**Some Biomechanical Aspects Regarding the Salah of a Muslim**

**Part 1: Standing (Qiyam)**



But why? Why is this the recommended position?

When you twist and have your feet in “V” position, it increases torque (torsion) on your knees.

Step 1: Identify the Forces

The primary force acting on the body in the Qiyam position is body weight (gravitational force). This force is represented as:

Where:

* m = body mass (in kg)
* g = acceleration due to gravity ()

Step 2: Moment Arm (r) Calculation Based on the Knee-Toe Angle

The **moment arm** can be determined by considering the geometry of the leg and the angle between the knee and the toes. If the knee is flexed at an angle θ (between the knee and the toes), the **moment arm** can be expressed as:

Where l is the length of the tibia and is the angle between knee and toes.

Step 3: Apply the Torque (Torsional stress) Formula

Torque (τ) around the knee joint can be calculated using the formula:

Where:

* τ = torque around the knee joint (in Newton-meters, Nm)
* r = distance from the knee joint to the center of mass (in meters)
* F = applied force (in Newtons) = mg
* θ = angle between knee and toes.

Step 5: Calculation

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Take home points:

* Knee Joint: When the body is fully straight in Qiyam, the knees are in a more neutral position with less flexion. This reduces the moment arm (distance from the knee to the point where force is applied) and thus the torque acting on the knee. The smaller the angle of flexion, the less torque is created at the knee joint.
* Hip Joint: In a fully straight posture, the body's center of mass is more aligned over the hips. This reduces any forward lean (the angle θ) and decreases the torque on the hip joint. The more upright the body, the shorter the distance from the hip to the center of mass, and the smaller the force component acting around the joint, which results in lower torque.

**Part 2: Rukuk**

Ideal Position

A young person bending over

AI-generated content may be incorrect.

“Letak kepala juga harus sejajar dengan tulang belakang. Posisi yang benar ini menjaga fungsi kolom vertebra sebagai penahan tubuh dan sistem saraf pusat.”

[Maulida, H. S., & Kinanti, H. L. (2024). Analisis Biomekanika Gerakan Salat: Implikasi untuk Kesehatan. *Islamologi: Jurnal Ilmiah Keagamaan*, *1*(2), 167-176.]

Spinal Alignment in Ruku, Torque on Spine

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| Hip Flexion (Straight Back) | vs | Lumbar Flexion (Arched Back) |
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distance from centre of mass to hip/lumbar

The calculations clearly show that proper spinal alignment during Ruku (i.e., keeping the back straight and neutral) minimizes the torque acting on the lumbar spine, which reduces muscular strain and the risk of injury. When the spine is curved (e.g., during lumbar flexion), the moment arm increases, resulting in higher torque that the back muscles must resist. This highlights the importance of maintaining a straight back during Ruku to optimize biomechanical efficiency and minimize strain on the spine.

In summary, the center of mass in the Ruku position is located close to the pelvic area, slightly above the sacrum, and about 0.5 meters from the lumbar spine. This is an approximation for an average adult person during Ruku, and the distance can vary slightly depending on individual body proportions.

**Part 3: Sujood**

[**https://www.jstage.jst.go.jp/article/jpts/24/10/24\_JPTS-2012-180/\_pdf**](https://www.jstage.jst.go.jp/article/jpts/24/10/24_JPTS-2012-180/_pdf)

**Part 4: Overall**

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