusion documented. Additional filters were applied (i.e., only full text articles, published 2018 or later, minimum 12-month follow-up, and light/medium weight mesh) post-screening to increase homogeneity across included articles. Articles that passed this stage were further confirmed for inclusion during data extraction, which involved evaluating the study design, baseline characteristics of the study population, and reported efficacy outcomes.

## Study selection

Study selection was conducted using the systematic review platform DistillerSR (DistillerSR Inc., 2021, Ottawa, Canada).

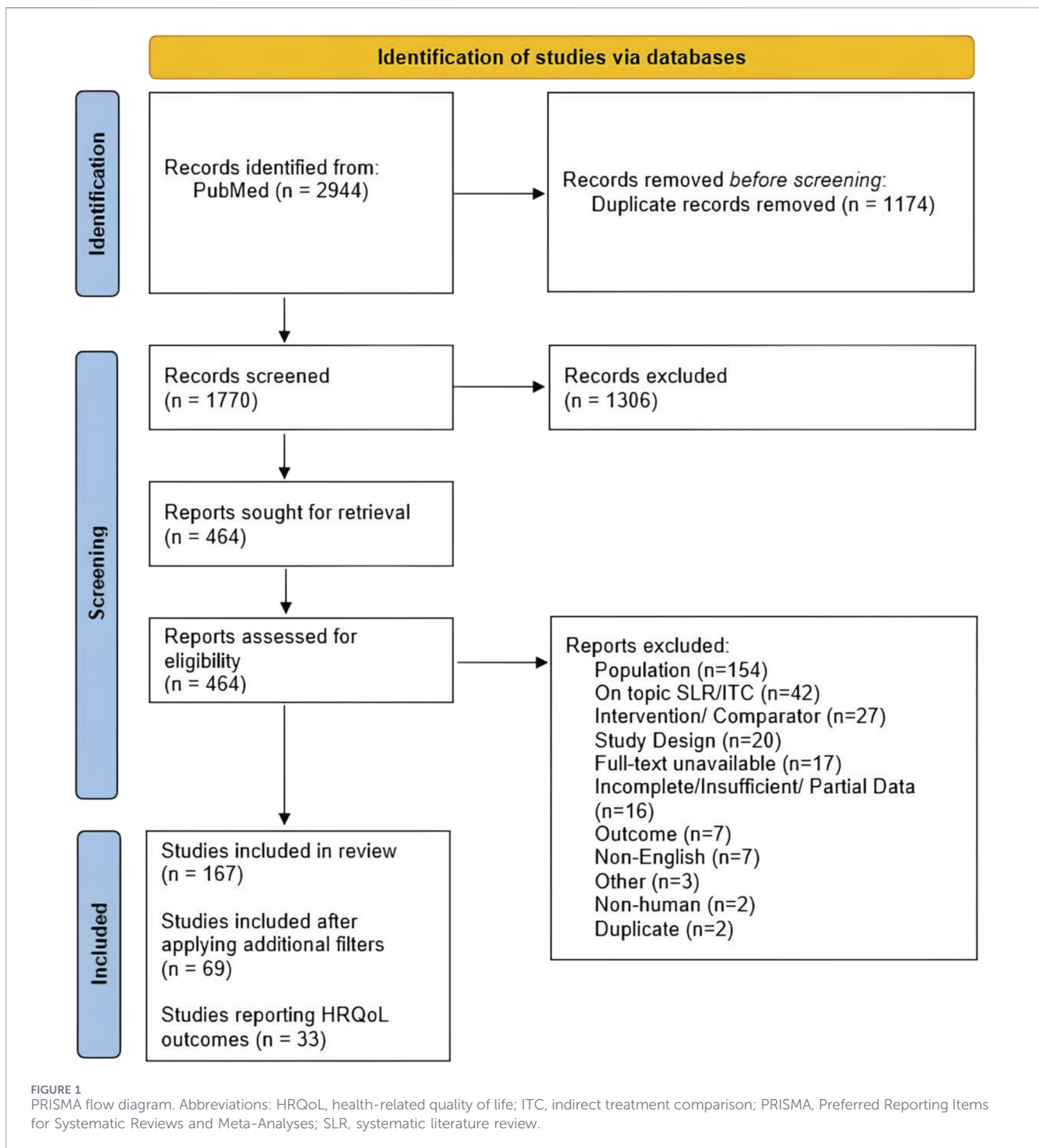
Two reviewers independently evaluated the study records, including titles and abstracts, to determine their eligibility. Reviewers recorded the reasons for excluding studies, and any disagreements between the two reviewers were resolved either through consensus or by consulting a third independent reviewer.

## Data extraction

Data extraction was conducted by a primary reviewer and independently confirmed by a second reviewer to ensure accuracy. Any disagreements between the two were resolved through discussion, or if necessary, by consulting a third independent reviewer. Data from the selected studies were gathered using standardized extraction templates created in Microsoft® Excel. The extracted study characteristics and outcomes included study information (i.e., author name, publication year, registration number, country of origin, follow-up duration, and study design), baseline population characteristics, treatment and disease details, and efficacy.

## Study quality

Risk of bias for the included studies was assessed using the Newcastle-Ottawa Scale (NOS) as it is specifically designed for observational studies (which comprised the majority of included studies) [35]. The assessment was completed in duplicate by two independent reviewers and any differences in judgments were resolved through discussion, or, if needed, by involving a third reviewer. With the NOS, the total score ranges



from 0 to 9 stars, with studies scoring 7 or more considered high quality [35].

### Data synthesis

Although the SLR included studies reporting both clinical and HRQoL outcomes, HRQoL outcomes were the focus of the study described herein. A narrative synthesis was conducted which included detailed descriptions of study characteristics, methodologies, types of mesh used, and key findings. The

interpretation of results considered the study populations, treatment factors, and methodological rigor. Additionally, a narrative overview of each study’s strengths and limitations was provided, along with responses to individual items from the risk of bias assessment to offer insight into the overall quality of the evidence. Quality of life results generated using the Hernia-Related Quality of Life Survey (HerQLes) were prioritized since this tool is validated for use in patients with hernia and results were consistently reported with sufficient detail across studies, thereby minimizing heterogeneity and facilitating robust comparisons.

TABLE 2 HRQoL instruments used across included studies.

HRQoL instrument	Phasix™ Mesh (number of studies)		Permanent synthetic mesh (number of studies)	
	Pre-operative	Post-operative	Pre-operative	Post-operative
AHQ	4	5	1	1
CCS	1	1	1	2
EQ-5D	0	0	2	2
EQ VAS	0	0	2	2
HerQLes	4	4	3	3
NRS	0	0	1	1
PROMIS	0	0	1	1
SF-12	2	2	0	0
SF-36	0	0	2	2
VAS	3	4	3	6
VHS	0	1	0	0
VRS	0	0	0	1

Abbreviations: AHQ, abdominal hernia questionnaire; CCS, Carolinas comfort scale; EQ-5D, EuroQol 5-dimension; EQ VAS, EuroQol visual analogue scale; HerQLes, hernia-related quality of life survey; HRQoL = health-related quality of life; NRS, numeric rating scale; SF-12, short-form 12-item; SF-36, short-form 36-item; VAS, visual analogue scale; VHS, ventral hernia screening; VRS, verbal rating scale.

## Results

### Literature search and screening

The database searches yielded 2,944 records; after removing duplicates, 1,770 records were screened at the title and abstract phase, of which 1,306 were excluded. Of the remaining 464 records considered at the full-text screening phase, 297 were excluded for reasons as detailed in the PRISMA flow diagram (Figure 1) [34]. After completion of article screening and applying post-hoc filters to increase homogeneity across the included studies, an additional 98 articles were excluded, ultimately resulting in the inclusion of 69 articles. Of the 69 articles included, 33 reported HRQoL outcomes (with the remainder reporting clinical outcomes).

### HRQoL instruments

Of the 33 studies reporting HRQoL outcomes, 28 studies reported such outcomes using 12 different HRQoL scales; namely, abdominal hernia questionnaire (AHQ) [36–41], the Carolinas comfort scale (CCS) [42–44], EuroQol 5-dimension (EQ-5D) [4, 45–47], EuroQol visual analogue scale (EQ VAS) [4], HerQLes [4, 36, 39, 46, 48–50], numeric rating scale (NRS) [42], patient-reported outcomes measurement information system (PROMIS) [50], short-form 12-item survey (SF-12) [43, 51], short-form 36-item survey (SF-36) [52, 53], the visual analogue scale (VAS) [38, 43, 46, 54–60], the ventral hernia screening (VHS) [61], and verbal rating scale (VRS; Table 2) [62]. The remaining five articles reported HRQoL outcomes as the proportion of patients returning to usual activities or with chronic pain and/or swelling [63–67].

Among the studies that reported both pre-operative and post-operative HRQoL scores, all Phasix™ Mesh studies demonstrated improvements in HRQoL, regardless of the assessment instrument used [36, 37, 39–41, 43, 48, 49, 51, 54, 59]. Similarly, studies involving synthetic meshes consistently reported HRQoL improvements, independent of the measurement tool applied [4, 38, 42, 46, 50, 52, 53, 58].

The most commonly used HRQoL instruments across both Phasix™ Mesh and permanent synthetic mesh studies were the AHQ, HerQLes, and VAS (Table 2). Results derived using the AHQ were reported more often in Phasix™ Mesh studies relative to permanent synthetic mesh studies, whereas HerQLes and VAS were reported more evenly across studies of both mesh types (Table 2). The VAS is a validated tool used to measure pain intensity and is not specific to patients with hernia [68], whereas HerQLes is a validated, hernia-specific HRQoL instrument developed specifically for this patient population [69]. Its widespread adoption in hernia research supports its relevance and reliability [30, 70–72]. Therefore, only studies reporting HerQLes results were described further in this narrative review.

### Characteristics of studies reporting HerQLes outcomes

In total, seven records reporting HerQLes outcomes were included in this review, comprising six distinct studies and one secondary analysis based on one of the included studies. Four of the included studies evaluated Phasix™ Mesh and three assessed permanent synthetic mesh. The characteristics of the included studies are provided in Table 3. All studies were conducted in the United States and primarily employed retrospective designs,

TABLE 3 Study and patient characteristics of included studies.

Author, year	Registration number	Study design	Country	Follow up duration (months)	Patient population (n)	Proportion male, n (%)	BMI (kg/m <sup>2</sup> ), mean (SD or range)	Mean age, years (SD or range)	Diabetic status, n (%)
<b>Phasix™ Mesh</b>									
Messa [48]	Protocol # 832515	Retrospective review	USA	Mean (range): 24 (12.2–41)	70	37 (52.8)	33.0 (20.3–53.3)	58 (23–81)	16 (23)
Christopher [36]	NR	Retrospective cohort study	USA	Mean (SD): 24.2 (12.9)	60	23 (38.3)	31 (26–44)	52.5 (45–66)	11 (18.3)
Christopher [49]	NR	Retrospective cohort study	USA	Median (IQR): 43.1 (38.2–49.1)	71	37 (52.1)	31 (25.8–38.8)	61.2 (50.5–68.5)	17 (23.9)
Talwar [39]	NR	Retrospective analysis of prospective assessments	USA	Median (IQR): 62.3 (57.8–66.6)	51	24 (47.1)	31.7 (24.1–38.7)	62.3 (50.8–67.6)	9 (17.6)
<b>Permanent synthetic mesh</b>									
Miller [46]	IDE# G120130, NCT#02451176	Post hoc analysis of RTC	USA	Total follow-up time: 24	51	29 (57)	31.7 (27–35)	63.4 (59–71)	8 (16)
Rosen [4]	NCT02451176	Multicenter single-blinded parallel RCT	USA	Total follow-up time: 24	126	61 (48)	32.3 (28–37)	63.7 (55–69)	29 (23)
Zolin [50]	NR	Retrospective analysis	USA	Median (IQR): 24 (12–48)	1,203	558 (46)	32 (28–36)	60 (52–67)	275 (23)

Abbreviations: BMI, body mass index; IDE, investigational device exemption; IQR, interquartile range; kg, kilogram; m, meter; n, number of patients; NCT, national clinical trial; NR, not reported; RCT, randomized controlled trial; SD, standard deviation; USA, United States of America.

with one randomized controlled trial (RCT) [4] and one secondary analysis of a RCT [46].

Across studies, follow-up durations ranged from approximately 12–66 months, with reported follow-up durations spanning 12.2–66.6 months in Phasix™ Mesh studies and 12–48 months in permanent synthetic mesh studies. This variability in follow-up time points introduced significant heterogeneity and limited the ability to pool outcomes across studies. Sample sizes varied from 51 to 1,203 patients in permanent synthetic mesh studies, and from 51 to 71 patients in Phasix™ Mesh studies.

The mean patient age across studies ranged from the early 50s to mid-60s, and body mass index (BMI) values ranged from approximately 31–33 kg/m<sup>2</sup>. The proportion of male patients ranged from 38% to 57%, and the prevalence of diabetes ranged from 16% to 23.9%.

Hernia disease characteristics of included studies are presented in Table 4. The included studies primarily addressed ventral hernias, with some studies reporting detailed hernia location including umbilical, paramedian, or parastomal hernias. Hernia defect sizes were consistently large, with reported mean or median areas ranging from approximately

273 cm<sup>2</sup>–345 cm<sup>2</sup>. Varied reporting of hernia dimensions was noted, with lengths typically between 18–23 cm and widths between 13 and 16 cm. The patients included in these studies were complex, as all were diagnosed with large hernias (defined as having a defect of ≥10 cm in width or length, or an area of ≥78.5 cm<sup>2</sup>); such patients commonly experience high rates of recurrence and complications [73, 74].

## HerQLes outcomes

HerQLes is a 12-item, 6-point Likert-style survey (with higher scores indicating better results) assessing HRQoL related to abdominal wall function in patients with hernia disease [75]. An increase of at least 15.6 points represents the minimal clinically important difference (MCID) when using the HerQLes [72].

A summary of HerQLes results spanning the included studies is presented in Table 5 and Figure 2. Both Phasix™ Mesh and permanent synthetic mesh studies demonstrated notable improvements in patient-reported HerQLes scores following hernia repair. However, the magnitude and trajectory of improvement varied between mesh types.

TABLE 4 Hernia disease characteristics.

Author, year	Hernia type	Hernia size
Messa [48]	Ventral	Mean (range): 323 cm <sup>2</sup> (25–972 cm <sup>2</sup> )
Christopher [36]	Incisional/ventral, umbilical, paramedian	Median (IQR): 300 (150–480) cm <sup>2</sup>
Christopher [49]	Ventral	Defect size area: 300 cm <sup>2</sup> (180–444) Median (IQR) length: 20 (15–23) cm Median (IQR) width: 16 (12–23) cm
Talwar [39]	Ventral	Median (IQR): Area: 289 (150–440) cm <sup>2</sup> Length: 18 (15–22) cm Width: 16 (11–23) cm
Miller [46]	Parastomal hernia, parastomal and midline	Median (IQR): Length: 21.0 (18.0–25.0) Width: 13.0 (10.5–15.0) Calculated area: 273 cm <sup>2</sup>
Rosen [4]	Ventral	Median (IQR): Length: 23 (16–25) cm Width: 14.0 (11–15) cm Calculated area: 322 cm <sup>2</sup>
Zolin [50]	Incisional, primary epigastric, primary umbilical, spigelian, lumbar	Median (IQR): Length: 23 (19–27) cm Width: 15 (2–19) cm Calculated area: 345 cm <sup>2</sup>

Abbreviations: cm, centimeter; IQR, interquartile range; n = number; NR, not reported; SD, standard deviation.

In studies evaluating Phasix™ Mesh, improvements in HerQLes scores were observed across multiple follow-up time points relative to baseline. The average increase in HerQLes scores across all time points compared to baseline was approximately 27.5 points. Improvements were evident as early as 0–12 months post-operatively (i.e., mean increase of 25.6 points compared to baseline in Messa 2019 [48] and mean increase of 30.9 points compared to baseline in Christopher, 2021 [49]) and continued to increase through longer-term follow-up, reaching a maximum mean difference of 38.6 points compared to baseline at 36+ months [49]. The longest follow-up timepoint reported was 60 months, whereby a 30.8 points increase in HerQLes score was observed relative to baseline [39].

Permanent synthetic mesh studies demonstrated numerically large and immediate improvements, with an average HerQLes score increase of 42.4 points compared to baseline scores across all time points. While cohorts treated with permanent synthetic mesh experienced early HRQoL improvements (i.e., within the first 12 months), HerQLes scores declined over time in all three studies [4, 46, 50]. For example, in the Zolin 2023 study [50], by the 60 months, the mean difference in HerQLes scores decreased from 48 to 38. Similarly, Rosen 2022 [4] and Miller 2022 [46] reported substantial early improvements (45.01 and 39.1 points increase in HerQLes compared to baseline at 12 months, respectively), which declined to respectively 39.17 and 33.4 points improvements at 24 months.

Overall, considering the longest follow-up in each study, the mean post-operative HerQLes score was 75.25 in Phasix™ Mesh studies and 75.56 in permanent synthetic mesh studies.

## Risk of bias assessment

The NOS was used to assess the risk of bias among included studies. A summary of these assessments is provided in [Supplementary Material 2](#). The methodological quality of included studies varied between mesh types.

Studies evaluating Phasix™ Mesh generally demonstrated moderate methodological quality, with total quality scores ranging from 5 to 7 out of 9 and a corresponding low-to-medium risk of bias. Among these, Messa 2019 achieved a score of 7 and low risk of bias, with strengths in exposure ascertainment, outcome assessment, and follow-up procedures, although it lacked a well-selected non-exposed cohort and did not adjust for secondary risk factors [48]. The two Christopher studies and the Talwar study shared similar limitations, including the absence of adjustments for key confounders and weaknesses in cohort selection, resulting in medium risk of bias and slightly lower scores [36, 39, 49]. On the other hand, the permanent synthetic mesh studies were generally of high quality, with all three studies receiving low risk of bias ratings. Rosen achieved a score of 9, indicating robust methodology across all domains, including comprehensive adjustment for confounders [4]. Miller and Zolin also performed well, each scoring 7, though they shared some limitations in non-exposed cohort selection and adjustment for secondary risk factors [46, 50].

TABLE 5 Summary of HerQLes results across included studies.

Study	Pre-operative (baseline)		Post-operative			Mean difference
	N	Mean pre-operative score (SD)	N	Time point (months)	Mean post-operative score (SD)	
<b>Phasix™ Mesh</b>						
Messa [48]	59	45.6 (NR)	59	6–12	71.2 (NR)	<b>25.6</b>
			59	12–18	82.0 (NR)	<b>36.4</b>
			59	18–24+	73.0 (NR)	<b>27.4</b>
Christopher [36]	24	53.0 (NR)	24	NR	61.0 (NR)	8.0
Christopher [49]	56	48.9 (NR)	51	0–12	79.8 (NR)	<b>30.9</b>
			44	12–36	80.5 (NR)	<b>31.6</b>
			37	36+	87.5 (NR)	<b>38.6</b>
Talwar [39]	38	46.7 (26.6)	43	0–24	68.5 (25.2)	<b>21.8</b>
			24	36–48	71.6 (NR)	<b>23.9</b>
			43	60	79.5 (NR)	<b>30.8</b>
<b>Permanent synthetic mesh</b>						
Zolin [50]	768	35 (29.6)	768	12	79 (29.9)	<b>44</b>
			498	24	82 (29.9)	<b>47</b>
			349	36	83 (31.1)	<b>48</b>
			216	48	83 (31.1)	<b>48</b>
			153	60	73 (37.0)	<b>38</b>
Miller [46]	51	39.3 (47.6)	41	12	78.4 (44.1)	<b>39.1</b>
			45	24	72.7 (45.5)	<b>33.4</b>
Rosen [4]	126	41.79 (39.9)	108	12	86.81 (37.2)	<b>45.01</b>
			110	24	80.97 (37.5)	<b>39.17</b>

Bolding indicates mean difference in score surpasses the minimal clinically important difference of 15.6 points.

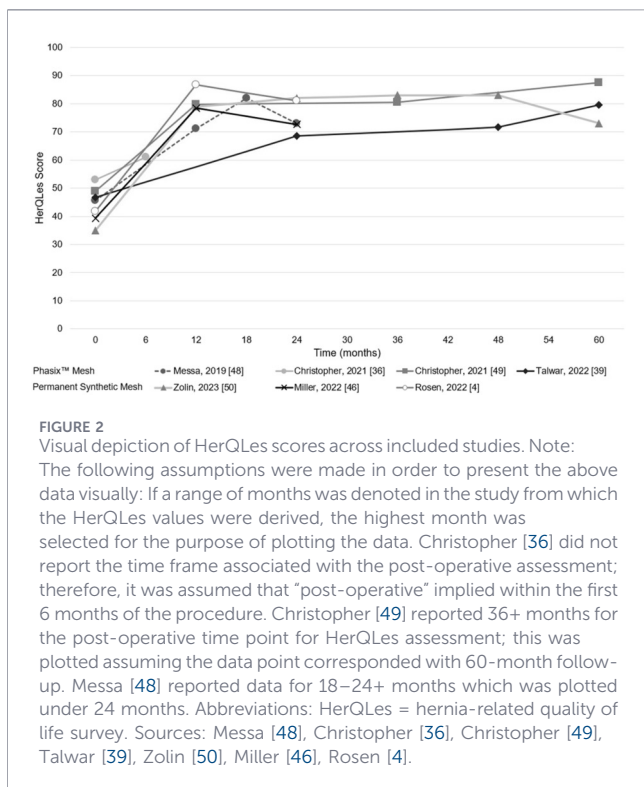
Abbreviations: HerQLes, hernia-related quality of life survey; n, number of patients; NR, not reported; SD, standard deviation.

## Discussion

The objective of this study was to conduct a SLR for studies reporting HRQoL outcomes in patients undergoing ventral hernia repair with either Phasix™ Mesh or permanent synthetic meshes culminating in a narrative synthesis of results generated via the HerQLes. A total of seven records met the pre-specified inclusion criteria: four evaluating Phasix™ Mesh and three assessing permanent synthetic mesh. Both Phasix™ Mesh and permanent synthetic mesh studies showed improvements in HerQLes scores post-operatively relative to baseline. Phasix™ Mesh studies demonstrated improvements in HerQLes scores up to 60 months post-surgery (average increase of 27.5 points in HerQLes compared to baseline). The improvements in HRQoL with Phasix™ Mesh were maintained even in studies involving complex hernia cases [36]. Permanent synthetic mesh studies showed early improvements (average 42.4 points increase in HerQLes compared to baseline) which tended to decline over time (the mean difference in HerQLes scores decreased by 10 points in Zolin [50], 5.84 points in Miller

[46], and 5.7 points in Rosen [4] over their duration of follow-up). This declining trend raises questions about the sustainability of early gains in the permanent synthetic mesh studies. Nonetheless, these findings suggest that both permanent synthetic mesh and Phasix™ Mesh impart clinically significant improvements in HerQLes scores relative to baseline. Improvements in HerQLes scores were reported through the longest follow-up assessments in studies evaluating Phasix™ Mesh. In studies evaluating permanent synthetic mesh, HerQLes scores at the longest follow-up assessments were lower than those reported at earlier post-operative time points. These observations are descriptive and should be interpreted cautiously given the lack of comparative data.

The gains in HRQoL described herein are particularly important since, as a bioabsorbable mesh, Phasix™ Mesh minimizes the footprint within the abdominal wall [60, 76], which may result in a reduced risk of chronic pain and foreign body sensation compared to the use of permanent synthetic mesh [77]. Furthermore, the results of two independent meta-analyses have reported on the safety and efficacy of Phasix™ Mesh, underscoring it as a



promising alternative to permanent synthetic mesh, especially for patients at higher risk of foreign body reactions, by providing a natural and bioabsorbable material [28, 32]. In a time where the selection of surgical mesh for ventral hernia repair is increasingly guided by patient-centered outcomes, offering patients a variety of mesh options that improve HRQoL over the long-term is of critical importance and facilitates shared decision-making which, in turn, leads to patient satisfaction [78].

Several methodological strengths helped enhance the robustness of the findings. A comprehensive systematic literature review was conducted to identify the relevant evidence for this study. To ensure the relevance and reliability of the patient-reported outcomes presented, data extraction prioritized values derived from a validated, hernia-specific quality of life instrument (i.e., HerQLes). However, this approach may limit the comprehensiveness of HRQoL assessment and introduce outcome reporting bias. The inclusion of both baseline and post-operative data allowed for a comprehensive assessment of changes in HRQoL over time. Also, the alignment of follow-up durations across studies evaluating different mesh types supported the comparison of outcomes, minimizing the risk of bias associated with time-dependent variables. Finally, risk of bias assessments indicated that the included studies were overall of good methodological quality, further supporting the credibility of the findings.

This review is subject to some limitations that should be considered when interpreting the findings. The absence of prospective protocol registration may limit reproducibility and is acknowledged as a limitation; however, efforts were made to mitigate this risk by adhering to established methodological guidance, including the PRISMA statement

and relevant principles from the Cochrane Handbook for Systematic Reviews of Interventions [33, 34]. The small number of included studies, combined with heterogeneity in the characteristics of their recruited patients, limits the generalizability of the results. Additionally, incomplete data reporting in some studies hindered comprehensive data extraction and quantitative data synthesis. The reliance on narrative synthesis, necessitated by the high heterogeneity and incomplete data reporting among included studies, restricts the ability to perform meta-analyses and/or direct between-study comparisons. Nonetheless, this narrative review of data provides an initial assessment that warrants further investigation via head-to-head comparative studies. To reduce bias, the review was conducted using a predefined and transparent methodology, including systematic literature searches, explicit inclusion and exclusion criteria, and reliance exclusively on published data. Data extraction and synthesis were descriptive and non-comparative in nature, and no selective interpretation of outcomes was performed.

To enhance the reliability and interpretability of HRQoL outcomes, future research should prioritize the inclusion of more homogenous patient populations and standardized HRQoL assessment tools. This approach would reduce heterogeneity across studies, allowing for more meaningful comparisons and quantitative synthesis of findings. By minimizing heterogeneity in both participant characteristics and measurement tools, researchers can better isolate the effects of interventions on HRQoL and draw reliable conclusions that are more applicable to clinical practice.

In summary, this study found that post-operative HRQoL, as assessed using HerQLes, improved for patients with ventral hernia treated with either Phasix™ Mesh or permanent synthetic mesh. These findings reflect within study observations derived from heterogeneous, noncomparative data. Studies evaluating bioabsorbable Phasix™ Mesh showed improvements in HerQLes scores across multiple follow-up time points extending up to 60 months post-surgery. As a bioabsorbable material, Phasix™ Mesh is designed to resorb over time and therefore does not result in a permanent abdominal mesh footprint. Early improvements in HerQLes scores were reported in permanent synthetic mesh studies, with reduced scores observed at the longest follow-up time points. The absence of head-to-head comparisons precludes any conclusions regarding comparative effectiveness. Large-scale, rigorously designed comparative studies are needed to establish definitive comparative effectiveness of Phasix™ Mesh relative to permanent synthetic mesh.

## Author contributions

EA participated in the study design, collected data, and drafted the manuscript. MW, HGü, HGa, and JF have made substantial contributions to the conception of the work, design of study, and editing of the manuscript. All authors contributed to the article and approved the submitted version.

## Funding

The author(s) declared that financial support was received for this work and/or its publication. The authors declare that this study received funding from Becton Dickinson. The funder had the following involvement with the study: several authors that were involved in the study design, data collection, analysis, and manuscript writing were employees of Becton Dickinson (MW, HGü, and HGa).

## Conflict of interest

Authors MW, HGü, and HGa were employed by Becton Dickinson at the time of publication. JF has received consulting payments from 3M, AbbVie, Baxter, Becton Dickinson, WL Gore, and Integra Life Sciences. EA was employed by Eversana which received consulting fees from Becton Dickinson for this project.

## Generative AI statement

The author(s) declared that generative AI was not used in the creation of this manuscript.

## References

- Pandya B, Huda T, Gupta D, Mehra B, Narang R. Abdominal wall hernias: an epidemiological profile and surgical experience from a rural medical college in central India. *Surg J (N Y)* (2021) 7(1):e41–e6. doi:10.1055/s-0040-1722744
- Ma Q, Jing W, Liu X, Liu J, Liu M, Chen J. The global, regional, and national burden and its trends of inguinal, femoral, and abdominal hernia from 1990 to 2019: findings from the 2019 global burden of disease study - a cross-sectional study. *Int J Surg* (2023) 109(3):333–42. doi:10.1097/j9.0000000000000217
- Schlosser KA, Renshaw SM, Tamer RM, Strassels SA, Poulouse BK. Ventral hernia repair: an increasing burden affecting abdominal core health. *Hernia* (2023) 27(2):415–21. doi:10.1007/s10029-022-02707-6
- Rosen MJ, Krpata DM, Petro CC, Carbonell A, Warren J, Poulouse BK, et al. Biologic vs synthetic mesh for single-stage repair of contaminated ventral hernias: a randomized clinical trial. *JAMA Surg* (2022) 157(4):293–301. doi:10.1001/jamasurg.2021.6902
- Rubin DS, Huisingsh-Scheetz M, Ferguson MK, Nagele P, Peden CJ, Lauderdale DS. U.S. trends in elective and emergent major abdominal surgical procedures from 2002 to 2014 in older adults. *J Am Geriatr Soc* (2021) 69(8):2220–30. doi:10.1111/jgs.17189
- Fry BT, Howard RA, Thumma JR, Norton EC, Dimick JB, Sheetz KH. Surgical approach and long-term recurrence after ventral hernia repair. *JAMA Surg* (2024) 159(9):1019–28. doi:10.1001/jamasurg.2024.1696
- Henriksen NA, Helgstrand F. Prospective nationwide analysis of long-term recurrence rates after elective ventral, incisional and parastomal hernia repairs. *BJS Open* (2024) 8(4):zrae070. doi:10.1093/bjsopen/zrae070
- Gillion JF, Sanders D, Miserez M, Muysoms F. The economic burden of incisional ventral hernia repair: a multicentric cost analysis. *Hernia* (2016) 20(6):819–30. doi:10.1007/s10029-016-1480-z
- Omar I, Zaimis T, Townsend A, Ismael M, Wilson J, Magee C. Incisional hernia: a surgical complication or medical disease? *Cureus* (2023) 15(12):e50568. doi:10.7759/cureus.50568
- Hill S, Bullock J, Sanders DL. Quality of life with a Hernia-A novel patient led study. *J Abdom Wall Surg* (2023) 2:11214. doi:10.3389/jaws.2023.11214
- Fischer JP, Basta MN, Wink JD, Krishnan NM, Kovach SJ. Cost-utility analysis of the use of prophylactic mesh augmentation compared with primary fascial suture repair in patients at high risk for incisional hernia. *Surgery* (2015) 158(3):700–11. doi:10.1016/j.surg.2015.02.030
- East B, Hill S, Dames N, Blackwell S, Laidlaw L, Gök H, et al. Patient views around their hernia surgery: a worldwide online survey promoted through social media. *Front Surg* (2021) 8:769938. doi:10.3389/fsurg.2021.769938
- Aiolfi A, Cavalli M, Micheletto G, Lombardo F, Bonitta G, Morlacchi A, et al. Primary inguinal hernia: systematic review and Bayesian network meta-analysis comparing open, laparoscopic transabdominal preperitoneal, totally extraperitoneal, and robotic preperitoneal repair. *Hernia* (2019) 23(3):473–84. doi:10.1007/s10029-019-01964-2
- Wang See C, Kim T, Zhu D. Hernia mesh and hernia repair: a review. *Engineered Regen* (2020) 1:19–33. doi:10.1016/j.engreg.2020.05.002
- Aiolfi A, Cavalli M, Micheletto G, Bruni PG, Lombardo F, Morlacchi A, et al. Open mesh vs. suture umbilical hernia repair: systematic review and updated trial sequential meta-analysis of randomized controlled trials. *Hernia* (2020) 24(4):707–15. doi:10.1007/s10029-020-02146-1
- Baylón K, Rodríguez-Camarillo P, Elías-Zúñiga A, Díaz-Elizondo JA, Gilkerson R, Lozano K. Past, present and future of surgical meshes: a review. *Membranes (Basel)* (2017) 7(3):47. doi:10.3390/membranes7030047
- Elango S, Perumalsamy S, Ramachandran K, Vadodaria K. Mesh materials and hernia repair. *Biomedicine (Taipei)* (2017) 7(3):16. doi:10.1051/bmdcn/2017070316
- Morales-Conde S, Berrevoet F, Jorgensen LN, Marchi D, Ortega-Deballon P, Windsor A. Establishing peer consensus about the use of long-term biosynthetic absorbable mesh for hernia (grades 2-3) as the standard of care. *World J Surg* (2022) 46(12):2996–3004. doi:10.1007/s00268-022-06743-2
- Buell JF, Sigmon D, Ducoin C, Shapiro M, Teja N, Wynter E, et al. Initial experience with biologic polymer scaffold (Poly-4-hydroxybutyrate) in complex abdominal wall reconstruction. *Ann Surg* (2017) 266(1):185–8. doi:10.1097/sla.0000000000001916
- Morrison BG, Gledhill K, Plymale MA, Davenport DL, Roth JS. Comparative long-term effectiveness between ventral hernia repairs with biosynthetic and synthetic mesh. *Surg Endosc* (2023) 37(8):6044–50. doi:10.1007/s00464-023-10082-1
- Khan S, Hornick MM, Voytik M, Broach RB, Kovach SJ, 3rd, Fischer JP. Biosynthetic compared with synthetic mesh in retrorectus ventral hernia repair: a matched analysis with 3-year outcomes. *Surgery* (2025) 186:109579. doi:10.1016/j.surg.2025.109579
- Clapp B, Kara AM, Nguyen-Lee PJ, Annabi HM, Alvarado L, Marr JD, et al. Does bioabsorbable mesh reduce hiatal hernia recurrence rates? A meta-analysis. *Surg Endosc* (2023) 37(3):2295–303. doi:10.1007/s00464-022-09514-1
- Martin DP, Badhwar A, Shah DV, Rizk S, Eldridge SN, Gagne DH, et al. Characterization of poly-4-hydroxybutyrate mesh for hernia repair applications. *J Surg Res* (2013) 184(2):766–73. doi:10.1016/j.jss.2013.03.044
- Deeken CR, Matthews BD. Characterization of the mechanical strength, resorption properties, and histologic characteristics of a fully absorbable material (Poly-4-hydroxybutyrate-PHASIX mesh) in a porcine model of hernia repair. *ISRN Surg* (2013) 2013:238067. doi:10.1155/2013/238067
- Scott JR, Deeken CR, Martindale RG, Rosen MJ. Evaluation of a fully absorbable poly-4-hydroxybutyrate/absorbable barrier composite mesh in a porcine model of

Any alternative text (alt text) provided alongside figures in this article has been generated by Frontiers with the support of artificial intelligence and reasonable efforts have been made to ensure accuracy, including review by the authors wherever possible. If you identify any issues, please contact us.

## Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

## Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontierspartnerships.org/articles/10.3389/jaws.2026.16382/full#supplementary-material>

- ventral hernia repair. *Surg Endosc* (2016) 30(9):3691–701. doi:10.1007/s00464-016-0507-9
26. Rognoni C, Bassi UA, Cataldo M, Crovella C, Crovella F, Cuccurullo D, et al. Budget impact analysis of a biosynthetic mesh for incisional hernia repair. *Clin Ther* (2018) 40(11):1830–44.e4. doi:10.1016/j.clinthera.2018.09.003
27. Deeken CR, Chen DC, Lopez-Cano M, Martin DP, Badhwar A. Fully resorbable poly-4-hydroxybutyrate (P4HB) mesh for soft tissue repair and reconstruction: a scoping review. *Front Surg* (2023) 10:1157661. doi:10.3389/fsurg.2023.1157661
28. Tran DH, Rubarth C, Leeds SG, Fair L, McGowan T, Ramakrishnan S, et al. The use of poly-4-hydroxybutyrate (P4HB, phasix™) mesh in ventral hernia repair: a systematic review and meta-analysis. *Hernia* (2024) 28(4):989–1004. doi:10.1007/s10029-024-02996-z
29. Brown BN, Londono R, Tottey S, Zhang L, Kukla KA, Wolf MT, et al. Macrophage phenotype as a predictor of constructive remodeling following the implantation of biologically derived surgical mesh materials. *Acta Biomater* (2012) 8(3):978–87. doi:10.1016/j.actbio.2011.11.031
30. Harji D, Thomas C, Antoniou SA, Chandratan H, Griffiths B, Henniford B, et al. A systematic review of outcome reporting in incisional hernia surgery. *BJS Open* (2021) 5(2):zrab006. doi:10.1093/bjsopen/zrab006
31. Fry BT, Campbell DA, Jr., Englesbe MJ, Vu JV. Using patient-reported outcomes to enhance appropriateness in low-risk elective general surgery. *Ann Surg* (2019) 269(1):41–2. doi:10.1097/sla.0000000000002864
32. Ahmed A, Gandhi S, Ganam S, Diab ARF, Mhaskar R, Sujka J, et al. Ventral hernia repair using bioresorbable poly-4-hydroxybutyrate mesh in clean and contaminated surgical fields: a systematic review and meta-analysis. *Hernia* (2024) 28(2):575–84. doi:10.1007/s10029-023-02951-4
33. Higgins JPT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, et al. *Cochrane Handbook for Systematic Reviews of Interventions* version 6.5 (updated August 2024). *Cochrane* (2024). Available online at: [www.cochrane.org/handbook](http://www.cochrane.org/handbook).
34. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *Bmj* (2021) 372:n71. doi:10.1136/bmj.n71
35. Wells GA, Shea B, O'Connell D, Peterson J, Welch V, Losos M, et al. *The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses*. Ottawa, Canada: Ottawa Hospital Research Institute (2013).
36. Christopher AN, Morris MP, Jia H, Broach R, Fischer JP. Resorbable synthetic ventral hernia repair in contaminated fields: outcomes with Poly-4-Hydroxybutyrate mesh. *Plast Reconstr Surg* (2021) 148(6):1367–75. doi:10.1097/prs.00000000000008579
37. Christopher AN, Patel V, Othman S, Jia H, Mellia JA, Broach RB, et al. Onlay Poly-4-Hydroxybutyrate (P4HB) mesh for complex hernia: early clinical and patient reported outcomes. *J Surg Res* (2021) 264:199–207. doi:10.1016/j.jss.2021.02.012
38. Olavarria OA, Bernardi K, Dhanani NH, Lyons NB, Harvin JA, Millas SG, et al. Synthetic versus biologic mesh for complex open ventral hernia repair: a pilot randomized controlled trial. *Surg Infect (Larchmt)* (2021) 22(5):496–503. doi:10.1089/sur.2020.166
39. Talwar AA, Perry NJ, McAuliffe PB, Desai AA, Thrippleton S, Broach RB, et al. Shifting the goalpost in ventral hernia care: 5-year outcomes after ventral hernia repair with Poly-4-hydroxybutyrate mesh. *Hernia* (2022) 26(6):1635–43. doi:10.1007/s10029-022-02674-y
40. Messa CA, Amro C, Niu EF, Habarth-Morales TE, Talwar AA, Thrippleton S, et al. Transversus abdominis release with biosynthetic mesh for large ventral hernia repair: a 5-year analysis of clinical outcomes and quality of life. *Hernia* (2024) 28(3):789–801. doi:10.1007/s10029-023-02889-7
41. Lemdani MS, Niu EF, Amro C, Gala Z, Ewing JN, Honig SE, et al. Outcomes and quality of life after resorbable synthetic ventral hernia repair in contaminated fields. *Ann Plast Surg* (2024) 92(4S Suppl. 2):S156–S60. doi:10.1097/SAP.0000000000003860
42. Berrevoet F, Doerhoff C, Muysoms F, Hopson S, Muzi MG, Nienhuijs S, et al. Open ventral hernia repair with a composite ventral patch - final results of a multicenter prospective study. *BMC Surg* (2019) 19(1):93. doi:10.1186/s12893-019-0555-z
43. Roth JS, Anthonie GJ, Selzer DJ, Poulou BK, Pierce RA, Bittner JG, et al. 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* (2022) 235(6):894–904. doi:10.1097/XCS.0000000000000363
44. Kulkarni GV, Elliott Z, Rudd R, Barnes D, Hammond TM. A comparison of patient-reported outcomes in patients undergoing abdominal wall repair with either synthetic or biosynthetic mesh: a pilot study. *Hernia* (2024) 28(5):1679–85. doi:10.1007/s10029-024-03022-y
45. Rognoni C, Cuccurullo D, Borsoi L, Bonavina L, Asti E, Crovella F, et al. Clinical outcomes and quality of life associated with the use of a biosynthetic mesh for complex ventral hernia repair: analysis of the "Italian Hernia Club" registry. *Sci Rep* (2020) 10(1):10706. doi:10.1038/s41598-020-67821-w
46. Miller BT, Krpata DM, Petro CC, Beffa LRA, Carbonell AM, Warren JA, et al. Biologic vs synthetic mesh for parastomal hernia repair: post hoc analysis of a multicenter randomized controlled trial. *J Am Coll Surg* (2022) 235(3):401–9. doi:10.1097/xcs.0000000000000275
47. Van Rooijen MMJ, Tollens T, Jorgensen LN, de Vries Reilingh TS, Piessen G, Kocklering F, et al. Slowly resorbable biosynthetic mesh: 2-year results in VHWG grade 3 hernia repair. *Hernia* (2022) 26(1):131–8. doi:10.1007/s10029-021-02453-1
48. Messa CAI, Kozak G, Broach RB, Fischer JP. When the mesh goes away: an analysis of Poly-4-Hydroxybutyrate mesh for complex hernia repair. *Plast Reconstr Surg - Glob Open* (2019) 7(11):e2576. doi:10.1097/gox.0000000000002576
49. Christopher AN, Morris MP, Patel V, Mellia JA, Fowler C, Messa CA, et al. An evaluation of clinical and quality of life outcomes after ventral hernia repair with poly-4-hydroxybutyrate mesh. *Hernia* (2021) 25(3):717–26. doi:10.1007/s10029-021-02394-9
50. Zolin SJ, Krpata DM, Petro CC, Prabhu AS, Rosenblatt S, Rosen S, et al. Long-term clinical and patient-reported outcomes after transversus abdominis release with permanent synthetic mesh: a single center analysis of 1203 patients. *Ann Surg* (2023) 277(4):e900–e6. doi:10.1097/sla.0000000000005443
51. Plymale MA, Davenport DL, Dugan A, Zachem A, Roth JS. Ventral hernia repair with poly-4-hydroxybutyrate mesh. *Surg Endosc* (2018) 32(4):1689–94. doi:10.1007/s00464-017-5848-7
52. Fei L, Munegato G, Allaria A, Catauro A, Rosati S, Giordano F, et al. A modified rives-stoppa technique with composite mesh (FLaPp) in large incisional hernia: a multicentric retrospective cohort study. *Eur Surg* (2023) 55:149–57. doi:10.1007/s10353-023-00805-y
53. Kroh A, Zufacher M, Eickhoff R, Heise D, Helmedag M, Ulmer F, et al. No difference in outcomes between large- and small-pore meshes in a prospective, randomized, multicenter trial investigating open retromuscular meshplasty for incisional hernia repair. *Langenbecks Arch Surg* (2023) 408(1):22. doi:10.1007/s00423-022-02751-x
54. Roth JS, Anthonie GJ, Selzer DJ, Poulou BK, Bittner JG, Hope WW, et al. Prospective evaluation of poly-4-hydroxybutyrate mesh in CDC class I/high-risk ventral and incisional hernia repair: 18-month follow-up. *Surg Endosc* (2018) 32(4):1929–36. doi:10.1007/s00464-017-5886-1
55. Holmdahl V, Stark B, Clay L, Gunnarsson U, Strigard K. One-year outcome after repair of giant incisional hernia using synthetic mesh or full-thickness skin graft: a randomized controlled trial. *Hernia* (2019) 23(2):355–61. doi:10.1007/s10029-019-01900-4
56. Unek T, Sokmen S, Egeli T, Avkan Oguz V, Ellidokuz H, Obuz F. The results of expanded-polytetrafluoroethylene mesh repair in difficult abdominal wall defects. *Asian J Surg* (2019) 42(1):131–43. doi:10.1016/j.ajsurg.2017.12.001
57. Akalin C, Karagulle OO. The effects of onlay titanium-coated mesh on recurrence, foreign body sensation and chronic pain after ventral hernia repair. *Asian J Surg* (2021) 44(9):1158–65. doi:10.1016/j.ajsurg.2021.02.022
58. Miserez M, Lefering R, Familietti F, Mathes T, Seidel D, Sauerland S, et al. Synthetic versus biological mesh in laparoscopic and open ventral hernia repair (LAPSiS): results of a multinational, randomized, controlled, and double-blind trial. *Ann Surg* (2021) 273(1):57–65. doi:10.1097/SLA.00000000000004062
59. Roth JS, Anthonie GJ, Selzer DJ, Poulou BK, Pierce RA, Bittner JG, et al. Prospective, multicenter study of P4HB (Phasix) mesh for hernia repair in cohort at risk for complications: 3-year follow-up. *Ann Med Surg (Lond)* (2021) 61:1–7. doi:10.1016/j.amsu.2020.12.002
60. Van den Dop LM, Van Rooijen MMJ, Tollens T, Jorgensen LN, De Vries-Reilingh TS, Piessen G, et al. Five-year Follow-Up of a slowly resorbable biosynthetic P4HB mesh (Phasix) in VHWG grade 3 incisional hernia repair. *Ann Surg Open* (2023) 4(4):e366. doi:10.1097/as9.00000000000000366
61. Talwar AA, McGraw JR, Thrippleton S, Broach RB, Henniford BT, Fischer JP. Missing the mark: evaluating the validity of the ventral hernia screen in detecting recurrence. *Am Surg* (2024) 90(6):1211–6. doi:10.1177/00031348241227185
62. Mitura K, Skolimowska-Rzewuska M, Rzewuska A, Wyrzykowska D. Is mesh always necessary in every small umbilical hernia repair? Comparison of standardized primary sutured versus patch repair: retrospective cohort study. *Hernia* (2021) 25(3):571–7. doi:10.1007/s10029-020-02170-1
63. Al TJ. Outcome of open intraperitoneal dual mesh versus on-Lay mesh for incisional hernia repair. *Medico-legal Update* (2020) 20(1):1253–1258. doi:10.37506/mlu.v20i1.546
64. Eltyeb H, Dowker F, Light D. Long-term results of Progrid mesh for retromuscular repair of ventral hernia. *Int J Abdom Wall Hernia Surg* (2021) 4(1):20–2. doi:10.4103/ijawhs.ijawhs\_42\_20
65. Nour H, Mohamed H, Farid M. Evaluation of double mesh modification of Chevrel's technique in management of midline incisional Hernia. *The ANNALS AFRICAN SURGERY* (2021) 18(1):18–22. doi:10.4314/aas.v18i1.4
66. Victor C, Titus DK, Roopavathana B, Nadarajan A, Chase S, Nayak S. Clinical outcomes of ventral hernia repair with ventralax Patch- A retrospective study from a tertiary care centre. *J Clin Diagn Res* (2021) 15(5):PC01–PC04. doi:10.7860/JCDR/2021/47550.14826
67. Moradian S, Klosowiak JL, Boctor MJ, Issa T, Park S, Dumanian GA. Novel approach for umbilical hernia repair using mesh strips. *Plast Reconstr Surg Glob Open* (2023) 11(4):e4947. doi:10.1097/GOX.00000000000004947

68. Physiopedia. Visual analogue scale. Available online at: [https://www.physio-pedia.com/Visual\\_Analogue\\_Scale](https://www.physio-pedia.com/Visual_Analogue_Scale) (Accessed December 18, 2025).
69. Krpata DM, Schmotzer BJ, Flocke S, Jin J, Blatnik JA, Ermlich B, et al. Design and initial implementation of HerQLes: a hernia-related quality-of-life survey to assess abdominal wall function. *J Am Coll Surg* (2012) 215(5):635–42. doi:10.1016/j.jamcollsurg.2012.06.412
70. Collins CE, Renshaw S, Gupta A, Santry H, Poulouse BK. Elective ventral hernia repair provides significant abdominal wall quality of life improvements in older patients. *Surg Endoscopy* (2022) 36(3):1927–35. doi:10.1007/s00464-021-08475-1
71. Kim JE, Mourad M, Phillips SE, Kothari VM, Haskins IN. Association of changes in HerQLes scores with objective hernia outcomes: an analysis of the ACHQC database. *Surg Endoscopy* (2024) 38(11):6812–26. doi:10.1007/s00464-024-11140-y
72. Renshaw SM, Gupta A, Poulouse BK. Establishing the minimal clinically important difference for the hernia-related quality of life survey (HerQLes). *The Am J Surg* (2022) 223(2):245–9. doi:10.1016/j.amjsurg.2021.06.018
73. Bhardwaj P, Huayllani MT, Olson MA, Janis JE. Year-over-year ventral hernia recurrence rates and risk factors. *JAMA Surg* (2024) 159(6):651–8. doi:10.1001/jamasurg.2024.0233
74. Henriksen NA, Bougard H, Gonçalves MR, Hope W, Khare R, Shao J, et al. Primary ventral and incisional hernias: comprehensive review. *BJS Open* (2025) 9(1):zrae145. doi:10.1093/bjsopen/zrae145
75. Kenawy DM, Collins CE. Evaluating the role of the minimal clinically important difference for the hernia-related quality of life survey; how do we know who will benefit from hernia repair? *The Am J Surg* (2022) 223(2):243–4. doi:10.1016/j.amjsurg.2021.07.005
76. Talwar A, Perry NJ, Desai A, McAuliffe P, Thrippleton SL, Broach RB, et al. Minimizing the mesh footprint: 5-year follow up after hernia repair using Poly-4-hydroxybutyrate mesh. *J Am Coll Surgeons* (2023) 236(5):S41–S2. doi:10.1097/01.XCS.0000932628.35596.3c
77. Aldohayan A, Bamehriz F, Khalid AG, Ahmed AJR, AlBalawi M, Zakaria Aldhayan A, et al. A novel use of fully absorbable Phasix(TM) mesh for laparoscopic inguinal hernia repair. *JLS* (2020) 24(3):e2020.00041. doi:10.4293/JLS.2020.00041
78. Hauser K, Koerfer A, Kuhr K, Albus C, Herzig S, Matthes J. Outcome-relevant effects of shared decision making. *Dtsch Arztebl Int* (2015) 112(40):665–71. doi:10.3238/arztebl.2015.0665

## Glossary

<b>AHQ</b>	abdominal hernia questionnaire
<b>BMI</b>	body mass index
<b>CCS</b>	Carolinas comfort scale
<b>EQ VAS</b>	EuroQol visual analogue scale
<b>EQ-5D</b>	EuroQol 5-dimension
<b>EuraHS QoL</b>	European registry of abdominal wall hernias quality of life
<b>HerQLes</b>	hernia-related quality of life survey
<b>HRQoL</b>	health-related quality of life
<b>IDE</b>	investigational device exemption
<b>IQR</b>	interquartile range
<b>ITC</b>	indirect treatment comparison
<b>MCID</b>	minimal clinically important difference
<b>NA</b>	not applicable
<b>NCT</b>	national clinical trial
<b>NOS</b>	Newcastle-Ottawa scale
<b>NR</b>	not reported
<b>NRS</b>	numeric rating scale
<b>PICOS</b>	population, intervention, comparison, outcome, study design
<b>PRISMA</b>	preferred reporting items for systematic reviews and meta-analyses
<b>PRO</b>	patient-reported outcome
<b>PROMIS</b>	patient-reported outcomes measurement information system
<b>RCT</b>	randomized controlled trial
<b>SD</b>	standard deviation
<b>SF-12</b>	short-form 12-item survey
<b>SF-36</b>	short-form 36-item survey
<b>SLR</b>	systematic literature review
<b>USA</b>	United States of America
<b>VAS</b>	visual analogue scale
<b>VHS</b>	ventral hernia screening
<b>VRS</b>	verbal rating scale