RESEARCH

Standards for structured reporting of dual-energy X-ray absorptiometry scans: best practice recommendations by the Pan Arab Osteoporosis Society

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Abstract

Background Dual-energy X-ray absorptiometry (DXA) is an important diagnostic test for bone mass status. The aim of this work was to set the standards for structured reporting of DXA measurements in adults within the context of fracture and fall risk assessment.

Results Two rounds of Delphi were completed. The first Delphi round had a 68% response rate, while round two had a 100% response rate. After round 2, a total of 28 items were obtained, which were classified into three domains. The percentage of people who agreed with the recommendations (ranks 9–7) ranged from 76.5 to 100%. The wording of all 19 clinical standards determined by the scientific committee was agreed upon (i.e., 75% of respondents strongly agreed or agreed).

Conclusion The DXA scan report is an independent document that contains sufficient information to enable optimal osteoporosis management advised by an experienced healthcare professional. Setting up quality standards for DXA scans not only supports healthcare professionals reporting/interpreting bone densitometry but also meets the parameters outlined in national as well as international guidelines or recommendations for the optimal management of osteoporosis and subsequent prevention of low trauma fractures.

Keywords DXA scan, Report, Bone mineral density, FRAX, Falls, FRAS, Fracture, BMD, Pan Arab Osteoporosis Society, Egyptian Academy of Bone Health

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Background

The World Health Organization (WHO) considered bone mineral density (BMD), assessed by dual-energy X-ray absorptiometry (DXA), as the diagnostic test for bone mass status and a valid tool for estimation of the individual's fracture risk [1]. Acquisition and accurate interpretation of the bone mineral density scans are vital initial steps toward any clinical assessment process of bone health. A timely, to-the-point, informative report is necessary to relay the DXA outcomes and to prevent the potential of misinterpretations by healthcare professionals unfamiliar with densitometry data [2].

The clinical DXA report should target 4 main objectives: firstly, to provide the referring healthcare professional with an easily understood, concise statement that includes basic numeric measures documenting the bone mineral density data; secondly, to enable the comparison of the current DXA scan measure to former or subsequent DXA assessments; thirdly, to provide a preliminary interpretation of the findings and the individual person's risks in a clinical context; and fourthly, to provide the treating healthcare professional as well as the patient with medical advice tailored to the individual patient's condition and suggested by a qualified, knowledgeable specialist with experience in DXA interpretation and management of osteoporosis.

The DXA scan report is an independent document that includes adequate information to allow the referring healthcare professional to manage the patient optimally [3]. Currently, there is no formal regional consensus as to the elements that should be provided in every clinical DXA report. Therefore, this work was performed with the goal of defining the standards for structured reporting of DXA measurements in adults in a setting of fracture and fall risk assessment. This activity has been launched by the Pan Arab Society for Osteoporosis in collaboration with the Egyptian Academy of Bone Health.

Methods

Study design

The consensus, evidence-based standards for DXA scan reporting was formulated based on the "Clinical, Evidence-based, Guidelines" (CEG) guideline protocol which involves a systematic review of the literature and consensus, based on the existing clinical experience and scientific evidence. The manuscript followed the preferred reporting items for systematic reviews and meta-analyses [4].

Study teams

Core team: to manage, coordinate, and help with formulating the project's parameters and initial clinical inquiries, selecting the expert panel, and writing the manuscript.

The literature review team: conducted systematic literature reviews for the key clinical questions, selected and evaluated individual studies, and graded the body of evidence for each outcome. The Oxford Centre for Evidence-based Medicine (CEBM) system was used to determine the level of evidence and grade of recommendation (Table 1) for each section [5].

The expert panel: those were chosen by the core team. Participants are members of the Pan Arab Osteoporosis Society, representing their countries, and have expert knowledge, training, and practical experience regarding osteoporosis management and DXA scan reporting, as well as active participation in scientific research in this field.

Studies selection

Relevant studies were identified through the addition of inclusion and exclusion criteria to the literature obtained via the search strategies.

Table 1 Levels of evidence and grades of recommendations

Level of evidence	
1	Systematic review of all relevant randomized clinical trials or n-of-1 trials
2	Randomized trial or observational study with dramatic effect
3	Non-randomized controlled cohort/follow-up study (observational)
4	Case series, case–control study, or historically controlled study
5	Mechanism-based reasoning (expert opinion, based on physiology, animal, or laboratory studies)
Grades of recommendation	
A	Consistent level 1 studies
B	Consistent level 2 or 3 studies or extrapolations from level 1 studies
C	Level 4 studies or extrapolations from level 2 or 3 studies
D	Level 5 evidence or troubling, inconsistent, or inconclusive studies of any level

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Inclusion criteria

Systematic reviews, randomized controlled trials (RCTs), uncontrolled trials, and observational studies such as cohort, case–control, and cross-sectional studies were all included. The formal process for developing recommendations should have been outlined in the included studies.

Exclusion criteria

Commentary, editorials, non-evidence-based reviews whether narrative or personal, conference abstracts, and manuscripts without an English translation were all disqualified.

Delphi rounds

This is based on a 2-stage online survey.

- Round 1: The participants were asked to think about the key clinical questions, to suggest new items that might have been overlooked, and to clarify items that may have been unclear.
- Round 2: On the basis of the results of the first round, participants were asked to rate each statement, formulated in view of the revised key clinical questions, from 1 (not appropriate) to 9 (completely appropriate). All the participants were encouraged to give their comments.

Voting process

Voting was done live online in timed rounds. All task force members were invited to participate and were given advance notice of the start and end times of each round of voting. Particular access links were distributed, and anonymous votes were collected and processed. During the voting process, comments on rephrasing, potential ambiguity, and unidentified overlaps were gathered for each statement. Only task force members were allowed to vote on the statements.

Rating

Each statement is given a rating between 9 and 1, with 9 representing complete agreement, and 1 representing complete disagreement. Generally, 9–7, 6–4, and 3–1 are used to denote agreement, uncertainty, and disagreement, respectively. The "uncertainty" vote expresses "discomfort about the statement's accuracy." The members were urged to abstain if they believed a statement was outside of their area of expertise, but voting is not required on all statements. After each round of voting, the scientific committee reviewed all comments on all statements. Every time a vote was taken, the same scenario was used, and members were urged to comment whenever they disagreed. This made it possible for the panel to spot a case of incorrect interpretation or ambiguity in any statement.

Definition of consensus

Prior to data analysis, the definition of consensus was determined. The consensus was considered to be reached when at least 75% of participants reached an agreement (scores 9–7) or disagreement (score 3–1) [6–8]. A statement is withdrawn if it receives fewer than three votes or a "low" level of agreement. Statements with an uncertainty score of (6–4) were revised in light of the comments. The levels of agreement on each recommendation statement were defined as "high" if, following the second round of voting, all votes on a statement fell into the agreement bracket (9–7) [8].

Results

Literature research and evidence selection

The review of the literature included 17 articles. Figure 1 illustrates the PRISMA diagram of the study selection process.

Expert panel characteristics

The Delphi form was sent to the expert panel ($n = 25$), of whom 17 (68%) completed the two rounds. The participants were 5 from Egypt, 3 from Jordan, 2 from the Emirates, and 1 each from Kuwait, Saudi Arabia, Qatar, Iraq, Palestine, Algeria, and Morocco. 67.4% of the experts' panel were rheumatologists, in addition to 2 from the medicine department (11.8%), 1 endocrinologist (5.9%), and 1 orthopedic surgeon (5.9%).

Delphi round 1

This round was devoted to the key clinical questions, which consisted of 16 items. No question was retired but more items were suggested, and there were further recommendations for 5 items.

Delphi round 2

On the basis of the input of the first Delphi round and literature search, a list of 28 sectioned standards was generated. The expert panel's response rate for round 2 was 100%. For two statements, wording changes were suggested. Consensus was reached for all statements (75% of respondents strongly agreed or agreed). The statements were reviewed by the core team, and the frequency of strongly agreed-upon recommendations (ranks 9–7) ranged from 76.5 to 100%. The experts were satisfied with the final list of statements and with the Delphi process as a whole.
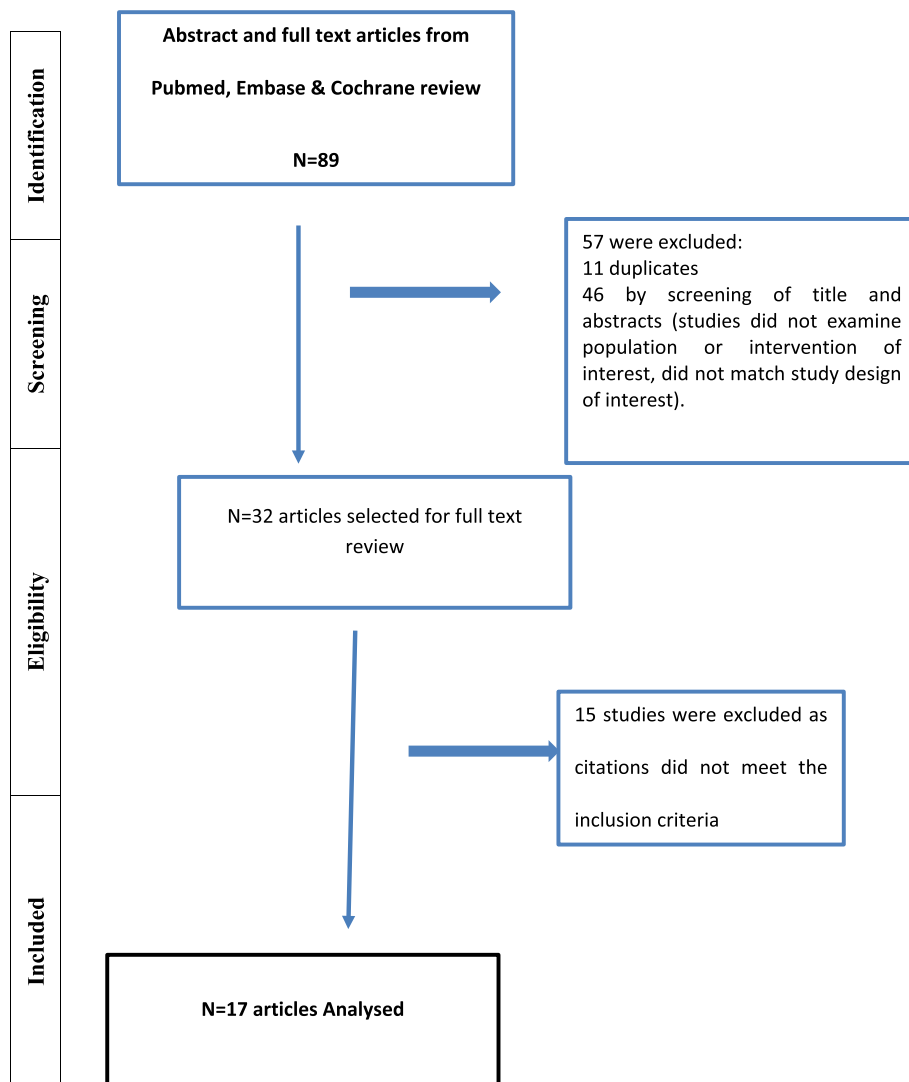
Fig. 1 Flow chart for the study selection process

Statements and grade of recommendations (GOR) for the DXA standards

The recommendations developed to address the key clinical questions are detailed below. Under each section, the mean level of agreement among expert panel members, percentage of agreement, level of evidence (LOE), and recommendation grades are listed.

Overarching principles

Mean rate ± SD: 8.9 ± 0.32, % of agreement: 100%

– The DXA scan report is a stand-alone document that should be issued within 2 weeks of the scan and includes sufficient information to enable optimal management of osteoporosis by the non-specialist referrer.

– Population: adults over the age of 20 who underwent a DXA scan.

– Targeted audience: healthcare professionals undertaking DXA scans reporting as part of fracture risk assessment.

– The patients should be referred for DXA using a standard referral form (Fig. 2), and the patients should complete a questionnaire to assess for further details regarding their risk factors prior to having the DXA scan carried out.

– Comprehensive DXA reporting is critical in the patient care system.

OSTEOPOROSIS & FALLS INTEGRATED SERVICE
Hospital Name
Referral for DXA scanning

Patient Name:		Referring Dr./GP:	For Official Use
Address:		Address:	DXA scan For
			Previous DXA ☐
			Spine: ☐
		Routine: ☐ Urgent: ☐	Hip: ☐
		Date:	Forearm: ☐
D.O.B.: Tel:		Signature:	Vr. Morph.: ☐
Hospital No.:		B.wt. (Kg) Hgt. (cm):	Tilting Table: ☐
Private: ☐ NHS: ☐			

Reason for DXA Referral

Diagnosis of Osteoporosis:	☐	Monitoring of Osteoporosis Drug therapy:	☐
Assessment of Fr. Risk:	☐	Medication Name: Treatment Duration:	

Indication for DXA		Other Current Health Problems	
* Low Trauma Fracture	☐	Chronic Liver / Kidney Disease	☐
Hip: ☐ Spine: ☐ Forearm: ☐ Other: ☐		Malabsorption syndrome	☐
		Male osteoporosis / Hypogonadism	☐
* Steroid Therapy	☐	Ca Prostate on Depletion Therapy	☐
* Early or Surgical Menopause (< 45 years)	☐	Ca Breast on Hormone antagonist	☐
* Post-Menopause (+Risk factors)	☐	Thyroid Disease	☐
* Radiological Osteopenia (+Risk factors)	☐	Epilepsy (anticonvulsant Therapy)	☐
* Secondary Osteoporosis	☐	Joint Replacement	☐
		Others:	☐

Other Comments:

Pls turn over for questionnaire to be completed by the patient

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Questionnaire to be completed by the Patient

المعلومات التالية سوف تساعدنا على تقييم للخطر الخاص بك في المستقبل للكسورأو السقوط على الأرض، يرجى وضع علامة في الصندوق أمام كل جمله

تقييم مخاطر حدوث الكسور (FRAX)		تقييم مخاطر السقوط	
حدث كسر بأحد عظامي نتيجه صدمه (خبطه) بسيطه	☐	لقد فقدت توازني خلال العام الماضي (1)	☐
واحد من والدي أو كلاهما كان يعانى كسر في مفصل الفخذ	☐	لدي مشاكل في نظري (1)	☐
أنا أخذ عقار (دواء) الكورتيزون	☐	اصبحت سرعة المشي أبطأ / مشيتي تغيرت (1.5)	☐
لدي التهاب المفاصل الروماتويدي		قوة قبضتي أصبحت أضعف (1)	☐
أنا أدخن حاليا		سقطت (وقعت) على الأرض أكثر من مره خلال ال١٢ شهر الأخيره (2)	☐
أنا أشرب أكثر من 3 وحدات مشروبات كحوليه في اليوم			
لدي مرض مزمن آخر: ....ما هو؟	☐		

10-year Fracture risk Probability:	Score: (0-6.5)
Major Osteoporosis Fracture: % (high if ≥20%)	High Falls Risk ≥ 3.5
Hip Fracture: % (High if ≥3%)	Moderate Falls risk: ≥ 2 – 3 Low Falls risk <2

☐ I consent to my clinical data being used for research/audit. Signature of the patient: ……………………………………………………………	Gadallah N and El Miedany. Egypt Rheumatol Rehabil 2022; 49, 11 .

Fig. 2 A suggested referral form for bone mineral density assessment including the aim of the referral and the risk factors. Quoted from Gadallah, N., El Miedany, Y. Operative secondary prevention of fragility fractures: national clinical standards for fracture liaison service in Egypt—an initiative by the Egyptian Academy of Bone Health. Egypt Rheumatol Rehabil 49, 11 (2022)

- Expert knowledge is required to interpret DXA scans and provide a report that precisely delivers the information and recommendations in a suitable format for the referring physician and the patient.
- The report should contain sufficient information to help the referring physician and the patient understand the diagnosis, the scan's limitations, and recommendations for further evaluation, intervention management, and follow-up.
- The report should be saved digitally, ideally along with the DXA scans, in the patient's clinical record. It should also be easily retrievable.
- Quality assurance: using a standard audit model, DXA scan reports should be audited to evaluate local performance.
- The quality-assured DXA reports should be completed in a standardized format according to DXA reporting protocols and include fracture risk assessment and rates of change in serial BMD measurements as well as commentary on the reliability of measurements.
- A copy of the DXA report should be sent to the referrer as well as the patient.

I. Demographics and machine characters

Mean rate ± SD: 8.8 ± 0.42, % of agreement: 100%, level of evidence (LOE): 5, grade: D

Q1. What are the demographics to be included?

- Name
- Date of birth
- Age
- Menopausal age
- Sex
- Weight
- Height
- BMI

Q2. What are the machine characters to be included?

- DXA scan service name, address, and contact no./email
- Unique identifier: hospital no
- Name of the referrer
- Date of assessment
- Primary reason for referral
- Make and model of the DXA scanner
- Indication

II. Scan results (provided by a trained technician)

Q3. How to ensure the quality of the DXA scan figures?

Mean rate ± SD: 8.9 ± 0.23, % of agreement: 100%, LOE: 3, grade: C

1. Spine

    (a) Appropriate positioning.
    (b) Correct placement of the top and bottom of the spine "box" is critical.
    (c) The intervertebral lines can be moved or angled, if necessary.
    (d) There must be sufficient soft tissue on both sides of the spine.

2. Hip

    (a) Appropriate positioning
    (b) The hip regions of interest include the femoral neck, trochanter, and total hip
    (c) Appropriate location of the femoral neck box

Q4. What are the valid BMD results to be included by the DXA technician?

Mean rate ± SD: 8.9 ± 0.23, % of agreement: 94.1%, LOE: 2, grade: B

Usually presented in a table:

- Lumbar spine: T-score, Z-score, and BMD as g/cm.^{2}
- Total hip: T-score, Z-score, and BMD
- Neck of the femur: T-score, Z-score, and BMD
- Distal forearm: T-score, Z-score, and BMD (upon referrer request in patients with primary hyperparathyroidism or another condition that primarily affects cortical bone, or if measurements of the spine or hip cannot be made with confidence [9])
- Vertebral morphometry: semiquantitative assessment [upon referrer request/in cases with suspicion of vertebral fracture(s)]

Young adults

T-scores were developed primarily for post-menopausal women, but they are also valid for men over 50. In young adults (< 30 years), the results are presented as Z-scores, as they have not reached peak bone mass.

1. Z-scores may be interpreted as follows:

    (a) $Z > 0$: above average for age
    (b) $Z \leq 0$ and ≥ -2: below average for age
    (c) $Z < -2$: low for age

2. The consequences of growth retardation/delayed puberty should be taken into account.

3. Between the ages of 30 and 50, either *T*- or *Z*-scores may be used [3].

Q5. What are the measures to be included in the serial BMD assessment?

Mean rate ± SD: 8.7 ± 0.57, % of agreement: 100%, LOE: 3, grade: C

- Date(s) of the previous DXA scan(s).
- Represented as an absolute change in BMD (g/cm^2), but it is more commonly expressed as a percentage.
- Presented as percentage of change versus baseline DXA scan as well as previous DXA scan.
- Changes in TBS score.

Q6. What are the technical scan data to be included?

Mean rate ± SD: 8.6 ± 0.58, % of agreement: 100%, LOE: 3, grade: C

- Introduction: the abovementioned patient underwent a bone mineral density (BMD) assessment by DXA (equipment make) on dd/mm/yyyy.
- Scan type (lumbar spine/hip)
- Analysis date
- Analysis protocol: spine/hip
- Report date
- Institution
- Operator
- Model: discovery C
- Software version
- Precision error
- Referring physician

Q7. What are the technical notes to be reported by the DXA technician to ensure the reliability of the measurement?

Mean rate ± SD: 8.5 ± 0.69, % of agreement: 100%, LOE: 5, grade: D

- External artifact
- Internal artifact
- Vertebral exclusions
- Patient positioning
- Spinal deformity

Q8. What are the items to be included by the DXA technician in the TBS assessment?

Mean rate ± SD: 8.8 ± 0.32, % of agreement: 100%, LOE: 3, grade: C

- TBS software version
- TBS score
- TBS graphs

- Comparison of the current TBS to the last assessment if available

III. DXA scan report (provided by the reporting healthcare professional)

Q9. Who can report DXA scans?

Mean rate ± SD: 8.6 ± 0.68, % of agreement: 100%, LOE: 5, grade: D

- Reports are created by healthcare professionals with specialized training and experience in DXA scan interpretation.
- Accreditation should be maintained through proof of continuing education, regular auditing, and research.

Q10. Patient's fracture risks: What are the individual patient's fracture risks to be included in the report?

Mean rate ± SD: 8.8 ± 0.32, % of agreement: 100%, LOE: 3, grade: C

1. History of fracture
2. Parental history of fracture
3. History of glucocorticoid (dose, duration, current or past treatment)
4. History of rheumatoid
5. Current smoking
6. Secondary osteoporosis, specify
7. Other comorbidities or therapies known to affect bone mineral density:

   (a) Diabetes mellitus
   (b) Cancer prostate on androgen depletion therapy
   (c) Breast cancer on hormone antagonist therapy
   (d) Malabsorption syndrome
   (e) Renal impairment

Q11. Patient's fall risk: What are the individual patient's fall risk factors to be included in the report?

Mean rate ± SD: 8.0 ± 1.87, % of agreement: 94.1%, LOE: 5, grade: D

- Imbalance within the last month
- Visual problems
- Slowness or changed pattern of walking
- Falling more than once during the last 12 months

Q12. Osteoporosis medications: What is the information to be included regarding the current medications)?

Mean rate ± SD: 8.1 ± 1.93, % of agreement: 88.2%, LOE: 5, grade: D

- Yes/no

- Type of medications
- Dose
- Duration
- Patient compliance

Q13. Past-osteoporosis therapy: What is the information included regarding the previous osteoporosis medications)?

Mean rate ± SD: 8.2 ± 1.9, % of agreement: 94.1%, LOE: 5, grade: D

- Yes/no
- Type of medications
- Dose
- Duration
- Patient compliance
- Why the medication was stopped?
- Route of administration: IV, SC, or oral

Q14. Other current non-osteoporosis medications: What is the information included regarding the other medications?

Mean rate ± SD: 7.4 ± 2.19, % of agreement: 76.5%, LOE: 5, grade: D

- Yes/no
- List of the medications for any associated comorbidities, e.g., thyroxine, methotrexate, folic acid

Q15. DXA result: What is the standard approach to interpret DXA results?

Mean rate ± SD: 8.3 ± 1.67, % of agreement: 94.1%, LOE: 3, grade: B

1. According to the WHO diagnostic category—in order to make diagnostic coding easier, the terms normal, osteopenia, and osteoporosis were recorded.
2. Based on the locally accepted reference database, and given to adults who have reached peak bone mass (over the age of 30).
3. Results of any other relevant investigations:

    (a) Vertebral morphometry
    (b) Distal forearm

Q16. Serial BMD assessment: How to describe the rate of change of serial BMD measurement?

Mean rate ± SD: 8.7 ± 0.57, % of agreement: 100%, LOE: 3, grade: B

- Serial BMD: a percentage change from the baseline and/or prior scan is reported.

- A least significant change (LSC) for individuals measured on different DXA systems is defined as 2.77 multiplied by the precision error (coefficient of variance) for the scanning equipment at a single system [10].
- The total hip and lumbar spine BMD have a calculated long-term precision error of 1.6%, indicating an LSC of 4.5% is appropriate for serial measurements taken in clinical cohorts [11].
- Changes are only reported when they meet or exceed the LSC
- The LSC for the DEXA technologists should not exceed 6.9%, 5.3%, and 5% for the femoral neck, lumbar spine, and total hip, respectively.
- Differences greater than the LSC are reported as a percentage change from the baseline and/or previous scan.

Q17. How to interpret TBS?

Mean rate ± SD: 8.8 ± 0.38, % of agreement: 100%, LOE: 3, grade: C

1. TBS—TBS score interpretation:

    (a) ≥ 1.35: normal microarchitecture
    (b) Between 1.2 and 1.35: partially degraded microarchitecture
    (c) ≤ 1.2: degraded microarchitecture

2. Percentage of TBS improvement in serial TBS measurement

Q18. Patient stratification: How important is it to include patients' stratification according the risk of fracture or falls?

1. Fracture risk: mean rate ± SD: 8.5 ± 1.4, % of agreement: 94.1%, LOE: 4, grade: C

    (a) Based on the FRAX for hip and major osteoporotic fractures, adjusted by BMD of the neck femur and TBS
    (b) Patient stratified into very high fracture risk, high fracture risk, moderate fracture risk, or low fracture risk

2. Fall risk: mean rate ± SD: 8.5 ± 1.4, % of agreement: 94.1%, LOE: 2, grade: C

    (a) Based on FRAS score
    (b) High [≥ 3.5], moderate [2–3.5], and low: < 2

Q19: Recommendations: What should be included in the section for discussion and treatment?

Mean rate ± SD: 8.7 ± 0.45, % of agreement: 100%, LOE: 5, grade: D

- Summary of the clinical risk factors
- Summation of all the available data including referral, clinical risk factor questionnaire, number of fragility fractures, DXA results, operator, medications, and functional ability from the clinical records
- Include fracture and falls risks

- Management advice:

  - Include treatment needed, and lifestyle modification.
  - Any needed additional investigations.
  - Fracture and fall risk assessment.
  - Onward referral, further DXA assessment (including suggested timing).
  - Management recommendations should be according to the national guidelines.

- Lifestyle changes:

  - Consumption of a diet rich in calcium and vitamin D
  - Adequate and safe sun exposure
  - Smoking cessation
  - Limit alcohol consumption
  - Regular exercise
  - Patient education

- Vertebral morphometry:
  - Valuable to identify undiagnosed a mild vertebral fracture, where further investigations may be advised in the report to clarify the diagnosis and differentiate it from other deformities
- Serial BMD changes:

  - Comment on whether the change is expected (either menopausal or due to secondary causes) or unexplained (e.g., ongoing bone loss despite regular intake of osteoporosis medications).
  - Recommended time interval to consider repeat DXA.

- Complex patients:
  - In order to manage specific patients, referrers should have access to support and guidance from a clinician with experience in bone health and DXA.
- Reporter recognition:

  - This should include the name of the reporting HCP, professional title, signature, professional registration number, and date.
  - This can be implemented automatically by using digital systems.

- References and resources:
  - This includes a list of abbreviations as well as national guidelines. Digital reports should contain hyperlinks.

Implementation of the recommendations to standardize clinical practice and individualized osteoporosis management

Clinical practice guidelines encompass the recommendations that are intended to optimize patient's care who should be aware of the benefits and harms of available treatment options. A checklist for DXA scan reporting is shown in Table 2, and a suggested template is shown in Fig. 3.

Discussion

There are several recommendations and guidelines for the diagnosis and management of osteoporosis in adults [12–14]. However, published recommendations for DXA scan reporting are less common. Most DXA scanners can generate pre-set, standardized reports. Some of these are good and useful, and some less so. However, these pre-set DXA reports just provide technical data and include any expert advice regarding the individual patient's plan of management [15]. Therefore, this study was carried out to set the standards for DXA scan reporting. The results revealed that the DXA scan report can be split into 3 main sections: (1) patient's data which include demographics (recorded by the admin team) and medical history (provided by the referrer), (2) technical section (provided by the technician) which includes the DXA results and any other technical comments, and (3) interpretation and recommendation (provided by the bone health/osteoporosis specialist). These have been stratified into 19 items. These results of this work are consistent with those previously published by the Royal Osteoporosis Society [3] as well as the International Society for Clinical Densitometry (ISCD) Guidance for Best Practices for Dual-Energy X-ray Absorptiometry Measurement and Reporting [16]. Most importantly, the results of this work agree with the ISCD statement that interpretation and reporting should be carried out by a certified practicing DXA interpreter and that the report should include the name of the DXA manufacturer and model. There should be a separate statement regarding the scan factors that may impact negatively on the quality of imaging/analysis as well as the presence of artifacts, if present.

Center Name

Contact: Telephone Number   Email:

Patient Demographics
Name:
Hospital No.
Address:
Post Code:
Sex
DoB: Age:
Body weight: Height
BMI
Menopause Age
Referring Physician:

DXA figure

Scan Information
Scan Date: Time:
Scan Type:
Analysis Protocol:
Report Date:
Institution:
Operator:
Scanner:
Model:
Comment:
Software:
LSC/ Precision error:
Comment:

Results Summary

Region	Area	BMC (g)	BMD (gm/cm2)	T-score	Peak Reference	Z-score	Age Matched

Comparison to previous scans

Scan Date	Age	BMD	T-score	BMD (Change Vs baseline)	BMD (change Vs Previous)

Scanner Make
Hologic/Lunar

10-year Probability fracture risk	
Major Osteoporosis Fracture	%
Hip Fracture	%

Report:

- **Introduction:**
  The above patient attended for a bone mineral density (BMD) assessment by DXA (equipment make) on dd/mm/yyyy.
- **Primary reason for referral:**
  Indications: Diagnosis/ Monitoring of therapy, fractures, current osteoporosis treatments/relevant supplements.
- **BMD interpretation:**
  WHO diagnostic category (where appropriate)
  Comment on rate of change and statistical and clinical significance.
- Other investigations:
  Comment on VFA if performed, other imaging or laboratory tests where appropriate.
- **Summary of risk factors:**
  Fracture risk:
  Falls risk:
- **Clinical interpretation of risk factors:**
  Fracture risk: Very high/high / moderate/low.
  Falls risk: High/ moderate / low
- **Suggestions on further management:**
- **Recommendations for medical management:**
  - Osteoporosis medical management
  - Lifestyle modification
  - Falls management
  - Additional investigations
  - Onward referral.
- **Repeat DXA scan:**
  Provide a recommendation for appropriate time interval to consider repeat DXA assessment.
- **Reported by:**
  Name, title, signature, Affiliation, date.
- **Reference**

Fig. 3 A suggested template for the DXA scan report

Table 2 DXA report checklist

DXA scanning Center name, address and contact information: Telephone number and email address		
Patient Demographics: Name, Date of Birth, Age, sex, Menopausal age Weight, Height, BMI	**Scan Data:** Date of Assessment. Hospital Number, Name of Technician, Make and Model of the DXA scanner	**Referrer:** Name and address of the referrer Primary cause for referring the patient for DXA scanning
Scan Data (usually set by the manufacturer)		
Valid BMD measures	Most likely in a table	
WHO diagnostic category		
Rate of change for serial BMD measurements		
• Trabecular Bone Score		
Technical notes:		
10-year probability of fracture risk		
Falls risk score		
DXA scan report (by experienced healthcare professional)		
1. Clinical Impression:		
- Comment on risk factors, fracture risk and falls risk		
- Current Osteoporosis therapy		
- Past osteoporosis therapy		
- Other current medications:		
- Other investigations: Comment on VFA if performed, other imaging or laboratory tests where appropriate		
2. DXA result:		
- BMD interpretation		
- Serial BMD		
- TBS		
- Patient stratification		
3. Medical recommendation		
4. Reporter recognition		
5. References and Resources		

For each technically valid BMD, the skeletal site, region of interest, and body side should be identified.

Correct DXA measurement and reporting is the responsibility of both the operator as well as the reporter. That is why this guideline stratified each section separately. While the operator is responsible for ensuring the accurate reliability of the results, the reporter should conclude mainly the clinically useful results in the report and how to apply the results to the patients' management. This agrees with the fundamentals set by Watts et al. [17]. Inaccurate DXA scans may lead to major mistakes in the diagnosis and management of osteoporosis [18, 19]. Patients who identify as transgender should receive special consideration. BMD measurements in this patient cohort should be interpreted in relation to the currently applicable gender-matched reference data, but it is possible that skeletal size also needs to be taken into account [3].

This work identified the qualifications of the reporting healthcare professional. Such accreditation provides proof that a basic body of knowledge has been attained. As both osteoporosis management and DXA standards

evolve, it is mandatory that DXA interpreters remain updated in the field. Accreditation should be maintained through proof of continuing education, regular auditing, and research, as standards of bone densitometry keep on developing. This agrees with the criteria set by the Royal Osteoporosis Society which commended that reports are to be performed by healthcare professionals with DXA interpretation training and experience [3]. Furthermore, DXA scan report quality assurance should be a part of routine audit, peer review, and clinical governance processes. In general, DXA reports should be archived and retrievable.

Assessment of risk factors of fractures has become a vital component of DXA scan reporting. Evaluation of the fracture risk as well as propensity to fall has been recommended in this standard to be included in the final report. This not only ensures comprehensive fracture risk assessment but also agrees with the new concept of osteoporosis management which is based on distinguishing between intervention thresholds and diagnostic thresholds of osteoporosis. Consequently, this would help to close the treatment gap in the

management of patients at increased risk of fracture. The newly developed FRAXplus® would help to incorporate all the risk factors into one score. Such assessments of risk factors are important when deciding where to refer a patient for DXA scanning.

Children's bone density measurement and reporting present some unique challenges. The presence of both a clinically significant fracture history and low bone mineral density/bone mineral content (defined as a BMC or areal BMD Z-score less than or equal to − 2.0, adjusted for age, gender, and body size, as appropriate) is required for the diagnosis of osteoporosis in children [16]). Additionally, because T-scores are determined for a peak bone mass that occurs between the ages of 20 and 30 years, they are of little use for this cohort. Z-score is therefore applied to these patients. The reporting healthcare professional should take these factors into account. The first measurement of bone mineral density should be used as a baseline, and the referring doctor should be advised that a repeat scan should be considered within a given time frame to track the change in bone mineral density.

Limitations of the guideline: Though this recommendation is the first of its type not only nationally but also regionally and the fact that it reflects the best data available at the time the report was prepared, only 17 studies met the inclusion criteria of this work. Therefore, the results of future studies may require amendments to the conclusions or recommendations in this report.

In conclusion, the type of DXA scan report received is critical when selecting a DXA scan referral site. DXA scan acquisition and accurate interpretation are critical first steps in any clinical assessment and management plan for patients at risk of fragility fracture. Setting quality standards for DXA scans helps healthcare professionals report bone densitometry and meets the requirements outlined in national and international quality standards for osteoporosis management and low trauma fracture prevention. An experienced reporter and a trained operator are critical for quality assurance and proving the reproducibility of DXA measurements.

Abbreviations

BMC	Bone mineral content
BMD	Bone mineral density
CEBM	Centre for Evidence-based Medicine
CEG	Clinical, Evidence-based, Guidelines
DXA	Dual-energy X-ray absorptiometry
FRAX	Fracture risk assessment
GOR	Grade of recommendations
ISCD	International Society for Clinical Densitometry
LSC	Least significant change
LOE	Level of evidence
RCTs	Randomized controlled trials
SD	Standard deviation
WHO	World Health Organization

Declarations

Ethics approval and consent to participate
This study was performed in accordance with the Helsinki Declaration. The Clinical, Evidence-based, Guidelines (CEG) initiative protocol was approved by the local ethical committee: ethical approval code: 34842/8/21, ethical board Tanta University.

Consent for publication
All authors have approved the manuscript for submission.
Duplicate publication: This is to confirm that the content of the manuscript has not been published or submitted for publication elsewhere.

Competing interests
The authors declare that Mohammed H Abu-Zaid is the associate editor of the *Egyptian Rheumatology and Rehabilitation*. Waleed Hassan, Safaa Mahran, Naglaa GadAllah, and Yasser El Miedany are from the editorial board of the journal, and there is no financial support and sponsorship.

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