Assessment of Heart Rates and Blood Pressure in Different Salat Positions

HAZEM DOUFEISHI, MSc, BEng(1), FATIMAH IBRAHIM, PhD, MScE, BScEE(3), NOOR AZINA ISMAIL, PhD, MStats, BSc(2), WAN AZMAN WAN AHMAD, MRCP, MBBS(3)

1) Medical Informatics and Biological Micro-electro-Mechanical Systems (MIMEMS) Specialized Lab, Department of Biomedical Engineering, Faculty of Engineering, University of Malaya: 50603 Kuala Lumpur, Malaysia. E-mail: fatimah@um.edu.my
2) Department of Applied Statistics, Faculty of Economics and Administration, University of Malaya
3) Department of Medicine, Faculty of Medicine, University of Malaya

Abstract. [Purpose] This study reports the effects of the Muslim prayer, known as Salat, on heart rate (HR) and blood pressure (BP) while performing and miming the actions of Salat: standing, bowing, prostrating and sitting. [Subjects] Thirty Muslim subjects were asked to perform the actual and mime Salat. [Methods] HR and BP were measured using a Schiller AT-102 Electrocardiograph and an Omron SEM-1 Automatic Blood Pressure Monitor. [Results] The findings revealed that there was a significant difference in the HR of the subjects between performing and miming Salat. The standing and prostration positions of Salat produced the highest and the lowest HR, respectively. A lower HR may be of potential benefit to an individual’s health. The systolic and the diastolic BP decreased significantly after performance and mime of Salat, and a greater reduction in BP was observed during performance of Salat. [Conclusion] This is the first study of HR and BP in relation to Salat positions. The findings will encourage further studies to explore the benefits of Salat maneuvers for patients with cardiovascular diseases. Key words: Salat positions, Blood pressure, Heart rate

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INTRODUCTION

Salat is a Muslim prayer, it is a form of meditation(1), and it is obligatory in Islam to pray and to show one’s respect and worship the Almighty. It is a religious activity that involves recitations and specific positions: standing (qiyam), bowing (ruku), prostration (sujud), and sitting (tahiyyat). Muslims are required to perform Salat five times daily in addition to voluntary prayers (Sunnah, Nafla) Salat begins with the takbir, raising one’s hands to face level, and ends with the salam, turning the head to the right then to the left shoulder(2).

Salat serves many purposes. For example, it teaches the Muslims how to discipline themselves, by practicing good time management, and complying with the assigned time for the prayers.

Meditation is known to influence physiological parameters such as heart rate(3), blood pressure and respiration rate(4). Therefore meditation can be used as a therapy for patients who have heart problems such as hypertension or problems with their musculoskeletal system(5).

Heart rate (HR) is an indicator of cardiac function and a parameter of the heart’s performance. It can be observed non-invasively using an ECG (electrocardiogram). HR is the number of heartbeats per unit of time, typically expressed as beats per minute (bpm). It is the response of the heart to the demands of the body in many situations and positions(6).

HR changes due to many factors such as biological and physiological responses (sympathetic, parasympathetic and endocrine)(6–8), physical activities (exercises), behavioral and psychosocial factors(9), environment (temperature and altitude)(10), body positions and postures(10), and others (medication, drugs, chemical substances and diseases). All the factors that are mentioned above also affect blood pressure(11).

Blood pressure (BP) is one of the important physiological parameters to be considered in assessing a patients’ health status. BP is the force of the blood pushing against the walls of the blood vessels as blood flows through the body. This pressure is generated by the heart pumping blood around the body and by the resistance of the arteries to the flow of blood(12). Studies have provided strong evidence that meditation may help decrease BP of the persons who are moderately hypertensive(13–15). Many studies have also revealed that this positive effect disappears when meditation is discontinued(16, 17).

There are many studies that describe the correlation between meditation and its body positions or physical activities and their effects on HR, BP, and other hemodynamic parameters(10, 18–22). For example(23), a previous study compared three styles of yoga asana practice: the yoga posture, breathing exercises, and relaxation or resting posture. Some studies have reported that the heart rate decreases during meditation and while performing other
Nonetheless, long time practitioners of meditation have been shown to have a marked decrease in heart rate\textsuperscript{25, 26}. While changes in HR in relation to \textit{Salat} positions have been reported\textsuperscript{27}, the changes of HR and BP during performance of \textit{Salat} relative to its positions have not been studied. Understanding these changes would help enhance the understanding of the dynamic response of the cardiovascular system during \textit{Salat}. Thus the aim of this study was to assess the changes in HR and BP during and after performance of actual and acting \textit{Salat}, and to reveal the effect of \textit{Salat} on the human body. We also investigated at the effect of HR and BP during prayer recitations while performing the \textit{Salat}.

\section*{SUBJECTS AND METHODS}

Thirty male Muslim volunteers between the ages of 20 and 30 years old were recruited for this study. All of them were free from cardiac, pulmonary, metabolic and other diseases. These subjects had a decent knowledge of \textit{Salat}, including the various positions and movements. They were asked not to perform any strenuous physical activity or take any meal for at least two hours prior to the experiment.

Electrocardiography (ECG) data were recorded by three electrodes that were attached to a subjects’ chests in the standard Lead II configuration\textsuperscript{10} and connected to a Schiller AT-102 electrocardiograph. BP was measured using an Omron SEM-1 Automatic Blood Pressure Monitor.

The experimental protocol was divided into two sections, the actual performance and the mime action of \textit{Salat}. Each session commenced and ended with the subjects lying on a bed to rest in the supine position for 5 minutes before their HR and BP were recorded.

In the first session, the subjects performed \textit{Salat} in two cycles. The first cycle began with standing (\textit{qiyam}) for 60–90 seconds, then the bowing (\textit{rukuk}) at 90-degrees for 5–10 seconds; it is obligatory to bend at the waist until the palms can reach the knees. The subjects then stood up from this bowing position to standing for 2–5 seconds, before going down on their knees, and placing the forehead on the floor about 1–2 feet in front of the knees in prostration (\textit{sujud}) for approximately 5–10 seconds. After that, they sat up from the prostration position for 2–5 seconds, then performed a second prostration from the sitting position. This prostration is similar to the first prostration, and is followed by standing up for the second cycle. The only difference between the first and the second cycle exists after the second prostration in the second cycle, when the subjects remain in the sitting position (\textit{tahiyyat}) for 20–30 seconds to finish \textit{Salat}. A subject must recite Quranic verses or specific supplications during each of \textit{Salat} positions.

In the second session (miming \textit{Salat}), the subjects were asked to perform the four different \textit{Salat} positions in the proper sequence (standing, bowing, prostration, and sitting), without reciting any Quranic verses or supplications. This sequence was repeated in two cycles of 15 s. The \textit{Salat} positions during the measurement are illustrated in detail in Figure 1.

Statistical analyses were performed using SPSS version 15 (SPSS Inc. USA). The Paired t-test was used to compare the pre and post-experimental measurements. A probability value of less than 5% was accepted as significant.

\section*{RESULTS}

Table 1 shows a comparison between the positions of actual and mimed \textit{Salat}. The results of the actual and mimed \textit{Salat} reveal that the prostrate positions had recorded the lowest HR, while the standing positions had the highest HR. This shows that HR of the prostration position lower than that of the supine position. The Paired t-test indicates that there were significant differences in the means of HR between actual and mimed \textit{Salat} for all positions (p<0.05).

The paired t-test, also indicates that there were significant differences (p<0.05) in HR between the supine and standing, the supine and bowing, the supine and prostrating, and between the supine and sitting positions in both the actual and mimed \textit{Salat} positions.

Table 2, shows the systolic and the diastolic blood
pressures of both the actual and mimed Salat practice. The average systolic and diastolic blood pressures in actual Salat were lower than their respective values in mimed Salat: systolic BP was reduced by 2.5% after actual Salat and by 1.7% after the mimed Salat; diastolic BP was reduced by 2.8% after actual Salat and by 1.6% after mimed Salat.

### DISCUSSION

In this study, HR was measured during actual and mimed Salat. However, BP was measured immediately before and 5 minutes after performance of both actual and mimed Salat.

We note that in both performance of actual and mimed Salat, the change of heart rate was associated with postural change. The results of this study show that when the subjects stood, the highest HR was recorded and that HR decreased to the lowest rate in the prostrate position compared to the supine baseline, the results show that the mean HR in the standing, bowing, and sitting positions increased significantly, while HR in the prostrate position reduced significantly. We hypothesise that in the standing position, venous return would have increased to “venous pooling” in the lower limbs arising from the gravitational effects. This decrease in venous return would have lead to a reduced cardiac output, leading to a reduction in baroreceptor stimulation in the aorta and carotid arteries. This reduction in baroreceptor response would have produced a decrease in parasympathetic nervous activity and an increase in sympathetic nervous activity, directly affecting the cardiovascular center, consequently increasing HR. Whereas, in the prostrate position, the venous return would have increased to the highest level. In this position the brain, and head, are lower than the heart, hence, for the first time, the blood would flow towards the brain with the maximum gravitational pull. In this position, due to an increase in the amount of blood reaching the head, the amount of oxygen in the brain cells would have increased. The brain depends on oxygen to function, and brain cells die without oxygen. High blood oxygen in the brain leads to enhancements concentration, memory, vision and hearing. This is the reason why people who practice Salat on a regular basis can overcome many physical and mental problems. They have fewer headaches, psychological problems, and other cognitive difficulties. Our findings are in accord with Ibrahim and Ahmad 2008 and Jones et al. 2003 who have reported a decrease in heart rate, with decrease in the distance of the heart from the ground and the position of the head relative to the heart.

The difference in the results between the actual and mimed Salat in all the positions were statistically significant at the 5% level (Table 1). The actual Salat positions often had higher HR than the corresponding mimed Salat positions.

As indicated in the introduction, Salat is a worshipping procedure involving movements and recitations. In this study subjects recited verses from the Holy Quran during actual Salat, but not during mimed Salat. Various muscles and joints of the body are exercised by recitation. There is also a need to increase the blood flow to the face, tongue, the sensory and motor areas of the mouth, and the upper pre-motor cortex of the brain during recitation. Thus, heart rate would have increased during creative speech, but once the recitation had finished, the pulse rate would have slowly returned to its resting heart rate (set point). The set point is established and modulated by lifestyle and the physiological processes of the internal organs over the years. A temporal increase of the load on the heart during actual Salat, if practiced is daily over a long period, would decrease the set point level and strengthen the heart muscles, as well as improve the blood circulation within the heart muscles. A similar effect was achieved by miming Salat, but it was not as great as actual Salat, and subjects performing actual Salat had a higher HR. This result is in agreement with the findings of Cacippo and colleagues.

BP before and after actual and mimed Salat were also measured (Table 2). The results of the paired sample t-test indicate that there was a significant reduction in both systolic and diastolic BP after actual and mimed Salat. These significant reductions in systolic and diastolic blood pressures indicate a trend of gradual shift in autonomic equilibrium toward relative parasympathodominance due to a reduction in sympathetic activity.

Salat as a physical exercise is quite similar to the tai chi and yoga. It involves the movement of the whole body. Recent studies of yoga show that a decrease in the systolic pressure is observed when an individual performs yogic relaxation and meditation. Our study showed that Salat decreased systolic BP. This reduces the sympathetic discharge resulting in and predominance of the parasympathetic system.

Salat is a gentle exercise, which is regularly performed by Muslims. It is similar to other aerobic exercises such as tai chi and yoga, and as such may improve physical fitness. A study covering 17,000 Harvard alumni who entered college from 1916 to 1950 provides strong evidence that moderate aerobic exercise is equivalent to jogging about 3 miles a day. Ibrahim et al. 2008 suggests that subjects who perform Salat regularly, five times a day, would have a healthy body composition, increase the basal metabolic rate and reduced body fat mass. Elevated cholesterol increases the risk of cardiovascular disease. It has been shown that people in professions where physical exertion is required,

### Table 2. Mean ± SD of blood pressure before and after actual and mimed Salat

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<th>Systolic</th>
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<td></td>
<td>Before</td>
<td>After</td>
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<tr>
<td>Actual salat</td>
<td>118.0 ± 5.6</td>
<td>115.0 ± 4.7*</td>
</tr>
<tr>
<td>Mimed salat</td>
<td>119.3 ± 4.9</td>
<td>117.1 ± 4.2*</td>
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* Significant difference (p<0.05) from the mean value obtained before Salat, unit-mmHg.
have lower cholesterol in their bodies.\cite{37}

In conclusion we found that Salat maneuvers are equivalent to moderate exercise in terms of their physical exercise value. Salat also contributed towards increased in the cardiovascular system capability. The low value of HR in the prostrating position decreased systolic BP in both actual and mimed Salat. Salat, in this sense, can be used as a therapy for patients who have heart problems such as hypertension or problems in the musculoskeletal system.

HR in actual Salat was slightly higher than in mimed Salat, due to its recitation activity, providing good additional physiological benefits for the body. This pilot study will thus motivate further studies to discover the benefits of Salat on human health.

Future work, can be enhanced by taking into consideration other parameters such as the electroencephalography (EEG), electromyography (EMG), and respiration rate (RSP) in correlation to HR and BP.

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