Scientific Research Publishing

Journal of Cancer Therapy, 2026, 17(9), 449-459
https://www.scirp.org/journal/jct
ISSN Online: 2151-1942
ISSN Print: 2151-1934

Palliative Radiotherapy for Painful Bone Metastases: Experience from Bogodogo University Teaching Hospital, Burkina Faso

Gael Kietga*, Bertrand Compaore, Landry Zoungrana, Noufou Ouedraogo, Esdras Zongo

Department of Radiotherapy, CHU Bogodogo University Teaching, Training and Research Unit in Health Sciences (UFR/SDS), Joseph Ki-Zerbo University, Ouagadougou, Burkina Faso
Email: *gaelkietga@yahoo.fr

How to cite this paper: Kietga, G., Compaore, B., Zoungrana, L., Ouedraogo, N. and Zongo, E. (2026) Palliative Radiotherapy for Painful Bone Metastases: Experience from Bogodogo University Teaching Hospital, Burkina Faso. *Journal of Cancer Therapy*, **17**, 449-459.
https://doi.org/10.4236/jct.2026.179038

Received: August 5, 2026
Accepted: September 14, 2026
Published: September 17, 2026

Abstract

Introduction: Cancer remains a leading cause of global mortality, and bone metastases are among the most frequent complications of solid tumors, with incidence rising as survival after primary cancer treatment improves. Since bone metastases usually signal incurable disease, palliative radiotherapy accounting for over half of radiation oncology workloads worldwide is the mainstay of symptom management. While practice patterns have been well documented in North America, Europe, and Oceania, data from Africa remain limited. This study reports the experience of Bogodogo University Teaching Hospital (Burkina Faso) in managing patients receiving radiotherapy for painful bone metastases. **Methods:** A retrospective observational study included all patients treated with palliative radiotherapy for symptomatic bone metastases. Pain response was assessed against pre-treatment scores using internationally recognized criteria. Collected variables included age, sex, primary tumor site, metastatic site, lesion number, analgesic use, radiation dose/fractionation, and clinical evolution. Asymptomatic bone metastases, symptomatic non-bone metastases, and primary bone cancers were excluded. Follow-up occurred at day 3 and month 1. **Results:** Among 300 patients treated over one year, 24 (8%) had symptomatic bone metastases (58% male; median age 57.5, range 36 - 87). Prostate (41.67%), lung (33.33%), and breast (25%) cancers were the leading primary sites. The lumbar spine (58%) was the most common metastatic location. CT scan was the predominant imaging modality (66.6%). Most patients received 30 Gy (58%) or 20 Gy (42%). Overall pain response was 66.66% at 72 hours and 83.33% at one month. **Discussion/Conclusion:** Despite retrospective, single-center limitations and the difficulty of isolating radiotherapy's effect from adjustments in oral analgesics, our results demonstrate an improvement in pain

following radiotherapy of palliative radiotherapy in resource-limited settings. Expanding this research through larger multicenter cohorts will be essential to optimize palliative care delivery regionally.

Keywords

Bone Metastases, Palliative Radiotherapy, Pain Relief, Sub-Saharan Africa

1. Introduction

Cancer is a major and growing global public health challenge, making it one of the top causes of mortality after Cardiovascular diseases, with nearly one in six deaths globally attributing to cancer each year [1].

Bones are one of the most common sites of metastases for many types of solid cancers [2]-[4].

The number of patients with this metastasis is likely to increase due to improved treatment options for primary tumors and subsequent longer survival [5].

As the diagnosis of bone metastases often represents incurable disease, the main treatment goal is palliation of symptoms [6] [7].

Palliative radiotherapy (RT) constitutes more than 50% of the workload in radiation oncology departments worldwide: [8].

Surveys of patterns of practice in North America, Europe, Australia, and New Zealand [9]-[15] have been published, mainly regarding management of bone metastases.

Few studies have evaluated the management of bone metastases using radiotherapy in Africa.

The aim of this study was to report the experience of the Bogodogo University Teaching Hospital in the care pathway of patients treated with radiotherapy for bone metastases in Burkina Faso.

2. Methods

This retrospective observational study included all consecutive patients who received palliative radiotherapy for painful bone metastases at the Radiotherapy Department of CHU Bogodogo between 02/09/2024 and 08/09/2025. Data were extracted from *patient medical records* and all eligible patients meeting the inclusion criteria during this period were included, with no additional sampling.

Baseline demographic information was collected from all patients including age, gender, primary cancer site, site of bone metastases, number of bone metastases, Analgesy, Radiation: dose, number of fractions, evolution. Non-inclusion criteria: All patients with asymptomatic bone metastasis; Symptomatic non-bone metastasis; Primary Bone cancers.

Follow up was after Day 3 and Month 1.

	Definition of response criteria
Complete response	Pain score = 0 at the treated site Without concomitant increase in analgesic consumption, which remained stable or decreased
Partial response	Reduction in pain score ≥2 at the treated site without increase in analgesic consumption or decrease in analgesic consumption ≥25% without increase in pain
Progression	Increase in pain score ≥2 at the irradiated site with stable pain medication consumption Or Increase ≥25% in pain medication consumption with stable pain score ±1 point
Undetermined response	Any response that does not meet the definition of a complete, partial or progressive response

2.1. Ethical Considerations

This study was conducted in strict accordance with the ethical principles for medical research involving human subjects outlined in the Declaration of Helsinki. Administrative and institutional authorization to access and analyze the medical records was granted by the management of the Centre Hospitalier Universitaire de Bogodogo (Ouagadougou, Burkina Faso). Owing to the retrospective, non-interventional design of the study utilizing secondary routine clinical data, the requirement for individual written informed consent was waived. Patient confidentiality was strictly preserved; all data were fully anonymized and de-identified using numerical codes prior to statistical analysis traduction.

2.2. Radiotherapy Technique and Fractionation Selection

Fractionation schedule (20 Gy in 5 fractions or 30 Gy in 10 fractions) was selected by the treating radiation oncologist based on *performance status*. All patients were treated using 3*D-conformal radiotherapy and IMRT*. Target volume delineation was performed in accordance with the French Society for Radiation Oncology (SFRO) RecoRad™ 2022 guidelines. For standard spinal bone metastases, the clinical target volume (CTV) encompassed the involved vertebra along with the adjacent upper and lower vertebral levels ($N \pm 1$). In the presence of epidural extension (epiduritis), target delineation was modified to extend the CTV longitudinally further above and below the affected segment to ensure full coverage of intraspinal tumor spread. An isotropic expansion margin of 5 to 10 mm was applied to the CTV to construct the planning target volume (PTV) to account for patient positioning and setup uncertainties.

2.3. Assessment of Pain Response

Pain intensity was assessed using the *Visual Analogue Scale* (*VAS*), 0 - 10, recorded at baseline and at each follow-up visit by the *treating radiation oncologist*. Analgesic consumption was quantified by converting all analgesics to oral morphine equivalent daily dose (OMEDD) using standard equianalgesic conversion

tables, recorded by *the same evaluator* at baseline, day 3, and month 1.

Treatment response was classified according to the International Consensus Endpoints for palliative bone metastases radiotherapy trials (Chow *et al*., 2012, International Journal of Radiation Oncology, Biology, Physics). Complete response was defined as a pain score of 0 at the treated site with no increase in analgesic intake; partial response as a pain score reduction of ≥2 points without an increase in analgesic intake, or a reduction in OMEDD of ≥25% without an increase in pain score; progression as an increase in pain score of ≥2 points with a stable or increased OMEDD, or a ≥25% increase in OMEDD with a stable or increased pain score; and indeterminate response as any case not meeting the above criteria, including missing data. Analgesic doses were converted to oral morphine equivalents (OMEDD) prior to applying these criteria.

3. Results

Over a 1-year period, our radiotherapy department treated 300 patients across all cancer stages. Among them, 24 consecutive patients with symptomatic bone metastases were included in this study, comprising 14 males (58.3%) and 10 females (41.7%).

At Day 3 (72 hours), pain evaluation was performed for all 24 patients (100.0%). Based on international consensus criteria, 18 patients (75.0%) had a classified clinical response 4 (16.7%) complete responses, 12 (50.0%) partial responses, and 2 (8.3%) progressions while 6 patients (25.0%) were categorized as undetermined response due to incomplete analgesic or pain score documentation.

At Month 1, an overall pain response (complete or partial) was observed in 20 patients (83.3%). A total of 4 patients (16.7%) were classified as undetermined response: 3 due to missing follow-up data comprising intercurrent death (n = 2) and loss to follow-up/unavailable records (n = 1) and 1 due to incomplete pain assessment documentation.

Males predominate with 14 (58%) out of 10 (42%) female.

The characteristics of the patients are summarised in Table 1.

Table 1. Demographics.

Characteristics	n (%)
Total Number of patients	24 (100)
Male	14 (58%)
Female	10 (42%)
Mean age (range)	57.5 years (36 - 87 years)

The median ages were 57.5 with extremes 36 and 87. Primary sites were balanced with Prostate 10 (41.67%) Lung 8 (33.33%) Breast 6 (25%) Table 2.

Table 2. Primary sites.

Location	Number of Patients
Prostate	10 (41.67%)
Lung	8 (33.33%)
Breast	6 (25%)

Lumbar location was the most frequent with 14 cases (58%), Follow by sacrum 4 (16.66%) Table 3.

Table 3. Sites of secondary location.

Location	Number of patients
Lumbar bone	14 (58.33%)
Sacrum	4 (16.68%)
Shoulder	2 (8.33%)
Cervical bone	2 (8.33%)
Thoracic bone	2 (8.33%)

CT scan was the most frequently used imaging modality for the detection of bone metastases, representing 16 cases (66.6%), followed by MRI in 6 cases (25%) and bone scintigraphy in 2 case (8.3%) Table 4.

Table 4. Imaging modalities used for diagnostic of metastatic sites.

Type of imaging modalities	Number of patients (%)
CTAP	16 (66.67%)
MRI	6 (25%)
BONE SCINTIGRAPHY	2 (8.33%)

Patients were seen in consultation, simulated, started on treatment within the same week. 14 patients (58%) received a dose of 30 Gy of antalgic radiation therapy 10 Patients (42%) dose of 20 Gy Table 5.

Table 5. Radiation therapy dose.

DOSE	Number of patients (%)
30 Gy	14 (58.33%)
20Gy	10 (41.67%)

Seventy-two hours after treatment 16 (66.66%) patients have overall response

Table 6.

Table 6. Evaluation after 72 h.

EVALUATION	Number of Patients (%)
COMPLETE RESPONSE	4 (16.66%)
PARTIAL RESPONSE	12 (50%)
PROGRESSION	2 (8.33%)
UNDETERMINED	6 (25%)

After 1 month 20 (83.33%) have an overall response **Table 7**.

Table 7. Evaluation after 1 month.

EVALUATION	Number of Patients (%)
COMPLETE RESPONSE	8 (33.33%)
PARTIAL RESPONSE	12 (50%)
PROGRESSION	0
UNDETERMINED	4 (16.66%)

4. Discussion

4.1. Median Age

The median age at diagnosis of cancer in our study is globally lower 57.5 years. It's globally the same like a others study in Africa in Ibadan Nigeria 45 years and Dakar 53 years Senegal [16] [17] but remains lower than that reported in European populations [5]. This difference reflects the younger age structure of the Africa population and delayed diagnosis may contribute to earlier presentation with advanced disease.

4.2. Sex Ratio

The sex ratio observed in metastatic cancer cohorts is closely related to the distribution of primary tumor types. Male predominance is commonly reported in series with a high prevalence of prostate cancer, while female predominance is more frequently observed in cohorts where breast and gynecological malignancies are major contributors to metastatic disease.

Our study showed no more differences between male and female. In high income countries the sex ratio tends to be balanced due to significant contribution of breast cancer in women and lung cancer in both sexes [18]-[21].

4.3. Primary Site

In Our study, the three main primary tumors leading to bone metastases were

Prostate 10 (41.67%) Lung 8 (33.33%) Breast 6 (25%). Similar distributions have been reported in African series [22]-[24]. In a large retrospective analysis of the National Cancer Database (NCDB), encompassing 50,929 patients received palliative radiotherapy for osseous metastases. The most frequently represented primary tumor was non-small cell lung cancer (NSCLC), accounting for 45.2% of cases, followed by breast cancer (15.1%) and prostate cancer (10.8%) among patients treated with palliative bone radiotherapy [25].

The difference in ranking between African studies, where prostate cancer predominates, and the American NCDB study, where lung cancer is leading, may be explained by the late stage of presentation and underdiagnosis of lung cancer in African settings.

4.4. Imaging

In our study, CT scan was the most frequently used imaging modality for the detection of bone metastases, followed by MRI and bone scintigraphy. His finding is consistent with several international reports showing that CT remains one of the most commonly used imaging techniques in routine oncologic practice because it is widely available, fast, and frequently performed as part of staging or restaging examinations [26]-[28] although MRI and PET imaging have higher sensitivity for early marrow involvement [29]-[31].

In the African setting, the predominance of CT may also be explained by the limited availability of advanced imaging modalities such as MRI and PET, due to high costs, shortage of equipment, and unequal distribution of radiologic resources in Sub-Saharan Africa [32] [33].

4.5. Evaluation

In our study, overall response was observed in 66.66% of patients at 72 hours and increased to 83.33% at one month after radiotherapy.

In this large prospective real-world cohort study of patients with painful bone metastases treated with external beam radiotherapy (EBRT), approximately 70 % (n = 1442/2067) of patients experienced a partial or complete pain response between 2 and 12 weeks after treatment, according to internationally accepted response criteria. The median time to pain response was 4 weeks [34].

A recent Ethiopian prospective study reported overall response rates of 65%, 67%, and 78% at 2, 4, and 8 weeks respectively [35]. The higher responses rate observed in our study may be related to the small size.

Interestingly, the proportion of undetermined responses decreased from 25.0% at Day 3 to 16.7% at Month 1. This difference reflects the acute post-treatment phase, where rapid analgesic titrations and the lack of structured outpatient visits at 72 hours generated missing data, whereas the 1-month evaluation benefited from formal clinical consultation.

Our study is primarily limited by its retrospective, single-center design and small sample size, which naturally come with risks of selection bias and incom-

plete medical records. Additionally, separating the precise effect of radiotherapy from adjustments in oral pain medication was difficult. Nevertheless, these limitations reflect the true landscape of everyday palliative care, where radiation therapy is never an isolated intervention but part of a collaborative, urgent effort to ease patient suffering.

5. Conclusion

This study describes the experience of Bogodogo University Teaching Hospital in the management of patients with bone metastases treated with palliative radiotherapy in Burkina Faso. Although the retrospective design and concurrent changes in analgesic treatment limit the interpretation of our findings, an improvement in pain was observed following radiotherapy. However, in the absence of a comparison group, this improvement cannot be attributed only to radiotherapy. Nevertheless, these findings provide real-world insight into the use of palliative radiotherapy for bone metastases in a low-income setting where access to advanced cancer treatments remains limited. Larger prospective and multicenter studies are needed to further evaluate pain outcomes and help develop treatment strategies suited to resource-limited settings.

Author Contributions

Gaël Kietga: Conceptualization, Methodology, Formal analysis, Writing—original draft; Bertrand Compaore, Zoungrana Landry, Ouedraogo Noufou, Zongo Esdras—Data curation, Investigation, Resources.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Sung, H., Ferlay, J., Siegel, R.L., Laversanne, M., Soerjomataram, I., Jemal, A., *et al.* (2021) Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. *CA*: *A Cancer Journal for Clinicians*, **71**, 209-249. https://doi.org/10.3322/caac.21660

[2] Cook, G.J.R. and Thorpe, M.P. (2024) Bone Metastases. *The Cancer Journal*, **30**, 202-209. https://doi.org/10.1097/ppo.0000000000000717

[3] Deng, M., Ding, H., Zhou, Y., Qi, G. and Gan, J. (2025) Cancer Metastasis to the Bone: Mechanisms and Animal Models (Review). *Oncology Letters*, **29**, 1-12. https://doi.org/10.3892/ol.2025.14967

[4] Hernandez, R.K., Wade, S.W., Reich, A., Pirolli, M., Liede, A. and Lyman, G.H. (2018) Incidence of Bone Metastases in Patients with Solid Tumors: Analysis of Oncology Electronic Medical Records in the United States. *BMC Cancer*, **18**, Article No. 44. https://doi.org/10.1186/s12885-017-3922-0

[5] van der Velden, J.M., van der Linden, Y.M., Versteeg, A.L., Verlaan, J., Sophie Gerlich, A., Pielkenrood, B.J., *et al.* (2018) Evaluation of Effectiveness of Palliative Radiotherapy for Bone Metastases: A Prospective Cohort Study. *Journal of Radiation Oncology*, **7**, 325-333. https://doi.org/10.1007/s13566-018-0363-6

[6] Kirkbride, P. and Tannock, I.F. (2008) Trials in Palliative Treatment—Have the Goal Posts Been Moved? *The Lancet Oncology*, **9**, 186-187. https://doi.org/10.1016/s1470-2045(08)70041-x

[7] Westhoff, P.G., de Graeff, A., Monninkhof, E.M., Pomp, J., van Vulpen, M., Leer, J.W.H., *et al*. (2015) Quality of Life in Relation to Pain Response to Radiation Therapy for Painful Bone Metastases. *International Journal of Radiation Oncology Biology Physics*, **93**, 694-701. https://doi.org/10.1016/j.ijrobp.2015.06.024

[8] Sharma, V., Gaye, P.M., Wahab, S.A., Ndlovu, N., Ngoma, T., Vanderpuye, V., *et al*. (2008) Patterns of Practice of Palliative Radiotherapy in Africa, Part 1: Bone and Brain Metastases. *International Journal of Radiation Oncology Biology Physics*, **70**, 1195-1201. https://doi.org/10.1016/j.ijrobp.2007.07.2381

[9] Lievens, Y., Kesteloot, K., Rijnders, A., Kutcher, G. and Van den Bogaert, W. (2000) Differences in Palliative Radiotherapy for Bone Metastases within Western European Countries. *Radiotherapy and Oncology*, **56**, 297-303. https://doi.org/10.1016/s0167-8140(00)00215-2

[10] Chow, E., Danjoux, C., Wong, R., Szumacher, E., Franssen, E., Fung, K., *et al*. (2000) Palliation of Bone Metastases: A Survey of Patterns of Practice among Canadian Radiation Oncologists. *Radiotherapy and Oncology*, **56**, 305-314. https://doi.org/10.1016/s0167-8140(00)00238-3

[11] Roos, D.E. (2000) Continuing Reluctance to Use Single Fractions of Radiotherapy for Metastatic Bone Pain: An Australian and New Zealand Practice Survey and Literature Review. *Radiotherapy and Oncology*, **56**, 315-322. https://doi.org/10.1016/s0167-8140(00)00250-4

[12] Tsao, M.N., Lloyd, N.S. and Wong, R.K. (2005) Clinical Practice Guideline on the Optimal Radiotherapeutic Management of Brain Metastases. *BMC Cancer*, **5**, Article No. 34. https://doi.org/10.1186/1471-2407-5-34

[13] Maher, E.J. (1991) The Influence of National Attitudes on the Use of Radiotherapy in Advanced and Metastatic Cancer, with Particular Reference to Differences between the United Kingdom and the United States of America: Implications for Future Studies. *International Journal of Radiation Oncology Biology Physics*, **20**, 1369-1373. https://doi.org/10.1016/0360-3016(91)90251-x

[14] Haddad, P., Wong, R.K.S., Pond, G.R., Soban, F., Williams, D., McLean, M., *et al*. (2005) Factors Influencing the Use of Single vs Multiple Fractions of Palliative Radiotherapy for Bone Metastases: A 5-Year Review. *Clinical Oncology*, **17**, 430-434. https://doi.org/10.1016/j.clon.2005.03.012

[15] Chow, E., Zeng, L., Salvo, N., Dennis, K., Tsao, M. and Lutz, S. (2012) Update on the Systematic Review of Palliative Radiotherapy Trials for Bone Metastases. *Clinical Oncology*, **24**, 112-124. https://doi.org/10.1016/j.clon.2011.11.004

[16] Ka, K., Dieng, M.M., Gaye, P.M., Ndong, B., Yessoufou, M.I., Sall, E.H.A., *et al*. (2021) Analgesic Radiation Therapy for Bone Metastasis in Dakar. *World Journal of Advanced Research and Reviews*, **11**, 220-225. https://doi.org/10.30574/wjarr.2021.11.3.0451

[17] Ibrahim, H. and Umar, A. (2018) Pattern of Patients Presentation with Metastatic Breast Cancer for Palliative External Beam Radiotherapy in the University College Hospital Ibadan. *Annals of Tropical Pathology*, **9**, 131-134. https://doi.org/10.4103/atp.atp_36_18

[18] Ryan, C., Stoltzfus, K.C., Horn, S., Chen, H., Louie, A.V., Lehrer, E.J., *et al*. (2022) Epidemiology of Bone Metastases. *Bone*, **158**, Article ID: 115783. https://doi.org/10.1016/j.bone.2020.115783

[19] Jiang, W., Rixiati, Y., Zhao, B., Li, Y., Tang, C. and Liu, J. (2020) Incidence, Prevalence, and Outcomes of Systemic Malignancy with Bone Metastases. *Journal of Orthopaedic Surgery*, **28**, 1-5. https://doi.org/10.1177/2309499020915989

[20] Huang, J., Shen, J., Li, X., Rengan, R., Silvestris, N., Wang, M., *et al*. (2020) Incidence of Patients with Bone Metastases at Diagnosis of Solid Tumors in Adults: A Large Population-Based Study. *Annals of Translational Medicine*, **8**, 482-482. https://doi.org/10.21037/atm.2020.03.55

[21] Svensson, E., Christiansen, C.F., Ulrichsen, S.P., Rørth, M.R. and Sørensen, H.T. (2017) Survival after Bone Metastasis by Primary Cancer Type: A Danish Population-Based Cohort Study. *BMJ Open*, **7**, e016022. https://doi.org/10.1136/bmjopen-2017-016022

[22] Gbané, M., Soglo, J.C., Diomandé, M., Kengni, G.L., Ouattara, B., Kouassi, J.M.D., *et al*. (2020) Etiologies of Bone Metastases at the Rheumatology Department (UTH) of Abidjan. *Open Journal of Rheumatology and Autoimmune Diseases*, **10**, 1-7. https://doi.org/10.4236/ojra.2020.101001

[23] Kirakoya, B., Pare, A.K., Abubakar, B.M. and Kabore, M. (2017) Prostate Cancer Presenting with Parietal Bone Metastasis. *Case Reports in Urology*, **2017**, Article ID: 1928570. https://doi.org/10.1155/2017/1928570

[24] Amoako, Y.A., Hammond, E.N.B., Assasie-Gyimah, A., Laryea, D.O., Ankrah, A. and Amoah, G. (2019) Prostate-Specific Antigen and Risk of Bone Metastases in West Africans with Prostate Cancer. *World Journal of Nuclear Medicine*, **18**, 143-148. https://doi.org/10.4103/wjnm.wjnm_38_18

[25] McDougall, R.P., Ho, Q., Hsu, C. and Robbins, J.R. (2025) Implications of Primary Tumor Site and Fraction Size on Outcomes of Palliative Radiation for Osseous Metastases. *Frontiers in Oncology*, **15**, Article 1432916. https://doi.org/10.3389/fonc.2025.1432916

[26] Pesapane, F., Downey, K., Rotili, A., Cassano, E. and Koh, D. (2020) Imaging Diagnosis of Metastatic Breast Cancer. *Insights into Imaging*, **11**, Article No. 79. https://doi.org/10.1186/s13244-020-00885-4

[27] Roszkowski, N., Lam, S.S., Copson, E., Cutress, R.I. and Oeppen, R. (2021) Expanded Criteria for Pretreatment Staging CT in Breast Cancer. *BJS Open*, **5**, zraa006. https://doi.org/10.1093/bjsopen/zraa006

[28] Erasmus, L.T., Strange, T.A., Agrawal, R., Strange, C.D., Ahuja, J., Shroff, G.S., *et al*. (2023) Lung Cancer Staging: Imaging and Potential Pitfalls. *Diagnostics*, **13**, Article 3359. https://doi.org/10.3390/diagnostics13213359

[29] Yang, H.L., Liu, T., Wang, X.M., Xu, Y. and Deng, S.M. (2011) Diagnosis of Bone Metastases: A Meta-Analysis Comparing 18FDG PET, CT, MRI and Bone Scintigraphy. *European Radiology*, **21**, 2604-2617. https://doi.org/10.1007/s00330-011-2221-4

[30] Rashidi, A., Baratto, L., Theruvath, A.J., Greene, E.B., Hawk, K.E., Lu, R., *et al*. (2022) Diagnostic Accuracy of 2-[^{18}F]FDG-PET and Whole-Body DW-MRI for the Detection of Bone Marrow Metastases in Children and Young Adults. *European Radiology*, **32**, 4967-4979. https://doi.org/10.1007/s00330-021-08529-x

[31] Mourad, C., Cosentino, A., Nicod Lalonde, M. and Omoumi, P. (2023) Advances in Bone Marrow Imaging: Strengths and Limitations from a Clinical Perspective. *Seminars in Musculoskeletal Radiology*, **27**, 3-21. https://doi.org/10.1055/s-0043-1761612

[32] Anazodo, U.C., Ng, J.J., Ehiogu, B., Obungoloch, J., Fatade, A., Mutsaerts, H.J.M.M., *et al*. (2023) A Framework for Advancing Sustainable Magnetic Resonance Imaging Access in Africa. *NMR in Biomedicine*, **36**, e4846. https://doi.org/10.1002/nbm.4846

[33] Brink, A., Kleynhans, J., Grigoryan, A., Omar, W., Mekonnen, B.W., Kolade, O.U., *et al*. (2025) The Current Status of Nuclear Medicine in Africa. *Journal of Nuclear Medicine*, **67**, 196-203. https://doi.org/10.2967/jnumed.125.271248

[34] Hovenier, R., Huele, E.H., Bindels, B.J.J., van Oss, A., Kuijten, R.H., Verlaan, J.J., *et al*. (2026) Pain Response of Patients Treated with Radiotherapy for Painful Bone Metastases between 2013 and 2024—An Analysis of the Prospective Real-World PRESENT Cohort. *Radiotherapy and Oncology*, **214**, Article ID: 111263. https://doi.org/10.1016/j.radonc.2025.111263

[35] Alemu, H.K., Jemal, A., Assefa, M. and Seife, E. (2025) Patient Reported Change in Pain Outcome among Stage IV Cancer Patients with Bone Metastases Following Palliative Radiotherapy: A Prospective Study from Ethiopia. *Translational Oncology*, **57**, Article ID: 102372. https://doi.org/10.1016/j.tranon.2025.102372