OsteoscanUK Ltd

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Radiofrequency Echographic Multi-Spectrometry (REMS) bone health screening scan and Grip Strength Assessment

Indication for REMS scan: Bone health screening

Date:

Name:

Date of Birth:

Age of Menopause:

Height (cm):

Weight (kg):

BMI (kg/m^2):

Current REMS Findings

	Bone Mineral Density; BMD (g/cm^2)	T-score	Fragility Score	Fragility score category	5-year fracture risk (%)
Left neck of femur					
Right neck of femur					
Lumbar Spine					

WHO Category for Screening

T score ≥ -1.0	*Normal bone density*
T score < -1.0 and > -2.5	*Osteopenia*
T score ≤ -2.5	*Osteoporosis*

REMS Fragility Score Category
Low fragility (normal toughness)
Intermediate fragility (partially degraded toughness)
High fragility (degraded toughness)

REMS 5-year fracture risk is estimated from a combination of the T-score and the Fragility Score

Comparison of current REMS scan with previous REMS scan(s)

Date	BMI (Kg/m^2)	Left Hip T-score	Right Hip T-score	Spine T-score (L1-L4)	Left Hip Fragility Score	Right Hip Fragility Score	Spine Fragility Score
Change							

Least significant change for REMS scans: Femoral neck 0.88%, Lumbar Spine 1.05%

Previous DXA scan results

Date	Left Hip T-score	Spine T-score	WHO Category	Diagnostic Discordance *	Numerical Discordance ±

International Society for Clinical Densitometry (ISCD) definitions

***** *Diagnostic Discordance:*
WHO category different between hip and spine.
Single category difference (normal / osteopenia; osteopenia / osteoporosis) is a minor discordance.
Two category difference (normal / osteoporosis) is a major discordance

± *Numerical discordance*
A difference between T-scores of > 1.0 (i.e. > 10% difference between the bone mineral density of the hip(s) and spine)
Difference of > 1.0 and < 2.0 is a minor numerical discordance
Difference of ≥ 2.0 is a major numerical discordance

Grip Strength Assessment

Best of three	
Right (kg)	Left (kg)

Cut-off for a diagnosis of sarcopenia:

Grip strength < 16.0 kg

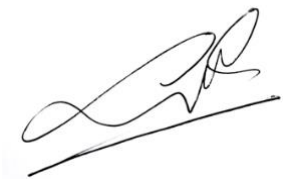
Summary of REMS screening results and Grip Strength assessment:

1. Normal bone mass / Low bone mass / Very low bone mass according to T-scores
2. Normal / low bone mineral density (BMD) according to Z-scores
3. Future fracture risk in the hip(s): Low / Medium / High
4. Future fracture risk in the spine: Low / Medium / High
5. Grip strength shows sarcopenia threshold exceeded / not exceeded

Bone Health Recommendations:

1. Take HRT advice from GP / specialist clinic (www.newsonhealth.co.uk)
2. Optimise diet considering the 11 key bone nutrients: .. g protein / day
3. Maintain vigorous weight-bearing exercise program
4. Review REMS scan in .... years

REMS report reviewed and confirmed by Dr Nick Birch:



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REMS provides an estimate of bone mineral density (BMD), a T-score, a Z-score and a Fragility Score. The Royal Osteoporosis Society advises that REMS is not suitable for monitoring bone health over time or measuring the effect of treatment. The National Health Service in the UK does not recognise REMS as a valid diagnostic technology.

Definitions

The T-score compares the patient's bone mineral density (BMD) to the peak bone mass of young, medically normal adults and is expressed as a standard deviation (SD). The lower the T score (i.e., more negative), the greater the loss of bone mass.

World Health Organization T-score Categories (*Operational diagnosis of osteoporosis*)

T-score: +2.0 to -1.0	Normal.
T-score: < -1.0 and > -2.5	Osteopenia.
T-Score: -2.5 and lower	Osteoporosis.

The Z-score compares this patient's bone density to others of the same age and biological sex. It is expressed as a standard deviation from the modal value of the BMD for patient's age.

Z score Categories

> + 2.0	Abnormally high BMD for age
+2.0 to -2.0	Normal BMD for age
< -2.0	Low BMD for age

Z-scores are preferred to T-scores in pre-menopausal women and men < 50 years of age (*International Society for Clinical Densitometry: 2023 Reporting Guidance*)

Bone Strength: Density and Toughness

Density and toughness are distinct properties that describe different aspects of a material's behaviour, and their importance depends on the context of use, particularly when assessing the likelihood of a material breaking.

Density

Definition: Density is the mass per unit volume of a material, expressed as: rho (r) = (m/V), where m is mass and V is volume. It is typically measured in (kg/m^3).

Relevance: Density tells you how "heavy" a material is for its size. While it relates to the material's weight and structural applications (e.g., lightweight vs. heavy materials), it does not directly indicate how likely a material is to break under stress.

Toughness

Definition: Toughness measures a material's ability to absorb energy and plastically deform (i.e. bend) without fracturing. It is the area under the stress-strain curve up to the point of fracture.

Relevance: Toughness is critical in determining how resistant a material is to breaking. A tougher material can absorb more energy before failing, making it less likely to crack or fracture under impact or stress.

Which is More Important for Likelihood of Breaking?

Toughness is the more important property when considering the likelihood of a material breaking. A material with high toughness can withstand greater forces or impacts without fracturing, whether it is dense or lightweight.

Density might still be a factor in design considerations for weight-sensitive applications (e.g., in aerospace or automotive industries), but it does not directly indicate the material's resistance to breaking.

Example Comparison

Glass has a relatively high density but low toughness; it is prone to fracture because it cannot absorb much energy before breaking.
Steel also has high density, but it has very high toughness; it can absorb significant energy and deform without breaking.

In summary, both density and toughness are important characteristics of materials such as bone, but toughness is the more important factor to assess if you are concerned about the material breaking, not density.

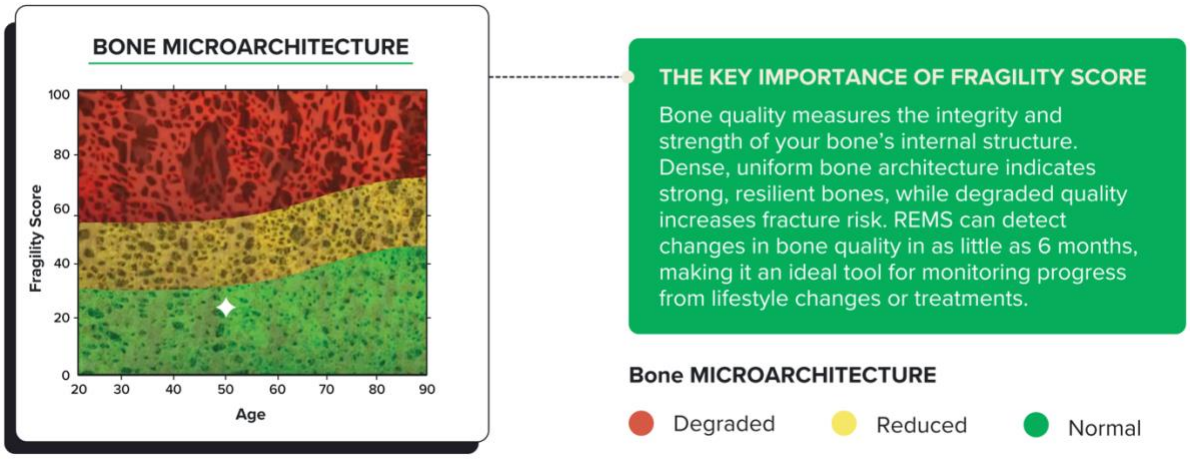
Accuracy of REMS:

Intra-operator repeatability (precision) for REMS is: 0.38%for the lumbar spine and 0.32% for the femoral neck; inter-operator repeatability is 0.54% for the lumbar spine and 0.48% for the femoral neck.

The Least Significant Change (LSC) for REMS is: 1.05% for the lumbar spine and 0.88% for the femoral neck.

The Fragility Score (FS):

FS evaluates the microstructural quality of the bone independently from BMD and is a non-dimensional parameter, ranging from 0 to 100 (with increasing values indicating lower quality of bone architecture). The FS is obtained by comparing the spectra of the acquired ultrasound signals with the spectral reference models obtained from patients who did, or did not, develop an osteoporotic fracture.



REMS future fracture risk calculator

Combining Matrix of REMS BMD and Fragility Score

Fragility Score Classification Bone Quality	T-SCORE classification: NORMAL	OSTEOPENIA	OSTEOPOROSIS
NORMAL	R1, R2	R2-R4	R4, R5
DECREASED	R2, R3	R3-R5	R5, R6
LOW	R3, R4	R4-R6	R6, R7

Total Fracture Risk at 5 years (%)

Risk class	Risk of major osteoporotic fracture per 100 subjects at 5 years
R1	≤ 0.5
R2	[0.5-1.0]
R3	[1.0-2.0]
R4	[2.0-3.5]
R5	[3.5-6.0]
R6	[6.0-10.0]
R7	> 10.0

(These images are examples used to demonstrate how the matrix works and do not show the results of any particular person)

R1 – R3 constitutes low risk of a fracture within 5 years

R4 – R5 constitutes a medium risk of a fracture within 5 years

R6 – R7 constitutes a high risk of a fracture within 5 years