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Selected morphological, cardiovascular and neuromuscular risk profiles among asymptomatic sedentary men performing Islamic prayer

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ABSTRACT

Background This study investigated morphological, cardiovascular and neuromuscular profiles among asymptomatic sedentary men performing the Islamic prayer (Salaah). This study emphasised the need for an inquiry into unique sedentary populations who perform Islamic prayer as physical activity.

Methods An experimental study was conducted among male participants (n=20). Resting heart rate (RHR), resting systolic blood pressure (SBP), resting diastolic blood pressure (DBP), body mass index (BMI) and percentage body fat (BF%) were measured before a timed Salaah simulation activity. Electromyography (EMG) of the vastus medialis oblique (VMO) was measured for maximum voluntary contraction (MVC) and two movement transitions of the Islamic prayer (Salaah). Bilateral manual muscle strength (MMT) testing was also completed. Inferential and descriptive statistical analyses were performed using SPSS (IBM, V.27.0). Pearson's correlation coefficient was used to determine statistically significant relationships between variables. The level of significance was set at $p<0.05$.

Results Negative correlations between post-Salaah SBP and MVC average ($r=-0.19$; $p=0.42$) and between the post-Salaah DBP and the MVC average ($r=-0.40$; $p=0.08$) were not significant. Weak correlations were found between the MVC average and the right ($r=0.14$; $p=0.56$) and left ($r=0.18$; $p=0.44$) quadriceps femoris MMT values.

Conclusions This study demonstrated that individuals who performed the Salaah were reasonably healthy in terms of BMI, BF%, RHR, resting SBP, resting DBP, MMT and MVC average values. The study further demonstrated the electromyographic activity of the VMO muscle through the Salaah for two movement transitions of the prayer. Verily, this demonstrates preliminary evidence of EMG activity for the VMO muscle in those who perform the Salaah.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ When studying the Salaah as a form of physical activity, many scholars have noted the Salaah as an example of a low-intensity aerobic activity that holds similarities to exercises including yoga and tai chi.

⇒ Investigations on the Salaah currently need more physiological risk profile data markers on sedentary populations, especially in African and South African contexts.

WHAT THIS STUDY ADDS

⇒ Individuals who performed the Salaah had reasonably healthy results for body mass index, percentage body fat, resting heart rate, resting systolic blood pressure, resting diastolic blood pressure (DBP), manual muscle strength and maximum voluntary contraction average values through reasonable clinical measurement tools and procedures.

⇒ Performing light-intensity aerobic activity such as Salaah positively lowered DBP and potentially lowered cardiovascular disease risk.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Further research into the Salaah will enhance the limited understanding of prayer and its (non-religious) beneficial effects on the physiology of sedentary individuals.

⇒ Larger samples are required to ensure generalisability for larger populations of those who perform the Salaah.

⇒ Insight into the Salaah draws parallels to other forms of low-intensity exercise or meditation activities, such as yoga or tai chi.

BACKGROUND

The word 'Salaah' is an Arabic name that describes the Islamic prayer that all members of the Islamic faith perform. The prayer is known to be comprised of a set of unique postures and movement transitions that are repeated alongside certain mantras and recitations[1] and may be subdivided into five times daily mandatory prayer as well as into special versions, with the latter being performed to gain more reward from God. It comprises sets of movement sequences termed 'raka'ah' (singular=rakaat). To begin a rakaat, an individual starts in the upright position known as the 'Qiyaam'. After certain Quranic recitations, the Qiyaam is followed by a brief bowing known as 'Ruku' and subsequent return into the upright position. From an upright position, an individual moves into

the 'Sujood' or prostration while kneeling and placing the forehead and palms on the ground twice. After that, the individual remains kneeling, termed the 'Tahiyaat'. In general, after two raka'ah are completed, the individual may then terminate their prayer by rotating their head to the right and left sides in an action called 'Salaam'[2]

When studying the Salaah as a form of physical activity, many scholars have noted the Salaah as an example of a beneficial low-intensity aerobic activity that holds similarities to exercises such as yoga and tai chi.[3] As a divine commandment from God, the Salaah is seen as the ultimate act of obedience.[4] Many scholars, however, have been investigating the Salaah in terms of understanding the physiological benefits of performing the Salaah as an act of worship and as a form of physical activity.[4] The problem experienced in many contemporary investigations on the Salaah is the need for physiological risk profile data markers on sedentary populations in the African and South African contexts. The rationale of this study was to use the Salaah as a form of activity to be measured, as the Salaah can be potentially strenuous and physically demanding. Therefore, the Salaah may provide information to attest to the potential benefits to physiological risk profiles of those who perform the prayer. This study investigated the physiological risk profiles of asymptomatic sedentary individuals who perform the Salaah through selected morphological, cardiovascular and neuromuscular parameters.

Study objectives

This research study had two objectives. The primary objective was to investigate each participant's cardiovascular disease risk (CVD) profiles and the response to a single simulation of the Salaah. This was completed by conducting selected cardiovascular measurements of heart rate (HR) and blood pressure (BP). The secondary objective was to investigate participants' selected neuromuscular risk profiles through electromyography (EMG) analysis and manual muscle strength (MMT) measurements of the lower extremity and the response to a single simulation of the Salaah. The study explored whether regular Salaah benefits morphological, cardiovascular and neuromuscular health.

MATERIALS AND METHODS

Study design

This study employed an experimental intervention design that used non-probability convenience sampling. To fulfil the research objectives, selected morphological, cardiovascular and neuromuscular measurements were conducted on the cohort of participants.

Study participants

The study included male participants (n=20), aged between 21and 40 years, who volunteered willingly through word-of-mouth recruitment by the researchers. These participants represented the adult population who perform the Islamic prayer daily. All participants were of African ethnicity. Each participant had to meet the inclusion criteria to be eligible to participate in this study. The participants had to be men and from the Islamic faith to be included in the study. Participants should not have had any chronic disease or orthopaedic injuries. Participants needed to be sedentary (performing less than 150 min of exercise per week) with no current exercise regimen.[5] These were all verified during recruitment. Due to the voluntary nature of this study, male participants were more willing to engage through word-of-mouth recruitment than female participants. This study is also not aimed at the elderly population who perform the Salaah as they may present with symptoms of chronic disease or orthopaedic pathologies. The study also noted the importance of investigating the levels of muscle strength in the younger sedentary population of men. Women were not included in the study as they have modified some of their positions in contrast to men, according to the Islamic faith. Women were not recruited based on their Islamic religious right and belief not to be touched by a man (assessor). As a result, this preliminary investigation was based on men exclusively. This was due to the nature of sedentary behaviour, which has been well researched to illicit potential muscle weakness and deconditioning in apparently healthy individuals.[5]

Data collection

Participants completed a Physical Activity Readiness Questionnaire (PAR-Q) 2020 and informed consent. The PAR-Q 2020 is a screening questionnaire that ensured that the participants' readiness for physical activity was screened before engaging in exercise testing and measurement. The participants participated in a combination of morphological, cardiovascular and neuromuscular measurements. Data were collected and measured by a qualified Biokineticist, the South African equivalent of a clinical exercise physiologist.

Morphological measurements

Resting measurements were taken before any simulation activities commenced to ensure participants were in a rested state. These included resting HR (RHR), resting systolic BP (SBP) and resting diastolic BP (DBP), which are all validated measures of cardiovascular vital signs in global healthcare settings. The participants' body mass index (BMI) values were gathered through weight and stature measurements. The sum of six skinfold sites, namely the triceps, subscapular, suprailiac, medial calf, thigh and umbilicus, were recorded and transferred into the Montreal Olympic Games Anthropometric project (MOGAP) skinfold formula (validated for males) to measure body fat percentage.

Salaah simulation activity and cardiovascular measurements

Participants completed a set of four raka'ah (sequences), with individuals performing a single rakaat (sequence) of specific postures mimicking those in Salaah. Normal Salaah consists of four main positions from which

participants spend time before musculoskeletal transitions are made between each one.[6] On conclusion of all four main postures, one rakaat would be complete. For this study, the Qiyaam (standing) for 40 s, Ruku (bowing) for 10 s, Sujood (prostration) for 10 s (two times, with a 2 s interval between each Sujood) and Tahiyaat (kneeling) for 1 min were conducted. The transitions between these static postures occurred at the participants' leisure, and this was not timed due to the variety in the strength profiles and capabilities between individuals. This simulation activity lasted 8.7 min, and the normative duration for a Salaah prayer of four raka'ah combined with recitations was approximately 10 min. Participants rested for 1 min before their post-Salaah BPs were measured. RHR post-Salaah simulation was not measured or investigated in this study due to the nature of the stimulation of HR, which would naturally increase after light to moderate aerobic activity. Notably, the rate of HR increase post-Salaah leaves a gap for future research to investigate. The simulation activity was not designed to submaximally or maximally elevate the cardiovascular system, and post-Salaah HR was not measured.

MMT myometry

A Lafayette manual muscle test system handheld dynamometer (01165) was used to objectively measure the muscle strength of the participants' quadriceps femoris group (knee extensors) and gastrocnemius (plantar flexor) muscles. Validated methods were used to conduct these MMT measurements.[7] Participants were subsequently asked to perform knee extension and plantar flexion against knee flexion and dorsiflexion resistance. The dynamometer recorded the forces of the quadriceps femoris group and the gastrocnemius muscles in Newton-metres per kilogram (Nm/Kg) of force. These procedures were repeated twice on both limbs to ensure measurement reliability.

EMG and Salaah movement transitions

For this section, there were two main objective test components, that is, (1) the maximum voluntary contraction (MVC) and (2) the experimental Salaah surface EMG activity, where two movements were completed, namely the Qiyaam to Sujood (QS) and the Tahiyaat to Qiyaam (TQ) postural transitions. All surface EMG measurements for this study were taken on the dominant leg as recommended by previous EMG studies.[8] This was due to the reasoning that individuals give their maximal effort on their dominant sides during any movement or skeletal muscle activity.[8] The vastus medialis oblique (VMO) muscle, which acts as one of the leg's knee extensors, underwent surface EMG measurements during the MVC and experimental Salaah activities. This activity measured the average MVC average and the EMG average values between two active postural transitions of the Salaah. The two movements assessed were the QS and the TQ, respectively. The action potentials from the EMG device provided objective, quantifiable data in microvolts (μV) for the electrical potentials and activity provided by the VMO muscle during the various measurement activities.

Data analysis

Research data were manually recorded from hard copy datasheets for all tests onto Microsoft Excel spreadsheets. The Shapiro-Wilk test was used to test for normality, where a sample of less than 50 was considered. All statistical data were taken from a normal population distribution where parametric testing was performed. The statistical analysis SPSS V.27 (IBM, USA) was used to analyse the study results. Inferential statistical analysis included Pearson's correlation coefficient to explore the relationships between various morphological, cardiovascular and neuromuscular variables of the study. The level of significance was set at $p<0.05$. The Pearson's correlation coefficient was used to determine the statistically significant relationships between the study's selected morphological, cardiovascular and neuromuscular variables. The R statistic value (r) was used within each correlation to determine statistical significance. An inversely proportional relationship was implied if the R statistic values were negative. A positive R statistic implied a directly proportional relationship between two variables. Due to outliers and a small sample size, the only non-parametric correlation found using Spearman's correlation coefficient in the subgroup analysis was positive. P values (p) indicated the level of significance ($p<0.05$) for each correlation was explored.

RESULTS

Selected morphological data

The selected morphological variables that participants were eligible for included age, height, weight, BMI and percentage body fat (BF%), which were calculated from the MOGAP (Montreal formula for men (∑6 skinfolds X 0.1051). Individual skinfold site averages were taken for each participant and inferentially analysed between other study variables. Among the participants (n=20), the overall mean and SD of age (29.40±6.06), height (1.74 m±0.08), weight (76.70 kg±13.09), BMI (22.02 kg/m²± 3.24) and BF% (9.06%±2.26) were analysed.

Table 1 illustrates specific skinfold site measurement data using the central tendency measures of means and SD measures. The skinfold site data were gathered from the triceps brachii (8.3 mm±4.05 mm), calf (8.3 mm±3.42

Table 1 Skinfold site measurement data

Measurement (n=20)	Mean±SD
Triceps brachii (mm)	8.3±4.05
Calf (mm)	8.3±3.42
Umbilicus (mm)	14.4±5.68
Thigh (mm)	10.4±4.55
Suprailiac (mm)	9.4±4.30
Subscapularis (mm)	10.9±5.52

Table 2 Selected cardiovascular data

Variable (n=20)	Mean±SD
Resting HR (bpm)	78.50±10.70
Resting systolic BP (mm Hg)	124.00±6.71
Resting diastolic BP (mm Hg)	81.90±7.64
Post-Salaah systolic BP (mm Hg)	124.40±4.71
Post-Salaah diastolic BP (mm Hg)	78.30±7.38

Bpm, beats per minute; BP, blood pressure; HR, heart rate.

mm), umbilicus (14.4 mm±5.68 mm), the anterior thigh (10.4 mm±4.55 mm), the suprailiac (10.4 mm±4.55 mm) above the pelvic crest, and finally, the subscapularis (10.9 mm±5.52 mm).

Selected cardiovascular data

The selected cardiovascular variables of the study that were measured included the RHR, which was 78.50±10.70 bpm, resting SBP (124.00 mm Hg±6.71 mm Hg) and resting DBP (81.90 mm Hg±7.64 mm Hg). After completing the simulation prayer sequence activity, post-Salaah SBP (124.40 mm Hg±4.71 mm Hg) and post-Salaah DBP were recorded (78.30 mm Hg±7.38 mm Hg) In table 2, means and SD as central tendency values are presented to describe the characteristics of the overall average RHRs and BPs. The relationship between RHR and resting SBP (r=0.44 ; p=0.05) was statistically significant.

Selected neuromuscular data

Selected neuromuscular variables were measured through EMG on the VMO muscle of the participants' dominant legs. The average MVC (25.33±9.20) measures were completed to establish the baseline values of the EMG activity for this particular muscle among participants. The same muscle was measured between two movement transitions to gain the QS (21.21±10.27) and TQ (24.47±13.17) averages in microvolts. Measurements through MMT of the right quadriceps femoris (33.34±7.41) and left quadriceps femoris (29.51±7.16) were also completed, along with measurements for the right gastrocnemius (28.80±9.94) and left gastrocnemius (28.83±8.96) to conclude the neuromuscular data presented in table 3.

Correlations

Several relationships were established between the selected morphological, cardiovascular and neuromuscular variables. The relationships were investigated using Pearson's correlation coefficient, outlined in table 4.

Table 4 illustrates that the correlation between RHR and MVC average was negative (r=−0.03; p=0.91) as well as the correlation between post-Salaah SBP and MVC average (r=0.19; p=0.42). Another negative correlation (r=−0.41; p=0.08) was found between post-Salaah DBP and the MVC average. None of these relationships was statistically significant.

Table 3 Selected neuromuscular data

Variable (n=20)	Mean±SD
MVC average (µV)	25.33±9.20
QS average (µV)	21.21±10.27
TQ average (µV)	24.47±13.17
Quadriceps MMT (R) (Nm/Kg)	33.34±7.41
Quadriceps MMT (L) (Nm/Kg)	29.51±7.16
Gastrocnemius MMT (R) (Nm/Kg)	28.80±9.94
Gastrocnemius MMT (L) (Nm/kg)	28.83±8.96

L, left side; MMT, manual muscle strength; MVC, maximum voluntary contraction; Nm/Kg, newton metres per kilograms; QS, Qiyaam to Sujood; R, right side; TQ, Tahiyaat to Qiyaam; µV, microvolts.

The MVC average and right quadriceps femoris MMT yielded a positive correlation (r=0.14; p=0.56) along with the MVC average and the left quadriceps femoris MMT (r=0.18; p=0.44). These relationships, however, were not statistically significant. A positive correlation (r=0.69; p=0.00) between the BMI and BF% for the participants was found to be statistically significant but not between BMI and RHR (r=0.26; p=0.27). Resting systolic (r=0.49; p=0.03) but not DBP (r=0.40; p=0.08) was positively correlated and significant when associated with BMI. Positive correlations (r=0.27; p=0.26) were found between the BMI and post-Salaah SBP. BMI and post-Salaah DBP (r=0.36; p=0.12) were also positively correlated. Table 5 demonstrates a summary of BMI and selected cardiovascular correlations. All correlations besides resting SBP and BMI were not statistically significant.

DISCUSSION

The study found that individuals who performed the Salaah presented with reasonably healthy morphology and cardiovascular values regarding BMI, BF%, RHR, resting SBP, resting DBP, MMT and MVC average values. A secondary finding of this study suggested that performing a timed simulation of four raka'ah movements of the Salaah lowered DBP. Additional findings of this study demonstrated electromyographic activity

Table 4 Muscle voluntary contraction average and post-Salaah cardiovascular correlations

	MVC average	
Variable (n=20)	R statistic	P value
Resting HR	−0.03	0.91
Post-Salaah systolic BP	−0.19	0.42
Post-Salaah diastolic BP	−0.41	0.08

BP, blood pressure; HR, heart rate; MVC, maximum voluntary contraction; NS, not statistically significant.

Table 5 Body mass index and selected cardiovascular correlations

	Body mass index	
Variable (n=20)	R statistic	P value
Resting HR	0.26	0.27
Resting systolic BP	0.49	0.03*
Post-Salaah systolic BP	0.27	0.26
Resting diastolic BP	0.40	0.08
Post-Salaah diastolic BP	0.36	0.12

*Statistically significant.
BP, blood pressure; HR, heart rate; NS, not statistically significant; S, statistically significant.

values of the VMO muscle through the Salaah for two movement transitions of the prayer. The MMT strength values for the quadriceps femoris and gastrocnemius muscles were presented and had positive relationships with the MVC average output data.

Selected morphological data

For morphological findings, sedentary individuals who perform the daily Salaah had an average BMI of 22.02 kg/m^2 (±3.24), which implied that they were within the healthy ranges and classified as low risk. In general, BMI is more accurately demonstrated as a risk profile indicator than a performance indicator.[9] The American College of Sports Medicine has documented the clinically recognised norms for a healthy BMI between 18.5 kg/m^2 and 24.9 kg/m^2. The finding of this study complements previous research where rhythmic light aerobic activity participation had a positive effect on maintaining a healthy BMI.[10] This study found the sedentary participants' BF% (9.06%±2.26) below the average norms for BF%. This finding, however, could still be attributed to lifestyle choices and calorie intake, which was not a finding of this study.

African ethnicity of participants may have also played a role in the BF% for these participants. Future studies should further investigate the relationship between BF% and diet for those who perform daily Salaah. These findings may apply to African ethnicity and specific physiology. Another finding of this study showed that in terms of phenotypes, participants were found to have lower BMI and BF%. Further investigation using a larger sample with a more robust methodology is required to illicit the clinical benefits of Salaah among African populations for these health parameters.

For skinfold data, the calf (8.30 mm±3.42 mm) and thigh (10.40 mm±4.55 mm) skinfolds demonstrated lower average values for sedentary individuals. Participants had a notable lack of physical conditioning. According to Oliveira *et al*,[11] the findings of this study were almost similar to those of athletes and those who condition those muscle groups. A trend is possible, suggesting that participants passively conditioned their calf and thigh musculature through daily Salaah. The Salaah engages musculoskeletal functions of the lower extremity through various movements of the Salaah.[12] Cheung *et al*[13] suggested that calf and thigh musculature have the potential to become conditioned through Yoga and Tai-chi, which are similar aerobically to Salaah.[13] Future study interventions investigating passive conditioning of musculature and skinfold thickness through the Salaah as a clinical experimental tool are warranted.

Selected cardiovascular data

The average RHR for this sample (78.50±10.70) was within acceptable healthy range values. Cardiovascular health studies have established that lower RHR indicates improved cardiovascular functioning. For example, Van CAG *et al* studied the clinically recognised norm for adults' RHR to be 60 bpm to 100 bpm.[14] The average for RHR 78.59 bpm, indicating a mildly higher resting value for those who are conditioned who average at 60 bpm. Compared with sedentary individuals, the sample had scored lower than 80 bpm. When evaluating this difference, the sample was healthier than sedentary but not as fit as conditioned norms. Performing the daily Salaah could contribute to this finding.

The average resting SBP (124 mm Hg±6.71 mm Hg) and resting DBP (81.90 mm Hg±7.64 mm Hg) converged with the universal norm of 120/80 mm Hg.[15] The resting DPB for participants was within a healthy range.[16] Motoyama *et al*[17] and Port *et al*[18] link high DBP (>40 years) to increased risk of heart disease.[19] The study suggests Salaah maintains healthy resting BP despite no conditioning. Ghous and Malik[20] pointed out the aerobic nature of Salaah when compared with other low-intensity cardiovascular activities and had an improved effect on resting BP when performed daily Salaah.[12]

Simulating a four-rakaat Salaah showed minimal change in BP compared with resting levels. When comparing resting DBP, there was evidence of decreased post-Salaah DBP (78.30 mm Hg±7.38 mm Hg) after the four rakaat timed activity. Decreases in DBP are present after low-intensity aerobic activity participation and place individuals at lower risk for CVD.[19] A study by Otsuki, Kotato & Zempo-Miyaki[21] substantiated the findings of this research for resting SBP and post-Salaah SPB, which are similar to each other after performing the timed Salaah activity.[22] It is suggested that this finding could be attributed to the regular participation of Salaah, whereby SPB is regulated throughout the activity in terms of CVD risk profile.

Selected neuromuscular data

During the neuromuscular investigation, selected measurements were taken through EMG and manual muscle testing. To establish baseline measurements, the surface EMG of the VMO muscle was tested on the participants' dominant leg. The resulting MVC average values (25.33 µV±9.20 µV) obtained from these measurements were shown to be in line with the norms for regular

surface EMG action potentials of asymptomatic individuals, which generally range from less than 50 µV up to 20 µV. However, Mathur, Eng & MacIntyre[23] recommend that these action potentials and output values may differ depending on the specific muscle group being tested through EMG.[24] The sample showed normal resting MVC and VMO activation. Since the VMO muscle acts as one of the knee extensors during Salaah movement transitions, it is evident that the sample was within the reasonably healthy condition for VMO activation. A study by Abdul Malik *et al*[25] suggests that regular Salaah could be a knee-saver for those who sit considerably, especially if they have optimal muscle activation.[26] Further investigations into the activity of the VMO and the Salaah are recommended.

EMG activity of the VMO muscle through two movement transitions of the Salaah was investigated. During the first transition, the participant was requested to move from the Qiyaam position into the Sujood position, demonstrating the QS average (21.21 µV±10.27 µV). The second transition, the TQ average value (24.47 µV±13.17 µV), measured the EMG of the VMO muscle between kneeling in the Tahiyaat and back into the upright standing Qiyaam position.

As a novel finding, the study tracked muscle activity in the VMO during specific Salaah movements to see how this key muscle works. The results demonstrated sufficient muscle activation within the VMO muscle during this transition. This encourages VMO engagement in the Salaah activity. When repeated over four raka'ah or sequences, it can be suggested that the VMO muscle is passively conditioning during the transitions, which are repeated through various rakaats. Regular passive conditioning of the VMO muscle has positive outcomes in treating and preventing patellofemoral pathologies and injury occurrence.[27] Notably, the TQ transition movement is similar to the functional sit-to-stand, which requires lower body strength. Many muscle groups are recruited during transitions of the Salaah.[28] Future studies should prioritise EMG analysis for long-term neuromuscular effects and explore knee health and cardiovascular benefits compared with non-Salaah participants.

The study further tested isometric MMT using a handheld dynamometer through the prescribed method.[6] The results for the right (33.34 Nm/kg±7.41 Nm/kg) and left (29.51 Nm/kg±7.16 Nm/kg) quadriceps femoris muscle groups demonstrated the participants' isometric muscle strength. Kittelson *et al*[29] found similar results for isometric muscle strength for sedentary individuals similar to conditioned ones.[30] In relation to this, it is suggested that participating in Salaah movements may positively impact the muscle strength of the knee extensors. Skou *et al*[31] have also recommended that repetitive knee extensor movements play a role in minimising the risk of developing knee pathologies.[32]

In addition, isometric MMT measurements of the right (28.80 Nm/kg±9.94 Nm/kg) and left (28.83 Nm/kg±8.96 Nm/kg) gastrocnemius muscles were conducted. The gastrocnemius is known anatomically as a powerful plantarflexor at the ankle joint and acts within daily locomotive activities. It is imperative to note that the strength of this muscle and its associated range of motion wanes as the human lifespan progresses.[33] Similar to the quadriceps, it can be postulated that gastrocnemius muscles are conditioned by daily Salaah movements, especially the TQ transition.

Correlations

Selected correlations between variables of this study were investigated due to their relationship with optimal morphological, cardiovascular and neuromuscular health.

Skinfolds and MMT testing

Calf skinfolds correlated positively with calf and thigh MMT values, but no significant link emerged between MMT and skinfolds. Lafère *et al*[34] recommend a larger sample size to strengthen statistical significance in skinfold-muscle strength relationships.[35]

RHR and maximum voluntary contraction

Although not statistically significant, a negative, weak correlation was found between RHR and the EMG average MVC (r=−0.03; p=0.91) for the VMO. Due to the negative relationship, as RHR increased, the MVC output average of electrical potential diminished. A larger sample to investigate the relationship would be warranted.[36] Through this association, lower RHRs linked to Salaah might improve muscle function in everyday activities.[37] It is also important to note that the regulation of RHR aids in performing isometric neuromuscular activities.[38]

Selected cardiovascular data and MVC average

The study found RHR negatively correlated (r=−0.03; p=0.91) with the MVC average. Due to the weak nature of this relationship, the study cannot generalise the possibility that lower RHRs may be beneficial to MVC output measurements. On further inquiry, the study found negative correlations between post-Salaah SBP and MVC average (r=−0.19; p=0.42) and between the post-Salaah DBP and the MVC average (r=−0.40; p=0.08), which were not found to be statistically significant. This study suggests higher BP weakens the VMO muscle MVC output. However, larger studies on Salaah are required to confirm this link.

MVC average and quadricep femoris MMT testing

Weak, positive correlations were found between the MVC average and the right quadriceps femoris MMT (r=0.14; p=0.56) and the left femoris quadriceps MMT (r=0.18; p=0.44). Since these findings were not statistically significant, no significant change in MVC output was found in this sample. Larger studies with more statistical power are required to discover if Salaah improves muscle strength.[39]

BMI and selected cardiovascular variables

Several correlations between BMI and selected cardiovascular variables of the study were explored. Non-significant, positive correlations were found between BMI and RHR (r=0.26; p=0.27), BMI with resting SBP (r=0.49; p=0.03) and resting DBP (r=0.40; p=0.08). BMI was positively correlated with post-Salaah SBP (r=0.27; p=0.26) and post-Salaah DBP (r=0.36; p=0.12). These findings suggested that as BMI increased, a proportionally positive increase could be expected in RHR and resting BP values. In essence, and according to previous clinical literature, high BMI values increase CVD risk.[40] Shigetoh *et al*[41] support this finding in their study, which explored the risks of elevated BMI and its relationship with RHR and resting BP. However, the findings of this research study are that the risk profile is dependent.[42] The participants had demonstrated acceptable BMI values despite being sedentary. The positive correlation (r=0.69; p=0.00) between the BMI and BF% was statistically significant, confirming that increases in BF% are directly proportional to an increased risk profile and BMI. Regular Salaah as a low-impact exercise might improve BMI, potentially lowering CVD risk with further scrutiny.

Limitations

This study includes several limitations. First, the study used convenience sampling due to participants' willingness in the recruitment region. Although successful in gathering and evaluating clinical data on a unique population, some findings may be prone to selective bias. As such, the study may only suggest and indicate trends in the discussion section. To alleviate the selective bias aspect, the study is still valuable in establishing the groundwork for future studies to investigate the Salaah and its associated physiology through a control group who do not perform the Salaah. If larger samples are not available, then a study methodology that is robust, reliable and replicable may be required for smaller samples with a control group. The addition of clinical intervention tools, study control groups and qualitative data may add merit to the statistical findings that require adequate significance for generalisation to larger populations. Based on the interpretation of results, future research using a control group may aid in confirming whether the Salaah has beneficial effects on the health of sedentary individuals.

The second limitation of this study was that it used participants of African ethnicity from South Africa. Regarding phenotypes and physiology, one should be aware of the clinical limitations of investigating a sample of only one racial ethnicity. Although valuable in its findings and groundwork, this research study has not delivered data on other ethnic groups in South Africa. This aspect must be investigated in future studies where a combination of various ethnicities should be included in a random sample. This will aid in producing a greater replication of the methodology used in this study for future studies on the Salaah and sedentary populations.

Recommendations

Future physiological studies may be required to investigate the parameters explored in this study by providing findings with greater statistical power. Since most findings in this study hold merit but were inconclusive due to the limitations of COVID-19 during data collection, it is recommended that larger samples be used to establish more rigorous methodologies when studying the Salaah. Although using a small sample of participants (n=20) and a statistical power of 80%, the study could still detect changes in DBP from performing the Salaah. Based on the unpredictability of conducting experimental research, it is clear that when samples are specific and unique, a clinical intervention approach to the Salaah may be explored with added control groups when investigating populations who perform the Salaah either as an act of worship and/or as physical activity. It may also be worthwhile to explore other outputs of the electrical activity of the human body, such as electroencephalography and potentially combine mixed methods studies with added qualitative data presented on the Salaah, especially in the South African context, where research on the Salaah is limited. Future studies may also pursue research into comparing individuals who perform Salaah with individuals who do not perform. Investigating the relationship between flexibility along muscle strength and Salaah may be of further interest for prospective research.

CONCLUSION

In summary, this study demonstrated that individuals who performed the Salaah had reasonably healthy results for BMI, BF%, RHR, resting SBP, resting DBP, MMT and MVC average values through reasonable clinical measurement tools and procedures. It was also evident in this study and supported by previous literature that performing light-intensity aerobic activity such as Salaah had positive outcomes in lowering DBP and potentially lowering CVD risk. New information has been investigated concerning the electromyographic activity of the VMO muscle and its rate of activation during certain movement transitions of the Salaah, which had not been studied in previous literature, including current isometric strength profiles of the quadriceps femoris and gastrocnemius muscles in the lower extremity. Further research into the Salaah will enhance the limited understanding of prayer and its beneficial effects on the physiology of sedentary individuals. However, this will need to be conducted using larger samples and potentially study control groups to ensure generalisability to larger populations of those who perform the Salaah.

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