

Fueling the Frame

Advancing Pediatric Musculoskeletal Health Through Nutrition
and Physical Activity in Chiropractic Practice

Dr. Tammy Fogarty, PhD, RD

Dean, MS in Pediatric Musculoskeletal Health & Performance — Parker University

Three Patients, One Week

Maya

Youth athlete
suspected bone stress injury

Ben

Age 9
2 low-trauma long-bone
fractures

Jordan

High training volume
restrictive intake

Three different presentations. One shared clinical blind spot.

Presenting complaint → hidden risk factor → appropriate evaluation / referral

The Blind Spot

“He’s been running track for three years —
this came out of nowhere.”

It didn’t.

The presenting complaint is what gets a patient through the door.

It is not always what explains why the problem occurred.

Why Childhood Is the Window

~90%

of adult bone mass
accrued by late adolescence

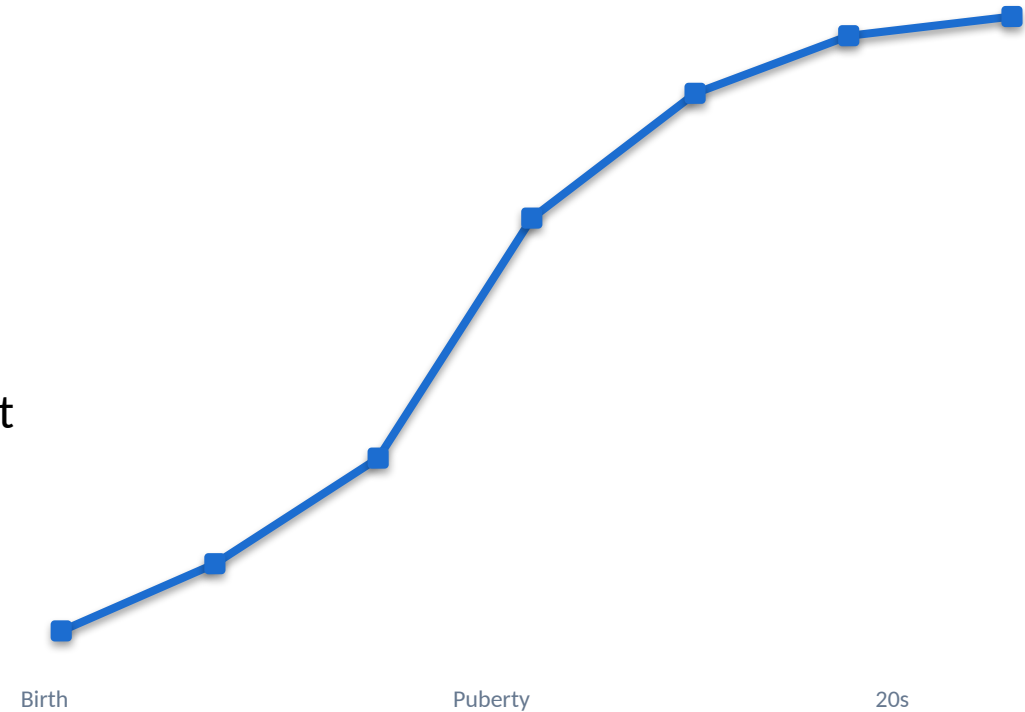
~36–40%

of adult total bone mineral
content acquired around the
pubertal growth spurt

The pediatric bone-health conversation is not only about preventing a fracture.

It is also about maximizing skeletal development during a period we do not recreate later.

Conceptual bone accrual across growth



Conceptual illustration — not measured values

Sources: Rodrick & Kindler, 2024; IOC REDs CAT2 review, 2023.

You Don't Control Most of This. But You Control Some.

Biology / genetics

- Major determinants of peak bone mass
- Sex, maturation, body size, pubertal timing, and inherited skeletal characteristics also matter

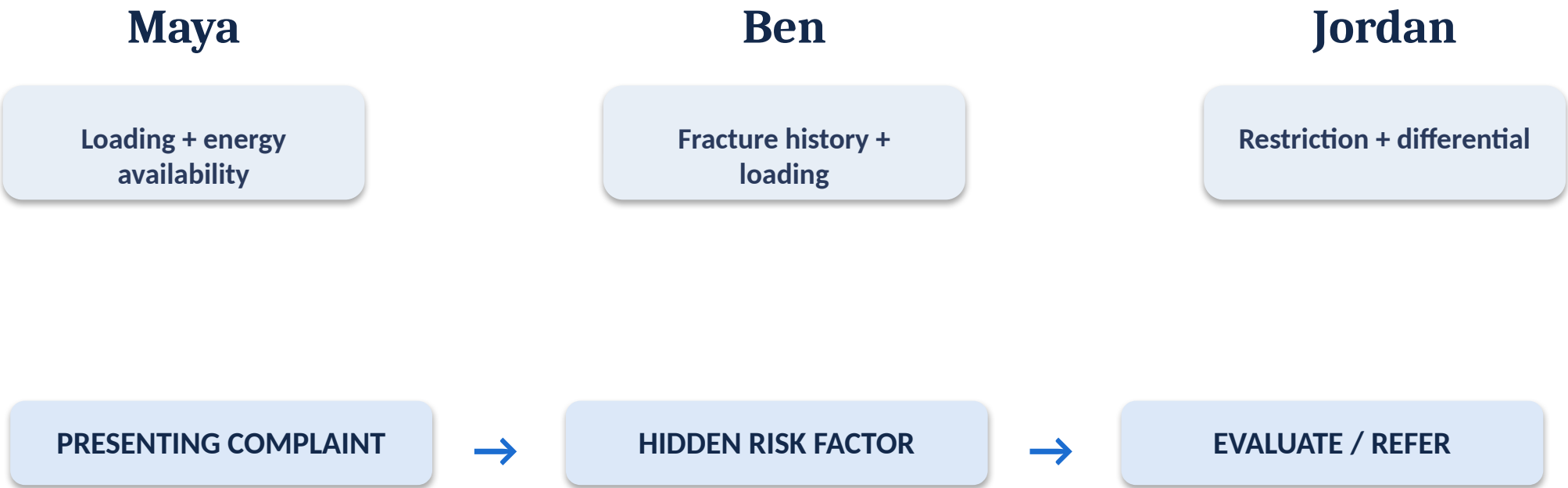
Modifiable factors

- Physical activity / mechanical loading
- Nutrition and energy availability
- Other lifestyle and health factors

Our leverage is not, 'I can determine the child's future bone density.'
Our leverage is, 'I can recognize modifiable risk factors during a period when the skeleton is highly responsive.'

Evidence summary: recent pediatric bone-health reviews; avoid interpreting genetic/environmental contributions as a precise pie chart.

Three Kids. One Pattern.



Meet Maya

Adolescent competitive athlete

- High weekly training volume
- Persistent focal bone pain / suspected bone stress injury
- High activity does not automatically mean optimal bone health

Stress reaction

Bone stress injury without a visible fracture line; repetitive loading exceeds current capacity for repair.

Stress fracture

Progression along the bone-stress-injury continuum with structural failure / fracture.

What would you ask that you may not be asking now?

Meet Maya

Questions to consider

- Training changes? Rest days?
- Food intake? Menstrual history?
- Previous stress injuries? Growth?

Those questions start to move us from treating a painful site to understanding the athlete.

Two Ways Bone Changes

Modeling

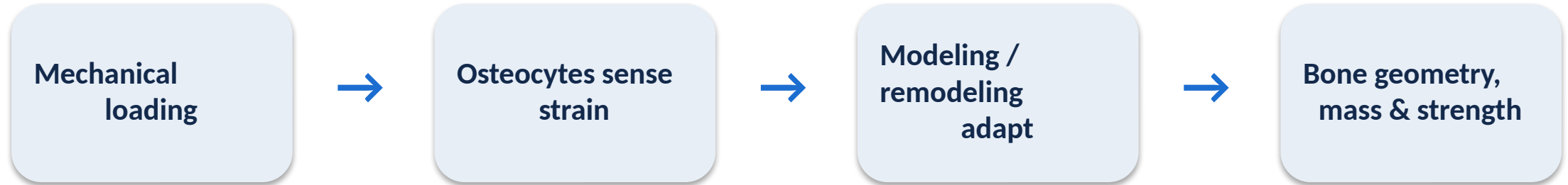
Changes bone size, shape and architecture.
Especially important during growth.

Remodeling

Replaces old bone with new bone at the same site.
Continues throughout life.

**Growing bone is highly responsive to its mechanical and nutritional environment.
This allows bone to not only maintain itself, but to build new structure at the same time.**

How Exercise Builds Bone



Bone adapts to the magnitude, rate, and novelty of loading.

Puberty is a particularly responsive window. The question is not simply, ‘Is the child active?’

It is, ‘What kind of mechanical stimulus is the skeleton actually receiving?’

Not All Activity Builds Bone the Same Way

More osteogenic loading

- Jumping
- Cutting / multidirectional sport
- Weight-bearing impact
- Progressive resistance training

Less direct skeletal loading

- Swimming
- Cycling
- Excellent for fitness — but lower osteogenic stimulus

Key point: all exercise is valuable, but not all exercise provides the same bone-building stimulus.

Evidence: PRO-BONE study; recent systematic reviews/meta-analyses of exercise and adolescent bone outcomes.

The Paradox

Maya is getting an osteogenic stimulus from her sport.

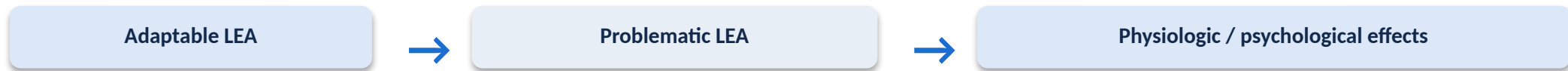
So why the bone stress injury?

Loading is only one part of the equation.

Hormonal environment? Nutrients? Recovery capacity? Energy availability?

Relative Energy Deficiency in Sport (REDs)

Energy availability = (dietary energy intake – exercise energy expenditure) ÷ fat-free mass



Bone pathway: problematic LEA may alter reproductive hormones (including estrogen/testosterone), bone turnover, endocrine/metabolic function, substrate availability and recovery.

IOC context: REDs is the clinical syndrome associated with problematic low energy availability. It can impair metabolism, reproductive function, MSK health, immunity, glycogen synthesis, cardiovascular and hematologic health, psychological function, and performance.

Source: Mountjoy et al. 2023 IOC REDs Consensus; IOC REDs CAT2 review (Br J Sports Med, 2023).

Not Just a Female Athlete Issue

Female Athlete Triad → 2014: REDs → 2023: more male-athlete data

Problematic LEA can affect female and male athletes. Male evidence has grown, but remains less extensive than female evidence.

Clinical implication: don't let sex or gender assumptions talk you out of considering REDs risk.

Source: Mountjoy et al., 2023. Only ~20% of original REDs studies from 2018–2022 included male athletes.

Before You Call It Overtraining...

Overlapping features

- Fatigue
- Declining performance
- Recurring injury
- Mood changes / poor recovery

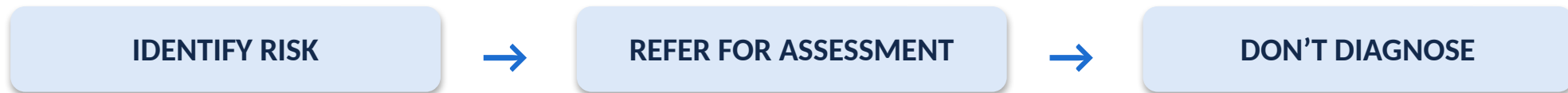
REDs belongs in the differential

When overtraining is suspected, evaluate energy and carbohydrate availability as part of the differential.

Same symptoms ≠ same mechanism.

What Should Raise Your Suspicion?

- High training load + possible inadequate intake
- Recurrent bone stress injuries
- Menstrual dysfunction, when applicable
- Declining performance / poor recovery
- Growth concerns or recurrent illness/injury



Refer for assessment. Do not turn a risk pattern into a diagnosis

Meet Ben

Ben, age 9

- Two prior long-bone fractures after low-impact falls
- Minimal participation in weight-bearing / impact activity
- No known underlying diagnosis

**Normal childhood fractures —
or a reason to look deeper?**

Low osteogenic activity may mean he is missing a stimulus that supports normal bone accrual, but recurrent low trauma fractures can also reflect genetic bone disorders, endocrine disease, malabsorption, illness, nutrition inadequacy, medication effects, or other causes.

Loading During Growth Matters

Growth + osteogenic loading

Opportunity for adaptive gains in bone mass, geometry, and strength

Growth + insufficient loading

Less osteogenic stimulus during a highly responsive developmental window

Evidence supports physical activity as beneficial for bone accrual; sedentary time itself is a less certain causal target.

Pediatric DXA $\neq$ Adult DXA

T-score

Compares bone density with a healthy young adult reference population.

Should not appear on pediatric DXA reports.

Z-score

Uses pediatric reference data; interpreted with age and sex appropriate reference data; growth/short stature may require adjustment.

A Z-score ≤ -2.0 alone does NOT diagnose osteoporosis in a child. Instead, a low bone mineral mass or density for age may be established.

ISCD Pediatric Positions (2019): without vertebral compression fracture, osteoporosis requires clinically significant fracture history + BMD Z-score ≤ -2.0 .

The Loading-Deficit Angle

What the evidence supports

- Moderate-to-vigorous physical activity predicts several measures of bone strength/structure/volume across adolescence.
- Exercise interventions improve adolescent bone mineral outcomes, especially with weight-bearing / impact loading.

What it does NOT prove

Ben's inactivity caused his fractures.

Association and contribution $\neq$ individual causation.

We can say that osteogenic activity supports bone development.

We can say Ben has low osteogenic activity.

We cannot say that one fact fully explains two low-trauma fractures.

Evidence: Gabel et al., 2017 longitudinal adolescent cohort; recent exercise/bone systematic reviews and meta-analyses.

What a Bone-Health History Should Ask

- What types of physical activity and sport does the child do?
- How much weight-bearing / impact activity?
- Any prior fractures or bone stress injuries — where, when and what mechanism?
- Any growth or developmental concerns? Any bone stress injuries?
- Any family history of skeletal fragility or relevant medical factors?

These questions can help you decide whether you are looking at a normal injury history, a modifiable loading issue, or a child who needs a more formal medical bone-health workup.

Ben's History Warrants Further Evaluation

2 low-trauma long-bone fractures before age 10



Clinically significant fracture history (ISCD)



Medical evaluation of skeletal fragility

DXA may be appropriate when results will influence management.

Low osteogenic activity may contribute — it does not establish the cause of Ben's fractures.

Meet Jordan

Adolescent athlete

- High training volume
- Parent reports increasingly restrictive eating / “picky eating”
- No established diagnosis

Under-fueling?

Eating disorder?

**GI / sensory / food allergies /
food insecurity?**

Something else?

The combination of high training demand and restricted intake is enough to raise concern.

It is not enough to tell us why restriction is happening.

More Isn't Better When Intake Is Already Adequate

Calcium

Adequacy matters.

Supplementation is most likely to help when baseline intake is inadequate.

Vitamin D

Important for skeletal health.

Routine supplementation has not consistently improved bone outcomes in already replete healthy children.

Assess adequacy. Correct deficiency. Don't assume more is better.

Evidence: recent pediatric calcium/dairy and vitamin D systematic reviews/meta-analyses cited in the source deck.

A Supplement Is Not a Diagnosis

We do not yet know whether Jordan has:

inadequate calcium / vitamin D

problematic LEA / low carbohydrate intake

an eating disorder

GI, sensory, access or other medical contributors

A supplement recommendation before assessment risks treating an assumption rather than the patient.

Could This Be REDs?

High training demand + Possible inadequate intake → REDs risk

This combination raises concern for problematic LEA and warrants further assessment for REDs and other causes.

REDs cannot be diagnosed from these findings alone so it should trigger further evaluation, not a label.

Same Concern, Different Front Door

Maya

Bone stress injury

+

high training demand / LEA

Jordan

Restrictive intake

+

high training demand / LEA

Both trigger further assessment for problematic LEA / REDs — neither vignette establishes the diagnosis.

Let's Talk

What hidden risk factor might you have missed in each patient if you focused only on the presenting complaint?

Turn to someone near you: 30 seconds. One sentence.

Then: What one question could you add to your intake tomorrow?

Let's Talk

The questions simply improve the history enough to tell you when the MSK complaint deserves a broader evaluation.

Same Gap, Different Risk Profiles

Maya

Bone stress injury + high training demand



Possible problematic LEA / Recovery / Menstrual / REDs risk

Ben

Clinically significant fracture history + low osteogenic activity



Skeletal fragility warrants evaluation

Jordan

High training demand + restrictive intake



Under-fueling / REDs risk + eating-disorder differential / GI, sensory, other medical issues

Different risks. Same screening gap.

**The shared lesson is not that all three have the same diagnosis...
... it is that the presenting complaint did not tell us enough.**

5 Questions to Add to a Pediatric MSK History

1 What does a typical week of physical activity and sport look like?

2 Any previous fractures or bone stress injuries? What happened?

3 Does food intake seem to keep pace with training and growth demands?

4 Any changes in menstrual function (when applicable), growth, recovery, fatigue or performance?

5 Any family history or medical factors that raise concern for bone health?

Conversation prompts — not a validated diagnostic instrument. Use formal tools (e.g., IOC REDs CAT2) when clinically appropriate.

Opening the Door, Not Diagnosing



“I want to ask a couple of extra questions today — it helps me make sure we’re supporting the whole child, not just what brought them in.”

The goal is not to make the diagnosis in the room. It is to recognize when the presenting complaint deserves a broader look.

Why This Matters

**You don't have to make the diagnosis
to make a difference.**

Sometimes your role is simply being the clinician who notices that something doesn't fit.

What Happens Next: Maya

TELL THE PARENT

“Her injury pattern and training history raise questions about whether she is getting enough energy to support both training and normal growth. I’d like that evaluated more closely.”

TELL MAYA

“Your body is working hard. We want to make sure it has enough fuel to grow, recover and support your sport.”

THE RD / TEAM APPROACH

Comprehensive nutrition + training assessment; growth and menstrual history when applicable; REDs risk assessment; sports-medicine coordination; mental-health referral when indicated; restore energy availability if problematic LEA is identified.

What Happens Next: Ben

TELL THE PARENT

“Two long-bone fractures from relatively low-impact falls at his age are worth looking into more closely. His low level of weight-bearing activity may be one contributing factor, but we should not assume that is the cause.”

“I recommend a medical evaluation of his bone health. Depending on that evaluation, DXA may be appropriate.”

APPROACH

- Medical evaluation first
- Fracture mechanism / history
- Growth and puberty
- Nutrition, medications, chronic disease
- Family history
- DXA when clinically indicated
- Then support adequate nutrition + age-appropriate weight-bearing activity

What Happens Next: Jordan

TELL THE PARENT

“Jordan’s eating pattern combined with a high training load makes me want to understand whether they’re getting enough nutrition to support growth and sport. There are several reasons this can happen, so rather than assume, I’d like it evaluated.”

TELL JORDAN

“Training requires a lot from your body. We want to make sure you’re getting what you need to grow, recover and perform well.”

ASSESS BEFORE LABELING

Dietary intake; training demand; growth trajectory; GI symptoms; food avoidance/restriction; body-image/eating concerns; REDs indicators; eating-disorder risk. Build the care team from what the assessment shows.

Change the Question

BEFORE TODAY

**What brought this
patient in?**

AFTER TODAY

**What risk factor might
be hiding behind it?**

PRESENTING COMPLAINT



HIDDEN RISK FACTOR



EVALUATE / REFER

Start with One Question. Build to Five.

You do not need to make the diagnosis to make a difference.

One better question can be what gets a child to the right evaluation earlier.

Dr. Tammy Fogarty, PhD, RD · Parker University · tammyfogarty@parker.edu
Follow [@tammyfogartyphd](https://twitter.com/tammyfogartyphd)