

Ausdance National

FACT SHEET

Healthy Bones for Dancers and Physical Performing Artists

What this Fact Sheet covers

Bone health in dance and physical performing arts — including how bones form and are maintained, bone stress injuries and their prevention, risk factors, management, and long-term bone health including osteoporosis.

Who is this for?

Dancers, circus artists and physical performers of all genders; parents and carers; dance and circus teachers; and studio owners working with students at any age or level.

Why this matters

Bone stress injuries (BSIs) are among the most common and most serious injuries in dancers and circus artists, and are largely preventable. Building strong bones during adolescence is critical for lifelong skeletal health.

Both female and male dancers are at risk — and teenage male dancers, whose energy needs increase significantly during puberty, are a commonly overlooked at-risk group. Understanding how bones work — and the specific risks in dance and circus training — supports prevention at every level.

Bone health and the benefits of dance

Healthy bones are formed from calcium and other minerals (approximately 65% by weight, giving bone its strength) and a matrix of collagen and other proteins (approximately 35% by weight, giving bone its flexibility). This collagen matrix is crucial for maintaining bone flexibility and may be more essential to preventing fractures than calcium content alone — without it, calcium-rich bones can be dense but brittle, and therefore at higher risk of fracture.

Dance and circus/physical performing arts are weight-bearing, impact activities and, when performed with adequate nutrition and recovery, provides positive stimulus for bone development. Early research confirmed dancers in weight-bearing activities tend to have higher bone density than non-athletes. The mechanical strain of dance — muscle pull, impact forces and loading patterns — stimulates bone deposition and strengthens the skeleton over time.

The challenge arises when training load increases faster than the body can adapt, or when the energy and nutritional needs that support bone remodelling are not adequately met.

Bone turnover — formation and resorption

Bone is not a static tissue. It undergoes a continuous cycle called bone turnover, in which old bone is broken down (resorption) by cells called osteoclasts and new bone is built (formation) by cells called osteoblasts. Under normal conditions, this cycle is balanced and bone maintains its strength and integrity.

When the rate of resorption exceeds the rate of formation — due to inadequate nutrition, hormonal disruption, insufficient recovery, or excessive training load — the net result is a loss of bone mass. Over time, this loss weakens the bone's structural integrity and increases the risk of injury.

Key factors that support healthy bone formation include:

- adequate energy availability — eating enough food to meet the demands of training and daily life
- hormonal balance — oestrogen in female bodies, testosterone in male bodies
- sufficient calcium, vitamin D, magnesium, phosphorus, potassium, vitamin K and vitamin C
- appropriate recovery between training sessions
- weight-bearing exercise and mechanical loading

50–60% of bone mass is developed during puberty (approximately age 11–15 years), with peak bone mass reached before the age of 20. This makes adolescence the most critical window for building bone density — and the period of greatest vulnerability if nutritional or training conditions are suboptimal.

Bone stress injuries — how and why they occur

Bone stress injuries (BSIs) occur when the rate of bone resorption exceeds the rate of formation, weakening the bone's structure so that it can no longer withstand normal loading. BSIs exist on a spectrum:

- **Stress reaction:** early microscopic damage, detectable on MRI but not always on X-ray. Pain with activity, relief with rest.
- **Stress fracture:** a partial or complete break in the bone, requiring more significant management and recovery time.

BSIs most commonly affect the lower limbs in dance — metatarsals, tibia and femoral neck — but can occur anywhere in the skeleton where repetitive loading is high and bone remodelling cannot keep pace.

Circus and acrobatics — additional considerations

In circus and acrobatics contexts, BSI risk is compounded by specific loading patterns that differ from conventional dance:

- High-impact landings from hard-floor tumbling and ground-to-air apparatus such as teeterboard or pole create high peak forces through the lower limbs and spine.
- Repetitive jumping — whether in dance or acrobatics training — places cumulative load on metatarsals, tibiae and calcanei. The frequency, height and landing surface all affect injury risk. Landing technique and surface compliance should be considered when assessing jump-related BSI risk.
- Acrobalance, partner work, hoop diving and tumbling introduce unexpected forces — slips, trips, falls and partner weight shifts can create sudden overload or torsion on bones that are not prepared for that direction of force. The smaller, finer bones of the fingers, feet and wrists are particularly vulnerable in these contexts.
- Repeated loading on upper limbs — unusual in dance but common in circus — can affect the radius, ulna and small bones of the hand and wrist, particularly in aerial and hand-balancing disciplines.

Key risk factors

- **Low energy availability:** a mismatch between energy intake and energy expended through training and daily life. Low energy availability can occur unintentionally during periods of high training output — not only as a result of deliberate dietary restriction. When prolonged or severe, this can develop into Relative Energy Deficiency in Sport (RED-S).
- **Hormonal disruption in female dancers:** oestrogen is critical for calcium absorption and bone maintenance. Menstrual irregularity or loss of period (amenorrhoea) is a sign of hormonal disruption associated with low energy availability and is directly linked to reduced bone density. Primary amenorrhoea (delayed onset), secondary amenorrhoea (loss of cycle) and dysmenorrhoea (irregular cycle) all carry bone health risk.
- **Hormonal disruption in male dancers:** male dancers, particularly adolescents during puberty, have significantly elevated energy needs. Under-fuelling during this period can suppress testosterone and compromise bone development. Teenage male dancers are a specifically at-risk group that is frequently overlooked in dance medicine contexts.
- **Sudden spikes in training volume or intensity:** rapid increases in the number of classes, rehearsal hours, performance commitments or jump repetitions give bone insufficient time to remodel. This includes both spikes in overall weekly load and within-session repetitions of high-impact movements such as jumps, landings and tumbling passes. Planned training load management (periodisation) is evidence-based prevention.
- **Insufficient calcium and vitamin D:** both are essential building blocks for bone tissue. Vitamin D is required for calcium absorption. In Australia, the primary source of vitamin D is safe sun exposure. Dancers who train predominantly indoors may be at particular risk of deficiency.
- **Disordered eating:** dancers with low caloric intake and low calcium intake have a relatively high incidence of stress fractures. Disordered eating — including fasting, restriction, purging and use of diet pills or laxatives — directly compromises bone health. See the Ausdance Eating Disorders and Dancers fact sheet.

Any dancer presenting with localised bone pain that worsens with activity and does not fully resolve with rest should be assessed by a sports physician or physiotherapist for BSI before returning to full training.

Prevention strategies

1. Adequate energy intake

Energy restriction — whether deliberate or inadvertent — is the most significant modifiable risk factor for BSI in dancers of all genders. Eating enough food, spread across regular meals, to meet the full demands of training and daily life is the single most important preventive strategy. This is particularly important for:

- adolescent dancers of all genders, whose energy needs are elevated due to growth
- teenage male dancers, whose energy requirements increase substantially during puberty
- female dancers, who risk menstrual disruption and oestrogen loss when under-fuelled
- dancers in periods of high training load, intensive programs or performance seasons

See the Ausdance fact sheets on Fuelling the Dancer and Nutrition for Young Dancers.

2. Calcium and Vitamin D

Calcium is the primary mineral that contributes to strong, healthy bones, but it relies on vitamin D and other nutrients to function effectively. Calcium is absorbed from the blood into bone in conditions of calcium sufficiency; if blood calcium drops, parathyroid hormone (PTH) is released, triggering calcium to be leached from bones — contributing to diminished bone density.

Calcium-rich food sources include: dairy products (yoghurt, cheese, milk); canned fish with bones (sardines, salmon); tofu; almonds; dark leafy greens (broccoli, kale, bok choy, collards); and fortified plant-based milks.

For a comprehensive calcium food source list, see [Healthy Bones Australia](#).

Vitamin D promotes calcium absorption and works in concert with other vitamins, minerals and hormones to promote bone mineralisation. In Australia, the primary source of vitamin D is sun exposure. Only 10–15 minutes of partial-body sun exposure per day can support adequate vitamin D production. Dance schools can support this by organising short periods outdoors during the day. For sunshine maps and safe sun exposure guidance by season and location, see: healthybonesaustralia.org.au/your-bone-health/vitamin-d-bone-health

Dancers with risk factors for deficiency — including those training predominantly indoors — should have vitamin D levels assessed by a GP.

3. Other key nutrients

Several other nutrients play important roles in bone formation and should be included through a varied diet:

- **Magnesium:** increases calcium absorption and is a component of bone. Sources include nuts, seeds, legumes, whole grains, avocado and dark leafy greens.
- **Phosphorus:** enables mineralisation of bone. Sources include meat, fish, poultry, dairy, eggs, legumes and whole grains.
- **Potassium:** contributes to proper acid balance in the blood and to muscle contraction. Sources include bananas, potatoes, avocado, tomatoes, dairy and legumes. Low potassium is also associated with cardiac risk in dancers with eating disorders.
- **Vitamin K:** contributes to collagen production and bone formation. Best sources are dark green leafy vegetables.
- **Vitamin C:** stimulates collagen matrix formation, which gives bone its flexibility. Sources include capsicum, citrus fruits, strawberries, kiwifruit and broccoli.
- **Protein:** stimulates collagen matrix formation alongside vitamin C. Adequate protein intake supports both muscle and bone health.

4. Training load management

Avoid rapid increases in class volume, intensity or impact. Key principles include:

- Plan training loads across the week, including classes, rehearsals and performances, using a periodisation approach
- Monitor jump repetitions and high-impact sequences within sessions — cumulative load from jumps is a specific and underappreciated BSI risk factor in dance and circus
- Return from breaks or injury gradually — the body needs time to rebuild tolerance to load after a period of reduced activity
- Increase weekly training volume by no more than 10% at a time as a general guideline

5. Encouraging sun exposure

Dance schools can actively support vitamin D production by organising short, safe periods outdoors each day — during fitness sessions, between classes, or at lunch. This is particularly important for dancers who train long hours indoors.

6. Avoiding risk factors

- Avoid or limit high caffeine intake (more than two cups of coffee per day)
- Avoid or limit alcohol
- Do not smoke — smoking accelerates bone loss
- Be aware that foods high in oxalates (spinach, beetroot, nuts, chocolate) can inhibit calcium absorption when eaten in large amounts alongside calcium-rich foods
- Seek medical advice before using anti-convulsant or long-term anti-inflammatory medication, which can affect bone density

Relative Energy Deficiency in Sport (RED-S)

When low energy availability is sustained over time, it can develop into Relative Energy Deficiency in Sport (RED-S) — a syndrome recognised by the International Olympic Committee (IOC) that extends well beyond bone health to affect metabolic, cardiovascular, immunological, psychological and reproductive health.

Historically, in female athletes, low energy availability combined with amenorrhoea and low bone density was referred to as the 'Female Athlete Triad.' RED-S expands this framework to recognise that low energy availability affects dancers of all genders, across a wide range of health systems.

The most common early signs of low energy availability are fatigue, lowered concentration and, in female dancers, disruption to the menstrual cycle. Critically, dance performance may not always be impaired in early stages — so performance quality alone should not be the basis for decision-making. If there is concern, refer to a registered dietitian, sports physician or sports medicine professional experienced in working with dancers.

For a comprehensive clinical reference, see: Mountjoy M, Ackerman KE, Berman S, et al. IOC consensus statement on Relative Energy Deficiency in Sport (RED-S) 2023. British Journal of Sports Medicine, 57(11), 592–607.

Managing a bone stress injury

If a BSI is suspected — localised bone pain that increases with activity and does not fully resolve with rest — act promptly:

- Stop the aggravating activity immediately.
- Seek assessment from a sports physician or physiotherapist with dance or circus experience. Imaging (MRI is more sensitive than X-ray for early BSI) may be required.
- Do not return to full training until medically cleared. Returning too early significantly increases the risk of a more severe injury.
- Address contributing factors — particularly energy availability, calcium and vitamin D, training load and hormonal health — as an integral part of the management plan, not as an afterthought.
- Recovery should follow a graduated, monitored return-to-activity plan guided by a health professional.
- A multidisciplinary approach is recommended for complex cases, involving a sports physician, registered dietitian and, where appropriate, a mental health professional.

It is important to note that if a dancer develops diminished bone density, osteopenia or osteoporosis in their teens or early twenties, they may never fully regain their previous bone density even if diet and vitamin intake subsequently improve. This underscores the critical importance of prevention during the bone-building years.

Long-term bone health — Osteoporosis

Bone density peaks before age 20 and remains relatively stable through the mid-30s. After this point, a gradual and natural decline in bone mineral content begins in bodies of all sexes. During menopause, the decline in oestrogen leads to accelerated bone loss — the first 3–5 years after menopause can involve significant reductions in bone density. This makes the prevention work done during adolescence and early adulthood critical to long-term bone health.

Osteoporosis is a progressive condition characterised by low bone mass and deterioration of bone tissue, leading to skeletal fragility and increased fracture risk. Osteopenia refers to bone mineral density that is lower than expected for a given age but not yet at the clinical threshold for osteoporosis. According to Osteoporosis Australia, one in three women over 60 will suffer a fracture as a result of osteoporosis — a major cause of long-term disability in older adults.

Although men develop osteoporosis at lower rates than women — because male bones are generally larger and the hormonal systems less abruptly disrupted — male dancers with a history of low energy availability, training overload or hormonal disruption are not without long-term risk.

The prevention strategies described in this fact sheet — particularly adequate energy intake, calcium, vitamin D, weight-bearing exercise and hormonal health — are the same strategies that support long-term bone health and reduce the risk of osteoporosis in later life. A dancer who builds strong bones during adolescence is making an investment in their health that extends well beyond their performing career.

For information on menopause and bone health, see the [Australian Menopause Society](#):

Supplementation

Dancers should be encouraged to obtain as many essential nutrients as possible through food. However, supplementation may be appropriate where specific deficiencies have been identified by a health professional, during winter months when sun exposure is reduced, or for dancers and teachers over the age of 50, who may need additional support.

Anyone considering supplementation should seek advice from a GP, Accredited Practising Dietitian or Accredited Sports Dietitian before beginning. Excessive doses of some vitamins and minerals can be harmful, and megadoses are not recommended without clinical guidance.

What teachers and studios should do

Dance teachers and studios play an important role in supporting the bone health of dancers. Evidence-based recommendations from IADMS include:

- Promote healthy, non-appearance-based attitudes towards body physique and food.
- Inform dancers of the relationship between energy intake, energy availability and bone health.

- Promote adequate nutrition and other factors that support bone health, including hydration and appropriate training loads.
- Be aware of early signs of problems across the spectrum of eating behaviour, menstrual health and bone health.
- Refer at-risk dancers to appropriate health professionals promptly.
- Support regular health check-ups to track hormone function and, where relevant, the menstrual cycle.
- Organise short periods of outdoor time each day where possible, to support vitamin D production.
- Monitor training load carefully across the week, including jump repetitions, to avoid spikes that increase BSI risk.

First Nations considerations

Bone health is a particularly important area for First Nations female dancers, grounded in well-documented patterns of nutritional deficiency directly relevant to skeletal health and injury risk.

Vitamin D deficiency

Vitamin D deficiency is prevalent among Aboriginal and Torres Strait Islander Peoples. A nationally representative study published in the British Journal of Nutrition found approximately 27% of Aboriginal and Torres Strait Islander adults were vitamin D deficient, rising to 39% in remote areas¹. Vitamin D is essential for calcium absorption and bone mineralisation — without adequate vitamin D, calcium intake alone cannot protect bone density. For female dancers in the critical bone-building years of adolescence and early adulthood, this represents a significant and often unaddressed risk factor for stress fractures and low bone mass.

Contributing factors identified in the research include reduced outdoor sun exposure, changes in diet from traditional to processed foods, and skin pigmentation factors affecting vitamin D synthesis. Dancers who train predominantly indoors — as most Western dance students do — are at compounded risk.

A First Nations female dancer presenting with repeated stress fractures, fatigue or poor recovery should be referred to a GP for assessment of vitamin D and iron status as a priority. These are treatable conditions whose consequences are serious if left unaddressed.

Iron deficiency and its impact on bone health

Iron deficiency is common among First Nations women and girls and has direct implications for bone health in dancers. Anaemia reduces the oxygen-carrying capacity of the blood, contributing to fatigue, poor recovery and reduced ability to build and maintain bone density through load-bearing activity. Iron deficiency and vitamin D deficiency frequently co-occur and compound each other's effects.

Traditional foods and bone health

Traditional First Nations diets — rich in lean game meats, bony fish, shellfish and native plant foods — provided excellent nutritional support for bone health, including high levels of calcium, phosphorus, vitamin D and iron. The displacement of these diets through colonisation and food

¹ <https://pubmed.ncbi.nlm.nih.gov/33028435/>

system disruption is a direct contributor to the nutritional vulnerabilities now seen in many First Nations communities. Dance teachers and health professionals should acknowledge the nutritional value of traditional foods rather than treating Western dietary guidelines as the sole framework.

Food access and food security

Food insecurity affects a significant proportion of First Nations families, particularly in regional and remote communities. Advice about calcium-rich or vitamin D-rich foods is only useful if those foods are accessible and affordable. Teachers should be sensitive to the possibility that food access barriers — not lack of knowledge or willingness — may be a factor in a student's nutritional status, and should connect families with community support services rather than providing dietary advice in isolation.

What teachers and studios can do

- *Be alert to signs of bone stress or repeated injury in First Nations female students and refer promptly to a GP.*
- *Encourage GP referral for assessment of vitamin D and iron status for any First Nations female dancer whose energy, recovery or injury pattern gives cause for concern. Ensure families are fully informed.*
- *Do not frame nutritional conversations around body size or weight.*
- *Connect families with local Aboriginal Community Controlled Health Organisations ([ACCHOs](#)), which provide Culturally safe primary health care.*
- *Recognise bone health is a structural health equity issue for many First Nations young women, not simply an individual dietary choice.*

Related reading and resources

IADMS Bone Health Resource Paper (Robson & Chertoff, revised 2025): iadms.org/media/zdwaocv1/iadms-resource-paper-bone-health-female.pdf

Healthy Bones Australia — vitamin D and bone health: healthybonesaustralia.org.au/your-bone-health/vitamin-d-bone-health/

Healthy Bones Australia — calcium-rich food list: healthybonesaustralia.org.au/wp-content/uploads/2022/10/calcium-rich-food-list_en_1_healthybonesaustralia-iof-version-draft-1.pdf

Bone Health Foundation Australia: bonehealth.org.au

One Dance UK — Bone Stress Injuries in Dancers: onedanceuk.org/news/bone-stress-injuries-bis-in-dancers

Australian Menopause Society — menopause and bone health: hub.menopause.org.au/Play?pld=5fc0cc92-bf79-45b4-9e1b-bad46bd439f0

IOC Consensus Statement on RED-S (Mountjoy et al., 2023): *British Journal of Sports Medicine* 57(11), 592–607

Black LJ, Dunlop E, Lucas RM et al. (2021). Prevalence and predictors of vitamin D deficiency in a nationally-representative sample of Australian Aboriginal and Torres Strait Islander adults. *British Journal of Nutrition*, 126(1), 101–109. doi.org/10.1017/S0007114520003931

Ausdance — Fuelling the Dancer: ausdance.org.au

Ausdance — Eating Disorders and Dancers: ausdance.org.au

NACCHO — Find an Aboriginal Community Controlled Health Organisation: naccho.org.au/find-a-clinic

AIHW — Health and wellbeing of First Nations people: aihw.gov.au/reports/australias-health/indigenous-health-and-wellbeing

Lowitja Institute — First Nations health research: lowitja.org.au

SNAICC — National Voice for our Children: snaicc.org.au

National Office for Child Safety — Keeping Our Kids Safe: childsafety.gov.au

Creative Workplaces — Culturally safe workplaces: creativeworkplaces.gov.au

13YARN — 24/7 crisis support for First Nations people: 13 92 76

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This fact sheet provides general information only and is not medical advice. Dancers with concerns about bone health, menstrual or hormonal health, energy availability or nutrition should consult a GP or healthcare practitioner with relevant expertise, such as a Sports Doctor, Dance Physiotherapist or Accredited Sports Dietitian. Ausdance Fact Sheet updates 2026 have been completed by Rita Pryce, Ashley Saltner Jr, Tom Davis, Annie Strauchs, Lynette Haines, Dr Joanna Nicholas, Ellen Paterniti, Isaac Campbell, Peta Blevins, Jacqueline Dimmock and Molly Tipping. Aboriginal and Torres Strait Islander content and Cultural Guidance – Rita Pryce, Pryce Centre for Culture and Arts.