Survey 4 Bone Health Findings

Overview

This report summarizes the preliminary findings from Survey 4 regarding bone and skeletal health conditions among the TSSUS Turner Syndrome Research Registry (TSRR) participants. The analysis includes overall prevalence, stratification by karyotype group, and stratification by age group (using education level as a proxy for adult versus child/adolescent status).

These findings represent self-reported data from approximately 257 participants.

To support interpretation of the findings below, the following brief explanations describe the bone and skeletal conditions assessed in Survey 4:

- **Low Bone Density (Osteopenia/Osteoporosis):** Reduced bone mineral content, which increases the risk of fractures.
- **Spine Curvature (Scoliosis/Kyphosis):** Abnormal curvature of the spine that may cause posture changes or back discomfort.
- **Hip Dysplasia:** A condition in which the hip joint is improperly formed or too shallow.
- **SCFE (Slipped Capital Femoral Epiphysis):** A hip disorder in which the ball of the hip joint slips from its normal position, typically occurring during adolescence.
- **Dental Issues:** Includes short tooth roots, enamel abnormalities, loose adult teeth, or malocclusion (misaligned bite).
- **Jaw/Palate Issues:** Structural differences such as a small lower jaw or high-arched palate.
- **Cubitus Valgus:** Outward angling of the elbows when the arms are extended.
- **Genu Valgum (Knock Knees):** Inward angling of the knees when standing straight.
- **Short 4th Finger or Toe:** A shortened fourth digit of the hand or foot.
- **Short Neck:** Reduced neck length, a common physical feature in Turner syndrome.
- **Chest Wall Difference:** Breastbone that protrudes outward or caves inward.
- **Fractures:** History of bone breaks.

1. Overall Prevalence of Bone-Related Conditions

Bone and skeletal conditions were common among participants.

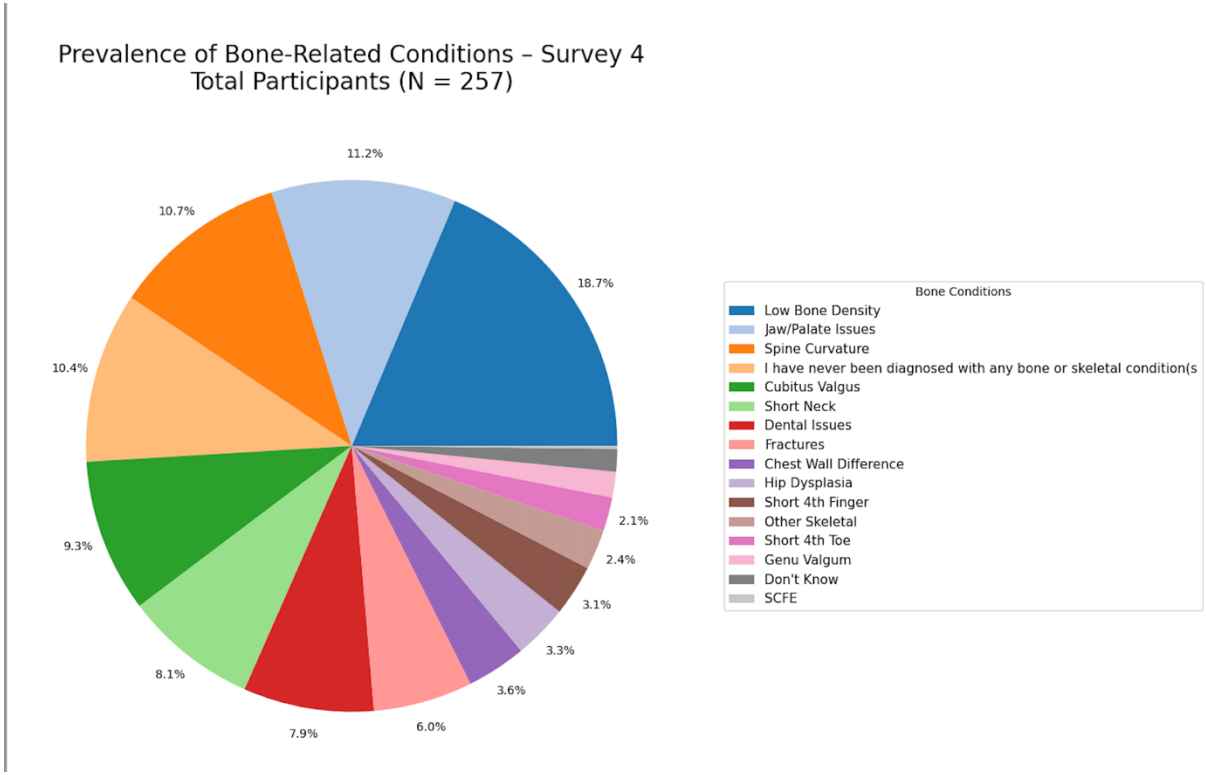

Figure 1. Prevalence of Bone-Related Conditions – Survey 4 (N = 257)

Bone and skeletal conditions were common among TSRR participants. The most frequently reported condition was low bone density, affecting 48 participants (18.7%). This was followed by jaw and palate abnormalities reported by 29 participants (11.2%), and Scoliosis reported by 27 participants (10.7%).

Additional skeletal findings included cubitus valgus in 24 participants (9.3%), short neck in 21 participants (8.1%), and dental issues in 20 participants (7.9%). A history of fractures was reported by 15 participants (6.0%).

Less frequently reported conditions included chest wall differences (3.6%), hip dysplasia (3.3%), short fourth finger (3.1%), short fourth toe (2.1%), and other skeletal conditions (2.4%). Notably, 27 participants (10.4%) reported no diagnosed bone condition.

These findings highlight the high prevalence of skeletal manifestations in individuals with Turner syndrome, with low bone density emerging as the primary clinical concern.

2. Bone Issues Stratified by Karyotype

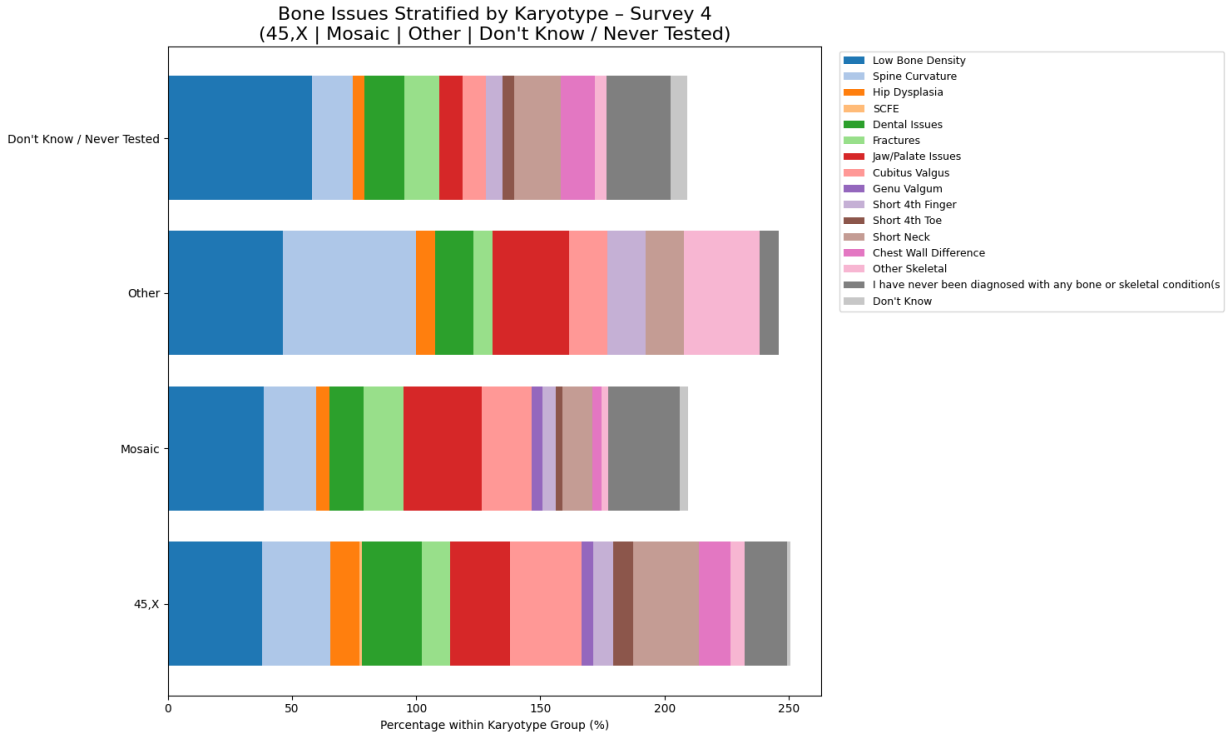

Figure 2. Bone Issues Stratified by Karyotype (45,X | Mosaic | Other | Don't Know / Never Tested)

Participants were categorized into four karyotype groups: 45,X (n = 109), Mosaic (n = 88), Other (n = 42), and Don't Know/Never Tested (n = 18).

Low bone density was consistently the most commonly reported condition across all karyotype groups. In the 45,X group, 21 participants (19.3%) reported low bone density. Similarly, 16 participants (18.2%) in the Mosaic group, 7 participants (16.7%) in the Other group, and 3 participants (16.7%) in the Don't Know/Never Tested group reported low bone density.

Jaw and palate abnormalities were reported by 13 participants (11.9%) in the 45,X group, 10 participants (11.4%) in the Mosaic group, 6 participants (14.3%) in the Other group, and 2 participants (11.1%) in the Don't Know/Never Tested group.

Scoliosis was reported by 12 participants (11.0%) in the 45,X group, 9 participants (10.2%) in the Mosaic group, 5 participants (11.9%) in the Other group, and 2 participants (11.1%) in the Don't Know/Never Tested group.

The distribution of additional skeletal findings, including cubitus valgus, short neck, dental issues, and fractures, was comparable across groups. No single bone-related condition appeared uniquely elevated within a specific karyotype category.

3. Bone Issues Stratified by Age Group

Age group was estimated using education level as a proxy:

- College or graduate education → Adult
- Elementary / middle / high school → Child/Adolescent
- Missing/unclear → Unknown

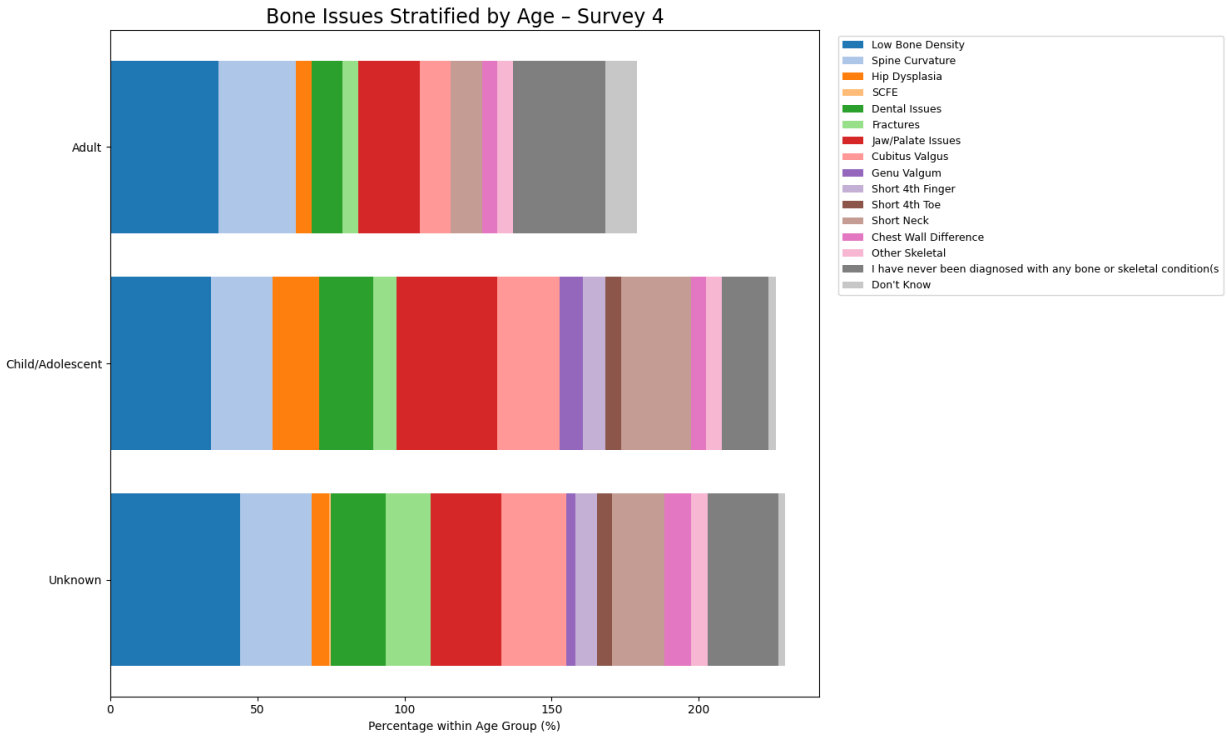

Figure 3. Bone Issues Stratified by Age (Adult | Child/Adolescent | Unknown)

Age classification was derived from education level and categorized as Adult (n = 192), Child/Adolescent (n = 61), and Unknown (n = 4).

Low bone density was reported by 37 adults (19.3%) compared to 8 children/adolescents (13.1%). Jaw and palate abnormalities were reported by 21 adults (10.9%) and 8 children/adolescents (13.1%). Scoliosis was reported by 20 adults (10.4%) and 7 children/adolescents (11.5%).

Fractures were more frequently reported among adults (12 participants; 6.3%) compared to children/adolescents (2 participants; 3.3%). Structural skeletal findings, including cubitus valgus and short neck, were observed at similar rates across both age groups.

The Unknown age category (n = 4) was too small for meaningful comparative interpretation.

Table: Key Differences in Bone-Related Conditions by Karyotype and Age Group – Survey 4

Condition	**45,X (n=109)**	**Mosaic (n=88)**	**Other (n=42)**	**Don't Know (n=18)**	**Adults (n=192)**	**Children (n=61)**	**Key Insight**
Low Bone Density	19.3% (21)	18.2% (16)	16.7% (7)	16.7% (3)	19.3% (37)	13.1% (8)	Most prevalent condition; higher in adults and slightly higher in 45,X.
Jaw/Palate Issues	11.9% (13)	11.4% (10)	14.3% (6)	11.1% (2)	10.9% (21)	13.1% (8)	Slightly higher in "Other" karyotype and in children/adolescents.
Scoliosis	11.0% (12)	10.2% (9)	11.9% (5)	11.1% (2)	10.4% (20)	11.5% (7)	Consistent across groups.
Cubitus Valgus	9.2% (10)	8.0% (7)	7.1% (3)	5.6% (1)	8.9% (17)	8.2% (5)	Similar distribution across groups.
Dental Issues	7.3% (8)	8.0% (7)	7.1% (3)	5.6% (1)	7.8% (15)	8.2% (5)	Comparable prevalence across age and karyotype.
Fractures	5.5% (6)	5.7% (5)	4.8% (2)	—	6.3% (12)	3.3% (2)	More common in adults, reflecting age-related bone fragility.
No Bone Condition	10.1% (11)	10.2% (9)	9.5% (4)	11.1% (2)	9.9% (19)	9.8% (6)	Similar proportion across all groups.

Clinical and Research Implications

Bone health remains a major clinical concern in individuals with Turner syndrome. Low bone density was the most prevalent finding across both karyotype and age groups, underscoring the need for early screening and ongoing monitoring. Structural skeletal differences, including scoliosis and craniofacial abnormalities, were consistently observed across groups, suggesting early developmental origins.

Future analyses incorporating estrogen exposure history, growth hormone therapy, gonadectomy status, and longitudinal follow-up data will provide further insight into the progression and management of skeletal health in this population.

Summary

Across the TSRR Survey 4 cohort, low bone density emerged as the most prevalent bone-related condition. Structural skeletal differences were consistently reported across karyotype and age groups. The similarity in distribution across cytogenetic categories suggests that skeletal manifestations are broadly shared features within the Turner syndrome population rather than being confined to specific karyotype subgroups. Age-stratified findings indicate a modest increase in low bone density among adults, consistent with progressive bone mineral loss over time.