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REVIEW

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Relationship between high VExUS score and echocardiographic parameters: a systematic review and meta-analysis

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Abstract

Background The Venous Excess Ultrasound (VExUS) score integrates inferior vena cava diameter and venous Doppler findings to quantify congestion. Findings are conflicting regarding whether higher VExUS grades reflect worse cardiac function. We conducted a systematic review and meta-analysis to evaluate echocardiographic changes across different VExUS grades and their clinical significance.

Methods The systematic review and meta-analysis were performed in accordance with the PRISMA guidelines, including hospitalized patients assessed with the VExUS score and echocardiography. The primary outcome was the association between high VExUS (grades 2–3) and TAPSE. Secondary outcomes explored the association between VExUS and other echocardiographic parameters in different subpopulations. Eligible studies were randomized or observational. The risk of bias was assessed using the ROBINS-I tool.

Results Eight studies were included in the primary outcome analysis. Patients with high VExUS scores had significantly lower TAPSE values compared to those with low scores, with a pooled mean difference of −2.35 mm (95% CI −3.27 to −1.42; $p < 0.00001$). Moderate heterogeneity was observed ($I^2 = 61\%$), but the overall effect remained robust. Secondary outcomes showed consistent associations between high VExUS scores and reduced cardiac output, stroke volume, RV S′, and LVOT VTI. However, in a sensitivity analysis excluding studies enrolling patients with heart failure, no significant association was observed between higher VExUS scores and right ventricular dysfunction. Moreover, the pooled mean values of right heart parameters (TAPSE, S′, and RV FAC) in patients with VExUS 2–3 remained within normal physiological ranges, suggesting preserved right ventricular function despite venous congestion.

Conclusion This systematic review and meta-analysis demonstrate that patients with venous congestion, as assessed by the VExUS score, may exhibit lower values of echocardiographic parameters of right ventricular function. This association is observed particularly in the subgroup of patients with known cardiac dysfunction and is not present in patients without heart failure. These findings suggest that the VExUS score should be primarily interpreted as a marker of established systemic venous congestion, rather than as an indicator of intrinsic right ventricular systolic impairment.

Keywords Venous excess ultrasound scale, VExUS, Venous congestion, Cardiac function, POCUS

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Background

Systemic venous congestion is a major determinant of organ dysfunction in critically ill and heart failure patients. The Venous Excess Ultrasound (VExUS) score was designed to grade the severity of systemic venous congestion by integrating inferior vena cava size with hepatic, portal, and intrarenal venous Doppler waveforms [1]. VExUS reflects the interaction between volume status, cardiac filling pressures, and cardiac function, particularly right ventricular (RV) function, including contractility, afterload, and RV-to-pulmonary artery coupling. Higher VExUS grades correlate strongly with right atrial pressure (RAP) and have been associated with adverse outcomes such as acute kidney injury after cardiac surgery, outperforming single-site surrogates like central venous pressure [1–3]. VExUS reflects downstream pressure on the venous side of the circulation and the transmission of that pressure to organ venous beds. Recent prospective studies demonstrate a strong correlation between VExUS grade and invasively measured RAP across diverse populations. Elevated RAP reduces organ perfusion pressure (MAP-RAP) and promotes venous congestion, especially in the presence of RV overload and increased intrathoracic pressure induced by mechanical ventilation. RV systolic dysfunction can precipitate this phenotype: impaired RV contractility leads to RV dilation, tricuspid regurgitation, and increased RAP, resulting in systemic venous congestion ("backward failure") [4, 5]. However, congestion itself may also depress RV longitudinal motion via pericardial constraint and interventricular dependence, introducing potential reverse causality [6].

Although VExUS is increasingly used as a bedside tool, its relationship with echocardiographic markers of RV function remains poorly defined. Existing studies are small, heterogeneous, and often limited to single parameters, leaving uncertainty about whether VExUS reflects RV systolic failure or a broader congestive hemodynamic phenotype.

We aimed to systematically review and meta-analyze the association between higher VExUS grades and echocardiographic parameters of RV function. We hypothesized that high VExUS (grades 2–3) could be driven by RV dysfunction.

Methods

Protocol and guidance for conducting and reporting

The Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) guidelines were followed for the development of the protocol [7]. The methodology for conducting and reporting the systematic review was based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses [8]. The protocol was registered in the International Prospective Register of Systematic Reviews (PROSPERO) (CRD420251125824).

Review questions and hypothesis

The primary review question is whether a high VExUS score (grade 2–3) is associated with lower Tricuspid Annular Plane Systolic Excursion (TAPSE) values compared to those in the low VExUS group (grade 0–1).

The secondary review questions investigate whether echocardiographic parameters such as Cardiac Output (CO), E/e' ratio, Left Ventricular Ejection Fraction (LVEF), Stroke Volume (SV), systolic tissue velocity of the tricuspid annulus (RV S′), Left Ventricular Outflow Tract Velocity Time Integral (LVOT VTI), E/A ratio, and Right Ventricular Fractional Area Change (RV FAC) also differ according to VExUS grading.

We hypothesize that RV systolic failure could be a potential driver of venous congestion.

Primary and secondary outcomes

The primary outcome of this study was to assess whether a high VExUS score (grade 2–3) is associated with significantly lower values of TAPSE compared to patients with a low VExUS score (grade 0–1) in the general population and in subpopulations.

The secondary outcomes were to evaluate the association between VExUS score and other echocardiographic parameters of cardiac function, including CO, E/e' ratio, LVEF, SV, RV S′, LVOT VTI, E/A ratio, and RV FAC in the general population and in subpopulations.

Eligibility criteria

We included hospitalized patients who underwent ultrasound assessment for venous congestion using the VExUS score, as proposed by Beaubien-Souligny et al. [1], and for whom echocardiographic parameters were also available. The VExUS score is based on the evaluation of the inferior vena cava diameter and Doppler waveforms of the hepatic, portal, and interlobular renal veins, and patients are classified into grades ranging from 0 to 3 according to the obtained measurements [1]. Patients were classified as congested if they had a VExUS grade of 2–3, and as non-congested if they had a VExUS grade of 0–1 [1]. Grades 2 and 3 of the VExUS score indicate significant venous congestion because they represent a dilated inferior vena cava (≥2 cm) combined with severe abnormalities in one or more venous Doppler waveforms, reflecting transmission of high right atrial pressure to organ venous beds, whereas grades 0–1 lack these combined signs and thus indicate no clinically relevant congestion.

Randomized controlled trials and both prospective and retrospective observational studies were included. Conference proceedings, abstracts, case reports, and studies not involving human subjects were excluded.

Search strategy

We conducted a comprehensive search of the Medline, Scopus, and Web of Science databases from their inception up to June 2025. The full electronic search strategies are reported in the in Supp. Material. The reference lists of all eligible studies and relevant review articles were also screened. Prior to manuscript submission, the search was updated on 1 October 2025 to identify any newly published studies, and the analysis was accordingly revised.

Study selection and data extraction

Two reviewers (A.C. and R.A.) independently screened the titles and abstracts of all records retrieved from the database search. They then independently evaluated the full texts of articles selected during the initial screening. The same investigators independently carried out data extraction. Any disagreements encountered during the study selection or data extraction process were resolved through discussion or, if necessary, by consultation with a third independent reviewer (A.D.). CADIMA software vers. 2.2.4.2 (JKI—Julius Kühn-Institut) has been used for screening and paper assessment.

Assessment of risk of bias and quality of the evidence

Two investigators with training and prior experience in systematic reviews and risk-of-bias assessment (A.R. and A.C.) assessed the quality of the included studies. Risk of bias was evaluated using the ROBINS-I tool (Risk Of Bias In Non-randomised Studies – of Interventions), considering potential confounding, classification of interventions, selection of participants, deviations from intended interventions, missing data, measurement of outcomes, and selection of the reported results [9]. Each domain was rated as having a low, moderate, or serious risk of bias, and for each study, the overall risk was determined by the highest level of bias observed in any domain.

Statistical analysis

In studies reporting echocardiographic parameters for each VExUS score [1, 10–13], data were consolidated into non-congested (VExUS 0–1) and congested (VExUS 2–3) groups by pooling VExUS 0 with 1 and VExUS 2 with 3, using weighted means and combined standard deviations according to the Cochrane Handbook (Section 6.5.2) [9]. For studies reporting data as median and interquartile range [1, 11–13], means and standard deviations were estimated using the methods proposed by Wan et al. and Luo et al. [14, 15], according to Cochrane Handbook recommendations (Section 6.5.2) [9].

For both primary and secondary outcomes, continuous variables were pooled using the inverse variance method and expressed as mean differences (MD) with corresponding 95% confidence intervals (CI). Pooled estimates were calculated using a fixed-effect model when statistical heterogeneity was low, and a random-effects model when substantial heterogeneity was present, in order to account for between-study variability. Statistical heterogeneity was assessed using the Chi^2 test and quantified with the I^2 statistic. Sensitivity analysis was considered if appropriate. Subgroup analysis has been performed considering ICU patients and patients with or without cardiac dysfunction. A two-tailed p-value < 0.05 was considered statistically significant. All analyses were performed using Review Manager (RevMan) software, version 5.4 (Cochrane Collaboration, Copenhagen, Denmark).

Results

Study selection and study characteristics

A total of 486 titles were identified. After removing duplicates ($n = 235$), the titles and abstracts of 251 articles were screened. Forty-nine articles were subsequently assessed for full-text screening. Of these, 34 articles were excluded because they did not report echocardiographic parameters. Finally, 11 studies were included in the systematic review and meta-analysis (Fig. 1).

The main characteristics of the included studies are summarized in Supp. Material (Supp. Material Table 1).

All studies included in this systematic review and meta-analysis were published between 2020 and 2025. Except for Prager et al. and Song et al. [12, 16], which are multicentric, all studies are single-center observational investigations. In all the included studies, patients were classified as non-congested with a VExUS score of 0–1 and congested with a score of 2–3, while only Viana-Rojas et al. considered non-congested those with a VExUS score of 0 and congested those with scores of 1–3 [17].

Five studies included patients with underlying cardiac disease [11, 13, 17–19], two studies focused on patients with renal impairment [10, 20], one study investigated patients scheduled for cardiac surgery, and three studies enrolled patients admitted to general intensive care units [12, 16, 21].

Data collection was performed at hospital admission in all studies, except for Espinosa-Almaranza et al. [21], in which data were collected 72 h after admission, and Wong et al. [20], which included patients prior to ultrafiltration.

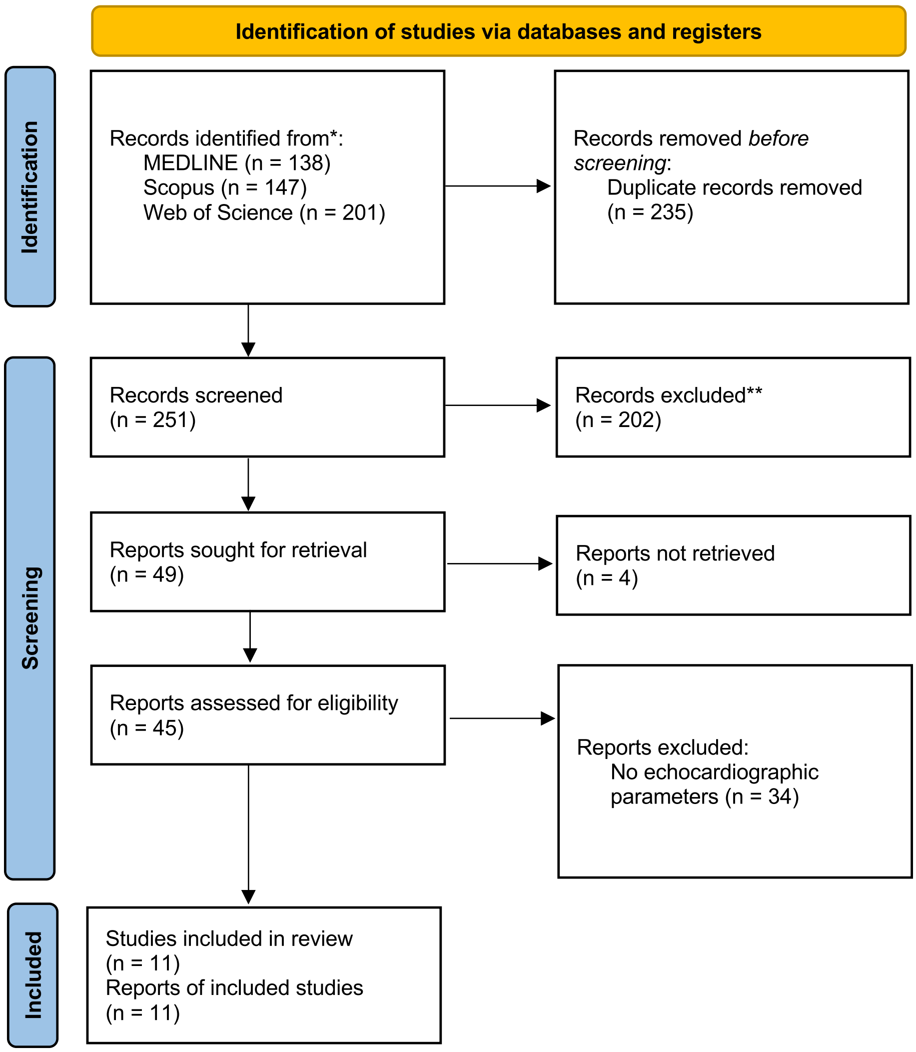

Fig. 1 PRISMA flow diagram of the study selection process

In six studies, the VExUS score was assessed by investigators with high ultrasound expertise or who had complete specific training or certification prior to data collection [12, 16, 18–21]. In the remaining 5 studies, the level of operator training was not explicitly reported [1, 10, 11, 13, 17].

Risk of bias and quality of evidence

The quality assessment of the studies is summarized in Figs. 2 and 3.

Overall, the risk of bias across studies was low, except for five studies where it was judged as moderate [10, 11, 13, 16, 17]. A moderate risk of bias was identified in three studies for domain 2 (selection of participants) [10, 16, 17] and in two studies for domain 6 (measurement of the outcome) [11, 13].

Primary outcome

Of the 11 studies considered, data for the primary outcome were available for 8 of them [10–13, 16, 18, 20, 21], involving 344 patients with high VExUS scores (grade 2–3) and 537 patients with low VExUS scores (grade 0–1). The pooled analysis showed that TAPSE values were significantly lower in the high VExUS group compared to the low VExUS group, with a mean difference of −2.35 mm (95% CI −3.27 to −1.42; $p < 0.00001$).

A descriptive summary of the pooled populations was obtained by calculating the overall mean and standard deviation of TAPSE across studies. The combined mean was 16.01 ± 4.74 mm in the group of congested patients (VExUS 2–3) and 19.20 ± 4.05 mm in the group of non-congested patients (VExUS 0–1). There was moderate heterogeneity among the included studies ($Chi^2 = 17.98$, $df = 7$, $p = 0.01$; $I^2 = 61\%$), suggesting some variability in

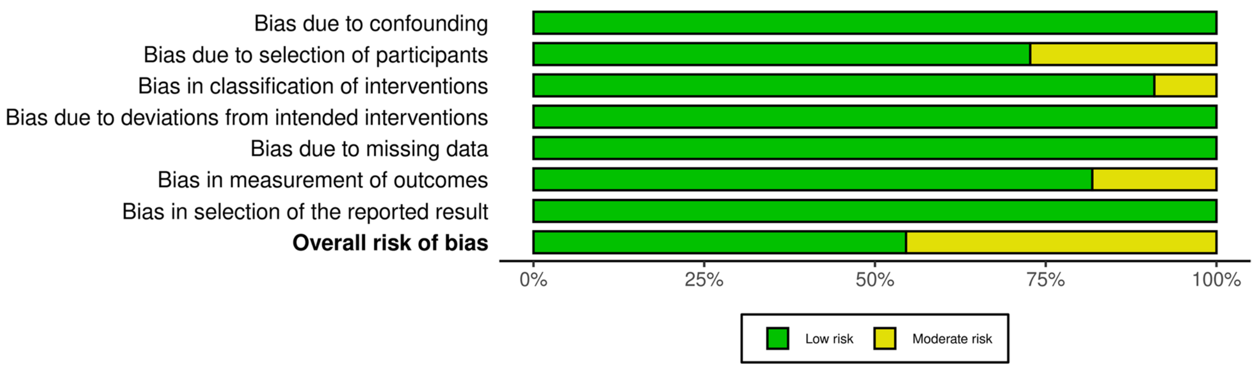

Fig. 2 Risk of bias assessment of included studies according to ROBINS-I tool

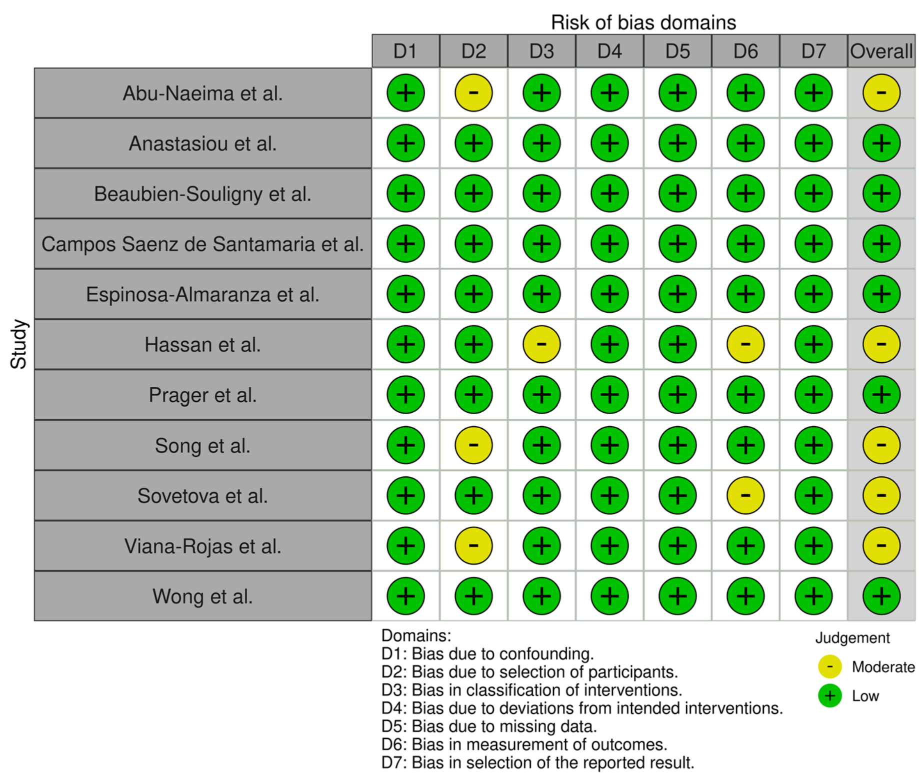

Fig. 3 Overall risk of bias assessment of included studies according to ROBINS-I tool

effect size, but the overall effect remained highly statistically significant ($Z = 4.96$, $p < 0.00001$) (Fig. 4).

To evaluate the robustness of the primary outcome, a sensitivity analysis was performed excluding the study by Wong et al. [20], as it accounted for 19.3% of the total weight of the analysis, with only 5 congested patients over 33. The pooled analysis confirmed significantly lower TAPSE values in the high VExUS group compared to the low VExUS group, with a mean difference of −2.11 [−3.30 to −0.91; $p = 0.0006$] (Supp. Material).

When sub-analyses were performed, including patients with heart failure (Table 1), higher VExUS scores were consistently associated with impaired right ventricular systolic function. In this subgroup, patients with VExUS 2–3 showed significantly lower TAPSE compared with those with VExUS 0–1, with a mean difference of −3.25 mm (95% CI −3.92 to −2.59; $p < 0.00001$), indicating a clinically and statistically meaningful reduction in longitudinal RV systolic performance.

However, when studies including patients with heart failure were excluded (Table 2), the association between

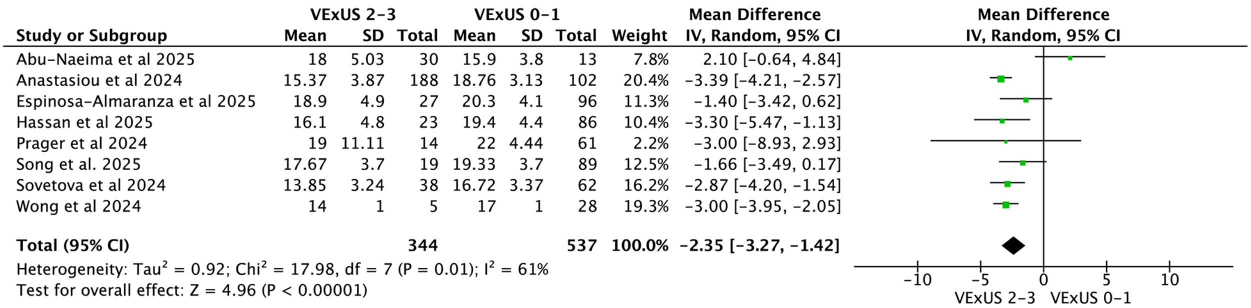

Fig. 4 Forest plot comparing TAPSE between patients with VExUS 2–3 and VExUS 0–1

Table 1 Descriptive and pooled results of echocardiographic and hemodynamic parameters, based on analyses conducted on studies that include patients with heart failure

Variable	VExUS 2–3 (Mean ± SD)	*N*	VExUS 0–1 (Mean ± SD)	*N*	MD (95% CI)	*p*-value	I^2
TAPSE (mm)	15.21±3.91	249	18.47±3.80	250	−3.25 [−3.92 to −2.59]	<0.00001	0%
E/e′ ratio	18.90±6.59	226	17.71±6.47	164	1.28 [−0.57 to 3.13]	0.17	28%
LVEF (%)	41.42±17.86	298	37.88±13.52	301	−0.79 [−7.78 to 6.20]	0.82	84%
S′	8.96±2.73	226	11.39±2.63	164	−2.15 [−2.66 to −1.65]	<0.00001	0%

I^2 heterogeneity, *LVEF* left ventricle ejection fraction, *MD* mean difference, *SD* standard deviation

Table 2 Descriptive and pooled results of echocardiographic and hemodynamic parameters, based on analyses conducted on studies that did not include cardiopathic patients

Variable	VExUS 2–3 (Mean ± SD)	*N*	VExUS 0–1 (Mean ± SD)	*N*	MD (95% CI)	*p*-value	I^2
TAPSE	18.13±5.95	95	19.84±4.16	287	−1.42 [−3.12, 0.28]	0.10	70%
S′	9.55±4.80	19	12.96±3.03	89	−2.53 [−2.99, −2.08]	<0.00001	0%
RV FAC	38.63±12.33	61	40.73±11.31	59	1.57 [−6.90, 10.03]	0.72	72%

FAC fractional area change, *I^2* heterogeneity, *MD* mean difference, *RV* right ventricle, *SD* standard deviation

higher VExUS scores and right ventricular dysfunction was no longer statistically significant. In this subgroup with normal cardiac function, the pooled mean difference for TAPSE was −1.42 mm (95% CI −3.12 to 0.28; $p = 0.10$), indicating that patients with VExUS 2–3 did not exhibit a clinically meaningful reduction in longitudinal RV systolic function (Supp. Material).

Secondary outcome

Results of secondary outcomes are reported in Tables 1 and 3. Forest plots are reported in the Supp. Material.

Discussion

This systematic review and meta-analysis demonstrate that patients with venous congestion, as assessed by the VExUS score, may exhibit lower values of echocardiographic parameters of right ventricular function. This association is observed particularly in the subgroup of patients with known cardiac dysfunction and is not present in patients without heart failure. In fact, in patient without cardiac failure, although RV S′ remained significantly lower in congested patients (mean difference −2.53 cm/s; 95% CI −2.99 to −2.08), the absolute mean values of TAPSE, RV S′, and RV FAC in the VExUS 2–3 population were consistently within normal physiological ranges (18.13 mm, 9.55 cm/s, and 38.63%, respectively). These findings are consistent with the physiological determinants of VExUS, which reflect the interplay between cardiac function, cardiac filling pressures, and intravascular volume status. In our systematic review and meta-analysis, among the parameters that showed a statistically significant difference between the high and low VExUS score groups, TAPSE and RV S′ stand out, all well-established indicators of right ventricular systolic function. In contrast, RV FAC did not show a significant association, which may reflect its greater dependence on image quality, ventricular geometry, loading conditions, and the severity of tricuspid regurgitation. Conversely, TAPSE and RV S′, as simple and robust measures of longitudinal RV systolic function, may be more sensitive to the hemodynamic changes captured by the VExUS score.

Table 3 Descriptive and pooled results of echocardiographic and hemodynamic parameters

Variable	VExUS 2–3 (Mean ± SD)	N	VExUS 0–1 (Mean ± SD)	N	MD (95% CI)	p-value	I^2
CO (L/min)	4.02±1.20	45	4.97±1.35	107	−0.65 [−1.02 to −0.28]	0.0006	0%
E/e' ratio	17.88±6.42	287	15.69±6.81	223	+1.79 [−0.60 to 4.18]	0.14	83%
LVEF (%)	41.98±17.31	397	44.99±15.35	590	−3.12 [−8.02 to 1.78]	0.21	82%
SV (mL)	49.05±19.23	202	59.24±16.51	163	−9.93 [−14.24 to −5.62]	<0.00001	1%
RV S' (cm/s)	9.01±2.95	245	11.94±2.86	253	−2.36 [−2.70 to −2.03]	<0.00001	0%
LVOT VTI (cm)	15.19±7.63	62	17.72±6.66	179	−2.52 [−3.33 to −1.71]	<0.00001	0%
E/A ratio	2.28±1.08	211	1.68±1.03	188	+0.45 [0.09 to 0.82]	0.01	53%
RV FAC (%)	35.99±12.10	84	39.41±12.54	145	−2.28 [−9.93 to 5.36]	0.56	85%
TAPSE ICU patients (mm)	17.02±5.73	128	19.45±4.34	321	−1.15 [−3.06 to 0.76]	0.24	73%
E/e' ratio ICU patients	16.90±7.18	68	18.05±6.66	75	−0.30 [−2.56 to 1.96]	0.79	0%
LVEF in ICU patients (%)	40.05±19.24	95	44.94±17.34	171	−2.37 [−11.09 to 6.34]	0.59	74%
S' ICU patients	9.95±3.92	52	13.09±3.27	123	−2.54 [−3.71 to −1.36]	<0.00001	0%
TAPSE ICU septic patients (mm)	18.23±7.63	33	20.42±4.21	150	−1.78 [−3.53 to −0.03]	0.05	0%
TAPSE ICU patients without cardiac disfunction (mm)	18.62±6.41	60	20.20±4.19	246	−1.62 [−2.94 to −0.29]	0.02	0%

CO cardiac output, *FAC* fractional area change, I^2 heterogeneity, *LVEF* left ventricle ejection fraction, *LVOT* left ventricle outflow tract, *MD* mean difference, *RV* right ventricle, *SD* standard deviation, *SV* stoke volume, *VTI* velocity–time integral

It should be noted that an accurate assessment of right ventricular function should include a combination of echocardiographic parameters, as a single one has poor correlation with the gold standard represented by RMN [22].

In the subgroup analysis of ICU patients, no significant association was found between elevated VExUS and worse TAPSE. More studies are required to explore this relationship, as the populations included so far are highly heterogeneous. Not all patients in the individual studies are mechanically ventilated, and, although most ultrasound assessments were performed within 24 h of ICU admission, one study evaluated VExUS within 72 h, which may significantly influence volume status. Moreover, the studies conducted in ICUs are themselves heterogeneous, being performed in mixed general ICUs [10, 12, 16, 21] and cardiac ICUs [13], and therefore include patients with very different clinical presentations. Mechanical ventilation may further complicate the interpretation of TAPSE, as positive pressure ventilation can reduce right ventricular preload and increase afterload; the level of applied PEEP is an important variable that should be considered in future analyses, given its potential impact on right ventricular performance. Importantly, none of the studies accounted for ongoing vasoactive therapies at the time of inclusion, and in our meta-analysis, data on diuretic use and fluid balance were not available. More precise and standardized data are therefore needed to better define the relationship between VExUS and right ventricular performance in critically ill patients.

First introduced by Beaubien-Souligny et al. [1], the VExUS score was applied to cardiac surgery patients, where it correlated with the development of acute kidney injury. However, studies on the general ICU population have shown contradicting results [23]. An observational ICU study examining different patterns of congestion found that the highest VExUS scores were observed in patients with cardiogenic shock, irrespective of fluid balance. In contrast, overall VExUS scores remained low in patients with preserved cardiac function ever with a more positive fluid balance [24]. Moreover, even at high VExUS grades, patients may exhibit fluid responsiveness, since VExUS indicates impaired cardiovascular tolerance to the current volume at acceptable filling pressures rather than absolute hypervolemia [25]. In other words, a patient with established right ventricular dysfunction may show a high VExUS score even when their volume status is normal. Conversely, a patient with preserved cardiac function could tolerate substantial hypervolemia without exhibiting an elevated VExUS score.

The findings of our systematic review and meta-analysis confirm the concept that right ventricular function may represent a determinant of venous congestion. Thus, our study highlights the importance of clinical context-dependent interpretation [26] and multiparameter evaluation. As proposed by Guinot [26], when the VExUS score suggests significant venous congestion, a comprehensive hemodynamic evaluation is warranted to delineate whether the observed congestion primarily reflects intrinsic cardiac dysfunction, excessive intravascular volume, or a combination of these pathophysiological mechanisms. The first step is to analyze each component of cardiac function. Subsequently, this information is integrated with the venous flow pattern of abdominal organs to determine the role of volume status as a determinant of congestion. A pulsatile portal vein flow pattern in the presence of altered cardiac functional parameters suggests a mixed mechanism of congestion, related to both hypervolemia and cardiac origin [26]. Conversely, when the cardiac assessment is abnormal while portal vein flow remains normal, venous congestion is primarily of cardiac origin [26].

Clinically, VExUS may also serve as a dynamic surrogate marker of response to decongestive therapies, guiding fluid management and supporting individualized decision-making during hospitalization.

More global parameters, such as SV, LVOT VTI, and CO, were also significantly reduced in patients with high VExUS scores, indicating diminished systolic output and thus impaired overall hemodynamic efficiency. This supports the hypothesis that the congestion may be determined by the impairment of overall cardiac function.

Our systematic review and meta-analysis have several limitations. First, heterogeneous patient populations have been considered. The analyzed cohorts is based on patients with acute and chronic heart failure [11, 18, 19], cardiorenal syndrome [10], septic shock [12, 16], acute coronary syndromes [17], end-stage renal disease [20], and critically ill patients admitted to general [21], or cardiac ICUs [13], as well as patients evaluated before cardiac surgery [1]. These populations differ substantially in terms of clinical context, severity of illness, hemodynamic profile, and underlying pathophysiological mechanisms of venous congestion. Moreover, several studies are based on patients with heart failure, so it is expected that they have altered echocardiographic parameters. Furthermore, this analysis did not account for important confounding factors such as volume status and renal function, both of which may significantly influence venous congestion and its hemodynamic consequences. Second, some heterogeneity between studies exists about venous congestion definition. While most studies classified patients with VExUS 2–3 as congested and those with VExUS score 0–1 as non-congested, one study considered patients with a VExUS score of 1 in the congested group [17]. Although this study was not considered for the primary outcome, this inconsistency in VExUS categorization may have introduced misclassification bias and contributed to between-study heterogeneity. Third, the VExUS score is an ultrasound-based assessment and may be subject to inter- and intra- operator variability [27]; furthermore, training of investigators performing ultrasound assessments was not uniformly reported across the included studies, which could have influenced measurement consistency. Finally, given the observational nature of the included studies and the contemporaneous assessment of venous congestion and right ventricular function, the possibility of reverse causality cannot be excluded, which limits causal inferences regarding the relationship between VExUS and right heart dysfunction.

More studies in critically ill patients are needed to determine whether a robust correlation truly exists between the VExUS score and cardiac function. Prospective studies focusing on well-defined patient populations — such as individuals with heart failure, septic shock, or critically ill patients without primary cardiac disease — are needed to reduce clinical heterogeneity and better delineate the pathophysiological significance of VExUS in each setting. Stratified analyses according to clinical context and care setting should be prespecified, particularly in critically ill patients, where factors such as mechanical ventilation, positive end-expiratory pressure, and right ventricular performance are considered. Standardized reporting of these variables would improve interpretability and comparability across studies. Furthermore, further studies are needed to clarify the role of the VExUS score in the management of critically ill patients and its impact on outcomes.

Conclusion

This meta-analysis demonstrates that a high VExUS score (grades 2–3), indicative of significant venous congestion, is associated with echocardiographic signs of impaired cardiac performance, predominantly involving the right heart. However, when focusing specifically on the population without heart failure, no significant association was found, and the cross-sectional nature of the available evidence does not allow inference on causality. In this population, although subtle decrements in longitudinal RV indices could be detected, absolute mean values of TAPSE and RV FAC remained within normal physiological ranges, supporting the interpretation of a congestive hemodynamic phenotype rather than established RV systolic failure.

Taken together, these findings suggest that the VExUS score should be primarily interpreted as a marker of established systemic venous congestion, rather than as an indicator of intrinsic right ventricular systolic impairment. In critically ill patients, VExUS may complement conventional echocardiography by providing additional information on venous congestion, but its clinical interpretation should remain closely integrated with the overall hemodynamic and clinical context. Further prospective and longitudinal studies are needed to better define the role of VExUS across different patient populations.

Abbreviations

CO	Cardiac output
IVC	Inferior vena cava
LVEF	Left ventricle ejection fraction
LVOT VTI	Left Ventricular Outflow Tract Velocity Time Integral
RA	Right atrium
RV FAC	Right ventricular fractional area change
RV S'	Systolic tissue velocity of the tricuspid annulus
SV	Stroke volume
TAPSE	Tricuspid annular plane systolic excursion
VExUS	Venous excess ultrasound

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s44158-026-00347-1.

Additional file 1: Supplementary material.

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Authors' contributions
AC has performed literature search, selected the studies, revised the analysis and the manuscript; RA has conceived the paper, drew the protocol, selected the studies, performed the analysis and the manuscript; RD has contributed to the analysis of results; ED has contributed to manuscript revision; EA has contributed to manuscript revision; AD has substantially contributed to manuscript revision. All authors read and approved the final manuscript.

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Data availability
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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