Hernia (2022) 26:701–714
https://doi.org/10.1007/s10029-022-02562-5

REVIEW

Physical activity recommendations pre and post abdominal wall reconstruction: a scoping review of the evidence

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Received: 24 October 2021 / Accepted: 31 December 2021 / Published online: 13 January 2022

Abstract

Purpose There are no universally agreed guidelines regarding which types of physical activity are safe and/or recommended in the perioperative period for patients undergoing ventral hernia repair or abdominal wall reconstruction (AWR). This study is intended to identify and summarise the literature on this topic.

Methods Database searches of PubMed, CINAHL, Allied & Complementary medicine database, PEDro and Web of Science were performed followed by a snowballing search using two papers identified by the database search and four hand-selected papers of the authors' choosing. Inclusion—cohort studies, randomized controlled trials, prospective or retrospective. Studies concerning complex incisional hernia repairs and AWRs including a "prehabilitation" and/or "rehabilitation" program targeting the abdominal wall muscles in which the interventions were of a physical exercise nature. RoB2 and Robins-I were used to assess risk of bias. Prospero CRD42021236745. No external funding. Data from the included studies were extracted using a table based on the Cochrane Consumers and Communication Review Group's data extraction template.

Results The database search yielded 5423 records. After screening two titles were selected for inclusion in our study. The snowballing search identified 49 records. After screening one title was selected for inclusion in our study. Three total papers were included—two randomised studies and one cohort study (combined 423 patients). All three studies subjected their patients to varying types of physical activity preoperatively, one study also prescribed these activities postoperatively. The outcomes differed between the studies therefore meta-analysis was impossible—two studies measured hernia recurrence, one measured peak torque. All three studies showed improved outcomes in their study groups compared to controls however significant methodological flaws and confounding factors existed in all three studies. No adverse events were reported.

Conclusions The literature supporting the advice given to patients regarding recommended physical activity levels in the perioperative period for AWR patients is sparse. Further research is urgently required on this subject.

Keywords Hernia · Abdominal wall · Exercise · Activity · Perioperative

Introduction

Ventral hernias and ventral hernia repairs (VHR) are common. A recent national database study found that five percent of all patients who had undergone a laparotomy in France during 2010 had subsequently undergone a repair of an incisional hernia resulting from that laparotomy by 2015 [1]. In the United States the number of ventral hernia repairs performed annually has increased by roughly 50% to around 500,000 in little more than a decade [2, 3].

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Recurrence after VHR is also common and the risk increases with numerous factors including the complexity of the patient and their operation as well as the number of previous attempts at repair [4–6]. Complicated and multiply recurrent cases may need an abdominal wall reconstruction (AWR) approach. In order to reduce recurrence and optimise both the short and long term outcomes of AWR increasing attention has been paid to developing enhanced recovery after surgery (ERAS) protocols [7, 8]. These have tended to focus on well recognised risk factors such as obesity, diabetes control and smoking cessation. While prehabilitation has gained traction in recent years, published studies have largely avoided addressing one of the most common patient concerns in the perioperative period, namely physical activity. Post-surgical physical exercise in particular is often left to individual interpretation. AWR, with variable degrees of musculoaponeurotic realignment, reinforcement, reapproximation, division and/ or chemo-denervation is akin to musculoskeletal surgery (MSK) yet rehabilitation after AWR represents a physicians' blind spot in contradistinction to the very well thought through and carefully planned physical therapy regimens after MSK. The purpose of this review was to identify and summarise the literature concerning physical activity levels both prior to and following AWR with a view to enabling clinicians to provide patients with evidence-based advice in the weeks and months either side of their surgery.

Method

Database literature search method

A systematic review protocol was devised, agreed upon by all authors and registered with the PROSPERO database (registration number CRD42021236745) [9]. PubMed, CINAHL, Allied & Complementary medicine database (AMED), PEDro and Web of Science were each searched by STA, NHB and LM with the most recent searches being conducted on 13th February 2021. The full search syntax is available in the supplemental material.

The inclusion criteria comprised of both randomized controlled trials (RCT) and cohort studies in order to minimize the risk of under-representing the literature thus providing an incomplete summary of the evidence. No restrictions were placed on the searches with regard to publication date or language of publication. The inclusion and exclusion criteria were shown as follows:

Inclusion criteria

- Cohort studies, randomized controlled trials.
- Prospective or retrospective.
- Studies concerning self-defined complex incisional hernia repairs and AWRs.
- Studies including the description of a "prehabilitation" and/or "rehabilitation" program targeting the abdominal wall muscles.
- Studies concerning "prehabilitation" or "rehabilitation" interventions.
- of a physical exercise nature and
- focused primarily on the kinesiological function of the abdominal wall structures.

Exclusion criteria

- Case series, case reports, review articles with no original data.
- Studies involving patients aged under 18 years.
- Studies primarily describing an ERAS program.

The search results were then checked by STA and duplicates were excluded before STA, NHB and LM screened the remaining papers initially by title, then abstract and finally by full article. The three independent reviewers were blinded to each other's decisions. At the end of each stage the lists were compared and any discrepancies were settled by discussion and mutual agreement. Where necessary, corresponding authors were contacted if clarification was required in order to determine suitability for inclusion.

The data from the final list of included studies was extracted using a table based on the Cochrane Consumers and Communication Review Group's data extraction template [10]. These data are shown in Table 1. The risk of bias for the included studies was assessed using the Robins-I tool for included cohort studies and RoB2 for included randomized studies [11, 12]. Draft characteristics of included studies tables were compiled by STA, NHB and LM independently with the other two members of the team then checking each other's tables and, as before, settling discrepancies by discussion and mutual agreement to produce the final consensus table (Table 1).

Snowballing technique search method and rationale

Following the screening process only two papers were identified from the database searches as meeting our inclusion criteria [13]. In response to this low yield it was agreed by the authors that the scope of the study should be widened to additionally include any papers identified via a second search performed by LM and NHB using the snowballing technique as described by Wohlin [14]. The starter set was comprised of six articles including both papers retrieved from the database search, Liang et al. and Pezeshk et al. [15, 16]. The other four papers comprising our starter set were hand-selected by the authors as being likely to yield relevant

Table 1 Description of included studies

Study			Participants							
Study	Country	Study type	Number	Age (yrs)	Gender M:F	BMI (kg/m^2)	ASA	Mean defect size (cm^2)	Inclusion	Exclusion
Liang [15]	USA	RCT	118 (59 study, 59 control)	Mean 49.5 (SD 10.1)	35: 83	Mean 36.8 (SD 2.6)	ASA 1–2: 35 (59.3%) intervention, 39 (66.1%) control ASA 3–4: 24 (40.7%) intervention, 20 (33.9%) control	Mean 38.2cm^2 (SD 63.6)	BMI 30–40 kg/m^2 3-20 cm diameter hernia defect width on CT scan	Severe co-morbidity Emergency operation Intending pregnancy
Ahmed [21]	Egypt	RCT	30 (15 study, 15 control)	20–45yrs	6:24	–	–	–	Patients with ventral hernias suitable for repair	–
Pezeshk [16]	USA	Retrospective cohort study	275 (137 study, 138 control)	Mean 55	48:89 (study) 44:94 (control)	32.3 (study) 32.9 (control)	–	102.2 (range 2–560) Study 100.6 (4.4–528.2) Control	"Patients are selected [for the programme] based on clinical and lifestyle assessments that optimize the likelihood of a successful outcome"	–

articles owing to their topics and content despite not meeting our inclusion criteria in themselves [17–20]. The resulting titles were screened by STA, NHB and LM using the same method as was applied following the database search.

Results

As shown in Fig. 1 the database literature search yielded a total of 5423 records. Of these, 5117 were excluded based on their titles alone and 287 were identified as being duplicates. The remaining 19 records were screened as abstracts with a further 12 not meeting our inclusion criteria. The seven records that were screened as full papers identified an additional five that were excluded for being expert opinion only or because they did not assess either physical activity or AWR. The database search thus yielded two titles which were included in our study. The snowballing search identified 49 records after three iterations by NHB and four iterations by LM of backward and forward snowball searching. Of these there were six duplicates. Ten records were excluded following the screening of their abstracts. Of the 33 records that were screened as full papers 32 were excluded for being systematic reviews or evaluations of a local ERAS protocol or because they did not assess either physical activity or AWR. The snowballing search, therefore, yielded one title which was included in our study bringing the total number of included studies to three.

Summaries of the three included studies are shown in Tables 1 and 2. The three included studies had markedly different methodological designs making direct comparison impossible. The reasons for exclusion of the 37 studies which were excluded after assessment as full papers are shown in Table 3.

Liang et al. is a RCT containing 118 subjects which investigated the impact of an intensive, individualized, MDT-derived prehabilitation program versus a generic standardized counselling approach prior to abdominal wall hernia repair [15]. Patients were assessed clinically for evidence of hernia recurrence and/or complications after a one month postoperative follow-up period [15]. 69.5% of the study group (SG) versus 47.5% of the control group (CG) were hernia and complication free at one month post-operation; however, this was largely due to more of the SG undergoing surgery [15] (Table 2).

Ahmed et al. is a RCT of 30 patients with abdominal wall hernias of whom a 15 patient SG underwent a 30-min per session, three sessions per week, six week preoperative flexibility and abdominal wall muscle strengthening program [21]. The peak abdominal muscle torque of all 30 participants was measured at initial assessment and then again preoperatively and 6 months postoperatively [21]. Although

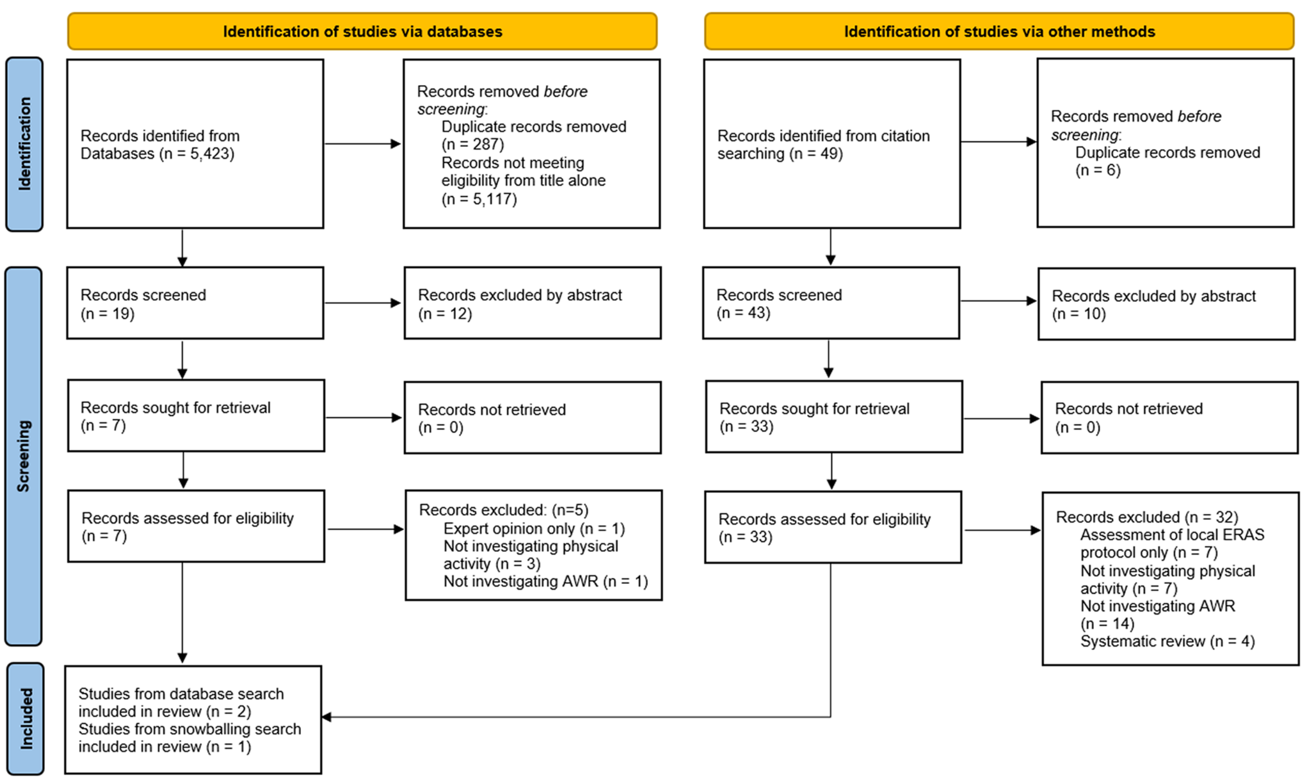

Fig. 1 PRISMA 2020 flowchart of identified, included and excluded papers during study

Table 2 Summary of interventions employed, outcomes measured and major findings of included studies

Study	Intervention timing	Intervention description	Follow-up	Primary outcome(s)	Secondary outcome(s)	Findings
Liang [15]	Pre-surgery: 6 months	Prehabilitation (SG): MDT consultation (nutrition, physical therapy, hernia navigator); weekly group meetings; daily goals checklist; home-exercise program (walking, DVD with Zumba, stretching, bed exercises, cardio-aerobics, resistance band exercises); peer support; support calls and texts; monthly assessment Standard counselling (CG): Standardized script (risks of obesity, risks of surgery; weight loss goals, basic weight loss, conditioning recommendations); answers to FAQs; monthly assessment In order to undergo surgery pts had to meet one of following three criteria: (i) lose 7% of total body weight OR (ii) complete 6mths follow-up & 75% prehab program compliance without gaining weight or developing a contraindication to surgery OR (iii) require emergency surgery	1 month post-surgery	Proportion of patients hernia-free and complication-free at 1 month post-surgery	Weight loss measures (body mass loss, waist and hip circumference) Physical function (30 s sit-to-stand test)	Hernia and complication free: SG 69.5% vs CG 47.5% ($p = 0.015$) Underwent surgery: SG 44 (81.5%) vs CG 34 (58.6%) Weight loss: $p \geq 0.188$ Physical function: $p = 0.421$ Four patients in SG and one in CG required emergency repair

Table 2 (continued)

Study	Intervention timing	Intervention description	Follow-up	Primary outcome(s)	Secondary outcome(s)	Findings
Ahmed [21]	Pre-surgery: 6 weeks	Prehabilitation (SG): 30 min, 3 days per week, 6 weeks; manual therapy by physical therapist (soft-tissue mobilization to lumbar and hip regions; joint mobilization/manipulation to pelvis, SIJ and hips; neuromuscular re-education, passive stretching); 4 abdominal muscle exercises (isometric trunk flexion, posterior pelvic tilt, prone plank, Swiss ball trunk flexion) CG: Normal activities of daily living without abdominal training procedures	6 months post-surgery	Not explicitly stated Trunk flexion maximum voluntary isometric contraction (peak torque (strength)) as measured with Biodex isokinetic dynamometer system at initial assessment, pre-surgery and six months post-surgery	–	Peak torque: Initial assessment: SG 34.4 ± 5.9 Nm; CG 35.1 ± 7.3 Nm (P not stated) Pre-surgery: SG 45.9 ± 10.0 Nm; CG 34.0 ± 6.8 Nm ($p = 0.0001$) 6 months post-surgery: SG 41.3 ± 8.9 Nm; CG 30.1 ± 8.9 Nm ($p = 0.002$)

Table 2 (continued)

Study	Intervention timing	Intervention description	Follow-up	Primary outcome(s)	Secondary outcome(s)	Findings
Pezeshk [16]	Post-surgery: 18 weeks	Rehabilitation (SG): 0–4 weeks: walking from day 0, up to 5 min, 3–6 times daily; lifting restrictions (0–2 weeks ≤ 5 lb, 2–4 weeks ≤ 10 lb); abdominal binder worn; tobacco cessation, proper diet, and protein intake addressed to promote wound healing 4–12 weeks: walking 30 min daily; lifting restrictions 10–15 lb; isometric abdominal exercises 12 + weeks: graduated return to full activity; lifting restrictions ≥ 15 lb, additional 10 lb monthly to 50–70 lb target; compression tank worn for 3 months; physical therapy guided rehabilitation at least 2 days per week for 6 weeks (abdominal strengthening and stabilization, abdominal and scar tissue soft tissue therapy, core strengthening in neutral only (no crunches), balance training, hip mobilization, gluteus medius strengthening, lumbar strengthening, posture retraining, and upper back strengthening) CG: No formal rehabilitation	SG 20 months (0–5 years) CG 16 months (0–6 years)	Not explicitly stated Outcomes described include recurrence rate, postoperative length of stay (LOS), time to recurrence and mortality	–	Recurrence: SG 13 (9%) vs CG 31 (22%) $p < 0.01$ Median LOS 6 days (NS) Median time to recurrence: SG 13 months; CG 6 months ($p < 0.05$) Mortality: SG 1%; CG 7% $p < 0.01$ SG had more underlay repairs (69% vs 50%) and fewer bridging (0% vs 4%) or inlay repairs (6% vs 14%) (all $p < 0.05$) Type of mesh used NS between groups

Table 3 Excluded studies

Study	Year	Title	Reason for exclusion	PMID/doi
Assessment of abdominal wall in patients with ventral hernia				
Gunnarsson et al. [43]	2011	Assessment of abdominal muscle function using the Biodex System-4. Validity and reliability in healthy volunteers and patients with giant ventral hernia	Not investigating AWR	21380564
Stark et al. [44]	2012	Validation of Biodex system 4 for measuring the strength of muscles in patients with rectus diastasis	Not investigating AWR	22471258
Jensen et al. [20]	2014	Abdominal muscle function and incisional hernia: a systematic review	Systematic review	24728836
Parker et al. [45]	2011	Pilot study on objective measurement of abdominal wall strength in patients with ventral incisional hernia	Not investigating AWR	21594738
Krpata et al. [46]	2012	Design and initial implementation of HerQLes: a hernia-related quality-of-life survey to assess abdominal wall function	Not investigating physical activity	22867715
Bigolin et al. [47]	2020	What is the best method to assess the abdominal wall? Restoring strength does not mean functional recovery	Not investigating AWR	32609254
Strigård et al. [48]	2016	Giant ventral hernia-relationship between abdominal wall muscle strength and hernia area	Not investigating physical activity	27484911
Abdominal wall assessment in healthy individuals				
Kato et al. [49]	2020	Reliability of the muscle strength measurement and effects of the strengthening by an innovative exercise device for the abdominal trunk muscles	Not investigating AWR	31658038
Grabiner et al. [50]	1990	Isokinetic measurements of trunk extension and flexion performance collected with the biodex clinical data station	Not investigating AWR	18787259
Estrázulas et al. [51]	2020	Evaluation isometric and isokinetic of trunk flexor and extensor muscles with isokinetic dynamometer: A systematic review	Systematic review	32726732
Guilhem et al. [52]	2014	Validity of trunk extensor and flexor torque measurements using isokinetic dynamometry	Not investigating AWR	25087981
Abdominal wall assessment before and after hernia repair				
Criss et al. [53]	2014	Functional abdominal wall reconstruction improves core physiology and quality-of-life	Not investigating physical activity	24,929,767
Jensen et al. [23]	2017	Abdominal wall reconstruction for incisional hernia optimizes truncal function and quality of life: a prospective controlled study	Not investigating physical activity	27,280,505
den Hartog et al. [54]	2010	Isokinetic strength of the trunk flexor muscles after surgical repair for incisional hernia	Not investigating physical activity	20091329
Effects of rehabilitation and/or prehabilitation on abdominal wall function after hernia repair				
Lode et al. [7]	2021	Enhanced recovery after abdominal wall reconstruction: a systematic review and meta-analysis	Systematic review	32974781
ERAS protocols for abdominal wall reconstruction				
Ueland et al. [55]	2020	The contribution of specific enhanced recovery after surgery (ERAS) protocol elements to reduced length of hospital stay after ventral hernia repair	Assessment of local ERAS protocol only	31705287
Stearns et al. [56]	2018	Early outcomes of an enhanced recovery protocol for open repair of ventral hernia	Assessment of local ERAS protocol only	29270803
Mohapatra et al. [57]	2019	Application of enhanced recovery pathway in abdominal wall reconstruction surgery in a tertiary care hospital in Andhra Pradesh	Assessment of local ERAS protocol only	10.33545/surgery.2019.v3.i4c.231

Table 3 (continued)

Study	Year	Title	Reason for exclusion	PMID/doi
Majumder et al. [58]	2016	Benefits of multimodal enhanced recovery pathway in patients undergoing open ventral hernia repair	Assessment of local ERAS protocol only	27049780
Harryman et al. [59]	2019	Enhanced value with implementation of an ERAS protocol for ventral hernia repair	Assessment of local ERAS protocol only	31576444
Fayezizadeh et al. [60]	2014	Enhanced recovery after surgery pathway for abdominal wall reconstruction: pilot study and preliminary outcomes	Assessment of local ERAS protocol only	25254998
Colvin et al. [61]	2019	Enhanced recovery after surgery pathway for patients undergoing abdominal wall reconstruction	Assessment of local ERAS protocol only	31262568
Crocetti et al. [62]	2020	Dietary protein supplementation helps in muscle thickness regain after abdominal wall reconstruction for incisional hernia	Not investigating physical activity	32223803
Rectus diastasis				
Gormley et al. [63]	2020	Impact of rectus diastasis repair on abdominal strength and function: A Systematic review	Systematic review	33520552
Emanuelsson et al. [64]	2016	Operative correction of abdominal rectus diastasis (ARD) reduces pain and improves abdominal wall muscle strength: A randomized, prospective trial comparing retromuscular mesh repair to double-row, self-retaining sutures	Not investigating AWR	27475817
Olsson et al. [65]	2019	Cohort study of the effect of surgical repair of symptomatic diastasis recti abdominis on abdominal trunk function and quality of life	Not investigating AWR	31832581
Jensen et al. [66]	2019	Enhanced recovery after abdominal wall reconstruction reduces length of postoperative stay: An observational cohort study	Not investigating physical activity	30195401
Animal models				
DuBay et al. [67]	2007	Incisional herniation induces decreased abdominal wall compliance via oblique muscle atrophy and fibrosis	Not investigating physical activity	17197977
Culbertson et al. [68]	2013	Reversibility of abdominal wall atrophy and fibrosis after primary or mesh herniorrhaphy	Not investigating physical activity	22801088
Effects of abdominoplasty on abdominal wall function				
Mazzocchi et al. [69]	2014	A study of postural changes after abdominal rectus plication abdominoplasty	Not investigating AWR	23132640
Wilhelmsson et al. [70]	2017	Abdominal plasty with and without plication-effects on trunk muscles, lung function, and self-rated physical function	Not investigating AWR	27577956
Staalesen et al. [71]	2016	The effect of abdominoplasty and outcome of rectus fascia plication on health-related quality of life in post–bariatric surgery patients	Not investigating AWR	26595030
Temel et al. [72]	2016	Improvements in vertebral-column angles and psychological metrics after abdominoplasty with rectus plication	Not investigating AWR	26764262
Effects of abdominal incision on abdominal wall function				
Paiuk et al. [73]	2014	Effects of abdominal surgery through a midline incision on postoperative trunk flexion strength in patients with colorectal cancer	Not investigating AWR	23263606
No assessment of abdominal wall function				
Khan et al. [74]	2012	Impact of training on outcomes following incisional hernia repair	Not investigating physical activity	23397825
Expert opinion				
Pommergaard et al. [75]	2014	No consensus on restrictions on physical activity to prevent incisional hernias after surgery	Expert opinion only	23712287

Table 3 (continued)

Study	Year	Title	Reason for exclusion	PMID/doi
Assessment of respiratory function				
Rodrigues et al. [76]	2018	Preoperative respiratory physiotherapy in abdominoplasty patients	Not investigating AWR	29040352

the primary outcome is not explicitly stated, the SG was shown to have experienced a significantly greater change in abdominal wall muscle strength postoperatively compared to the CG (45.89 ± 9.53 Nm preoperative to 41.3 ± 0.89 Nm postoperative ($p = 0.0001$) versus 33.97 ± 6.78 Nm preoperative to 30.05 ± 8.94 Nm postoperative ($p = 0.002$)), respectively [21].

Pezeshk et al. is a retrospective cohort study of 275 abdominal wall hernia patients of whom 137 were prescribed a regimen of abdominal wall flexibility and strengthening exercises to be done both preoperatively as well as postoperatively [16]. The exact nature of the outcome measures and follow-up protocol was inadequately described however patients were followed up longitudinally and the duration from surgery until recurrence was recorded [16]. Significantly fewer recurrences were recorded in the SG (9% vs 22% ($p < 0.01$)) and their median time to recurrence was significantly longer than the CG (13 months vs 6 months ($p < 0.05$)) [16]. However, each of these findings may have resulted from differences in the surgical techniques used [16].

None of the three included studies reported any adverse events resulting from their interventions.

Owing to the heterogeneity and low number of yielded studies no pooling of data or meta-analysis was feasible. Liang et al. and Ahmed et al. were each found to have moderate risk of bias (Fig. 2), whereas Pezeshk et al. showed a critical risk of bias (Fig. 3) [11, 12, 22].

Discussion

The literature regarding physical activity in relation to AWR is indeed limited as only three papers examining physical exercise before or after AWR were found. Each of the three studies had significant methodological issues preventing confident conclusions and there was no consistent message which could be used to guide patient care. The paucity of studies on physical exercise in the context of AWR raises

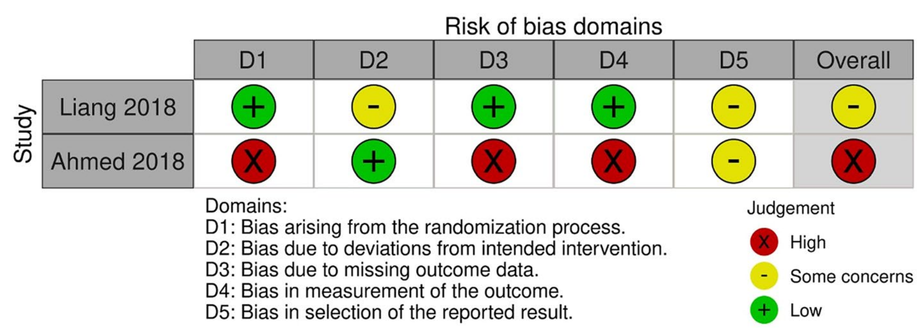

Fig. 2 Graphic representation of risk of bias assessments for included randomised studies using RoB2 and Robvis

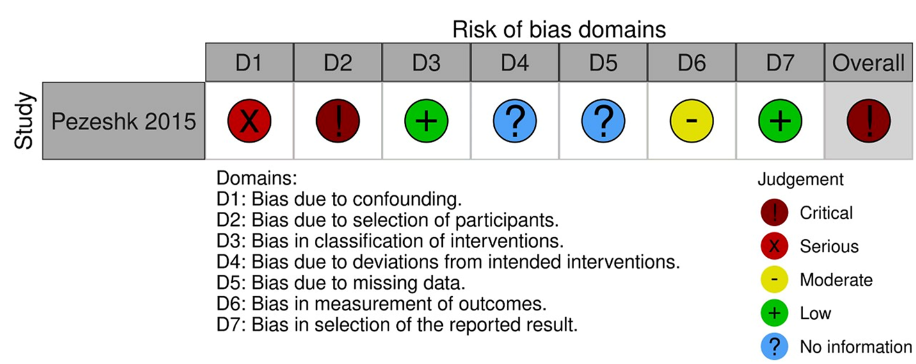

Fig. 3 Graphic representation of risk of bias assessments for included cohort studies using Robins-I and Robvis

important questions. First and foremost, we must conclude that any current recommendations are based on assumptions or expert opinions.

The concern regarding increased physical activity prior to AWR is that it may result in the aggravation of symptoms or enlargement or incarceration of the hernia. The studies included in the current review reported no adverse events related to the preoperative physical activity which is consistent with other previously published work on abdominal wall function before and after AWR [23]. There is no evidence that physical activity prior to AWR is harmful. The main argument for encouraging physical activity prior to AWR is that it hypothetically improves the postoperative outcomes. A recent multinational Delphi consensus statement outlined a variety of preoperative recommendations for AWR patients [24]. One of the strong recommendations listed was specialist prehabilitative/physiotherapeutic treatment to patients with poor exercise tolerance although whether this treatment pertains to general fitness or the abdominal wall specifically is unclear [24]. There is evidence indicating improved patient-reported recovery after different surgical procedures albeit with varying results as regards complications and length of stay [25, 26]. Preoperative physical therapy prior to cardiac surgery reduces the risk of postoperative pulmonary complications, which are also common after AWR [27, 28]. Patient-reported physical activity quality of life (QOL) scores suggest that AWR improves abdominal wall function [23].

Another hypothetical advantage of preoperative physical exercise may be the hypertrophy of abdominal wall musculature resulting in easier identification of surgical planes when performing retromuscular dissection and transversus abdominis release [29, 30]. Theoretically, it could be argued that the optimal preoperative prehabilitation program prior to AWR should include both cardiopulmonary exercise and core strength training, enhancing both the pulmonary reserve and the abdominal wall function.

Preoperative exercise programs also need to take into consideration the increasingly common adjunct of preoperative administration of botulinum toxin A into the abdominal oblique muscles prior to AWR. This temporary chemo-denervation facilitates midline fascial reapproximation with reconstruction of the linea alba and permits a greater number of patients to avoid permanent anatomical division of functionally important muscles due to either anterior or posterior components separation. Whilst several studies have reported this technique to be safe and without serious adverse events, it is not without its issues [31, 32]. The paralysis of the oblique muscles impacts the patient by limiting their respiratory capacity and some patients have reported reduced muscular function when trying to utilize the lateral abdominal wall [33]. It has been suggested that the pharmacological properties of botulinum toxin are not purely due to its local action at the site of muscular injection but also that a heteronymous effect is seen at the spinal level [34]. Little research has been done to show how paralysing the lateral abdominal wall impacts those core and trunk stabilizing muscles which are not injected and how this may impact a preoperative prehabilitation program remains unknown and fully undescribed in the literature.

We must acknowledge that we do not actually have meaningful evidence-based advice on how best to physically rehabilitate after AWR. The natural concern regarding physical activity for patient and surgeon alike is damage to the repair and a subsequent recurrence of the hernia. However, the concern that too much physical activity increases the risk of fascial dehiscence may be overestimated considering that simple coughing has been shown to generate significantly higher intraabdominal pressures (100 mmHg) and tensile forces (25 N/cm) than any other non-resistance activity aside from jumping (170 mmHg and 50 N/cm, respectively) [35–37]. Conversely, cadaveric studies have shown that the maximum tensile strength of the abdominal wall is 15 N/cm and that this force is achieved when the intraabdominal pressure reaches 55 mmHg [38–40]. These figures correspond with those experienced when lifting as little as five kilograms from a squatting position [37, 40]. Considering the wide range of physiological stresses imposed on the abdominal wall by different physical activities, and the supposed implications to the hernia and its subsequent repair, it is notable that none of the three included studies detailed the underlying reasons for how or why they chose the specific components of the exercise regimen used in their methods [36, 37, 41]. The exercise regimen used are described in broad terms in the studies by Ahmed et al. and Pezeshk et al. but no specifics were provided in the paper by Liang et al. [15, 16, 21]. A detailed exercise prescription as described in the 2011 position stand by the American College of Sports Medicine, in which the frequency, intensity, timing, type, volume or repetitions, pattern and progression of each prescribed exercise is clearly documented, would enable investigators to predict the expected physiological stresses on the abdominal wall or hernia repair and thus determine whether patients are liable to exceed safe limits [42]. Such an exercise prescription would also enable the replication of a study's method thus allowing other investigative teams to assess reproducibility.

The previous considerations are related to preventing exercise-related damage to a hernia repair in the postoperative period; however, modern AWR techniques are about return of abdominal wall function as well as correcting a fascial defect. In this regard there is little known on how a postoperative exercise program might expedite or enhance this return of function. If this is so in general terms there is even less sense of how different surgical techniques, with or without preoperative chemo-denervation or components separation, might differ in their postoperative exercise program. A major MSK operation without a prescribed postoperative physical therapy regimen is an anathema, yet in AWR surgery there is no identifiable prescribed postoperative rehabilitation program evident in the published literature to enhance functional recovery.

The current study has both strengths and limitations. The primary strength is the robustness of the search performed. By utilizing an intentionally broad strategy for the database search yet yielding only two papers from this process it has been demonstrated that there is little evidence to support current clinical advice. By then responding to this low yield by widening the scope of the study to include the results of the additional snowballing search, a further dimension has been added to the process of examining the literature that is entirely separate to the traditional database search and thus we have been able to fully expose the lack of applicable literature on this topic. Including allied health professionals in the investigative team has made it possible to highlight some of the more kinesiological implications of prehabilitation and rehabilitation. Arguably the primary weakness of the study is the lack of literature found.

Conclusion

In conclusion, the current literature review found that the evidence behind perioperative physical activity in relation to AWR is simply too sparse and too weak to justify making any confident recommendations at all.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10029-022-02562-5.

Funding No funding sources were used for this study.

Declarations

Conflict of interest The authors confirm that they have no competing interests in the conduction or publication of this study. Individual conflict of interest forms have been provided for each author.

Ethical approval This article did not require ethical approval of any kind.

Human and animal rights This article does not contain any studies with human participants or animals performed by any of the authors.

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