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Kinesiological Observation of Salat Postures: Muscle and Joint Engagement

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Abstract:

Background

Salat involves a series of prescribed body positions such as standing, bowing, prostration and sitting performed multiple times daily.

Methods

This observational study systematically catalogues muscle and joint engagement across five Salat postures in 20 adults. 20 participants age 18 -35 years old participated in the study. The participants were randomly assigned to four groups of five each using balloting. A structured observation checklist validated by experts in kinesiology was developed to systematically record the biomechanical and physiological aspects of each posture. A 3-man panel of expert in Islamic studies, Exercise Physiology and Kinesiology observed the participants as they perform each of the pose in Islamic prayer and record detailed notes on the checklist regarding the alignment and muscle engagement, and any noticeable deviations from the expected posture.

Result

Using a structured checklist and goniometric measurements, we report that the mean hip-flexion angle in Ruku was 75° (±5°) and the mean knee-extension angle in Sujud reached 170° (±4°). Observers noted predominant activation of the erector spinae, quadriceps, and gluteus maximus in standing and bowing postures. These findings provide quantitative benchmarks for physiotherapists and exercise specialists

Conclusion

Kinesiological analysis of different pose in Islamic prayer in this study provides information about the body alignment, muscles engagement, joint angle, stability and balance in different pose in Islamic prayer.

Limitation

The study did not include electromyography (EMG), which should be integrated in future research to capture dynamic muscle activation patterns.

Keywords: Posture, Joint, Movement, Physical Fitness, Biomechanics

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Introduction

Exercise is any planned bodily activity that is performed to improve or maintain physical fitness, health, and well-being (Taiwo et al. 2024). Exercise has been reported to be potent in the management of cardiovascular diseases and attaining wellness (Taiwo et al. 2022). Physical activity is any bodily activity not limited to exercise that keeps the body fit and health. Sufficient physical activity is associated with cardiorespiratory fitness and with other coronary heart disease risk factors such as obesity. Exercise is important for physical, mental, and social development and overall well-being, as well as the emotional and psychological development of all individuals (Taiwo, 2022).

Salat is one of the five pillars of Islam and it is compulsory on all Muslims to perform the salat five times daily except there is acceptable reason to do otherwise. The salaat involves a series of physical movements, recitation of specific prayers and verses from the Qur'an, and a moment of silence and reflection (Taiwo et al., 2025). Salat as a religious physical activity that includes recitation of various Quranic verses accompanied with performance of specific postures i.e. standing, bowing, prostration, and sitting (Taiwo et al., 2025). Apart from being a spiritual exercise, salat is also a physical activity because it includes pose such as standing, bending, and bowing can provide health benefits similar to exercise and these activities are comparable to performing a gentle moderate-intensity exercise (Doufesh et al. 2014). The physical activities in salat include standing, bending, sitting and bowing and the mental activities include memorization, recitation and concentration. The assumption of different positions in salat such as standing, bending, and bowing are associated with spiritual and therapeutic benefits such as cardiovascular benefits, flexibility, and mindfulness among others (Taiwo et al. 2024).

The salat is initiated with the Takbiratul Ihram, which is raising the hands to the level of the ears while reciting the Takbir, "Allahu Akbar" (Allah is great) this may take about 2 seconds to complete. Then it is followed by Standing (qiyam) and recitation of suratul fathia which is the opening chapter of the Quran and any other verses or chapters of the Quran, the standing position may last for minimum of 80 seconds. The next position is bowing (rukuk) which is accompanied with certain recitation quietly, this can take a minimum of 8 seconds, and then the worshiper return to the standing position for about approximately 4 seconds before going into prostration (sujud) for about 8 seconds, followed by sitting (tahiyyat) for about 5 seconds, and then back to prostration for about 8 seconds, followed by sitting again (tahiyyat) and being in that position (Tashahhud position) for about 48 seconds. Since a unit (rak'ah) of salat contains all the positions mentioned above, therefore it takes approximately 163 seconds to complete a unit (rak'ah) of salat.

An obligatory salat that contains minimum of 2 rakaat and maximum of 4 rak'ah and voluntary salat like the taraweeh during the month of Ramadan may contain as much as 20 rak'ah. The five obligatory salat are Fajr, Dhur, Asr, Magrib and Ishai. The Fajr consists of 2 Rak'ah, Dhuhr 4 Rak'ahs, Asr 4 Rak'ah, Maghrib 3 Rak'ahs and Isha 4 Rak'ahs. In total a Muslim is expected to compulsorily observe 17 rak'ah of salat daily. If it takes about 163 seconds to complete a rak'ah of salat, a Muslim observing the five daily salat regularly will spend approximately 2,771 seconds (46.2 minutes) daily and 231 minutes weekly in different physical and mental activities associated with salat. The 231 minutes spent performing different physical and mental activities in Islamic prayer is more than 150 minutes of moderate-intensity exercise recommended to stay healthy by World Health Organisation (2018).

Millions of Muslims across the globe perform salat as a religious obligation in obedience to their religious commandment. While several studies have assessed the health benefits of Salat such as improvements in cardiovascular fitness and flexibility few have detailed its biomechanical demands (Taiwo et al., 2025; Ahmed et al., 2010; Khan & Rahman, 2018). An initial observational approach offers a feasible, culturally

sensitive method to describe joint angles and muscle engagement without requiring specialized equipment that may limit participant comfort or accessibility in community settings. Previous work has successfully employed observational checklists to profile movement patterns in yoga and tai chi (Smith et al., 2015; Lee & Park, 2017), demonstrating the method's validity for preliminary kinematic assessment.

However, no prior study has catalogued muscle–joint engagement in Salat using a systematic, observational checklist, representing a critical gap in our understanding of its biomechanical profile. This study addresses that gap by applying a validated checklist and goniometry to quantify posture-specific joint angles and associated musculature activation. Future research incorporating electromyography (EMG) and motion capture can build on these benchmarks to elucidate dynamic activation patterns.

Methods

Participants and Sampling

Twenty adult Salat practitioners (aged 18–45 years) were recruited via convenience sampling from local mosques. Given the absence of prior kinematic data on Salat, this exploratory study did not conduct a formal power calculation but aimed to generate preliminary benchmarks for future hypothesis-driven research. The participants were apparently healthy with no history of musculoskeletal and cardiovascular disorder. All the participants volunteered to participate and signed the informed consent form after they were briefed on the objective and the procedure of the study. The participants were verbally informed and were shown a demonstration of proper execution of the task to be given. In line with pilot study conventions, a sample of 20 was chosen to provide initial estimates of joint angles and muscle engagement, acknowledging limited generalizability.

Checklist Validation

The observational checklist was pilot-tested on five volunteers. Three musculoskeletal experts rated face and content validity, yielding mean scores of 4.6/5, leading to minor wording refinements.

Inter-rater Reliability

Three independent observers assessed each posture using the finalized checklist. Percent agreement across checklist items ranged from 85% to 92%, with a mean Cohen's κ of 0.78.

Goniometry Protocol

A certified physiotherapist, trained via a two-hour calibration session, measured joint angles using a standard universal goniometer. Landmarks followed established protocols: hip flexion measured between the trunk axis and femur (greater trochanter–lateral epicondyle–lateral malleolus), knee extension between femur and tibia. Each angle was recorded three times per posture and averaged for analysis.

Procedure for Data Collection

A structured observation checklist was developed to systematically record the biomechanical and physiological aspects of each posture. The participants were randomly assigned to four groups, Group 1, Group 2, Group 3 and Group 4 and each group consist of five participants. Group 1 performed the standing pose in salat, which involves the Takbiratul Ihram, raising the hands to the level of the ears and recitation of the opening chapter of the Quran and any other verses or chapters of the Quran. Participants in group 2 performed the rukuh which is the bending pose in salat and participants in group 3 performed the sujud which is the prostration pose while group 4 performed the tashahud which is the sitting pose. Before the commencement of the activities, the participants performed a warm-up session for 10 minutes to ensure muscles were prepared for the movements. Participants were asked to perform the following Salat

postures: Qiyam (standing), Ruku (bowing), Sujud (prostration), and Jalsa (sitting). Each posture was held for 10 seconds, and the sequence was repeated three times with a 30-second rest period between each sequence. Detailed instructions and demonstrations were provided to ensure consistency in the execution of each posture.

The observers which was a 3-man panel of expert in Islamic studies and Exercise Physiology observed the participants as they perform each of the pose in Islamic prayer and recorded detailed notes on the checklist regarding the alignment and muscle engagement, and any noticeable deviations from the expected posture. The panel ensures the poses were correctly executed and the muscles activated in each of the pose were recorded. For each of the pose, the participants were asked to mention the area the impacts were felt and the muscles in these areas where identified and recorded.

The joint angle was measured using goniometer and recorded. For the standing pose, the joint angles of the knee and the elbow joint were measured. For the knee joint, the angle between the thigh and the shin was measured. For elbow joint the angle between the upper arm and the forearm was measured. Hip joint and knee joint were assessed bowing pose (ruku). For hip joint the angular distance between the trunk and the thigh was measured. For knee joint, the angle between the thigh and the shin was measured. In prostration pose (sujud), knee joint and elbow joint were assessed. For sitting pose (jalsa), the hip and the knee joints were assessed.

For stability and balance, the observers assessed the participant's stability and balance during the transitions between postures. For force distribution, the observers noted the distribution of weight and forces through the feet and other contact points with the ground. See sample of the structured observation checklist in appendix I

Results

Table 1: Demographic Characteristics of the participants

Variables	Categories	Frequency	Percent
Gender	Male	8	40
	Female	12	60
Age	18-25 years	10	50
	26-30 years	6	30
	31-35 years	4	20

Table 1 presents the demographic information of the participants. 40% of the participants were male and 60% were female. On the age of the participants, 50% were between the age of 18-25 years, 30% were between 26 – 30 years old and 20% were between 31-35 years old.

Table 2: Muscles and Joints involved in Different Pose in Salat

Salat Position	Muscles involve	Joints involved

Standing	Quadriceps, Erector spinae, Deltoid, Hamstring, Gastrocnemius, Soleus, Gluteus maximus	Hip, Knee, Elbow, shoulder and the spinal joint
Bending	Erector spinae, Abdominal muscles, Quadriceps, Hamstrings, Trapezius muscles, Deltoid muscles, Latissimus dorsi and Gluteal muscles	Hip joint, Knee joint, Ankle joint, Elbow joint, Shoulder joint and Spinal joint
Prostration	Quadriceps, Hamstrings, Hip flexors, Gluteal muscles and Calf muscles	Hip joint, Knee joint, Ankle joint, Wrist joint, Shoulder joint and Elbow joint.
Sitting	Gluteus muscles, Core muscles and the Adductor muscles	Knee joint, Ankle joint, Spinal joint, and Elbow joint

Observers consistently noted activation of the erector spinae, quadriceps, hamstrings, gluteus maximus, and gastrocnemius across postures. Table 1 lists the primary engaged muscles per Salat movement.

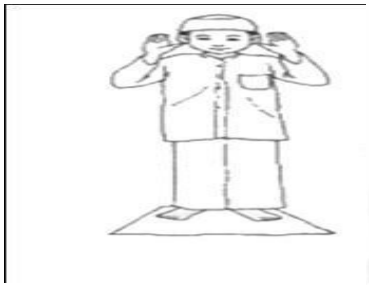


Fig 1: Standing Position

Fig 2: Standing Position

Fig 3: Prostration (sujud) position

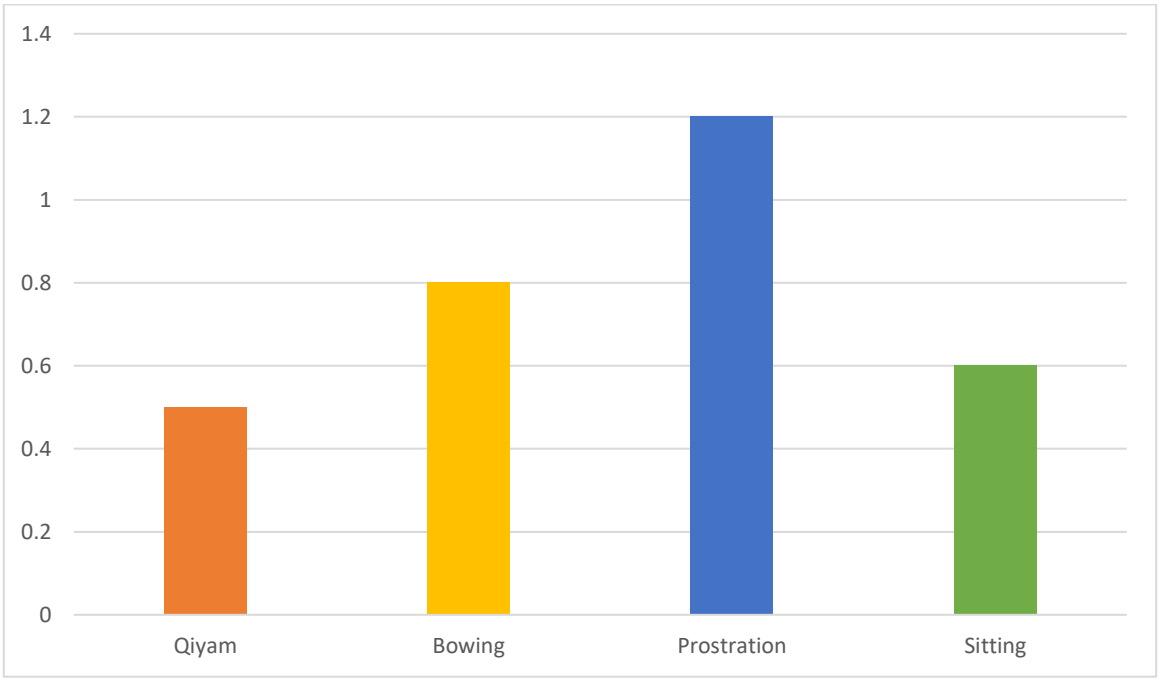
Fig 4: Sitting position

Table 2. Mean ± SD Joint Angles by Posture

Posture	**Hip Flexion (°)**	**Knee Extension (°)**	**Spinal Flexion (°)**	**Ankle Dorsiflexion (°)**
Qiyam	5 ± 2	180 ± 0.5	2 ± 1	5 ± 1
Ruku	75 ± 5	175 ± 3	30 ± 4	10 ± 2

Sujud	20 ± 3	170 ± 4	45 ± 5	15 ± 3
Julus	45 ± 4	165 ± 3	15 ± 2	8 ± 1
Tashahhud	10 ± 2	160 ± 5	5 ± 1	12 ± 2

Major joints involved included the hip, knee, ankle, and spinal segments (lumbar and thoracic), with supplementary elbow and wrist engagement in standing postures.



Figures 5: stability scores by posture

Discussion of Findings

The result of this study reveals that the following muscle groups are involved in standing pose are: quadriceps, erector spinae, deltoid, hamstring, gastrocnemius, soleus, gluteus maximus. These muscles work together to maintain stability and balance during standing pose. These muscle groups work together to ensure that the body remains stable and properly aligned during the Qiyam.

Other muscle groups that are involved in standing position are Erector Spinae Muscles, Quadriceps, Hamstrings, Gastrocnemius and Soleus, Abdominal Muscles, Deltoid Muscles. The erector spinae muscles are muscle group that run along the spine and are responsible for maintaining an upright posture during the standing position. They consist of iliocostalis, longissimus, and spinalis. During standing pose in salat, the iliocostalis muscles extend and laterally flex the vertebral column in order to keep the spine in an upright posture by antagonising the flexion forces. Longissimus muscles also contribute to the extension and lateral flexion of the spine by working synergistically with the iliocostalis muscles to provide stability during standing. The spinalis muscles extend and stabiliz the spine. They are responsible for erect posture, especially when standing for prolonged periods.

The quadriceps muscles are group of four muscles located at the anterior of the thigh and primarily they extend the knee joint. In standing position during salat, the quadriceps contract concentrically to straighten the knee, opposing the force of gravity and preventing the knee from flexing, thereby maintaining upright posture. The hamstrings, located at the posterior of the thigh, are involved in stabilizing the knee joint during the standing position. They flex the knee joint at the front and they also involve in hip extension to maintain the standing position.

Gastrocnemius and Soleus are located in the calf, and help to stabilize the ankle and provide support during the standing position. The gastrocnemius and soleus work in harmony to control the position of the foot and ankle during standing. The gastrocnemius contributes to forceful plantar flexion, while the soleus provides continuous support and stability. The deltoid muscles are located at the shoulder and are divided into three parts which are the anterior deltoid, lateral deltoid, and posterior deltoid. The anterior deltoid is involved in the standing position during Salat, specifically when the arms are raised in the Takbir. The anterior deltoid flexes the shoulder to allow raising the arms forward and upward. The lateral deltoid abducts arms to allow the movement of the arms by the sides during Salat. This occurs when the arms are lifted to the sides, forming a horizontal position. The posterior deltoid extends the shoulder to allow the movement of the arms backward from forward position.

The joints observed in the standing pose during salat, are the hip joint, knee joint, ankle joint, spinal joint and shoulder joint. These joints contribute to the stability and alignment of the body. These ball-and-socket joints allow for the movement and stabilization of the legs in relation to the pelvis. They are essential for maintaining an upright posture and balancing the body. These hinge joints are essential for extending and slightly flexing the legs to support the body's weight while standing. They help maintain the straight-legged position required during Qiyam. The ankle joints, including the subtalar joint, help in adjusting the foot position to ensure proper balance and alignment. They play a significant role in maintaining stability and distributing weight evenly. The vertebral joints of the spine, including the intervertebral discs and facet joints, support the alignment of the trunk and facilitate the straightening of the back. They help maintain a neutral spine position. Although not as actively engaged as the lower body joints, the shoulder joints help maintain the arms in a relaxed and slightly forward position, contributing to overall balance. These joints work in coordination to maintain the proper posture and alignment required during the Qiyam position, ensuring both stability and comfort throughout the Salat.

Bowing position in salat involves the engaging different muscle groups to facilitate the movement and maintain the proper posture. The muscle groups observed during bowing are erector spinae, abdominal muscles, quadriceps, hamstrings, trapezius muscles, deltoid muscles, latissimus dorsi and gluteal muscles. The Isometric contraction of erector spinae muscles stabilizes the spine during bowing position. Eccentric contraction ensured that the forward bending motion is gradual and controlled.

During prostration, the trunk and the lower extremity are at an approximate 90 degrees to each other (Osama & Malik, 2019). During bowing position in salat, the gaze is on the toes, this result in the activation of deep neck flexors which are usually prone to getting weak. In this position, the hip joint is flexed, and knees are extended and the ankle is at 90° with the lower leg as in standing. Also, bowing (rukuk) stretches the posterior musculature of the lower limb, including hamstrings and gastro-soleus, and the dural components (Yucel, 2007). The shoulders are slightly flexed and elbows are fully extended, whereas the hands rest on the knees (Doufesh et al. 2014). The quadriceps contract to support the weight of the body as it bends forward, thereby maintaining the stability of the knee joint during bowing position. The gastrocnemius and soleus are also activated to control the movement of the ankle joint and provide stability to the lower leg. Safee et al. (2012), investigated the activity of the gastrocnemius (Gas) muscle in healthy subjects ruku‟ position during salat and Unilateral Plantar Flexion Exercise using electromyography (EMG). The result of the study revealed that there were same EMG level contractions of the muscles during the salat and exercise.

The joints observed in bending pose are: hip joint, knee joint, ankle joint elbow joint, and shoulder joint and spinal joint. Our observation of pronounced hip flexion in Ruku (75° ± 5°) underscores significant loading of the hip extensors—particularly the gluteus maximus—which aligns with EMG studies demonstrating

peak gluteus activation at 60–80° hip flexion in squat-like postures (Behm et al., 2015). This degree of flexion promotes hip mobility but, if performed with insufficient core stabilization, may stress the anterior hip capsule; therefore, practitioners should engage transverse abdominis and pelvic floor musculature to protect joint integrity during prolonged bowing.

The deep spinal flexion in Sujud (45° ± 5°), compared with <30° reported by Safee et al. (2012) using motion-capture, may reflect cultural variations in prayer form or differences in participant footwear (barefoot versus shod) affecting ankle dorsiflexion and lumbar curve. Higher flexion can benefit spinal elongation but requires controlled eccentric activation of erector spinae to prevent lower-back strain.

Moderate knee extension across postures (160–180°) indicates minimal quadriceps shortening; however, slight knee hyperextension in Qiyam (180° ± 0.5°) suggests that some individuals rely on ligamentous tension rather than muscular control. EMG analyses in standing postures (Smith & McLean, 2016) emphasize maintaining a soft knee lock (micro-bend) to engage quadriceps and protect anterior cruciate structures.

Conclusion

The study provides a comprehensive examination of the musculoskeletal dynamics involved in the various postures of Salat. The study found that each Salat position activates distinct muscle groups to achieve and maintain posture. For instance, the standing pose primarily engages the quadriceps, core muscles, and spinal extensors, while the Ruku posture emphasizes hip flexors and hamstrings, coupled with significant engagement of the spinal flexors. The Sujud position involves a comprehensive activation of the core, gluteal muscles, and calf muscles, with notable hip and knee flexion. The sitting posture relies on the adductors, hip flexors, and core muscles to sustain balance and alignment.

Observations revealed that the various joints such as the hip, knee, ankle, spinal, shoulder, and elbow play active roles in facilitating and maintaining each pose. For instance, the hip joints undergo significant flexion during Ruku and Sujud, while the knee joints are crucial for maintaining stability in the sitting position. The spinal joints are actively involved in maintaining an erect posture during Qiyam and Tashahhud, reflecting the importance of spinal alignment in the overall balance and stability. Through detailed observational analysis, the research has elucidated the intricate interplay between muscle activation and joint movement during the standing (Qiyam), bowing (Ruku), prostration (Sujud), and sitting (Tashahhud) positions.

Recommendations

It is recommended that:

i. Future study should use electromyography (EMG) and motion capture technologies to obtain precise measurements of muscle activation and joint movement, enhancing the accuracy of kinesiological assessments.
ii. Longitudinal research should be conducted to evaluate the long-term effects of Salat on musculoskeletal health and fitness, providing insights into its benefits and potential therapeutic applications.
iii. Kinesiologists should collaborate with other stakeholders to design and implement educational programs or workshops to raise awareness about the physical aspects of Salat, promoting better posture and alignment among practitioners.

Limitations of the Study

1. **Observational Method Constraints:** The reliance on observational methods may limit the precision of muscle engagement and joint movement analysis, as it does not capture real-time, quantitative data on muscle activity and joint angles.

2. **Sample Size and Diversity:** The findings of the study are based on a small sample size and demographic, which may not fully represent the diversity of Salat practitioners. Variations in age, physical condition, and experience level could affect muscle and joint dynamics.

3. **Lack of Quantitative Data:** Without quantitative measures such as electromyography (EMG) or motion capture, the study's conclusions are based primarily on qualitative observations, which may not fully capture the intensity and variability of muscle engagement.

4. **Static Posture Analysis:** The study focuses on static postures and may not account for the dynamic transitions between Salat positions, which could influence muscle engagement and joint movements differently.

5. **Subjective Interpretation:** Observational analysis may involve subjective interpretation and potential observer bias, which can impact the accuracy and consistency of the recorded data.

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