



# Effect of a Supervised Exercise-Training Programme on Morbidity and Wellness of South African Hajj Pilgrims in 2018: A Pilot Study



Salim Parker<sup>1\*</sup>, Mohammed Nasir Jaffer<sup>2</sup>, Ozayr Mahomed<sup>3</sup>

<sup>1</sup>Division of Infectious Diseases and HIV Medicine, Department of Medicine, University of Cape Town, Cape Town, South Africa

<sup>2</sup>Sports Physician, 68 Florida Street Ravensmead, 7480, Cape Town, South Africa

<sup>3</sup>Discipline of Public Health Medicine, University of KwaZulu-Natal Nelson Mandela School of Medicine, Durban, South Africa

**Corresponding Author:** Salim Parker, MBChB, Honorary Research Associate, Division of Infectious Diseases and HIV Medicine, Department of Medicine, University of Cape Town, 472 Halt Road, Elsies River, 7490, Cape Town, South Africa. Tel: +27-825678938, Email: salimparker@yahoo.com

Received February 7, 2022; Accepted; May 18, 2022 Online Published June 5, 2022

## Abstract

**Introduction:** Ill health and poor physical and mental conditioning adversely affects pilgrims' ability to optimally perform the arduous physical rituals of Hajj. We postulate that a supervised, pre-departure exercise programme improves their health status and may reduce morbidity.

**Methods:** Ninety-three accredited pilgrims completed a 6-12 weeks graduated, supervised walking programme designed to get the participants fit to do a 10 km walk. Assessments including a morbidity survey, a six-minute walk test, and a POMS (Profile of Mood States) were conducted before and immediately after the exercise programme. A morbidity questionnaire, the six-minute walk test, and POMS were completed post-Hajj (n = 88). A group of 200 non-matched pilgrims who were not part of the exercise programme, were approached post-Hajj to fill in the morbidity questionnaire, with eight-two responding.

**Results:** Results for 88 participants were available with 13.7% reporting medical events during the Hajj period, significantly less than the non-participants (62.2% of 82 respondents), and less when compared to other studies (up to 91%). The mean distance recorded in the six-minute walk test increased by 5% after the exercise programme (481.3 meters before to 506.3 m after) and 3% after Hajj (520.7 m). Similar positive changes in the POMS were noted across the three time periods. The resting heart rate did not show significant changes.

**Conclusion:** This study shows that a supervised exercise programme for Hajj pilgrims has a positive effect on their physical and mental conditioning, which may reduce morbidity. Larger controlled trials are warranted to determine the optimum dose of exercise.

**Keywords:** Pilgrimage, Physical Fitness, Profile of Mood States, Walk Test, Respiratory Infections

**Citation:** Parker S, Jaffer MN, Mahomed O. Effect of a supervised exercise-training programme on morbidity and wellness of south african hajj pilgrims in 2018: a pilot study. Int J Travel Med Glob Health. 2022;10(2):64-69. doi:10.34172/ijtmgh.2022.12.

## Introduction

The Hajj, held in Saudi Arabia, is one of the world's largest annual mass gatherings with an estimated 3.5 million attendees, most being foreigners from over 180 countries.<sup>1</sup> Although the Hajj is performed over 5 days, most participants stay between 2-7 weeks. A study of 140 000 Indian pilgrims showed the average stay for this group was 45 days.<sup>2</sup> A large proportion of pilgrims are elderly with many having comorbidities. High morbidity has been documented; Indian pilgrims presented an average of 3.2 times to health care facilities for the 3 Hajj seasons from 2014-2016. In 2016 about 140 000 Indian pilgrims recorded 419 508 clinic visits, with

51.4% presenting with respiratory diseases.<sup>2</sup> The prevalence of cough in studies from 2011-2014 ranged from 46.3% to 86.8% and sore throat 34.7% to 91%.<sup>3</sup> The South African Medical Mission documented 4780 visits by the 2000 South Africans pilgrims who attended the 2014 Hajj.<sup>4</sup> Respiratory infections has been reported to be the commonest presenting symptoms amongst South African pilgrims.<sup>5</sup> A 2017 survey amongst 1138 of the 2500 South African Hajj pilgrims indicated that 65.1% of respondents suffered from medical conditions, 70.2% of the medical conditions being respiratory in nature.<sup>6</sup>

The Hajj involves the mass physical movement of pilgrims between the various ritual sites amongst crowded conditions

in temperatures that probably will exceed 40°C for the next decade. It is estimated that 70% of Hajj activities are of a physical nature with the remaining 30% being spiritual worship.<sup>7</sup> Table 1 depicts some of the distances covered by pilgrims. Although transportation is provided by Hajj authorities, up to 45% of pilgrims cover at least some parts of the pilgrimage routes on foot.

It is well known that regular exercise induces adaptations which contributes to the overall wellbeing of the individual and may prevent or ameliorate many medical illnesses.<sup>8</sup> Exercise is also prescribed as a treatment of established diseases.<sup>9,10</sup> Ill health and poor physical and mental conditioning negatively affect the ability of the pilgrims to perform at the maximum potential needed to complete the rituals of Hajj. It follows that those who are physically and mentally fit to undertake the journey are the most likely to gain the greatest benefits. We postulated that a supervised exercise programme in preparation for the physical demands associated with the pilgrimage could reduce morbidity during Hajj and assist in improving the physical and mental health status of pilgrims prior to departure and upon their return. The aim of this pilot study was to determine the effect of a pre-Hajj exercise programme on the participating pilgrims' physical fitness, mood states and morbidity patterns.

## Methods

### Study Design

A prospective cohort study determining the effect of a supervised exercise-training programme on the morbidity and wellness of accredited 2018 Cape Town based Hajj pilgrims.

### Study Population and Sample

South Africa was allocated a quota of 2500 pilgrims for 2018. About 1300 were based in the Western Cape province and about 500 in the catchment area of the sports club in Cape Town where the programme was to be conducted. Prospective 2018 Cape Town based Hajj pilgrims were recruited during February and March 2018 (4 months before departure) after the South African Hajj authorities released the names of those accredited to perform the pilgrimage. The number of participants was limited due to the logistical consideration of the time needed to complete the exercise programme before Ramadan (16 May 2018). By the closing date, 128 participants (25.6% of eligible) had enrolled. As this was a pilot study, no

sample size was predetermined. There was not enough time to recruit a matched control group, and this did not form part of the study design. Two hundred non-matched South African Hajj pilgrims who were not part of the study were approached in Saudi Arabia immediately after Hajj to fill in the morbidity health questionnaire only.

### Supervised Exercise Program

Participants received a graduated, supervised walking programme for 6-12 weeks. The prescribed walking programme was conducted by qualified trainers from a local sports club in Cape Town on Saturday afternoons (supervised and logged by the trainers) and at least two other days during the week (unsupervised and logged by the participants) for between 6-12 weeks on various predetermined routes which intended to get the participants fit to comfortably complete a 10 km walk. The walking programme continued with a weekly supervised maintenance programme during Ramadan and until departure for Hajj.

A six-minute walk test was done to determine existing fitness levels, and to assess the exercise tolerance of participants when subjected to an exertional load.<sup>11</sup> Participants were graded and allocated into appropriate walking groups designed to accommodate their own individual capacities based on the distances covered in the six-minute walk test. Candidates were then placed in the various groups under the supervision of qualified fitness instructors. The exercise programme was designed to reproduce the workload, pace and effort expended during their participation in the rituals of Hajj.

### Data Collection

Data were collected at three intervals; pre-exercise programme (mid-February to early March 2018), post-exercise programme (May 2018), and post Hajj (August 2018).

### Pre-exercise Programme

Baseline data included a self-administered medical questionnaire, a medical examination, a six-minute walk test<sup>11</sup> and a Profile of Mood States (POMS) questionnaire.<sup>12</sup> The short version of the POMS was utilised, which is a self-report questionnaire assessing psychological wellbeing and includes thirty-seven items across six different categories.<sup>13</sup> A Total Mood Score (TMS), a reflection of the Total Mood Disturbance, is calculated by adding the raw scores from tension, depression, anger, fatigue and confusion and then subtracting the vigour score. Lower TMS scores point to a more stable and positive mood profile.

### Post-exercise Programme Completion Assessment

On completion of the walking programme, a pre-departure assessment was conducted to determine the improvement in the physical and psychological state of the participants using the six-minute walk test and POMS. Participants continued with a maintenance programme until departure.

### Post Hajj Assessment

A morbidity questionnaire was handed out to the pilgrims

**Table 1.** Distances Involved in Some Hajj Rituals

Activity	Distance Covered	Time Involved
Walking: Hotel-Mosque	500 m - 1 km (5 times daily)	14-60 minutes
Tawaf of Kaba'aa (7 rounds)	400 m - 4 km (level dependent)	30 min-2 h
Sa'ee Safa-Marwa (7 times)	420 m x7 = 2.94 km	1-2 h
Mecca to Mina	5 km	1-2 h if walking
Mina to Arafat	15 km	3-5 h if walking
Arafat to Musdalifah	10 km	3-5 h if walking
Musdalifah to Mina	5 km	1-2 h if walking
Mina to Jamarat for pelting	0.5-3 km	1-2 h

after completion of the pilgrimage to assess the prevalence of illnesses, injuries and psychological events during the Hajj. A final six-minute walk test and POMS evaluation was done immediately on return of the pilgrims back home. This same morbidity questionnaire was distributed amongst 200 South African pilgrims housed in three separate buildings in Saudi Arabia who did not take part in the programme. No POMS or six-minute walk test was done on this group and they were not matched with the fitness group.

### Data Management and Analysis

The data were entered into a customized Microsoft Excel database. The data were then imported to Statcorp Software for Statistics and Data Science (STATA 13). The mean resting heart rate, distance covered and POMS scores pre-programme, post-programme and post Hajj were calculated. The incidence of medical illness during the pilgrimage was also documented. The overall POMS score was calculated by summing the totals for the negative subscales and then subtracting the totals for the positive subscales: Total Mood Score (TMS) = [Tension + Depression + Anxiety + Fatigue + Confusion] – [Vigour].<sup>13</sup> An initial descriptive analysis was performed. This was followed by a one-way repeated measure ANOVA to determine statistical differences between the three testing intervals using a  $P < 0.05$  as statistically significant.

### Results

One hundred and twenty-eight participants enrolled into the programme. Two were disqualified as they failed the initial medical evaluation. Another thirty-three dropped out between the first and the second assessment. Five completed the programme but decided to defer their journey to the following year and were thus withdrawn from the data analysis. The final analysis was conducted on 88 participants. Fifty-four (61.4%) of the participants were females with a mean age of 53 (SD 8.50) years. The mean age of the males was 55 (SD 9.60). Eleven participants (12.5%) were smokers. One co-morbid condition existed in at least thirty (34.1%) participants with fifteen (17.0%) having hypertension. Thirty-seven (42.1%) had a previous operation (Table 2).

### Morbidity Profile of Participants during Hajj

Thirteen of the 88 participants (14.7%) reported having suffered either an injury or illness during the Hajj trip. Six (6.8%) reported a respiratory illness which amounted to 46.2% of all illnesses, 3 (3.4%) sustained lower limb injuries, whilst 1 experienced diarrhoea whilst the others reported diabetes related complications. Of the 200 pilgrims who were not part of the exercise programme but undertook to fill in the morbidity questionnaire, there were 82 respondents (41.0% response rate). Three did not indicate gender, 42 were male (51.2%) and 38 female (46.3%). Fifty-one (62.2%) reported either an injury or illness. There were 17 injuries (20.1%) and 35 respiratory illnesses (42.7%), 10 hypertension related consultations (12.2%) with 8 abdominal complaints (8.8%) accounting for most of the balance.

### Resting Heart Rate and Distance Covered

**Table 2.** Frequency Table of Sociodemographic Profile of Study Participants

	Males	Females	Total
<b>Age</b>			
Mean age	55 (9,60)	53 (8,50)	53 (8,92)
Median age	57 (IQR: 47-63)	54 (IQR: 47-59)	55 (IQR:47-61)
Gender	34 (39%)	54 (61%)	88 (100%)
<b>Risk Factors</b>			
Smokers	8 (23.5%)	3 (5.6%)	11 (12.5%)
<b>BMI</b>			
Mean BMI	24 (SD:11.5)	27 (SD: 11)	26 (SD: 11)
Median BMI	28 (IQR: 24-31)	28 (IQR: 26-33)	28 (IQR: 25-33)
Pre-existing medical condition (% of gender and of total)			
Circulatory	12 (35.1%)	18 (33.3%)	30 (34.1%)
Hypertension	3(8.8%)	12(22.2%)	15(17.0%)
Respiratory	3 (8.8%)	7 (13.0%)	10 (11.4%)
Gastro-intestinal	4 (11.8%)	8 (14.8%)	12(13.6%)
Urinary tract	5 (14.7%)	3 (5.6%)	8 (9.1%)
Mental health	6 (17.6%)	8 (14.8%)	14 (15.9%)
ENT/ophthalmology	13 (38.2%)	16 (29.6%)	29 (33.0%)
Skin/muscular skeletal	9 (26.5%)	21 (38.9%)	30 (34.1%)
Metabolic/blood	9(26.5%)	9 (16.7%)	18 (20.5%)
Previous operation	13 (38.2%)	24 (44.4%)	37 (42.1%)

Abbreviations: BMI, body mass index, IQR, interquartile range; SD, standard deviation.

The mean resting heart rate prior to the exercise programme was 80 (SD: 11.93) bpm, with a slight decline to 79 bpm (SD: 9.61) bpm after completion of the exercise programme, and an increase to 84 bpm (SD: 11.41) post pilgrimage. The resting heart rate was centrally distributed across all three intervals. The mean resting heart rate across all three measurements for both males and females were very similar with no statistically significant differences (Table 3).

The mean distance covered over six-minutes was initially 481.3 (SD: 67.29) m before the programme, increasing to 506.3m (SD: 71.57) m after the exercise training programme, and 520.7m (SD: 68.46) post Hajj. The average distance covered by males was consistently more than that of females. Males achieved 501.4m initially, then 531.0m and finally 558.3m. Females achieved 468.6m initially, then 490.9m and finally 497.0m for the three respective periods (Table 3 and Figure 1).

A one-way repeated measure ANOVA was conducted on the 88 participants to determine if there were differences in resting heart rate and distance covered due to the supervised exercise programme. The results showed that the exercise programme elicited no significant differences in mean resting heart rate ( $P > 0.429$ ) pre and post programme but showed a significant increase between the pre-Haj and post Haj measurement ( $P < 0.004$ ). The distance covered increased significantly from pre to post programme, as well as from post-programme to post Hajj,  $F(2, 174) = 20.7$  ( $P < 0.001$ ).

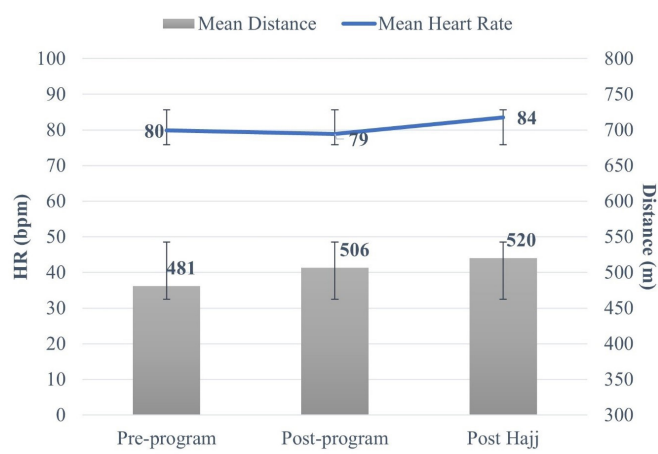
### Profile of Mood States

The mean POMS TMS score improved from 4.23 (SD: 13.10) before the programme to -3.89 (SD: 12.05) post programme,

**Table 3.** Measures of Central Tendency for Resting Heart Rate and Distance Covered by Gender

Resting Heart rate		Females	Males	Combined	p-value
Mean (SD)	Pre-programme resting heart rate	80 (12.50)	79 (11.15)	80 (11.93)	Reference
Median (IQR)		80 (70-90)	79 (72-86)	80 (72-88)	
Mean (SD)	Post-programme resting heart rate	79 (10.03)	79 (9.03)	79 (9.61)	0.429
Median (IQR)		78 (72-84)	80 (72-86)	80 (72-86)	
Mean (SD)	Post Hajj resting heart rate	83 (12.00)	84 (10.40)	84 (11.41)	0.004
Median (IQR)		83 (76-90)	84 (80-92)	84 (76-91)	
Distance covered		Females	Males	Combined	
Mean (SD)	Pre-programme 6-minute distance	468.6 (59.91)	501.4 (75.76)	481.3 (67.29)	Reference
Median (IQR)		473 (433-500)	507 (450-530)	482 (436-520)	
Mean (SD)	Post-programme 6-minute distance	490.8 (54.86)	531.0 (88.48)	506.3 (71.57)	<0.001
Median (IQR)		500.0 (456-526)	524 (480-581)	504 (462-541)	
Mean (SD)	Post Hajj 6-minute distance	497.0 (57.32)	558.3 (69.67)	520.7 (68.46)	<0.001
Median (IQR)		501 (470-532)	550 (520-602)	521 (480-562)	

Abbreviations: IQR, interquartile range; SD, standard deviation.

**Figure 1.** Heart Rate and Distance at Three Intervals.

and finally to  $-7.95$  (SD: 11.17) post Hajj (Table 4). There was a significant improvement in POMS between the pre-programme measurement and the post programme measurement ( $P < 0.001$ ) and between the post programme measurement and post Hajj measurement ( $P < 0.001$ ) (Table 4). There was no statistical difference between mean POMS of males versus females across all three measurements.

A one-way repeated measures ANOVA on a sample of 88 participants to determine if there were differences in the POMS scores due to a six-week supervised exercise programme showed that the exercise programme elicited statistically significant differences in mean POMS scores ( $F_{2,174} = 279$  ( $P < 0.001$ )).

The mean scores of the positive indicators (vigour) increased from the pre-exercise programme to the immediate post-exercise programme measurement, and post Hajj. Mental status across the negative measures (fatigue, tension, anger, depression and confusion) declined significantly from the pre-exercise programme levels and remained much lower than the baseline measures post Hajj (Table 4).

## Discussion

Our study is the first that the authors are aware of where a cohort of Hajj pilgrims participated in a specially designed walking programme to prepare them for the physical demands of the pilgrimage and followed up. Although the sample size was relatively small, the results suggest that the pilgrims who participated in the exercise programme had fewer negative consequences after Hajj compared to the non-participants. These initial positive outcomes warrant further experimental studies and interventions to provide more substantial evidence.

The mean age of the study sample of 53 years is consistent with the average age of South African pilgrims that have been attending the Hajj pilgrimage over the past decade.<sup>4</sup> The percentage of females in our study was larger than in other studies. Pre-existing medical conditions in our study was 34% which is similar to the prevalence described in other studies.<sup>6</sup> The co-morbidities, together with the harsh environmental conditions and large crowds, place these pilgrims at increased risk of developing community acquired pneumonias and invasive pneumococcal disease.<sup>14</sup> In the current study only 13 (14.7%) of participants suffered illness or injury with 6 (46.2% of presentations) reporting respiratory conditions during Hajj. Respiratory illnesses are the overwhelming cause of morbidity and reason for admission to hospital during the Hajj pilgrimage. The post Hajj survey in a group of South African pilgrims who did not take part in the exercise programme and was documented at the same time, revealed infections or injuries in 62.2% of respondents, of which 68.6% were respiratory conditions. This was similar to the 2017 study where the prevalence of illnesses or injuries amongst South African Hajj pilgrims was recorded as 65.1%, of which 70.2% of presentations were respiratory conditions.<sup>6</sup> The prevalence of respiratory symptoms was reported as high as 77.6% amongst Iranian pilgrims,<sup>15</sup> in excess of 47.0% in 2016 amongst Indian pilgrims<sup>2</sup> and a reported 95.2% in a cohort of 394 Malaysian pilgrims.<sup>16</sup> Our findings are suggestive of the positive effect of exercise on improving immune function and stress resistance and thereby reducing susceptibility to respiratory infections.



**Table 4.** Mean Scores Across POMS Components

	Mean	SD	P value
<b>Positive Indicators</b>			
<b>Vigour</b>			
Pre-programme	2.32	0.79	Reference
Post programme	2.83	0.69	<0.001
Post Hajj	2.96	0.80	<0.001
<b>Negative Indicators</b>			
<b>Fatigue</b>			
Pre-programme	1.20	0.86	Reference
Post programme	0.68	0.66	<0.001
Post Hajj	0.63	0.73	<0.001
<b>Tension</b>			
Pre-programme	0.87	0.75	Reference
Post programme	0.55	0.57	<0.001
Post Hajj	0.26	0.48	<0.001
<b>Anger</b>			
Pre-programme	0.31	0.54	Reference
Post programme	0.17	0.32	<0.001
Post Hajj	0.09	0.2710	<0.001
<b>Depression</b>			
Pre-programme	0.23	0.39	Reference
Post programme	0.13	0.27	<0.001
Post Hajj	0.07	0.28	<0.001
<b>Confusion</b>			
Pre-programme	0.65	0.61	Reference
Post programme	0.42	0.52	<0.001
Post Hajj	0.25	0.43	<0.001
<b>Total Mood Scores (TMS)</b>			
Pre-programme	4.23	13.10	Reference
Post programme	-3.89	12.05	<0.001
Post Hajj	-7.95	11.17	<0.001

This is supported by a Cochrane meta-analysis that showed that exercise has the potential to reduce the number and severity of respiratory tract infection symptoms.<sup>17</sup>

Hajj is a demanding physical journey and therefore physical fitness is crucial for the pilgrims. Our study showed the benefit of the supervised programme in improving aerobic fitness as measured by the six-minute distance walk. There is increasing evidence that suggests regular physical activity provides numerous health benefits,<sup>18,19</sup> including in middle-aged and older patients with type 2 diabetes.<sup>20</sup> Endurance exercise increases efficient oxygen utilisation.<sup>21</sup> Our findings suggest that these exercise-induced adaptations are translated into beneficial effects during Hajj.

The resting heart rate did not decrease as anticipated post Hajj. Most pilgrims returned a week or later after Hajj to South Africa and the physical and emotional stress of the return journey may account for that.

The programme increased the fitness levels of the participant hence the six-minute distance covered increased. After the programme the fitness was maintained because the pilgrims were subjected to intense physical exertion during the Hajj and therefore retained most of the fitness gained prior to leaving for Hajj.

This study found that there were significant changes in the POMS from the baseline (pre-programme), to immediately post programme and post Hajj. The main contributor to the change in scores is the improvement in vigour of the participants in

## Research Highlights

### What Is Already Known?

- Physical fitness improves both medical and mental well-being and may offer an increased immune response.
- There is a high prevalence of underlying medical conditions amongst participants during the physically demanding Hajj pilgrimage. There is a known high incidence of especially respiratory infections during and after the Hajj.

### What Does This Study Add?

- A pre-departure structured exercise programme improves the physical and mental status of pilgrims. This was largely maintained during and after Hajj.
- Such a programme which attempted to mimic the workload of the pilgrimage, may reduce morbidity during and after Hajj.

the supervised exercise programme. These findings are in accordance with other research that indicates exercise has a mood enhancing effect characterised by increasing positive parameters and reducing negative ones.<sup>22</sup> A study examining the effects of a 24-week resistance training programme amongst healthy older adults revealed similar results.<sup>23</sup>

Although, the exercise programme may be a contributor to the improved mood state, there may be other factors such as the effect of social cohesion and group membership, and the enthusiasm of participating in the journey of a lifetime.

Our study is innovative and proactive. The benefits attained by the pilgrims has served to promote the idea of a Fit for Hajj programme and this may be a useful tool in the COVID-19 era. A recent systematic review and meta-analysis indicated that regular, moderate to vigorous physical activity was associated with a reduced risk of community-acquired infectious diseases as well as infectious disease mortality. In addition, it found that there is enhancement of the first line of defence of the immune system and an enhanced response to vaccination.<sup>24</sup> Another study found that COVID-19 infected adults who participated in regular physical activity, had a significantly reduced risk for severe COVID-19 outcomes.<sup>25</sup> Physicians should identify a patient's level of risk for starting or increasing exercise and provide guidance on the frequency, intensity, time, and type of activity necessary to safely elicit maximal health benefits.<sup>26</sup>

Although, due diligence was ensured in the conduct of the study, limitations of the study include the small sample size, that there was no control group and that we did not control for potential confounders. Another limitation was that the training load was not quantified, and therefore it is not possible from this data to work out the dose response. A future study should do this so that more precise recommendations can be made about how much exercise is required. The study population composition and morbidity profile may not be reflective of the general South African Muslim population attending the Hajj pilgrimage. Our exercise program was for a minimum of six weeks and we conducted three cross sectional measurements

and did not collect information on long-term outcomes.

### Conclusion

A supervised exercise programme for potential Hajj pilgrims has demonstrated positive effects on both the physical and mental wellbeing of the pilgrims and may reduce morbidity. We recommend that this study be expanded, and a randomised control trial be implemented to strengthen the evidence base. Furthermore, the beneficial effect of this limited study serves to propel the idea that exercise be considered as a routine prescription for all potential Hajj pilgrims.

### Authors' Contributions

SP: Conceptualising, data collection, training of participants, drafting and reviewing of manuscript. MNJ: Conceptualisation, training of participants, drafting of manuscript. OM: Drafting protocol, data analysis, drafting.

### Conflict of Interest Disclosures

The authors declare that they have no conflict of interest.

### Ethics Approval

The protocol for the study was approved by the full committee of Biomedical Research Ethics Committee of the University of KwaZulu Natal (BFC 294/18). Informed consent was obtained from each participant prior to inclusion in the programme. Patients who were considered to be at risk were provided with medical advice and referred to their general practitioners and excluded from the study.

### Funding/Support

The authors declare that there was no financial support.

### References

- Ebrahim SH, Ahmed Y, Alqahtani SA, Memish ZA. The Hajj pilgrimage during the COVID-19 pandemic in 2020: event hosting without the mass gathering. *J Travel Med.* 2021;28(2):taaa194. doi:10.1093/jtm/taaa194.
- Khan ID, Khan SA, Asima B, Hussaini SB, Zakiuddin M, Faisal FA. Morbidity and mortality amongst Indian Hajj pilgrims: a 3-year experience of Indian Hajj medical mission in mass-gathering medicine. *J Infect Public Health.* 2018;11(2):165-170. doi:10.1016/j.jiph.2017.06.004.
- Benkouiten S, Al-Tawfiq JA, Memish ZA, Albarrak A, Gautret P. Clinical respiratory infections and pneumonia during the Hajj pilgrimage: a systematic review. *Travel Med Infect Dis.* 2019;28:15-26. doi:10.1016/j.tmaid.2018.12.002.
- Parker S, Hoosen AA, Feldman C, Gamil A, Naidoo J, Khan S. Respiratory infections due to *Streptococcus pneumoniae* and the influenza virus in South Africans undertaking the Hajj. *S Afr J Infect Dis.* 2018;33(5):1-5. doi:10.1080/23120053.2018.1484591.
- Parker S. The Hajj: a constant travel destination amidst changing times. *S Afr J Epidemiol Infect.* 2010;25(1):14-18. doi:10.1080/10158782.2010.11441371.
- Mushi A, Yassin Y, Khan A, et al. A longitudinal study regarding the health profile of the 2017 South African Hajj pilgrims. *Int J Environ Res Public Health.* 2021;18(7):3607. doi:10.3390/ijerph18073607.
- Prasetyo Y, Doewes M, Rahma N, Anantanyu S. Effects of aerobic exercise and weight training-aerobic towards physical fitness of elderly Hajj candidates. *Int J Adv Sci Eng Inf Technol.* 2017;7(1):106-117. doi:10.18517/ijaseit.7.1.1446.
- Penedo FJ, Dahn JR. Exercise and well-being: a review of mental and physical health benefits associated with physical activity. *Curr Opin Psychiatry.* 2005;18(2):189-193. doi:10.1097/00001504-200503000-00013.
- Booth FW, Roberts CK, Laye MJ. Lack of exercise is a major cause of chronic diseases. *Compr Physiol.* 2012;2(2):1143-1211. doi:10.1002/cphy.c110025.
- Pedersen BK, Saltin B. Exercise as medicine-evidence for prescribing exercise as therapy in 26 different chronic diseases. *Scand J Med Sci Sports.* 2015;25 Suppl 3:1-72. doi:10.1111/sms.12581.
- ATS Committee on Proficiency Standards for Clinical Pulmonary Function Laboratories. ATS statement: guidelines for the six-minute walk test. *Am J Respir Crit Care Med.* 2002;166(1):111-117. doi:10.1164/ajrccm.166.1.at1102.
- McNair D, Lorr M, Droppleman L. EITS Manual for the Profile of Mood States. San Diego: Educational & Industrial Testing Services; 1971.
- Shacham S. A shortened version of the Profile of Mood States. *J Pers Assess.* 1983;47(3):305-306. doi:10.1207/s15327752jpa4703\_14.
- Torres A, Blasi F, Dartois N, Akova M. Which individuals are at increased risk of pneumococcal disease and why? Impact of COPD, asthma, smoking, diabetes, and/or chronic heart disease on community-acquired pneumonia and invasive pneumococcal disease. *Thorax.* 2015;70(10):984-989. doi:10.1136/thoraxjnl-2015-206780.
- Razavi SM, Sabouri-Kashani A, Ziaee-Ardakani H, et al. Trend of diseases among Iranian pilgrims during five consecutive years based on a Syndromic Surveillance System in Hajj. *Med J Islam Repub Iran.* 2013;27(4):179-185.
- Deris ZZ, Hasan H, Sulaiman SA, Wahab MS, Naing NN, Othman NH. Preference of treatment facilities among Malaysian Hajj pilgrims for acute respiratory symptoms. *Saudi Med J.* 2009;30(8):1103-1104.
- Grande AJ, Keogh J, Silva V, Scott AM. Exercise versus no exercise for the occurrence, severity, and duration of acute respiratory infections. *Cochrane Database Syst Rev.* 2020;4(4):CD010596. doi:10.1002/14651858.CD010596.pub3.
- Warburton DER, Bredin SSD. Health benefits of physical activity: a systematic review of current systematic reviews. *Curr Opin Cardiol.* 2017;32(5):541-556. doi:10.1097/hco.0000000000000437.
- Reiner M, Niermann C, Jekauc D, Woll A. Long-term health benefits of physical activity--a systematic review of longitudinal studies. *BMC Public Health.* 2013;13:813. doi:10.1186/1471-2458-13-813.
- Mendes R, Sousa N, Themudo-Barata J, Reis V. Impact of a community-based exercise programme on physical fitness in middle-aged and older patients with type 2 diabetes. *Gac Sanit.* 2016;30(3):215-220. doi:10.1016/j.gaceta.2016.01.007.
- Morici G, Gruttad'Auria CI, Baiamonte P, Mazzuca E, Castrogiovanni A, Bonsignore MR. Endurance training: is it bad for you? Breathe (Sheff). 2016;12(2):140-147. doi:10.1183/20734735.007016.
- Berger BG, Motl RW. Exercise and mood: a selective review and synthesis of research employing the profile of mood states. *J Appl Sport Psychol.* 2000;12(1):69-92. doi:10.1080/10413200008404214.
- McLafferty CL Jr, Wetzstein CJ, Hunter GR. Resistance training is associated with improved mood in healthy older adults. *Percept Mot Skills.* 2004;98(3 Pt 1):947-957. doi:10.2466/pms.98.3.947-957.
- Chastin SFM, Abaraogu U, Bourgois JG, et al. Effects of regular physical activity on the immune system, vaccination and risk of community-acquired infectious disease in the general population: systematic review and meta-analysis. *Sports Med.* 2021;51(8):1673-1686. doi:10.1007/s40279-021-01466-1.
- Sallis R, Young DR, Tartof SY, et al. Physical inactivity is associated with a higher risk for severe COVID-19 outcomes: a study in 48 440 adult patients. *Br J Sports Med.* 2021;55(19):1099-1105. doi:10.1136/bjsports-2021-104080.
- Bull FC, Al-Ansari SS, Biddle S, et al. World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *Br J Sports Med.* 2020;54(24):1451-1462. doi:10.1136/bjsports-2020-102955.