Human Packing:
Density Bounds for Coffins, Cars, and Chambers

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Human (unpacked)

Abstract

We approximate the human body as a rigid sphere and pack it into nine everyday enclosures—coffins, phone booths, hot tubs, and a Boeing 747—via lattice optimization with exact geometric containment. A standard coffin cannot hold a single spherical human (the sphere exceeds casket depth by 119 mm), real humans outperform idealized spheres by 1.7–5.0× in venues with world records for human stuffing, and the Boeing 747 is underutilized by a factor of 13.6 (though we expect this margin to narrow as legroom continues to shrink).

1. Introduction

Readers may be familiar with spherical cows of uniform density. We take the logical next step: approximating the human body as a rigid sphere and investigating how many fit inside everyday enclosures. The problem turns out to be choosing *which* sphere: a volume-equivalent sphere has a radius of 25 cm (a beach ball); a height-bounding sphere has a radius of 85 cm (a hamster ball). That is a 240% difference in radius and a 3,800% difference in volume.

Fortunately, sphere packing is well-studied. Kepler conjectured in 1611 [1] that the face-centered cubic (FCC) arrangement achieves maximum density at $\pi/(3\sqrt{2}) \approx 74.05\%$, proved by Hales in 2005 [2] and formally verified in 2017 [3]. The analogous problem of packing into finite containers, where wall effects dominate, has been studied for squares [21]. We encounter the same boundary-dominated regime in venues as small as the K6 telephone booth (0.80 m × 0.80 m × 2.30 m).

Astute readers may wonder why we approximate humans as spheres when Cui et al. [4] recently demonstrated spectral packing of arbitrary 3D meshes at SIGGRAPH, achieving 670 objects in 40 seconds. In principle, one could obtain a high-resolution full-body 3D scan, segment the mesh into a watertight manifold, compute the signed distance field, voxelize the container geometry, evaluate the spectral correlation function via FFT, solve the resulting nonlinear optimization problem, and produce a physically exact packing of anatomically correct humans. However, those readers would have failed to consider that this paper was written on a literal potato that barely runs Doom and would take approximately three hundred million years per venue. Thus spheres were selected for no other arbitrary reason such as laziness.

The phone booth stuffing craze of 1959 produced a record of 25 students in a South African booth [5]. The VW Beetle record is 20 [6]. These serve as our primary experimental validation, and constitute useful evidence against the sphere packing methodology.

1.1 Contributions

1. Four spherical human models derived from anthropometric data.
2. Packing results for nine human enclosures with exact geometric containment.
3. The *Child Advantage Factor* (CAF): children pack 1.9–4.8× more efficiently.
4. The *Overfat Paradox*: real humans outperform spheres in the K6 phone booth (5:1) and Volkswagen Beetle (1.7:1).
5. The *Coffin Curiosity*: the Meatball exceeds the casket's depth by 119 mm.

2. Models and Enclosures

We develop four spherical human models from anthropometric data:

Table 1. Spherical human models.

Model	Basis	r (m)	Vol. (L)
Meatball	Body volume	0.250	65.2
Hamster Ball	Standing height	0.850	2572
Freedom Sphere	American mass	0.273	84.9
Kid	Child (∼8) mass	0.182	25.3

The **Meatball** uses the average human body volume of 65.22 L [7]. The **Hamster Ball** encloses a standing 1.70 m human [8]—97.5% of the interior is air. The **Freedom Sphere** uses average American mass (83.6 kg, CDC [9]), yielding 9% more radius than the Meatball. The **Kid** uses an 8-year-old at the 50th percentile [10].

We select nine enclosures spanning three orders of magnitude in volume:

Table 2. Enclosures with dimensions, volumes, and rated capacities.

Venue	Vol. (m^3)	Rated
Standard Coffin [11]	0.44	1
K6 Phone Booth [12]	1.38	1†
Jacuzzi J-345 [13]	1.96	6
Porta-Potty [14]	2.25	1
VW Beetle [15]	2.28	4‡
Elevator [16]	8.31	21
ISS Destiny [17]	122	3
King's Chamber [18]	319	1
Boeing 747-400 [19]	968	660

† Record: 25 (Natal, 1959) [5]. ‡ Record: 20 (Guinness, 2010) [6].

3. Methodology

For each (model, venue) pair, we generate FCC and simple cubic lattices over a $5^3 = 125$ grid of origin offsets, keeping the best. Each sphere is tested against exact boundaries—box, dome, cylinder, fuselage, or rounded box. No partial containment is permitted.

Simple cubic *outperforms* FCC in three of nine venues (Jacuzzi, Porta-Potty, VW Beetle—all small containers). We suspect Kepler did not test his conjecture in a Jacuzzi.

4. Results

Table 3. Spherical humans packed per venue.

Venue	Meat.	Ham.	Free.	Kid	Ratio
Coffin	0	0	0	5	0×
Jacuzzi	9	0	6	32	1.5×
Elevator	53	0	45	160	2.5×
VW Beetle	12	0	10	36	3×
K6 Booth	5	0	4	24	5×
Porta-Potty	16	0	6	30	16×
ISS Destiny	1,050	15	774	2,954	350×
King's Ch.	3,080	54	2,220	8,512	3,080×
747-400	8,966	165	7,072	24,724	13.6×

Ratio = Meatball count / rated capacity.

5. Discussion

The Coffin Curiosity. A coffin holds exactly one human but zero spherical ones. The casket interior is just 0.380 m deep [11]; the Meatball's diameter of 0.499 m exceeds it by 119 mm. The one container purpose-built for a human fails precisely *because* it was designed for the actual shape. At $\varepsilon = 23.8\%$ strain, a determined mortician could close the lid. We consider this the mortician's problem, not ours.

The Overfat Paradox. Our spherical model *overfits* to geometry and *underfits* to reality. Real humans outperform spheres where world records exist: 25 vs. 5 in the K6 booth (5.0×), 20 vs. 12 in the VW Beetle (1.7×). Those 1959 students packed more efficiently than frictionless rigid spheres the size of Pilates balls. Humans have articulated limbs and the ability to scream at each other to move over. Spheres have none of these.

The Child Advantage. In a spirit reminiscent of Swift [20], we define CAF $= n_{\text{Kid}}/n_{\text{Meatball}}$. Average CAF (excluding the coffin, where CAF $= \infty$): 3.1×. A 747 configured for spherical children seats 24,724.

6. Conclusion

The Meatball overpredicts by 1.5–3,080×. The Hamster Ball predicts zero for six of nine venues. The Overfat Paradox—real humans outperforming idealized spheres—undermines our central premise. The Jacuzzi J-345, at only 1.5×, comes closest to rated capacity. People in hot tubs are seated, partially submerged, and relatively still. They are, we suggest, the most spherical humans available in everyday life.

Code and data: https://kaelanyim.com/sigbovikxx

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