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Quality of life, physical activity and cardiorespiratory fitness in black African women: B-Healthy project

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Running Title: PA, fitness, and HRQoL in Black African Women

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ABSTRACT

Purpose: To study the associations between physical activity (PA), cardiorespiratory fitness (CRF), and health-related quality of life (HRQoL) in black African women from a low socioeconomic community in South Africa.

Methods: Black African women (n = 146) aged 35-75 years from a low socioeconomic community in South Africa participated in this study. We measured PA levels via ActiHeart® accelerometers, and CRF by measuring peak oxygen consumption ($\dot{V}O_2$ peak). HRQoL was assessed once with the SF-8 Health Survey (SF-8). Participants were classified into groups based on age, moderate to vigorous PA (MVPA), and $\dot{V}O_2$ peak. Logistic regressions were used to compare the odds of having total HRQoL component scores above reported norms across PA and fitness groups. Two multiple linear regression models were developed using physical component summary (PCS) and mental component summary (MCS) as response variables respectively.

Results: $\dot{V}O_2$ peak and MVPA varied considerably across the sample and declined with increasing age. Participants in higher quartiles of MVPA and CRF showed trends to higher PCS scores. For CRF these trends were statistically significant, and persisted after adjustment for age and other possible confounders ($p = 0.036$). PCS was significantly associated with age, relative $\dot{V}O_2$ peak, and income (all $p < 0.05$), while MCS was associated with income ($p = 0.028$).

Conclusions: CRF is the most significant predictor, together with age and income, on the PCS of the HRQoL among black African women. We recommend that when seeking improvements in HRQoL, interventions should focus on improving CRF, particularly $\dot{V}O_2$ peak.

Kew words: quality of life; physical activity; cardiorespiratory fitness; female

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INTRODUCTION

Non-communicable diseases (NCDs) are one of the leading health and development challenges of the 21st century [1]. The burden of such diseases is increasing rapidly, and almost 40 million people die each year from NCDs [1]. The anticipated increase in NCDs has been attributed to the rise in risk factors associated with the disease, including hypertension, obesity, and physical inactivity [2, 3].

The World Health Organization (WHO) [4] identifies insufficient physical activity (PA) as the fourth leading risk factor for global mortality. Physical inactivity increases the risk of many adverse health conditions emanating from NCDs such as coronary heart disease (CHD), cardiovascular disease (CVD), type II diabetes, breast and colon cancer, and shortens life expectancy [5]. Furthermore, it also contributes all-cause mortality, and an overall decrease in health-related quality of life (HRQoL) [2, 3].

A new South African Constitution commenced in 1996, following the end of apartheid (1994). Since this time, some key studies have evaluated CVD risk factors and socio-economic positions in the new South Africa [6–8]. These studies found that modern South Africa has seen mass urbanisation, with many rural migrants adopting westernised diets. In the North West Province, higher body mass index, blood pressure and triglyceride levels have been found among urban black men and women compared with those residing in rural areas [6]. Furthermore, amongst adults living in low resource urban areas, physical inactivity has been regarded as a major contributing factor to increase the risks of developing NCDs [6, 9]. South African adults have particularly high levels of physical inactivity: according to WHO, 53.1% of adult women and 40.5% of adult men do not undertake sufficient activity to obtain health benefits [1].

Peak oxygen consumption ($\dot{V}O_2$), a key indicator of aerobic physical fitness, is also a powerful predictor of mortality. Better cardiorespiratory fitness (CRF) is associated with lower risks of all-cause mortality and CHD/CVD [10]. In a study on young Finnish men, higher levels

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of CRF were reported to be associated with higher levels of HRQoL [11]. Additionally, a study by Shibata et al. (2007) [12] reported that in Japanese adults, higher levels of PA were associated with higher levels of HRQoL.

Health-related quality of life is a subjective, multidimensional, integrative construct that includes individual physical and mental well-being. Quantifying HRQoL involves the measurement of self-reported health across multiple domains (e.g.: physical, cognitive, emotional, social). Measuring HRQoL can inform clinicians' and policy-makers' healthcare and treatment decisions to select interventions that afford benefits across many domains [13]. Generally, HRQoL tools include subscales to capture physical function or physical limitations. None of these subscales capture the extent of physical fitness or function, and are not a replacement for physiological measures of CRF (e.g.: $\dot{V}O_2$ peak), however, there is room to consider that HRQoL and CRF may be covarying phenomena – that is, better CRF is likely to be correlated with higher self-reports of physical health or lower self-reports of physical impairment. Further, self-report scales, both generic and disease-specific scales, appear to correlate with disease status, and may even serve as predictors of disease progression, in some non-communicable diseases [14, 15].

Notably, previous studies in this field were undertaken in affluent, indistrialised communities. The association between HRQoL, CRP and PA has not been established in persons from low-socio-economic environments, therefore, the main objective of this study was to determine possible relationships between PA and CRF with HRQoL in black African women from a low socioeconomic community in South Africa. Secondary to the main objective, in this study we also analysed whether factors beyond PA, and CRF (e.g., hypertension, education, income, marital status) predicted HRQoL in these participants.

2. MATERIALS AND METHODS

Study design and participants

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This study followed a cross-sectional research design. Participants were from a convenience sample recruited from the catchment area of two primary health clinics as part of the overarching B-Healthy project (trial registration number: PACTR201609001771813). A total of 210 black Africans between 35 to 75 years old were invited to take part in this study.

Using the WHO's CVD risk assessment and guidelines [16], including assessment of cardiovascular risks, clinical history, physical examination, blood pressure, and recommendations on lifestyle modifications, and lipid modification therapy, all participants were classified as being at risk of developing CVD based on their current health status and lifestyle behaviours. Specifically, as part of the B-Healthy study sample, all the participants had one or more risk factors for developing CVD: overweight or obesity, hypertension, dyslipidemia, pre-diabetes or diabetes, smoking, sedentary lifestyle.

Participation in the study required informed consent from all participants. After signing the informed consent, participants completed the Physical Activity Readiness Questionnaire (PAR-Q) [17] before testing, to detect any limitations or contraindications in following the study protocol. During the screening, education status; marital status and gross annual household income (GAHI) were obtained to ensure that all participants were from a low socioeconomic group. Exclusion criteria included orthopedic or mobility limitations, mental limitations, and any contraindications to exercise.

The Institutional Review Board (ref: NWU-00049-15-A1) of the North-West University approved the study which followed the Helsinki guidelines for ethical behaviour.

Anthropometric measurements

Height and weight were measured to the nearest 0.1cm and 0.1 kg respectively. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared ($kg•m^{-2}$). Participants were categorised as normal weight (BMI <25 $kg•m^{-2}$), overweight (BMI of 25-29.99 $kg•m^{-2}$), or obese (BMI ≥30 $kg•m^{-2}$) [18]. Waist circumference (WC) was measured

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according to the International Society for the Advancement of Kinanthropometry guidelines [19]. Participants were categorized as normal or elevated WC (WC </≥88 cm) [18]. All measurements were taken three times by the same trained person with the mean of the two closest assessments used for the analysis.

Habitual physical activity levels assessments

Physical activity levels were assessed by using a combined heart rate and accelerometry device (ActiHeart®, CamNtech Limited, UK), and data were downloaded using the accompanying ActiHeart® software [20].

Before fitting the accelerometers, we performed an eight minute individual calibration step test as recommended by the manufacturer. Participants wore the accelerometer 24 hours a day for seven consecutive days. Data from an accelerometer was considered valid if the participant wore it for ≥ 600 min during the hours not spent asleep, across a minimum of 4 days including one weekend day [21–23].

Outcome measures collected were total PA (TPA) (counts•min^{-1}); time spent (min•day^{-1}) in sedentary/sleeping time (SST) (<1.5 METs); light PA (LPA) (1.5 – 2.99 METs); moderate PA (MPA) (≥3 – 5.99 METs); vigorous PA (VPA) (≥6 METs) and moderate to vigorous PA (MVPA) (≥3.0 METs).

Consistent with guidelines from the WHO and the 2018 Physical Activity Guidelines Advisory Committee [4, 24], the total volume of MVPA performed during a week was used to classify participants as inactive (0 min of MVPA•week^{-1}), insufficiently active (1–149 min of MVPA•week^{-1}) or active (≥150 min of MVPA•week^{-1}).

Participants were further categorized into quartiles based on the age-specific distribution of daily time spent in MVPA.

Cardiorespiratory fitness assessment

Participants performed a standardized step test that consists of stepping up and down from 215 mm high step, incrementally increasing step frequency from 15 to 43 body lifts per minute (rate of change: 2.5 body lifts•min^{-2}). Respiratory gas-exchange was measured breath-by-breath with an automatic gas analysis system (Metalyzer 3B, Cortex, Leipzig, Germany). Peak values were recorded as the highest value during the last 30 seconds of exercise. Heart rate was measured concurrently using a heart rate monitor (Polar Electro, OY, Finland). Peak effort was identified by a plateau in HR or when a participant could no longer continue stepping.

Using these data, participants were categorized into quartiles based on age-specific distributions of relative $\dot{V}O_2$ peak achieved during the test.

Health-related quality of life assessment

The SF-8 Health Survey is a multipurpose short-form with eight questions designed to provide a HRQoL profile [25]. It is the most recent version of the short-form health surveys, which are the most widely used patient-based surveys in the world [25]. The survey was completed by interview to accommodate illiterate participants. The SF-8 was validated for the South African context [26].

The SF-8 survey assesses the following eight ordinal items: general health (GH), physical functioning (PF), role physical (RP), bodily pain (BP), vitality (VT), social functioning (SF), mental health (MH), emotional roles (RE). All 8 items are used to calculate the physical (PCS) and mental (MCS) component summary scores [25]. Scoring ranges from 0 to 100, with higher scores representing better HRQoL.

Statistical analysis

Descriptive statistics were obtained for age, weight, height, BMI, WC, PA outcomes, CRF outcomes, and HRQoL across age groups. Continuous variables are presented as means and SD, and categorical variables presented as percentages. Chi-square tests were used to investigate differences in proportions between age groups, and one-way ANOVA tests were used to compare means.

To examine the differences in HRQoL dimensions between age groups we conducted, separate ANCOVAs with post hoc Bonferroni test adjusting for potential covariates for each dimension. In addition, logistic regressions were used to compare the odds of having an HRQoL PCS or MCS above the US norms [25] across PA groups and fitness groups, with the lowest quartiles serving as the reference groups. Fully-adjusted models included the following covariates: age group, BMI, hypertension (yes or no); GAHI, marital status, and educational attainment.

Finally, two multiple linear regression models identifying significant variables ($p \leq 0.05$) were developed using PCS as response variable in model one, and MCS as response variable in model two. The explanatory variables introduced into the models were those found to be correlated at an alpha level $p \leq 0.10$ with PCS and MCS respectively, using a linear relationship.

Statistical analyses were conducted using the Statistical Package for the Social Sciences (IBM SPSS, v 22.0, Chicago, IL, USA). Statistical significance was set at < 0.05.

RESULTS

Two hundred women agreed to participate in this study, but only 146 participants returned complete datasets for analysis. See Table 1 for general characteristics of study participants: mean age of the participants was 56 years, 79.45 % were classified as overweight/obese, 64.38% were in the elevated WC category, 63.70% presented with hypertension, 59.60% had attainted primary education or less, 61.60% reported GAHI of <3200 euros, and 65.75% identified themselves as single, divorced, or widowed.

Table 1

Descriptive characteristics of the participants.

	All n = 146	≤ 50 y n = 44	51 to 64 y n = 58	≥ 65 y n = 44	*p*-trend
Age (yr)	56 (12)	40 (5)	58 (4)*	69 (4)**;***	**< 0.001**
Height (m)	1.55 (0.07)	1.56 (0.08)	1.55 (0.07)	1.55 (0.06)	0.687
Weight (kg)	77.54 (18.30)	79.05 (20.14)	79.37 (18.17)	73.63 (16.24)	0.238
BMI (kg•m^{-2})	32.16 (7.67)	32.60 (8.62)	32.88 (7.57)	30.76 (6.72)	0.349
Normal (%)	20.55	20.45	15.52	27.27	0.542†
Overweight (%)	19.86	22.73	17.24	20.46	
Obese (%)	59.59	56.82	67.24	52.27	
WC (cm)	92.29 (15.06)	92.55 (14.83)	93.69 (14.71)	90.18 (15.84)	0.506
Normal (%)	35.62	43.18	27.59	38.64	0.234†
Elevated (%)	64.38	56.82	72.41	61.36	
Hypertension					
Yes (%)	63.70	40.91	70.69	77.28	**0.001**†
No (%)	36.30	59.09	29.31	22.72	
Education status					
Primary school or less (%)	59.60	43.20	63.30	75.00	**0.010**†
High school or less (%)	40.40	56.80	39.70	25.00	
Marital Status					
Single, divorced or widowed (%)	65.75	65.91	56.90	77.27	0.099†
Married or living with a partner (%)	34.25	34.09	43.10	22.73	
GAHI					
< 3200 €	61.60	68.20	62.10	54.50	0.419†
≥ 3200 €	38.40	31.80	37.90	45.50	

Note: data are expressed as mean (SD) or percentage of group.

Abbreviations: BMI = body mass index; WC = waist circumference; GAHI = gross annual household income.

† Differences based on chi-square test.

* Significant differences between ≤ 50 vs 51-64 years old ($p < 0.05$)

** Significant differences between ≤ 50 vs ≥ 65 years old ($p < 0.05$)

*** Significant differences between 51-64 vs ≥ 65 years old ($p < 0.05$)

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See Table 2 for PA, CRF and HRQoL of the participants grouped by age. Significant differences were observed in the daily PA between women ≤ 50 vs ≥ 65 years old ($p = 0.015$). Women ≥ 65 years performed significantly less total PA than women in the other two age groups (all $p < 0.005$). Women ≤ 50 years performed significantly more MVPA than women ≥ 65 years ($p = 0.005$). Also, women ≤ 50 years performed significantly more VPA than women in the other two groups (all $p < 0.050$).

Significant differences were observed between women ≤ 50 years and women aged 51-64 years on measures of systolic blood pressure (SBP), heart rate (HR), absolute $\dot{V}O_2$ peak, peak HR, ventilation (VE), and breaths per minute (BF) (all $p < 0.005$). Also, significant differences were observed between women ≤ 50 years and women ≥ 65 years for HR, absolute and relative $\dot{V}O_2$ peak, peak HR, VE, BF, and respiratory exchange ratio (RER) (all $p < 0.005$). Significant differences were found between women aged 51-64 years and women ≥ 65 years for absolute and relative $\dot{V}O_2$ peak, peak HR, VE, and RER (all $p < 0.005$).

Regarding HRQoL dimensions scores, women ≤ 50 years reported significantly higher values for the item RE than the 51-64 years women ($p < 0.034$).

Table 2

Physical activity levels, cardiorespiratory fitness and HRQoL among black African women according to different age groups.

	All n = 146	≤ 50 y n = 44	51 to 64 y n = 58	≥ 65 y n = 44	*p*-trend
Physical activity levels					
Monitor wearing time (day)	5.96 (0.75)	5.82 (0.84)	5.90 (0.69)	6.18 (0.69)	0.053
Total PA (counts•min^{-1})	22.71 (11.24)	27.78 (12.93)	23.27 (10.70)	16.90 (6.76)**; ***	**< 0.001**
SST (mins•day^{-1})	1164.05 (188.97)	1109.55 (245.38)	1174.75 (150.74)	1204.45 (158.79)	0.052
LPA (mins•day^{-1})	235.35 (146.41)	268.07 (176.62)	228.94 (119.43)	211.09 (142.94)	0.173
MPA (mins•day^{-1})	40.19 (56.52)	61.06 (80.99)	36.34 (45.90)	24.39 (26.41)**	**0.007**
VPA (mins•day^{-1})	0.59 (1.71)	1.36 (2.75)	0.38 (0.95)*	0.09 (0.36)**	**0.001**

MVPA (mins•day^{-1})	40.78 (57.38)	62.43 (82.36)	36.72 (46.27)	24.48 (26.59)**	**0.006**
PA classification [4, 24]					
Inactive = 0 min of MVPA•week^{-1} (%)	3.42	2.27	3.45	4.55	0.151†
Insufficiently active = 1–149 min of MVPA•week^{-1} (%)	47.95	34.09	50.00	59.09	
Active ≥ 150 min of MVPA•week^{-1} (%)	48.63	63.64	46.55	36.36	
Cardiorespiratory fitness					
SBP (mmHg)	132.22 (19.73)	124.73 (14.99)	136.20 (20.06)*	134.48 (21.69)	**0.009**
DBP(mmHg)	82.93 (12.96)	84.00 (11.22)	84.66 (13.04)	79.59 (14.07)	0.119
HR (beat•min^{-1})	78 (10)	83 (12)	76 (9)*	74 (9)**	**< 0.001**
VO_2peak (L•min^{-1})	1.43 (0.41)	1.65 (0.45)	1.47 (0.36)*	1.17 (0.28)**; ***	**< 0.001**
VO_2peak (ml•kg^{-1}•min^{-1})	18.92 (5.05)	21.39 (5.34)	19.20 (4.99)	16.09 (3.18)**; ***	**< 0.001**
Peak HR (beat•min^{-1})	138.25 (22.28)	152.34 (20.10)	139.37 (18.08)*	122.69 (19.59)**; ***	**< 0.001**
VE (L•min^{-1})	38.36 (13.35)	45.99 (14.29)	39.31 (11.67)*	29.47 (8.62)**; ***	**< 0.001**
BF (breath•min^{-1})	35.90 (7.35)	39.75 (7.51)	35.63 (6.70)*	32.43 (6.24)**	**< 0.001**
RER	1.01 (0.14)	1.03 (0.13)	1.03 (0.12)	0.95 (0.14)**;***	**0.003**
Percentage of the predicted HR max (%)	84.24 (11.56)	84.74 (10.74)	85.97 (10.71)	81.46 (13.09)	0.141
HRQoL [a]					
Physical functioning	46.98 (9.71)	47.57 (7.97)	47.30 (9.72)	45.96 (11.30)	0.652
Role physical	47.58 (9.55)	45.71 (10.41)	48.95 (8.23)	47.65 (10.17)	0.207
Body pain	46.51 (12.35)	46.33 (12.55)	45.75 (11.83)	47.71 (13.00)	0.992
General health	44.89 (9.89)	45.13 (9.48)	44.95 (10.06)	44.57 (10.29)	0.867
Vitality	51.48 (9.49)	50.26 (9.52)	52.74 (9.38)	51.03 (9.65)	0.373
Social functioning	48.96 (8.97)	48.95 (8.98)	49.81 (8.13)	47.87 (10.03)	0.531
Role emotional	47.34 (8.56)	44.57 (10.38)	48.78 (7.15)*	48.21 (7.76)	**0.035**
Physical component summary	46.61 (10.22)	45.22 (10.05)	47.51 (9.65)	46.82 (11.17)	0.318
Mental component summary	49.82 (10.03)	49.54 (8.96)	51.09 (10.11)	48.45 (10.92)	0.241

Note: values are mean (Standard Deviation).

Abbreviations: PA = physical activity; SST = sedentary/sleeping time; LPA = light physical activity; MPA = moderate physical activity; VPA = vigorous physical activity; MVPA = moderate to vigorous physical activity; SBP = systolic blood pressure; DBP = diastolic blood pressure; HR = heart rate; VO_2 = oxygen consumption; VE = ventilation; BF = breath frequency; RER = respiratory exchange ratio; HRQoL = health related quality of life.

[a] The scales range from 0 to 100, with 0 indicating the worst situation and 100 indicating the best situation in the domains. HRQoL models were adjusted for body mass index, hypertension, gross annual family income, marital status and education status.

† Differences based on chi-square test.

* Significant differences between ≤ 50 vs 51-64 years old ($p < 0.05$)

** Significant differences between ≤ 50 vs ≥ 65 years old ($p < 0.05$)

*** Significant differences between 51-64 vs ≥ 65 years old ($p < 0.05$)

Table 3 shows the odds ratios (ORs) and 95% confidence intervals (CIs) for above the norm (score of 50) PCS and MCS across MVPA quartiles. Individuals in the lowest MVPA group served as the reference group. No significant trends above the median across MVPA quartiles were observed among the participants when adjusting for age for the ORs of PCS or MCS. After adjusting for potential confounding variables, no significant trends were observed among PCS or MCS above the median across MVPA quartiles.

Table 3

Odds ratios above the norms [25] for PCS and MCS according to moderate to vigorous physical activity levels.

	Moderate to vigorous physical activity levels, quartiles [a]				*p*-value for linear trend
	Q1 (ref)	Q2	Q3	Q4	
n	36	37	36	37	
PCS					
Prevalence of PCS Scores ≥ 50	50.00%	40.54%	50.00%	51.35%	
Age-Adjusted OR (95% CI)	1	0.68 (0.27 - 1.72)	1.00 (0.39 - 2.52)	1.06 (0.42 - 2.66)	0.702
Multivariate OR (95% CI)[b]	1	0.93 (0.35 - 2.79)	1.70 (0.56 - 4.20)	1.79 (0.61 - 5.20)	0.187
MCS					

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Prevalence of MCS Scores ≥ 50	58.33%	56.76%	72.22%	62.16%	
Age-Adjusted OR (95% CI)	1	0.94 (0.37 - 2.37)	1.86 (0.69 - 4.97)	1.17 (0.46 - 3.00)	0.459
Multivariate OR (95% CI)[b]	1	0.95 (0.34 - 2.62)	1.28 (0.41 - 3.90)	1.36 (0.47 - 3.95)	0.478

Note: values are presented as OR and 95% CI unless otherwise specified.

Abbreviations: PCS = physical component summary; MCS = mental component summary; OR = odds ratio; CI = confidence interval.

[a] Participants were categorized into quartiles based on age-specific distribution of daily time spent in moderate to vigorous physical activity. Cutpoints for quartiles are: Q1 = 3.09–12.84 min of MVPA•day^{-1}; Q2 = 14.29–19.15 min of MVPA•day^{-1}; Q3 = 31.02–42.28 min of MVPA•day^{-1}; Q4 = 72.19–129.35 min of MVPA•day^{-1}.

[b] Adjusted for age, body mass index, hypertension, gross annual household income, marital status, and education status.

Table 4 shows the ORs and 95% CIs for above the norm (score of 50) PCS and MCS across CRF quartiles. Individuals in the lowest CRF group served as the reference group. Adjusting for age, significant positive trends across CRF levels were observed among the participants for the ORs of PCS above the median (p = 0.009), while no significant trends were observed across MCS (p = 0.927). After adjusting for potential confounding variables, the significant trends observed among PCS above the median across CRF groups persisted (p = 0.036).

Table 4

Odds ratios above the norms [25] for PCS and MCS according to cardiorespiratory fitness level.

	Cardiorespiratory Fitness Levels, quartiles [a]				*p*-value for
	Q1 (ref)	Q2	Q3	Q4	linear trend
n	35	37	37	37	
PCS					
Prevalence of PCS Scores ≥ 50	31.42%	45.94%	51.35%	62.16%	
Age-Adjusted OR (95% CI)	1	1.85 (0.70 - 4.83)	2.31 (0.88 - 6.06)	3.61 (1.36 - 9.60)	**0.009**
Multivariate OR (95% CI) [b]	1	0.90 (0.33 - 2.58)	1.68 (0.41 - 3.35)	1.97 (0.62 - 4.18)	**0.036**
MCS					

Prevalence of MCS Scores ≥ 50	54.28%	70.27%	67.57%	56.76%	
Age-Adjusted OR (95% CI)	1	1.99 (0.76 - 5.26)	1.75 (0.67 - 4.56)	1.10 (0.43 - 2.79)	0.927
Multivariate OR (95% CI) [b]	1	2.86 (0.98 - 8.31)	3.18 (1.03 - 9.80)	1.92 (0.60 - 6.08)	0.268

Note: values are presented as OR and 95% CI unless otherwise specified

Abbreviations: PCS = physical component summary; MCS = mental component summary; OR = odds ratio; CI = confidence interval.

[a] Cardiorespiratory fitness level quartiles established using age specific peak oxygen consumption values. Cutpoints for quartiles are: Q1 = 12.75–14.12 ml•kg^{-1}•min^{-1}; Q2 = 16.44–17.89 ml•kg^{-1}•min^{-1}; Q3 = 18.99–20.93 ml•kg^{-1}•min^{-1}; Q4 = 23.47–26.18 ml•kg^{-1}•min^{-1}.

[b] Adjusted for age, body mass index, hypertension, gross annual household income, marital status, and education status.

The multivariate linear regression that was fitted to identify factors that significantly affected the PCS showed that age, relative $\dot{V}O_2$ peak and GAHI had a strong effect on the PCS of the participants (Table 5). It was found that GAHI was the only factor affecting the MCS (Table 5).

Table 5

Variables affecting the Physical and Mental Component Summaries of the HRQoL.

Variables	β	β Error	*t*	*p*-value	β 95% CI	
PCS						
Age (yr)	0.20	0.07	2.65	**0.009**	0.05	0.35
Peak HR (beat•min^{-1})	0.08	0.04	1.77	0.078	-0.01	0.18
VO_2peak (ml•kg^{-1}•min^{-1})	0.60	0.20	2.97	**0.003**	0.20	1.00
GAHI	3.92	1.64	2.38	**0.018**	0.66	7.17
MCS						
Peak HR (beat•min^{-1})	.059	.043	1.36	0.173	-0.02	0.14
VO_2peak (L•min^{-1})	2.64	2.34	1.13	0.260	-1.98	7.28
GAHI	3.72	1.67	2.21	**0.028**	0.40	7.03
Hypertension	-3.10	1.64	-1.88	0.061	-6.35	0.14

Regression model statistically significant for PCS ($p < 0.001$; $R^2 = 0.153$)

Regression model statistically significant for MCS (p = 0.010; R^2 = 0.089)

Abbreviations: PCS = physical component summary; HR = heart rate; VO_2 = oxygen consumption; GAHI = gross annual household income; MCS = mental component summary.

DISCUSSION

Our results suggest that there is a positive relationship between the PCS of the HRQoL and CRF, with a significant trend across CRF quartiles observed for PCS. Furthermore, our multiple regression analysis found that CRF is the strongest predictor of the PCS in this population. The GAHI was the only variable affecting the MCS of the HRQoL. To our knowledge, this is the first time that a study uses direct measurement of the CRF and objective measures of PA level in black South African women from a low-resourced community.

Two-thirds of our study population had obesity values for BMI and higher than normal waist circumference. These findings are comparable to the statistics reported for the general female population of South Africa [27], which showed that the mean BMI of women between ages of 55-64 years was 31.5 kg•m^{-2} with 81.30% being overweight/obese. We found similar results to another study which reported that 77% of black African women in Soweto (mean age of 41 years) were overweight or obese [28].

The South Africa Demographic and Health Survey (SADHS) showed that in 2016, prevalence of hypertension in women between ages 55-64 was 77.6 % compared to ~64% with a mean age of 56 in this study. This lower percentage can be accounted for by our population sample of only black African women, which have a lower prevalence rate of hypertension compared to White, Colored and Indian women in South Africa [27].

Physical activity is a modifiable risk factor reported to influence NCDs. Results from this study, however, indicate that half of the participants achieved the recommended habitual PA volume according to the recommendations of the WHO on Physical Activity for Health [4]. With an increase in age, the levels however decreased significantly. These findings are comparable to

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previous reports that found an estimated 55% of all South Africans not being sufficiently active [29] according to self-reported data. In a self-reported Global PA Questionnaire (GPAQ) completed by 977 black African women in Soweto in 2014 (mean age of 41), 67% of the women identified themselves as active [28]. Our study based on objective physical activity measurement showed that fewer women were active, possibly due to our participants being older than those in previous studies - with increased age, there is decrease in MVPA (see Table 2).

More specifically, MVPA was significantly higher in women under the age of 50 in comparison to women over the age of 65 years as well as total PA, MPA and VPA, when comparing these two age groups. The findings indicate that with an increase in age, there is a marked reduction in all levels of PA, from moderate to vigorous. The variation in PA in different age groups has several contributing factors. Primarily, ageing is associated with a decrease in aerobic capacity, muscle mass and strength. Other factors that contribute to lower PA with age could be due to less walking since the majority of participants older than 65 years are retired while the vast majority of those under 50 years are more likely to be working on an ad-hoc basis, with walking as part of their primary mode of transportation [28]. These are some of the few factors of why older people do not participate in PA with lack of interest as the most powerful deterrent [30]. Moreover, ownership of television has also been shown in one study to significantly lower MVPA [28]. The finding that there is marked reduction in all levels of PA in black African women from low socioeconomic communities with increase in age has several important implications, as this is the group most vulnerable to NCDs. The lack of PA combined with obesity could compound and increases the risk of developing hypertension, particularly in this population [31, 32].

In a worldwide study done in 2012, where the impacts of physical inactivity on major non-communicable disease worldwide was studied [33], elimination of physical inactivity would remove 6-10% of all NCDs worldwide. Pertaining to South Africa, an estimated increase in life expectancy of 1.26 years by decreasing physical inactivity was projected [33]. Thus, it is imperative that future policies target eradication of physical inactivity to alleviate the NCD epidemic in South Africa [34].

In general, regular and structured PA contributes to the fitness levels of persons. Although 48.6% of the participants in this study reported sufficient levels of PA for health improvement, the direct measurement of CRF indicates very low levels of $\dot{V}O_2$ peak. Our results corroborate that of the findings from the first SA-NHANES study where two-thirds of the participants were not able to complete a fitness step test [35]. These levels of CRF, which decrease significantly with an increase in age, are pointing out the necessity of implementing programs of physical exercise to directly impact its values, which has been demonstrated to be an independent predictor of CVD risk, CVD mortality, and total mortality [10].

Our study found that overall, for 7/8 components of the SF-8 HRQoL questionnaire, the mean scores for the participants were all below the normal of 50, with GH scoring the lowest (44.89) and only Vitality scoring above the normal (51.48). The finding of a mean score of 44.89 in GH may be due to the demographics of the participants, as all of them had at least one comorbidity such as hypertension or diabetes and that majority live in poverty.

As far as we know, this is the first study where the SF-8 was used to assess the HRQoL in black African women from low socioeconomic communities. Future studies should be done to rigorously test whether scoring below 50 truly reflects HRQoL below the normal, in comparison to the general population in Africa and other parts of South Africa. Nevertheless, the results of our study show that the participants' HRQoL is below the values obtained by females in other countries [2, 25, 36]. The factors affecting their HRQoL could include the poor over-crowded living conditions that many of the participants live in, financial instability, poor access to health care and fear of crime, to name a few [27, 37]. Also, the inclusion criteria for participation in the study was to have a risk factor for NCDs, which could also explain the low values of HRQoL, since the burden of the disease is influencing both the mental and physical functioning of the participants.

We also found that the Role Emotional score of the ≤ 50-year-old women was lower than the RE score obtained by the 51-64-year-old women. Although we do not know which aspects of emotional role are particularly problematic for these specific groups of women, we hypothesize that the difference may be due to the fact that ≈ 66 % of the ≤ 50-year-old were single, with no husband or partner and ≈ 68% of them having a GAHI < 3.200 €, so we postulate that they may shoulder increased responsibilities in family life and reduced incomes to take care of their families [38, 39].

South Africa is burdened by a high prevalence of HIV/AIDS [40], and high incidence of tuberculosis (TB) [41] among working age adults, as well as concurrence of these diseases, multidrug resistant strains of tuberculosis, and high drug costs for both conditions, such that morbidity and mortality from HIV/AIDS and TB are substantial social concerns. All these factors may influence the daily life activities, job performance and quality of life of the youngest group of participants in our atudy. Further, these findings are consistent with a previous study in which women with lower income, lower education levels, and without life partners, reported higher levels of emotional stress around their roles [38].

Regarding the odds of having a PCS and MCS above the population norm, our results suggest that there is a positive relationship between CRF level and the PCS of HRQoL among the participants. When women reported higher CRF levels, their physical components scores were also higher (Table 4). In line with different authors [42–44], which found that perceived health is a predictor of morbidity and mortality, our results suggest that it would be important creating long term and sustainable exercise programs to improve the CRF at community level if our objective is to positively impact on the PCS of this population.

On the contrary, no association was found between CRF levels and MCS for the participants. Previous studies support the positive associations between CRF levels and both PCS and/or MCS [11, 45, 46]. On the other hand, and similar to our results, Clennin et al. (2015) just found associations between CRF levels and PCS.

A positive trend was found pointing out that the higher PA levels the better the PCS, nevertheless the result was not significant. In the same way, no associations were found between PA levels and MCS. These results are contrary to those reported by other authors [47, 48]. The discrepancies between our results and these studies may have been caused by the use of different study populations or differences in methodology. In our case, GAHI is a significant predictor for the MCS in our participants, which are from very low resourced area (≈ 62% of them having a GAHI < 3.200 €). The lack of associations between PA or CRF and MCS could be due to objective measurements of PA levels, preventing the influence of factors, such as personal perceptions of PA levels or CRF. Self-reported physical activity is not a valid measure because of the combined influences of individual perception and social stigma [49].

Different factors affecting the HRQoL, such as the social environment of communities and societies, culture, socioeconomic factors, made it challenging to compare our results with other studies. Thus, it is important to conduct more studies analyzing the role PA, and CRF on the HRQoL in the African context where social inequalities play an important role for the health of the population [50–54]

Several limitations and strengths should be addressed for the present study. Although this study is the first to determine objectively the levels of PA and CRF in black African women from low socioeconomic communities and the correlates with HRQoL, the findings should be interpreted with caution. In this study, a convenience sample was used and therefore, it is not possible to generalize our results to the rest of the population. The variables analyzed in the current study were assessed in a specific district of the North West Province within a low sociodemographic and economic situation. Data for the validated SF-8 has not been used at a population level within the South African context but was validated within a comparative sample [26].

The strengths of this study include that we used objective measurements of PA and direct measurement of $\dot{V}O_2$ peak. The objective methods implemented in this study to assess PA and CRF reduce the risk of bias in the measurements.

In conclusion, we found that higher values in CRF are associated with higher self-reported levels of the PCS but not with the MCS of the SF-8 HRQoL questionnaire. Interestingly, no associations were found among PA levels and the PCS or MCS of the SF-8 HRQoL questionnaire. Finally, the results of the present study found that CRF is the most significant predictor and influencing factor, together with the level of income and age, on the PCS of the HRQoL of the participants. On the other hand, the only significant influencing factor on the MCS was the GAHI. Future interventions should focus on improving physical fitness, rather than increasing the moderate to vigorous physical activity levels, when health-related quality of life is to be improved. Implementing physical activity programs at the community level, with simple elements and low cost is feasible. These programs should be led by clinical exercise professionals to safely implement moderate and vigorous-intensity exercises, which are the exercise that will really benefit and impact on the health of the participants.

Also, in the African context more research is needed to analyze the relationship between fitness and HRQoL together with economic analyses, to inform policy development and resource allocation. These developments and allocations should emphasize the importance of prescribing exercise to reduce the risk of NCDs in low-resourced communities in Africa.

Author Disclosure Statement

No competing financial interests exist.

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