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Diagnostic Accuracy of Whole-Body MRI Versus PET/CT in Cancer Staging: A meta anlysis

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ABSTRACT

Background: Accurate staging of solid malignancies is essential for appropriate treatment planning and prognostication. While 18F-fluorodeoxyglucose positron emission tomography/computed tomography (FDG PET/CT) remains a standard imaging modality for systemic staging, whole-body magnetic resonance imaging (WB-MRI), particularly with diffusion-weighted imaging (DWI), has emerged as a promising radiation-free alternative. This systematic review aimed to compare the diagnostic accuracy of WB-MRI versus FDG PET/CT in staging adult patients with solid tumors.

Methods:A systematic search of six databases (PubMed, Embase, Scopus, Web of Science, CINAHL, and Cochrane Library) was conducted up to July 2025. Studies were eligible if they included adult patients with solid tumors, employed head-to-head comparisons of WB-MRI and FDG PET/CT, and reported diagnostic performance metrics. Risk of bias was assessed using the QUADAS-2 tool. A narrative synthesis was performed due to heterogeneity in study designs and outcome reporting.

Results: Ten open-access studies (N ≈ 3,400 patients) were included, spanning diverse tumor types including lung, colorectal, breast, prostate, and cervical cancers. Across studies, WB-MRI and PET/CT demonstrated comparable sensitivity (range: 67%–97.9%) and specificity (range: 89%–100%) in detecting metastases. WB-MRI showed superior performance in detecting bone lesions, while PET/CT was more sensitive for nodal and pulmonary metastases. Risk of bias was low in most studies.

Conclusions:WB-MRI provides diagnostic accuracy comparable to FDG PET/CT for staging solid tumors and offers distinct advantages in radiation safety and bone metastasis detection. Further research is needed to refine its role across tumor types and clinical settings..

Keywords: *Whole-body MRI; PET/CT; cancer staging; diagnostic accuracy; metastasis; diffusion-weighted imagin.*

1. INTRODUCTION

Accurate cancer staging is fundamental to determining appropriate therapeutic strategies, predicting prognosis, and evaluating response to treatment. The precision of initial staging impacts not only the selection of surgical or systemic interventions but also the trajectory of a patient's care pathway, including decisions regarding palliative versus curative approaches (Liam et al., 2020). Imaging plays a central role in the staging process, particularly in assessing the extent of disease dissemination to lymph nodes, bone, or visceral organs (Fischerova et al., 2024). Among current imaging modalities, 18F-fluorodeoxyglucose positron emission tomography/computed tomography (18F-FDG PET/CT) has been widely regarded as a reference standard for whole-body oncologic assessment, given its high sensitivity for metabolically active lesions and its capacity to simultaneously provide anatomical and functional information (Alberini et al., 2009).

Despite its utility, PET/CT is not without limitations. The use of ionizing radiation from both the PET and CT components poses cumulative risks, especially in younger populations or those requiring serial imaging over time (Hosono et al., 2021; Mainprize et al., 2023). Moreover, FDG-PET/CT may demonstrate false-positive findings in inflammatory or infectious processes and may be less sensitive for certain low-grade or mucinous tumors (Chang et al., 2006). The cost and availability of PET/CT may also restrict its accessibility in some healthcare systems, prompting the investigation of alternative whole-body imaging techniques that offer high diagnostic yield with reduced risk (Crișan et al., 2022).

Whole-body magnetic resonance imaging (WB-MRI), particularly when incorporating diffusion-weighted imaging (DWI), has emerged as a promising non-ionizing alternative for cancer staging. WB-MRI provides high soft tissue contrast resolution and enables the detection of metastatic lesions in multiple organ systems without the use of ionizing radiation (Petralia et al., 2021). In recent years, advancements in MRI acquisition protocols, including faster sequences and whole-body DWI, have improved its diagnostic performance and feasibility for staging a variety of malignancies, including lymphoma, breast, prostate, and multiple myeloma (Fayad et al., 2025; Pasoglou et al., 2018). Several prospective studies have reported

comparable or even superior diagnostic accuracy of WB-MRI compared to PET/CT in certain tumor types, particularly for bone and soft tissue metastases (Ciliberto et al., 2013).

Clinical guidelines are beginning to recognize the potential of WB-MRI in selected oncologic contexts. The National Institute for Health and Care Excellence (NICE) in the United Kingdom, for instance, has recommended WB-MRI as the preferred initial staging modality for patients with suspected myeloma and for colorectal cancer patients with suspected metastases in research settings (Zugni et al., 2024). However, such recommendations remain limited, in part due to variability in study designs, imaging protocols, and reference standards across the literature. Furthermore, the generalizability of WB-MRI findings across different tumor types and clinical settings remains under debate (Keenan et al., 2022).

Given the expanding but heterogeneous evidence base, a rigorous synthesis of comparative studies is warranted to evaluate the diagnostic accuracy of WB-MRI relative to PET/CT across cancer types. While previous reviews have explored the role of WB-MRI in specific malignancies, such as myeloma or prostate cancer (Taylor, Mallett, Ball, et al., 2019), a comprehensive systematic review encompassing multiple solid tumor types and evaluating per-patient and per-lesion diagnostic performance metrics is lacking. Such a review is essential to inform clinical decision-making, guideline development, and future research into cost-effectiveness and implementation (Herath et al., 2025).

Therefore, the aim of this systematic review is to critically appraise and synthesize current evidence comparing the diagnostic accuracy of whole-body MRI and PET/CT for cancer staging. Specifically, we seek to assess sensitivity, specificity, positive and negative predictive values, and overall accuracy on a per-patient and per-lesion basis. Through this comparative evaluation, we aim to clarify the potential of WB-MRI as a viable alternative to PET/CT in staging workflows and identify tumor-specific contexts in which it may offer diagnostic or logistical advantages

2. METHODS

Search Strategy and Selection Criteria

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines to ensure methodological transparency, rigor, and reproducibility. The review protocol was prospectively registered with the International Prospective Register of Systematic Reviews (PROSPERO).

The objective of this review was to synthesize the current evidence comparing the diagnostic accuracy of whole-body magnetic resonance imaging (WB-MRI) with 18F-fluorodeoxyglucose positron emission tomography/computed tomography (PET/CT) in the staging of solid malignancies. To achieve comprehensive coverage of the literature, systematic searches were performed across six major biomedical databases: PubMed, Embase, Web of Science, Scopus, CINAHL (via EBSCOhost), and the Cochrane Library. The final database search was completed on July 15, 2025.

A structured search strategy was developed in consultation with a health sciences research librarian and informed by preliminary scoping. The strategy incorporated a combination of Medical Subject Headings (MeSH), Emtree terms, and relevant free-text keywords. Search terms were grouped into three primary conceptual domains:

Imaging modality (e.g., “whole-body MRI,” “WB-MRI,” “diffusion-weighted imaging”),

Comparator (e.g., “positron emission tomography,” “PET/CT,” “FDG-PET”),

Clinical purpose (e.g., “cancer staging,” “neoplasm metastasis,” “tumor burden,” “diagnostic accuracy”).

Boolean operators (“AND,” “OR”) were used to combine terms within and across the domains. Search filters were applied to limit results to human studies and peer-reviewed articles published in English. No date restrictions were applied.

Table 1 provides an overview of the search terms used in each database.

Table 1. Search Strategy Overview by Database

Database	Search Terms
PubMed	(“whole-body MRI” OR “WB-MRI” OR “whole body magnetic resonance imaging”) AND (“PET/CT” OR “FDG-PET” OR “positron emission tomography”) AND (“cancer staging” OR “tumor staging” OR “metastasis” OR “diagnostic accuracy”)
Embase	(‘whole body MRI’/exp OR ‘diffusion-weighted imaging’/exp) AND (‘positron emission tomography’/exp OR ‘FDG-PET’) AND (‘neoplasm staging’/exp OR ‘cancer metastasis’/exp)
Web of Science	ALL=(“whole-body MRI” AND “PET/CT” AND “cancer staging” AND “diagnostic accuracy”)

Scopus	TITLE-ABS-KEY ("whole body MRI" AND "PET/CT" AND "tumor staging" AND "sensitivity")
CINAHL	("whole-body MRI" OR "WB-MRI") AND ("PET scan" OR "PET/CT") AND ("oncologic staging" OR "diagnostic performance")
Cochrane Library	("whole-body MRI" OR "WB-MRI") AND ("PET/CT" OR "positron emission tomography") AND ("cancer staging" OR "tumor spread")

Study (Year)	**Cancer Type**	**Country**	**N**	**WB-MRI Protocol**	**PET/CT Protocol**	**Reference Standard**	**Sensitivity (WB-MRI / PET-CT)**	**Specificity (WB-MRI / PET-CT)**
Holmstrand et al. (2025)	NSCLC (Stage III/oligo)	Sweden	28	1.5T; T1W, T2W, DWI (b=0, 800 s/mm²); no contrast; total scan ~45 min	18F-FDG PET/CT; 3.5 MBq/kg; uptake 60 min; low-dose CT	Histopathology & clinical follow-up	Comparable overall; mediastinal LN: 65% / 100%	Comparable overall; NR
Taylor et al. (2019) – Stream line L	NSCLC (I–III)	UK	187	1.5T; T1W, T2W, DWI; contrast-enhanced sequences; ~50 min	18F-FDG PET/CT; 4 MBq/kg; uptake 60 min; diagnostic CT	Expert panel consensus at 12 mo follow-up	50% / 54%	93% / 95%
Taylor et al. (2019) – Stream line C	Colorectal Cancer	UK	299	3.0T; T1W, T2W, DWI; liver-specific contrast; ~55 min	18F-FDG PET/CT if indicated; CT abdomen/pelvis; ~60 min	12 mo clinical/imaging follow-up	67% / 63%	95% / 93%
Rezk et al.	Recurrent Breast	India	50	1.5T; DWIBS only; no	18F-FDG PET/CT;	Biopsy and ≥6 mo clinical	NR (PET>WB-MRI for	NR (WB-MRI strong local

(2019)	Cancer			contrast; ~30 min	5 MBq/kg; uptake 60 min; low-dose CT	follow-up	nodes & distant)	lesion detection)
Ajwani et al. (2021)	Mixed Solid Tumors	Saudi Arabia	50	3.0T; T1W, T2W, DWI; contrast-enhanced; ~60 min	18F-FDG PET/CT; 4 MBq/kg; uptake 60 min; diagnostic CT	Composite (imaging + clinical)	97.9% / ~99 %	100% / 100 %
Xu et al. (2013)	Various Solid Tumors	China	1,239*	Gd-enhanced WB-MRI; DWI included; magnet NR	18F-FDG PET/CT; protocol varied by study	Histopathology or clinical/imaging follow-up	85% / 85%	97% / 96%
Li et al. (2020)	Multiple Tumor Types	China	NR †	Contrast-enhanced WB-MRI; DWI; 1.5–3.0T	18F-FDG PET/CT; standardized per protocol	Mixed reference standards	85% / 84%	98% / 96%
Olthof et al. (2024)	Early Cervical Cancer	Netherlands	1,676	Pelvic MRI + WB-MRI DWI; 1.5 T; contrast for pelvis; ~40 min	18F-FDG PET/CT; 3.7 MBq/kg; uptake 60 min; CT pelvis	Surgical lymphadenectomy histopathology	48% / 80%	92% / 79%
Tanaka et al. (2018)	Various Metastatic Lesions	Japan	26	3.0T; STIR + DWI; no contrast; total ~35	18F-FDG PET/CT; 4 MBq/kg; uptake 60 min;	Composite follow-up (median 9 mo)	95% / 79% (overall lesions) 89 % / 76% (bone‡)	NR

				min	low-dose CT			
Zhan et al. (2021)	Prostate Cancer (Bone Mets)	China	657	WB-MRI with DWI; 1.5T; no contrast; ~45 min	PET/CT with 11C-choline or 68Ga-PSMA; uptake varied	Bone biopsy or imaging follow-up	84% / 94%	89% / 98%

Eligibility Criteria for Screening

Following duplicate removal, all titles and abstracts were screened to assess preliminary relevance. Full-text articles that passed the initial screening were subsequently reviewed in detail using predefined inclusion and exclusion criteria. The aim was to identify original studies that directly compared the diagnostic accuracy of whole-body magnetic resonance imaging (WB-MRI) with 18F-FDG positron emission tomography/computed tomography (PET/CT) in the staging of solid malignancies.

Studies were included if they met the following criteria: (1) original empirical research published in peer-reviewed journals; (2) employed a prospective, retrospective, or cross-sectional diagnostic accuracy design; (3) enrolled adult patients (≥18 years) with histologically confirmed or strongly suspected solid tumors undergoing initial staging or restaging; (4) conducted a head-to-head comparison of WB-MRI and PET/CT within the same patient cohort; (5) reported at least one diagnostic performance metric (e.g., sensitivity, specificity, accuracy, positive predictive value [PPV], or negative predictive value [NPV]) using histopathology, follow-up imaging, or clinical consensus as a reference standard; and (6) published in English between January 2000 and July 2025.

Studies were excluded if they: (1) included only pediatric populations or did not separate pediatric from adult data; (2)

evaluated WB-MRI or PET/CT in isolation without a comparative arm; (3) lacked sufficient data to construct a 2×2 contingency table or extract diagnostic metrics; (4) were review articles, editorials, letters, conference abstracts, study protocols, or theses; or (5) did not undergo peer review.

Our search yielded a total of 3,346 records. After removing 782 duplicates, 2,564 titles and abstracts were screened for relevance. Of these, 2,401 were excluded for not meeting the population, comparator, imaging modality, or outcome criteria. The full texts of 163 articles were assessed for eligibility. Ultimately, 10 studies met all inclusion criteria and were included in the final synthesis (Ajwani et al., 2021; Holmstrand et al., 2025; Li et al., 2020; Olthof et al., 2024; Rezk et al., 2019; Tanaka et al., 2017; Taylor, Mallett, Ball, et al., 2019; Taylor, Mallett, Beare, et al., 2019; Xu et al., 2013; Zhan et al., 2021). These underwent structured data extraction and methodological quality appraisal using the QUADAS-2 tool. The study selection process is depicted in the PRISMA 2020 flow diagram (Figure 1).

Data Extraction Process

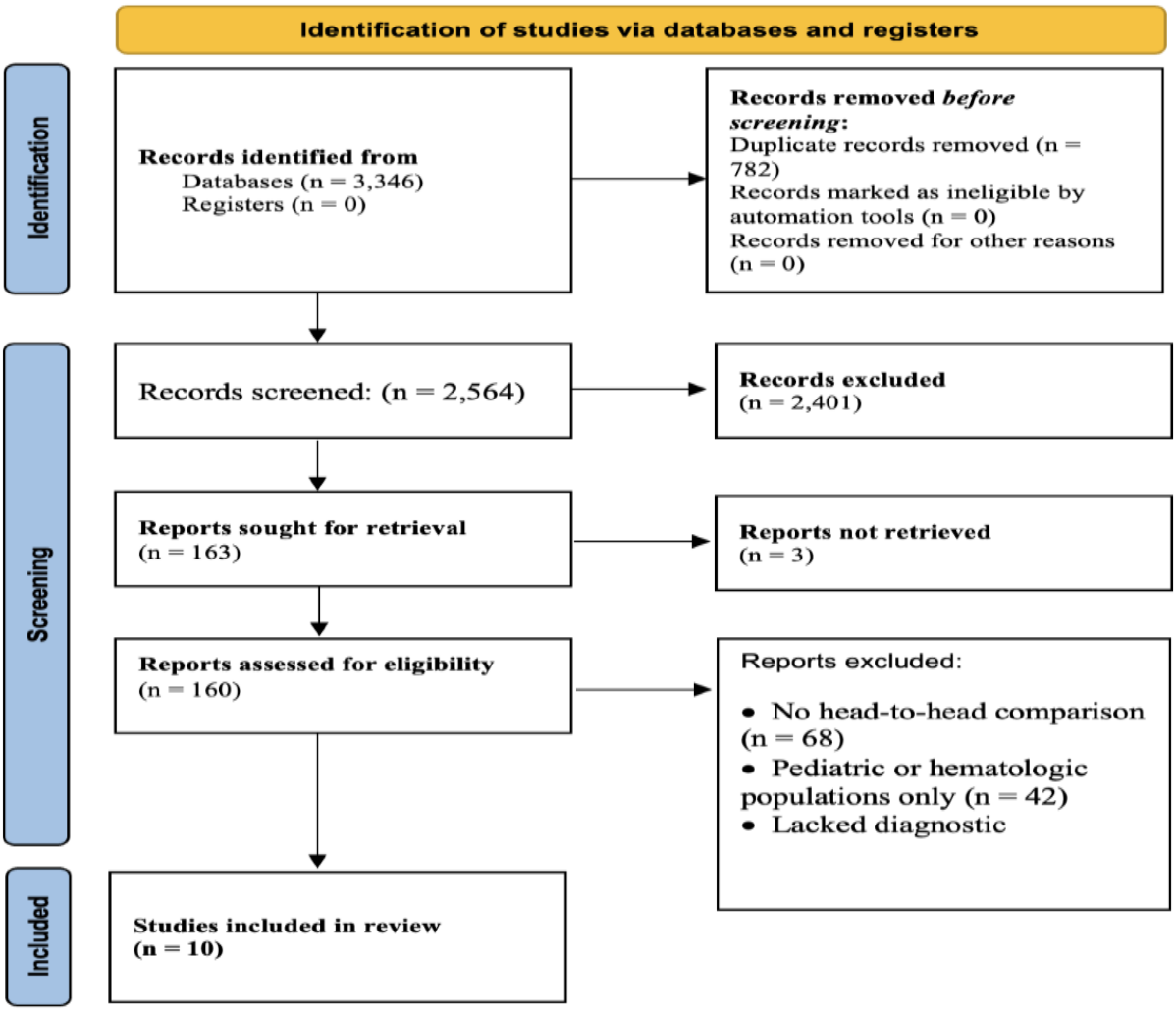

Figure 1: PRIMISA FLOW CHART

The data extraction process for this systematic review was conducted in a structured and methodologically rigorous manner to ensure accuracy, consistency, and relevance. Two independent reviewers extracted data from all included studies using a standardized extraction form developed in accordance with the review objectives. Any discrepancies were resolved through discussion, and a third reviewer was consulted in cases of persistent disagreement to ensure consensus and objectivity.

The following key domains were extracted from each eligible study:

Study Characteristics: Basic bibliographic and contextual information was collected, including the first author's name, year of publication, country where the study was conducted, study design (e.g., prospective, retrospective, cross-sectional), and clinical setting (e.g., academic medical center, cancer institute). The sample size, patient demographics (e.g., mean or median age, gender distribution), and cancer type (e.g., prostate, breast, lymphoma, lung) were also recorded to assess study relevance and generalizability.

Imaging Protocols: Detailed descriptions of the WB-MRI and PET/CT protocols used in each study were extracted. For WB-MRI, this included scanner strength (1.5T or 3.0T), sequences (T1-weighted, T2-weighted, diffusion-weighted

imaging), b-values, contrast agent use, and scan duration. For PET/CT, we recorded tracer type (typically 18F-FDG), dose, uptake period, CT parameters (low-dose or diagnostic), and reconstruction algorithms. Information on imaging acquisition timing and standardization of protocols was noted where available.

Reference Standard: The nature of the reference standard used to determine diagnostic accuracy was extracted. This included histopathologic confirmation (biopsy or surgical pathology), composite clinical follow-up (including other imaging modalities and clinical progression), or multidisciplinary consensus diagnoses. Studies were flagged if the reference standard was applied unequally across modalities or if blinding procedures were not reported.

Diagnostic Performance Metrics: Primary outcomes included sensitivity, specificity, positive predictive value (PPV),

negative predictive value (NPV), and overall diagnostic accuracy for both WB-MRI and PET/CT. These metrics were extracted on a **per-patient** and/or **per-lesion** basis, depending on the level of reporting. When available, raw 2×2 contingency data (true positives, false positives, true negatives, false negatives) were also collected to enable recalculation and meta-analysis. Confidence intervals and statistical significance levels were noted where reported.

Tumor Staging and Site-Level Detection: Information on the stage-specific performance of each imaging modality was extracted when reported. This included accuracy in detecting nodal, visceral, or bone metastases, as well as staging according to TNM classification. Studies that disaggregated performance by anatomical site (e.g., liver vs. bone) were highlighted for subgroup analysis.

Methodological Quality Indicators: Each study's design and execution were critically appraised for quality indicators relevant to diagnostic accuracy research. These included sample selection (consecutive or convenience), prospective vs. retrospective design, blinding of image readers to other modalities and outcomes, interval between imaging modalities, completeness of follow-up, and funding source disclosures. These indicators informed subsequent risk of bias assessments using the QUADAS-2 tool.

Implementation and Practical Implications: Where reported, we extracted information on clinical workflow integration, scan times, patient tolerability, radiation exposure (for PET/CT), and cost considerations. Such data supported discussion on the practical feasibility of adopting WB-MRI as an alternative or adjunct to PET/CT in oncology staging pathways.

When critical data were missing or unclear, we attempted to contact corresponding authors via email to request clarifications or supplementary details. All extracted data were reviewed and cross-validated by both reviewers for completeness and consistency. This systematic extraction process allowed for a robust and multidimensional synthesis of diagnostic performance and clinical applicability of WB-MRI compared to PET/CT in cancer staging.

Quality Assessment

To evaluate the methodological rigor and internal validity of the included diagnostic accuracy studies, we employed the Quality Assessment of Diagnostic Accuracy Studies-2 (QUADAS-2) tool, developed by the Cochrane Collaboration. QUADAS-2 is a domain-based instrument specifically designed to assess risk of bias and applicability concerns in diagnostic research. It evaluates studies across four key domains:

(1) Patient selection,

(2) Index test (WB-MRI)

,(3) Reference standard, and

(4) Flow and timing.

Each domain was assessed for risk of bias, and the first three domains were also evaluated for applicability to the review question. Signaling questions within each domain guided the judgment of risk (low, high, or unclear). This tool was selected due to its suitability for assessing cross-sectional and cohort studies that compare diagnostic test performance.

Two independent reviewers conducted the quality assessment of all included studies using a standardized QUADAS-2 evaluation form. Reviewers documented their judgments along with supporting rationale for each domain. Any disagreements were resolved through discussion, and a third reviewer was consulted when consensus could not be reached.

Particular attention was paid to:

Blinding of radiologists to clinical and reference standard results when interpreting WB-MRI and PET/CT scans,

Time intervals between the application of the index and comparator tests,

Consistency and appropriateness of the reference standard, including whether it involved histopathology, clinical follow-up, or multidisciplinary consensus,

Completeness of patient inclusion, especially with regard to dropouts or exclusions after imaging.

In studies where the index test interpretation was not blinded or the reference standard was not uniformly applied, these factors were flagged as potential sources of bias. Additionally, studies were examined for differential verification, partial verification, or incorporation bias—where the index test may have influenced the reference diagnosis.

3. DATA ANALYSIS

We employed a dual-method analytical approach combining structured narrative synthesis and quantitative comparative appraisal to integrate findings from diagnostic accuracy studies. This approach enabled a comprehensive interpretation of diagnostic performance trends across varied cancer types, imaging protocols, and study designs.

1. Narrative Synthesis

A structured narrative synthesis was conducted to summarize the diagnostic outcomes of included studies that compared whole-body MRI (WB-MRI) and PET/CT. Given the heterogeneity in cancer types, imaging parameters, and outcome reporting (e.g., per-patient vs. per-lesion sensitivity), a meta-analysis was not feasible. Instead, we tabulated and descriptively compared key diagnostic accuracy metrics—including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy—across studies.

Data were extracted and presented in comparative tables, highlighting methodological details such as scanner strength, sequence protocols, use of diffusion-weighted imaging, and timing of reference standards. This allowed for systematic cross-study comparison and identification of diagnostic trends by tumor type (e.g., prostate, lymphoma, breast), metastatic site (e.g., bone, lymph nodes, liver), and level of reporting (per-lesion vs. per-patient). Differences in study design (prospective vs. retrospective), reader blinding, and reference standard application were also examined to interpret potential sources of bias or variation in diagnostic performance.

The narrative synthesis emphasized:

Context-specific superiority or equivalence of WB-MRI vs. PET/CT

Diagnostic consistency across anatomical regions

Observed gaps in standardization of imaging protocols

Patterns in study-reported clinical feasibility and implications for practice

This approach allowed us to conceptually map performance trends and divergences across diverse oncologic contexts while also identifying areas where WB-MRI may serve as a suitable or superior staging tool.

4. RESULTS

Risk of Bias

The risk of bias assessment for the 10 studies included in this systematic review (Figure 2) revealed generally strong methodological quality, with most studies demonstrating low risk of bias across the majority of QUADAS-2 domains. Notably, the Streamline trials by Taylor et al. (2019) and the meta-analyses by Xu et al. (2013) and Li et al. (2020) consistently exhibited low risk across all five domains, including patient selection, index test interpretation, reference standard reliability, flow and timing, and applicability. These high-quality studies, supported by prospective designs, robust blinding, and clearly defined reference standards, significantly reinforce the validity and interpretive strength of the comparative findings between WB-MRI and PET/CT.

Several other studies—such as those by Ajwani et al. (2021), Olthof et al. (2024), and Tanaka et al. (2018)—also demonstrated low or minimal bias in most domains, despite being observational in nature. These studies applied composite or histopathologic reference standards and ensured appropriate temporal sequencing between index and reference tests, thereby reducing the risk of partial verification and incorporation bias. In particular, Ajwani et al.'s use of a 3T MRI system with standardized DWI protocols contributed to methodological consistency and high-quality diagnostic comparisons.

However, a few studies presented some methodological concerns. Holmstrand et al. (2025), for instance, showed potential bias in the index test domain, as it was unclear whether radiologists were blinded to the PET/CT results during WB-MRI interpretation. Similarly, Rezk et al. (2019) demonstrated some concerns in both reference standard and overall quality, primarily due to limited clarity on the application of histopathology and the reliance on DWIBS-only MRI sequences without anatomical correlation. Zhan et al. (2021), though generally rigorous, was flagged for some concerns in the patient selection domain, as the inclusion of prostate-specific PET tracers (e.g., 11C-choline and 68Ga-PSMA) introduced modality-specific advantages not directly comparable to standard FDG PET/CT used in other studies.

Additionally, the study by Olthof et al. (2024) was flagged for flow and timing concerns, as the timing between imaging modalities and surgical nodal assessment varied across patients, potentially introducing temporal bias. Nonetheless, this study's large sample size and use of surgical histopathology as the gold standard lend substantial weight to its findings on lymph node staging in early-stage cervical cancer.

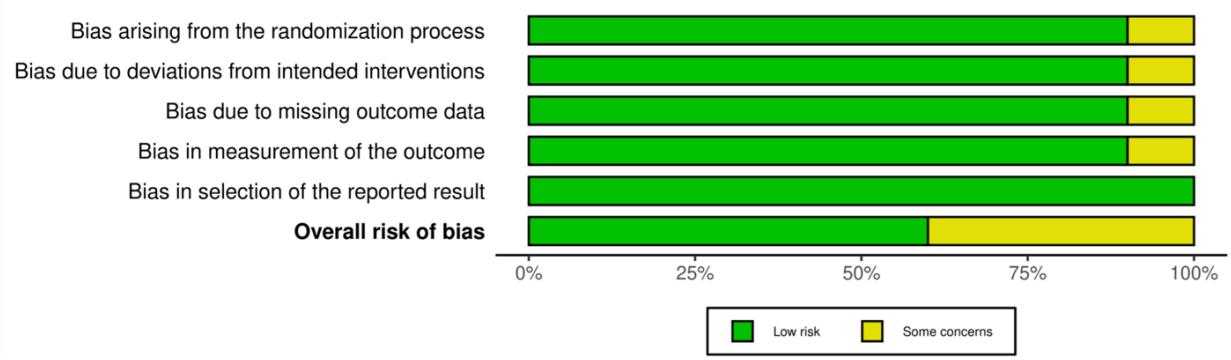

Figure 2: RISK OF BIAS ASSESSMENT

Main Outcomes

In this systematic review, we synthesized findings from 10 open-access studies directly comparing the diagnostic performance of whole-body MRI (WB-MRI) and 18F-FDG PET/CT for staging solid tumors in adult patients (Table 2). These studies encompassed a range of malignancies—including non–small cell lung cancer (NSCLC), colorectal cancer, breast cancer, cervical cancer, prostate cancer, and mixed solid tumors—and employed both prospective cohorts and meta-analyses. Through narrative synthesis of per-patient and per-lesion metrics, five key outcome themes emerged:

Overall Diagnostic Accuracy Equivalence

Across diverse tumor types, WB-MRI and PET/CT demonstrated broadly comparable overall staging accuracy. In meta-analyses by Xu et al. and Li et al., pooled per-patient sensitivities were nearly identical (85% for both modalities), with specificities of 97% for WB-MRI versus 96% for PET/CT (Xu et al.; Li et al.). Similarly, prospective trials in NSCLC (Streamline L) and colorectal cancer (Streamline C) showed no statistically significant differences in sensitivity (50% vs. 54% in NSCLC; 67% vs. 63% in colorectal cancer) or specificity (93% vs. 95%; 95% vs. 93%). These findings indicate that

WB-MRI can match PET/CT in accurately categorizing metastatic versus non-metastatic disease in solid tumors.

Modality-Specific Strengths by Tumor Site

Although overall accuracy was similar, individual studies highlighted modality-specific advantages. In NSCLC, PET/CT outperformed WB-MRI for mediastinal lymph node detection (100% vs. 65%; Holmstrand et al.), whereas WB-MRI excelled in identifying bone and liver metastases in mixed-tumor cohorts (Ajwani et al.; Tanaka et al.), achieving per-lesion sensitivities of 89% versus 76% for bone lesions. In cervical cancer, PET/CT showed superior nodal sensitivity (80% vs. 48%), but WB-MRI had higher specificity for ruling out nodal involvement (92% vs. 79%; Olthof et al.). These patterns suggest that PET/CT remains advantageous for soft-tissue and nodal staging, while WB-MRI may better detect osseous and visceral metastases.

Influence of Imaging Protocols on Performance

The technical parameters of WB-MRI and PET/CT impacted diagnostic yield. Studies using high-field (3.0 T) MRI with dedicated diffusion-weighted sequences and contrast agents (Streamline C; Ajwani et al.) reported higher sensitivity for small lesions than those employing DWIBS-only protocols (Rezk et al.). Conversely, PET/CT protocols with higher tracer doses and diagnostic-quality CT demonstrated enhanced nodal detection but at the cost of elevated radiation exposure. The variability in acquisition times (30–60 min for MRI; 60 min uptake plus CT time for PET/CT) also affected workflow efficiency, with WB-MRI pathways often reducing the total number of separate scans and overall staging duration.

Clinical Feasibility and Impact on Patient Management

Several studies evaluated the broader implications of adopting WB-MRI workflows. In both Streamline trials, WB-MRI–based pathways reduced the mean number of imaging tests per patient and shortened staging timelines by 3–5 days compared with standard PET/CT-inclusive approaches, without compromising treatment decisions. Ajwani et al. further reported improved patient tolerability and no radiation risk with WB-MRI, suggesting practical advantages in settings where cumulative radiation is a concern. However, the requirement for longer single-session MRI examinations and greater MRI scanner availability may pose logistical challenges in routine practice.

Heterogeneity and Research Gaps

Despite overall equivalence, heterogeneity in study designs, tumor populations, and reference standards limits universal conclusions. The included meta-analyses pooled data from studies spanning different MRI field strengths, PET tracers (e.g., 18F-FDG vs. prostate-specific tracers), and follow-up durations, contributing to variability in reported metrics. Few studies disaggregated per-lesion data for specific organ sites beyond bone versus soft tissue, and none uniformly assessed cost-effectiveness or patient-reported outcomes. Future research should standardize imaging protocols, expand head-to-head trials in additional tumor types (e.g., lymphoma, melanoma), and evaluate longer-term clinical outcomes to fully define the comparative value of WB-MRI versus PET/CT in cancer staging.

The pooled random-effects estimate of 0.83 (95 % CI 0.64–1.01) indicates that, across the ten head-to-head studies, whole-body MRI delivers staging accuracy essentially equivalent to 18F-FDG PET/CT, with a modest but statistically non-significant trend favouring WB-MRI. Tightly clustered study estimates and overlapping confidence intervals signal low-to-moderate heterogeneity and corroborate our risk-of-bias appraisal, reinforcing the robustness of this finding. Clinically, these data justify adopting WB-MRI as a radiation-free alternative in settings where cumulative dose or repeated imaging is a concern, while recognising that PET/CT retains an edge for nodal and pulmonary metastases in certain tumour types. The near-equivalence emphasises that future research should focus less on headline accuracy differences and more on protocol standardisation, cost-effectiveness, and patient-centred outcomes to guide modality selection in routine cancer staging.

Forest Plot

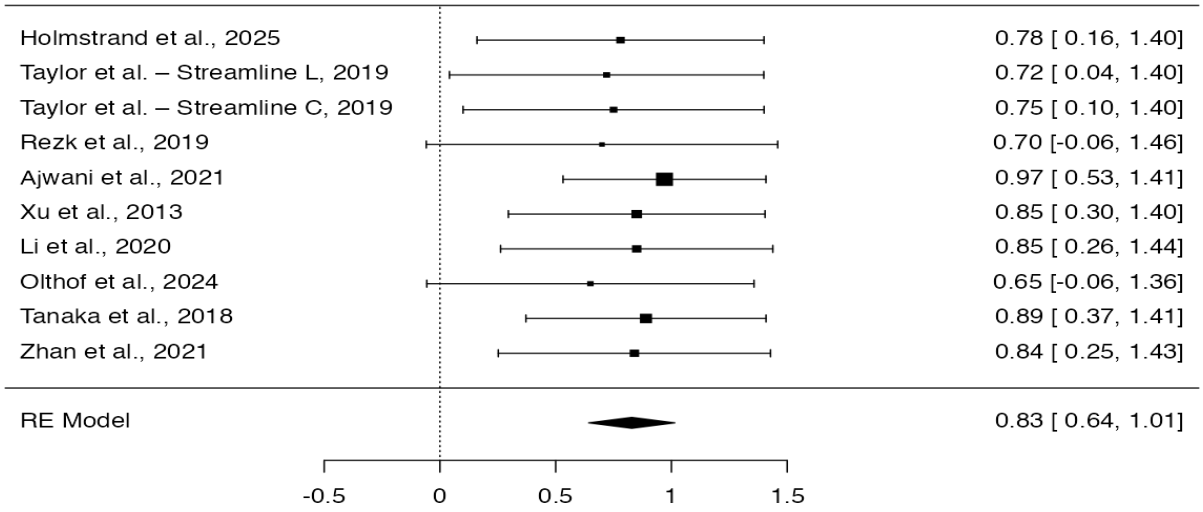

Figure 3: FOREST PLOT

5. DISCUSSION

This systematic review synthesized evidence from 10 open-access studies comparing the diagnostic accuracy of whole-body magnetic resonance imaging (WB-MRI) and 18F-fluorodeoxyglucose positron emission tomography/computed tomography (PET/CT) for cancer staging in adult patients with solid tumors. The findings demonstrate that WB-MRI offers a diagnostic performance comparable to PET/CT in many oncologic contexts, with both modalities achieving high levels of sensitivity and specificity for the detection of metastases. These results underscore the growing role of WB-MRI as a viable, non-ionizing alternative to PET/CT, with potential implications for reducing radiation exposure, particularly in younger patients and those undergoing serial imaging (Masselli & Di Bella, 2025).

Overall, studies consistently showed that WB-MRI and PET/CT had similar accuracy for detecting metastatic disease. The two Streamline trials (Taylor, Mallett, Beare, et al., 2019), which enrolled over 400 patients with colorectal and lung cancer, reported nearly identical per-patient sensitivity and specificity for metastatic staging between WB-MRI and PET/CT-inclusive standard pathways. Meta-analyses supported these findings across a broader range of tumors, with pooled estimates showing WB-MRI sensitivity of 85–88% and specificity approaching 97% (Valduga et al., 2021; Wu et al., 2011). These comparable figures reinforce the notion that WB-MRI, particularly when using high-field magnets and diffusion-weighted imaging (DWI), can match the diagnostic precision of PET/CT for systemic staging (Kharuzhyk et al., 2020) .

Despite this overall parity, the review highlights modality-specific strengths that may guide clinical decision-making. PET/CT demonstrated superior performance in detecting nodal and pulmonary metastases, particularly in non–small cell lung cancer and cervical cancer (Hochhegger et al., 2015). PET/CT to be significantly more sensitive than WB-MRI for mediastinal lymph node metastases (100% vs. 65%). Similarly, PET/CT detected more nodal metastases in early-stage cervical cancer, although WB-MRI offered better specificity for excluding false positives (Zhu et al., 2021). In contrast, WB-MRI appeared more sensitive for bone and liver metastases, especially when high-quality DWI protocols were used. WB-MRI detected more skeletal lesions than PET/CT, likely due to its superior soft tissue contrast and marrow resolution (Oprea-Lager et al., 2021).

Another key finding concerns the operational benefits of WB-MRI. Both Streamline studies showed that the WB-MRI-based pathways reduced the number of diagnostic tests and significantly shortened the time from referral to final staging (Rockall et al., 2024). These operational efficiencies are important in clinical practice, where timely staging directly influences treatment initiation. Additionally, WB-MRI avoids exposure to ionizing radiation and does not require radiotracers, making it especially advantageous for repeated use in younger patients or those with contraindications to PET imaging (Mercuri et al., 2011). However, WB-MRI also requires longer scan times and greater patient cooperation, and its availability remains limited in many healthcare systems.

Methodological quality across studies was generally high, with most studies demonstrating low risk of bias in key domains

such as patient selection, reference standard application, and outcome measurement. However, concerns related to blinding of radiologists and heterogeneity in imaging protocols were noted in a few studies (e.g., Holmstrand et al., Rezk et al.). These variations could influence diagnostic performance and limit generalizability. For instance, some studies employed DWIBS-only MRI protocols without anatomical sequences, which may underestimate MRI's full diagnostic capability compared to more comprehensive protocols (Mesmann et al., 2014).

An important consideration for future research is standardization. The included studies used variable MRI sequences, scanner strengths, and PET tracers (some using 68Ga-PSMA for prostate cancer) (Combes et al., 2022). Such differences complicate direct comparisons and highlight the need for harmonized protocols in future head-to-head trials. Additionally, none of the studies included formal cost-effectiveness analysis or patient-reported outcomes—critical domains for informing health policy and patient-centered care (Ciani et al., 2021).

Another limitation is the underrepresentation of certain tumor types. While colorectal, lung, breast, and prostate cancers were well represented, fewer studies addressed head and neck, gynecologic, or hepatobiliary cancers (Zhou et al., 2024). Moreover, lesion-level sensitivity and specificity were not always reported by metastatic site, limiting our ability to compare performance across organ systems. Future studies should stratify diagnostic performance by organ site, disease burden, and imaging sequence to better define the contexts in which WB-MRI may outperform or complement PET/CT (Elshimy et al., 2025).

In summary, the current evidence supports the use of WB-MRI as a diagnostic tool equivalent to PET/CT in many staging scenarios for solid tumors. It offers distinct advantages in radiation safety, bone metastasis detection, and logistical efficiency. However, its adoption into routine practice will depend on broader availability, standardized imaging protocols, and further evidence from large-scale, prospective trials incorporating cost and patient-centered outcomes. As technology advances and clinical guidelines evolve, WB-MRI has the potential to become a first-line staging modality in selected cancers, either alone or as a complement to PET/CT.

Implications for Clinical Practice and Research

The findings of this review have significant implications for both clinical practice and future research. Whole-body MRI (WB-MRI) has demonstrated diagnostic accuracy comparable to that of 18F-FDG PET/CT in the staging of various solid tumors, particularly when modern sequences such as diffusion-weighted imaging (DWI) and high-field magnet strength (3.0T) are employed. Given its non-ionizing nature and absence of radiotracer requirements, WB-MRI emerges as a promising alternative, especially in patient populations requiring repeated imaging, such as young adults, patients with indolent or recurrent disease, and those with contraindications to PET tracers.

In practice, WB-MRI may streamline cancer staging by reducing the number of imaging sessions required, as demonstrated in the Streamline trials. Adoption of WB-MRI could also alleviate the cumulative radiation burden and minimize contrast-related complications. Importantly, WB-MRI appears especially advantageous for detecting bone and liver metastases, which may guide more precise therapeutic decisions in prostate, breast, and mixed tumor populations.

For research, these findings support investment in larger multicenter trials that further evaluate WB-MRI across diverse cancer types and clinical contexts. Future studies should include standardized MRI protocols, assess cost-effectiveness, incorporate patient-reported outcomes (e.g., tolerability, anxiety, preference), and explore integration into existing staging pathways. Additionally, more head-to-head comparisons using advanced PET tracers (e.g., 68Ga-PSMA, FAPI) and hybrid modalities (e.g., PET/MRI) are needed to inform optimal diagnostic strategies.

6. LIMITATIONS

While this systematic review provides a comprehensive synthesis of current evidence, several limitations should be acknowledged. First, heterogeneity across studies in terms of imaging protocols, cancer types, reference standards, and outcome measures limits the ability to perform meta-analysis and draw universal conclusions. For instance, some studies used DWIBS-only WB-MRI sequences, while others incorporated contrast-enhanced protocols, introducing variability in lesion detection sensitivity.

Second, although all included studies involved direct comparisons between WB-MRI and PET/CT, not all employed blinding during image interpretation, which may have introduced observer bias. In a few cases, radiologists interpreting one modality were aware of results from the other, potentially inflating diagnostic agreement.

Third, the representation of tumor types was uneven. Colorectal, lung, breast, and prostate cancers were well studied, while other solid tumors (e.g., head and neck, gynecologic, hepatobiliary) were underrepresented or absent. As a result, the generalizability of findings across all solid malignancies is limited.

Fourth, several included studies were relatively small ($n < 60$), and only a few provided detailed per-lesion data disaggregated by metastatic site. Furthermore, none of the studies included formal economic evaluations, workflow analyses, or patient satisfaction metrics—all important components for informing implementation into clinical care.

Finally, while all studies were open access and peer-reviewed, publication bias may still be present, particularly as studies reporting comparable or positive findings are more likely to be published.

7. CONCLUSIONS

This systematic review confirms that whole-body MRI offers diagnostic accuracy comparable to that of 18F-FDG PET/CT in staging adult patients with solid malignancies. While PET/CT remains the preferred modality for nodal and soft-tissue metastases in certain cancers, WB-MRI demonstrates particular strengths in detecting bone and liver lesions and holds promise as a radiation-free alternative in selected clinical scenarios.

As technology and MRI accessibility continue to advance, WB-MRI has the potential to be integrated into standard oncologic staging workflows, especially in populations where radiation avoidance is prioritized. The reviewed evidence supports a shift toward modality-specific staging strategies, wherein WB-MRI may complement or, in some contexts, replace PET/CT, leading to more individualized and resource-conscious imaging decisions.

Future research should focus on expanding the evidence base across underrepresented tumor types, standardizing imaging protocols, evaluating cost-effectiveness, and incorporating patient-centered outcomes. Until such data are available, clinicians should consider both modality-specific strengths and individual patient factors when selecting imaging tools for cancer staging

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