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Physical activity, change in blood pressure and predictors of mortality in older South Africans - a 2-year follow-up study

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Physical activity, change in blood pressure and predictors of mortality in older South Africans - a 2-year follow-up study

Abstract

Objective. A 2-year follow-up study of a cohort of 200 historically disadvantaged older South Africans was conducted to: (i) characterise current levels of habitual physical activity; (ii) relate physical activity to current risk factors for chronic disease; and (iii) identify risk factors associated with 2-year mortaJity. The baseline sample, drawn in 1993, was found to have a high prevalence of hypertension (71.7%). Research design. Retrospective cohort study. Methods. A baseline sample of 200 persons aged ;:;.. 65 years, resident in the Cape Peninsula, was randomly drawn by means of a two-stage cluster design. Baseline measurements included: anthropometry, waist/hip ratio, systolic and diastolic blood pressure, body mass index (BMI), serum albumin, serum ferritin, haemoglobin and fasting plasma glucose levels, plasma lipid profiles, oral glucose tolerance test and self-reported health status. SUbjects were revisited after 2 years, at which time an adapted version of the Yale Physical Activity Survey was administered and measurements of blood pressure and anthropometry were repeated. Statistical analyses. Spearman's rank-order correlations were used to describe relationships between various current risk factors and physical activity. Logistic regression was used to detennine predictors of 2-year mortality from baseline data. Results. At follow-up, 142 of the SUbjects (66 men, 76 women) were traced and measurements collected. Thirtytwo subjects were reported to have died by relatives liVing in the same household (22 men, 10 women). Levels of reported physical activity in the survivors were two-thirds lower than those reported in a sample of North Americans of similar age. There was an inverse association between age and physical activity (r = --{).31; P < 0.0005) and a positive association between BMI and physical activity (r = 0.29; P < 0.005). There was, however, no association between physical activity and systolic or diastolic blood pressure. In men, BMI in the lower tertile (P = 0.07) and serum ferritin levels were positively associated with increased mortality. Serum albumin levels were protective overthe 2-year follow-up period (OR = 0.85; P < 0.05). In women, being diabetic (OR =4.88; P =0.06) and having a waistlhip ratio in the upper tertile (OR =3.26; P =0.06) were associated with mortality. Conclusions. Physical activity levels in this sample of older historically disadvantaged South Africans were habitually low. Simple anthropometric assessments incorporating weight and waistlhip ratio, together with serum albumin measurements, may be useful to screen general health risk for older adults at primary care level and provide indications for social or medical intervention. Further, strategies for earlier detection and effective management of diabetes, particularly in older women, may reduce premature mortality in this population.

Keywords

up, year, 2, africans, study, south, follow, older, physical, activity, change, blood, pressure, predictors, mortality

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Karen E Charlton, Estelle V Lambert, Judith Kreft

Objective. A 2-year follow-up study of a cohort of 200 historically disadvantaged older South Africans was conducted to: (*i*) characterise current levels of habitual physical activity; (*ii*) relate physical activity to current risk factors for chronic disease; and (*iii*) identify risk factors associated with 2-year mortality. The baseline sample, drawn in 1993, was found to have a high prevalence of hypertension (71.7%).

Research design. Retrospective cohort study.

Methods. A baseline sample of 200 persons aged $\geqslant 65$ years, resident in the Cape Peninsula, was randomly drawn by means of a two-stage cluster design. Baseline measurements included: anthropometry, waist/hip ratio, systolic and diastolic blood pressure, body mass index (BMI), serum albumin, serum ferritin, haemoglobin and fasting plasma glucose levels, plasma lipid profiles, oral glucose tolerance test and self-reported health status. Subjects were revisited after 2 years, at which time an adapted version of the Yale Physical Activity Survey was administered and measurements of blood pressure and anthropometry were repeated.

Statistical analyses. Spearman's rank-order correlations were used to describe relationships between various current risk factors and physical activity. Logistic regression was used to determine predictors of 2-year mortality from baseline data.

Results. At follow-up, 142 of the subjects (66 men, 76 women) were traced and measurements collected. Thirty-two subjects were reported to have died by relatives living in the same household (22 men, 10 women). Levels of reported physical activity in the survivors were two-thirds lower than those reported in a sample of North Americans of similar age. There was an inverse association between age and physical activity ($r = -0.31$; $P < 0.0005$) and a positive association between BMI and physical activity ($r = 0.29$; $P < 0.005$). There was, however, no association between physical activity and systolic or diastolic blood pressure. In men, BMI in the lower tertile ($P = 0.07$) and serum ferritin levels were positively associated with increased mortality. Serum albumin levels were protective over the 2-year follow-up period (OR = 0.85; $P < 0.05$). In women, being diabetic (OR = 4.88; $P = 0.06$) and having a waist/hip ratio in the upper tertile (OR = 3.26; $P = 0.06$) were associated with mortality.

Conclusions. Physical activity levels in this sample of older historically disadvantaged South Africans were habitually low. Simple anthropometric assessments incorporating weight and waist/hip ratio, together with serum albumin measurements, may be useful to screen general health risk for older adults at primary care level and provide indications for social or medical intervention. Further, strategies for earlier detection and effective management of diabetes, particularly in older women, may reduce premature mortality in this population.

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It is well established that hypertension is one of the main risk factors for the development of cardiovascular disease, affecting about 20% of adult populations in most developed countries.[1] Data from three large longitudinal studies (the Multiple Risk Factor Intervention Trial (MRFIT),[2] the Chicago Stroke Study[3] and the Framingham Study[4]) show that for both men and women in the seventh and eighth decades of life, blood pressure, particularly systolic blood pressure, continues to be a major independent risk factor for cardiovascular mortality and morbidity and loses almost no discriminatory power with the passing of time.

The prevalence of hypertension tends to increase after the age of 65 years,[5-7] and is estimated to affect more than 50% of older Americans.[6] In South Africa, 1.7 million people are currently aged 65 years and over, a figure predicted to rise to 7 million by the year 2035.[8] A South African population which has been historically disadvantaged has been shown to have the highest prevalence of hypertension in the country.[9]

Studies have previously demonstrated an inverse association between increased physical activity levels and blood pressure in the elderly, particularly in hypertensive individuals.[10-12] Further, habitual exercise has been shown to reduce other risk factors for chronic diseases of lifestyle, such as body fat accumulation with age. Older persons may have body compositions comparable to younger adults when at least moderate levels of physical activity are maintained throughout adulthood.[13,14]

There is a paucity of data on habitual physical activity patterns and the relationship between physical activity, morbidity and mortality in older South Africans. Inherent methodological challenges associated with the accurate assessment of physical activity in this age group include impaired eyesight, poor literacy skills and short-term memory loss in some subjects, as well as an inability to use job classification data in subjects who are no longer working. A modified version of the Yale Physical Activity Survey for Older Adults (YPAS)[15] questionnaire has

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previously been validated in a sample of 14 older South African subjects and a significant correlation between measured 24-hour energy expenditure, using indirect calorimetry and heart-rate monitoring methods, and weekly energy expenditure calculated from the questionnaire responses was found ($r = 0.82$; $P < 0.001$).[16]

There are also limited data available on factors associated with mortality in older South Africans from disadvantaged communities. Identification of risk factors for mortality in this age group has important implications for primary health care screening to assess those at risk. Various factors have been shown to be independently predictive of mortality risk in older people in epidemiological studies, including low body weight and rapid unintentional weight loss,[17-21] poor nutritional status as indicted by low serum albumin concentrations[22] and poor self-reported health status.[23]

In 1993, a nutrition and health survey was undertaken in a representative sample of 200 historically disadvantaged South Africans living in the Cape Peninsula. A high prevalence of hypertension was identified (66.7% (95% CI: 57.3 - 76.1%) and 76.5% (68.3 - 84.7%) in men and women, respectively).[24] This paper reports on a 2-year follow-up study of the baseline sample to: (*i*) characterise the current physical activity patterns of subjects who were still alive using the validated YPAS instrument; (*ii*) to assess the association between physical activity, blood pressure and body composition, as well as changes in these parameters over 2 years; and (*iii*) to identify predictive risk factors for 2-year mortality in the baseline sample.

Methods

The representative baseline sample of 200 persons (96 men, 104 women) aged 65 years and over, resident in the Cape Peninsula, was drawn using a two-stage cluster sampling technique. All subjects were re-visited 2 years later by two trained fieldworkers. Subjects who had moved out of the sample area, who refused to participate in the follow-up study or who were unavailable on three occasions were classified as lost to follow-up. The death of a subject was ascertained by asking household members whether the older person had died during the follow-up period. Causes and time of death were not specified.

Dependent variables collected in the baseline study included blood pressure (systolic and diastolic), measured according to the American Heart Association's 1967 guidelines.[25] Anthropometric measures included body mass index (BMI) (weight/height $(m)^2$); waist/hip ratio; arm skinfold thickness (triceps, biceps), measured in triplicate with Harpenden calipers; and arm muscle area, calculated according to the formula of Frisancho.[26] Percentage body fat and lean body mass were calculated indirectly from measurements of whole-body bio-electrical impedance by means of a standard tetrapolar bio-impedance monitor (Bodytrak 2000).

Fasting blood samples were drawn from all 191 consenting subjects for the following analyses: full blood count (Coulter S Plus II analyser, Hialeah, Florida, USA); serum folate, red cell folate and serum vitamin B_{12} levels (Becton Dickenson Simultrac-SNB, New York, USA); haemoglobin (cyan-methaemoglobin method); and ferritin levels (immunoturbidimetric methods). Conventional enzymatic assays were used to determine total plasma cholesterol (Boehringer Mannheim CHOD-PAP) and triglyceride (Boehringer Mannheim) levels. High-density lipoprotein (HDL) cholesterol was measured after lipoproteins containing apolipoprotein (apo) B were precipitated by polyethylene glycol.[27] Plasma low-density lipoprotein (LDL) cholesterol levels were calculated with the Friedewald equation.[28] A 2-hour oral glucose tolerance test was performed with a 75 g oral glucose monohydrate load. Fasting and 2-hour serum glucose levels were analysed by means of the glucose oxidase method[29] and the presence of diabetes was assessed on the basis of the WHO's 1985 criteria.[30]

Self-perceived health status was assessed according to a five-point scale, ranging from 'very good' (score = 5) to 'very poor' (score = 1). A composite health score was calculated, incorporating responses to three items: self-perceived health status (range 1 - 5); health status compared with peers of the same age (range 1 - 3); and current health status compared with health status 3 years before (range 1 - 3). In all cases, a higher score indicates a better health status (range 3 - 11).

An adapted version of the YPAS[15] questionnaire which includes composite questions on time spent performing activities associated with work, yardwork, caring, recreation and exercise, was used to quantify total weekly energy expenditure associated with physical activity (physical activity recall (PAR), kcal/week). A weighted summary index score comprising six items (moving, standing, sitting, vigorous walking, leisurely walking, and climbing a flight of steps) was also included in the instrument, and a total score was calculated and adjusted for reported seasonal variation.

For non-parametric data, the median and interquartile range are given in the summary statistics. Associations between reported current physical activity levels (PAR and summary score) and age, blood pressure, anthropometric measurements and self-reported health score at follow-up were investigated; Spearman correlation coefficients were used. Weight change was categorised according to a loss of $\geqslant$ 2 kg, a gain of $\geqslant$ 2 kg, or remaining the same (–1.9 kg to +1.9 kg). Differences in the change in systolic and diastolic blood pressure between these categories were investigated; analysis of variance (ANOVA) was used. Differences in the proportion of subjects who had died, according to BMI tertiles at baseline, were assessed with ANOVA. Differences between baseline variables of survivors and those who had died at follow-up were assessed by an independent *t*-test. Forward logistic regression modelling was used to identify which baseline variables were associated with 2-year mortality. Subjects lost to follow-up were assumed to be alive, and were included in the regression analyses.

Results

At follow-up 142 of the subjects (66 men, 76 women) from the baseline survey were traced and measurements collected. Thirty-two subjects (22 men, 10 women; $P < 0.05$) had died in the interim. The 2-year mortality rate was 16% (95 % CI: 10.9 - 21.2%). The remaining 26 subjects were classified as lost to follow-up.

The calculated weekly PAR associated with activity domains is shown in Table I. The summary index score was

20 ± 12.1 and 19.5 ± 8.6 for men and women, respectively (possible range 0 - 140). No differences in either PAR or summary index measures were found between men and women. Reported PAR was, on average, 14% and 21% of the recommended dietary allowance (RDA)[31] for energy for men and women, respectively, in this age group. Changes in blood pressure and anthropometric parameters between baseline and follow-up in survivors are shown in Table II. There was a trend ($P < 0.001$) for both systolic and diastolic blood pressure to decrease over time, by about 8 mmHg ($P = 0.07$ for the change in systolic blood pressure for women). BMI and waist/hip ratio decreased over time in both men and women. In men, mean weight loss was 1.7 ± 0.5 kg ($P < 0.005$); however, in women the weight loss was not significant. Arm measurements tended to increase in women. In men, the mean drop in both systolic and diastolic blood pressure was greater in subjects who had lost ≥ 2 kg compared with the other groups ($P < 0.05$); a similar but non-significant trend was found in women (Figs 1 and 2).

Table I. Reported weekly physical activity levels (kcal/week)

Variable	Mean	SD	Median	Q1*	Q3*	Range
Work (kcal/week)						
Men	1 217†	1 403	710	98	1 912	0 - 6 000
Women	1 845	1 490	1 568	823	2 611	0 - 7 430
Total	1 540	1 477	1 327	345	2 138	0 - 7 430
Yardwork (kcal/week)						
Men	411‡	573	150	0	630	0 - 2 250
Women	222	372	90	0	225	0 - 2 220
Total	314	488	90	0	405	0 - 2 250
Caring (kcal/week)						
Men	48	251	0	0	35.1	0 - 2 040
Women	405	2 567	0	0	36.1	0 - 21 600
Total	231	1 852	0	0	36.0	0 - 21 600
Recreation (kcal/week)						
Men	288	338	203	70	420	0 - 1 650
Women	316	521	140	70	315	0 - 3 255
Total	302	440	158	70	420	0 - 3 255
Exercise (kcal/week)						
Men	345	678	75	0	285	0 - 3 660
Women	83	133	30	0	90	0 - 585
Total	210	498	36	0	180	0 - 3 660
Total (kcal/week)						
Men	2 342	2 129	2 057	748	3 145	0 - 9 090
Women	2 842	3 676	2 235	1 002	3 513	0 - 29 345
Total	2 583	3 027	2 138	873	3 292	0 - 29 345

Men — N = 69; women — N = 73; total — N = 142.
* Q1 = 25th percentile; Q3 = 75th percentile.
† Difference between the sexes; 2-sample t-test ($P < 0.05$).
‡ $P = 0.065$.

An inverse association between age and total weekly PAR ($r = -0.31$; $P < 0.001$) and a positive association between BMI and PAR ($r = 0.29$; $P < 0.001$) were found in both men and women. Neither systolic nor diastolic blood pressure was associated with PAR. The summary index activity score was not associated with age, blood pressure or any of the anthropometric variables investigated.

Table II. Change in mean blood pressure and anthropometric measurements over the 2-year follow-up period

	Baseline	2-year	Change
Variable	Mean (SD)	Mean (SD)	Mean (SD)
Systolic blood pressure (mmHg)			
Men	160.1 (20.4)	150.6 (22.8)	−10.3 (2.7)*
Women	162.5 (20.6)	156.7 (30.9)	−5.4 (3.0)
Total	161.4 (20.5)	153.7 (27.4)	−7.7 (2.1)*
Diastolic blood pressure (mmHg)			
Men	93.9 (11.0)	83.1 (18.4)	−11.4 (2.2)*
Women	92.5 (14.0)	85.6 (21.5)	−6.7 (12.0)*
Total	93.2 (12.6)	84.4 (20.0)	−8.9 (1.5)*
Weight (kg)			
Men	66.7 (12.9)	64.8 (13.2)	−1.7 (0.5)†
Women	66.4 (13.4)	65.5 (15.2)	−0.7 (0.9)
Total	66.5 (13.1)	65.2 (14.3)	−1.2 (0.5)†
Height (m)			
Men	163.6 (7.7)	162.7 (7.4)	−0.40 (0.52)
Women	151.4 (6.9)	150.9 (6.4)	−0.23 (0.23)
Total	157.2 (9.5)	156.5 (9.0)	−0.31 (0.31)
BMI			
Men	25.0 (4.9)	24.3 (5.0)	−0.82 (0.29)†
Women	29.0 (5.9)	28.5 (6.3)	−0.58 (0.26)†
Total	27.1 (5.8)	26.5 (6.1)	−0.69 (0.19)*
Waist/hip ratio			
Men	0.95 (0.08)	0.91 (0.08)	0.04 (0.0091)*
Women	0.94 (0.07)	0.86 (0.06)	0.08 (0.008)*
Total	0.94 (0.07)	0.88 (0.08)	−0.06 (0.006)*
Biceps skinfold (mm)			
Men	6.7 (3.6)	5.6 (3.9)	−1.03 (0.35)†
Women	11.8 (5.9)	12.9 (8.6)	1.01 (0.79)
Total	9.3 (5.5)	9.3 (7.6)	0.03 (0.45)
Triceps skinfold (mm)			
Men	9.2 (6.0)	9.5 (5.9)	0.35 (0.48)
Women	17.6 (9.6)	22.5 (10.7)	4.98 (1.13)
Total	13.6 (9.1)	16.2 (10.9)	2.76 (0.66)*
Mid-arm circumference (cm)			
Men	26.8 (3.3)	27.1 (3.5)	0.14 (0.23)
Women	29.0 (4.2)	30.0 (4.9)	0.97 (0.26)*
Total	27.9 (4.0)	28.6 (4.5)	0.58 (0.18)†

Men — N = 69; women — N = 73; Total — N = 142.
* $P < 0.001$; paired t-test of differences between measurements.
† $P < 0.05$.

The mean blood pressure measurements of the subjects at baseline were categorised according to mortality status at 2 years (i.e. alive/lost to follow-up or dead). In men, systolic blood pressure at baseline was lower in those subjects who had died at follow-up than in those still alive (150 ± 21 v. 159 ± 20 mmHg; $P = 0.063$); however, in women no differences were demonstrated.

The proportion of subjects who had died during the follow-up period, according to tertiles of BMI at baseline for men and women, is shown in Figs 3 and 4, respectively. In men, a greater proportion of subjects in the lowest BMI tertile had died ($P = 0.069$); however, no difference was found in women.

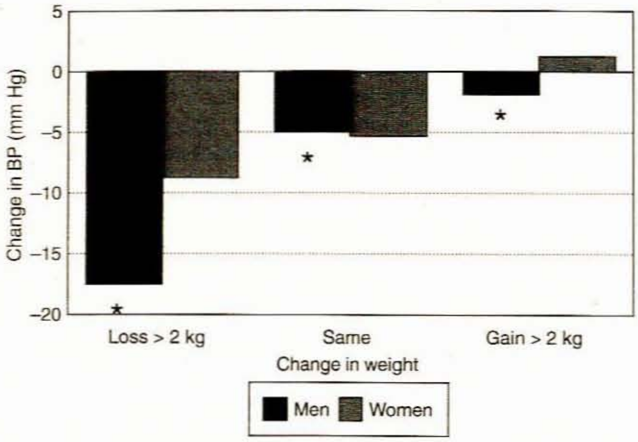

Fig. 1. Change in systolic blood pressure over 2 years, according to categories of weight change.

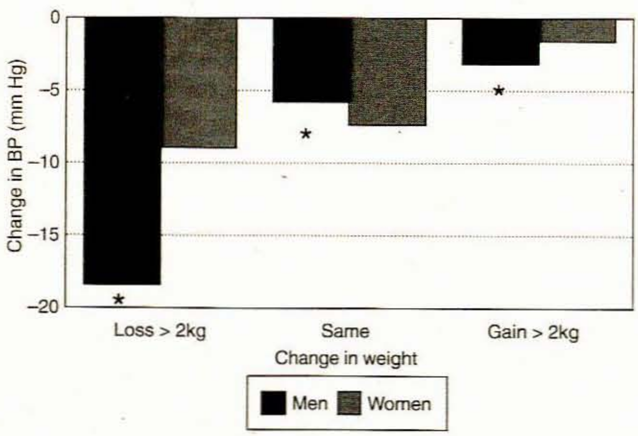

Fig. 2. Change in diastolic blood pressure over 2 years, according to categories of weight change.

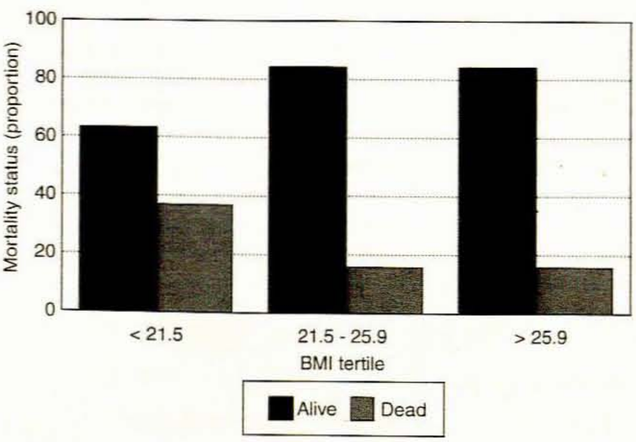

Fig. 3. Mortality status at follow-up, according to BMI tertile at baseline — men.

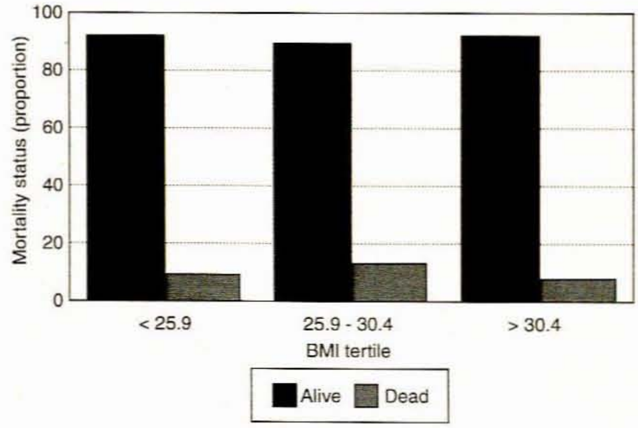

Fig. 4. Mortality status at follow-up, according to BMI tertile at baseline — women.

Differences in baseline measurements, according to sex and mortality status at follow-up, were investigated by means of an independent *t*-test. The only difference found in men was a lower body weight in those who had died (59.2 ± 17.7 kg v. 66.5 ± 13.1 kg; $P < 0.05$). Women who had died during the follow-up period had a lower hip circumference ($P < 0.062$) and a higher plasma triglyceride concentration ($P = 0.068$) at baseline than the survivors. A χ^2 test was performed to investigate the association between mortality status and waist/hip ratio, categorised according to tertiles for men (≤ 0.915; 0.916 - 0.97; > 0.97) and women (≤ 0.905; 0.906 - 0.965; > 0.965). For women, mortality status was significantly different across the tertiles of waist/hip ratio) ($\chi^2 = 6.017$; $P < 0.05$); however, no association was found in men.

The baseline variables which were entered into forward stepwise logistic regression models for exploratory purposes to investigate the predictive factors for mortality at 2 years included: (*i*) continuous variables: age, systolic blood pressure, diastolic blood pressure, self-perceived health status and health score, BMI, serum albumin, ferritin, fasting glucose, haemoglobin, triglycerides, total cholesterol, HDL cholesterol, LDL cholesterol; and (*ii*) categorical variables: sex, presence of diabetes, tertiles of waist/hip ratio. The outcome (dependent) variable was mortality status at follow-up (dead or alive/lost to follow-up). For the total sample, serum albumin and being male were risk factors for 2-year mortality (Table III). When stratified according to sex, serum albumin levels and systolic blood pressure were associated with a reduced risk of mortality in men (OR = 0.869 ($P = 0.078$) and OR = 0.972 ($P = 0.067$), respectively), while serum ferritin was positively associated with increased risk of death (OR = 1.002 ($P < 0.05$)). For every 100 µg increase in ferritin, risk of death increased by 15% (OR = 1.15; 95% CI 1.01 - 1.32). In women, being diabetic (OR = 4.27; $P = 0.077$) and having a high waist/hip ratio (OR = 2.89; $P = 0.087$) were associated with mortality, while serum albumin showed an inverse (but not significant) trend (OR = 0.872; $P = 0.159$). When the modelling was repeated, including the predictor variables identified in the forward modelling process and including smoking and age as possible confounders, systolic blood pressure lost significance in men (OR = 0.978; $P = 0.105$) and in women the OR associated with the presence of diabetes and waist/hip tertiles became more protective (Table III).

Table III. Forward stepwise logistic regression model parameters

Variable	Parameter estimates	Standard error	*P*-value	Odds ratio	OR (95% CI)
Total sample					
Intercept	6.8094	2.8460	0.017*		
Albumin	–0.1398	0.0558	0.012*	0.870	0.755 - 0.975
Ferritin	0.0015	0.0006	0.024*	1.001	1.0008 - 1.003
Sex†	–0.9067	0.4995	0.069	0.404	–0.589 - 1.373
Diabetic	0.7107	0.4963	0.1521	2.037	0.769 - 5.384
Modelling, by sex (including age and smoking)‡					
Men					
Intercept	7.1210	4.8681	0.1435		
Ferritin	0.0016	0.0007	0.0168*	1.002	1.001 - 1.003
Albumin	–0.1594	0.0715	0.0257*	0.853	0.741 - 0.981
Systolic blood pressure	–0.0227	0.0140	0.1049	0.978	0.951 - 1.005
Women					
Intercept	3.8135	7.2533	0.5991		
Albumin	–0.1366	0.0998	0.1712	0.872	0.717 - 1.061
Diabetic	1.5858	0.8301	0.0561	4.273	0.960 - 24.850
Waist/hip¶	1.1822	0.6242	0.0582	3.262	0.960 - 11.085

* $P < 0.05$.
† Sex variable: 1 = men, 2 = women.
‡ Regression modelling repeated, including age and smoking as possible confounders and predictor factors identified in initial forward regression models.
¶ Waist/hip ratio, categorised as tertiles.

Discussion

The baseline study population is representative of apparently healthy free-living people aged 65 years and older in the Cape Peninsula who are historically disadvantaged. Disadvantaged communities are typically characterised by low socio-economic status and a high prevalence of crime and violence. The majority of the study subjects lived in multigenerational households, had a low level of education and were reliant on the government old-age pension (R340 per month at the time of the survey) as their main source of income.[24]

Physical activity, anthropometry and blood pressure

At follow-up, subjects reported low levels of habitual energy expenditure associated with physical activity. Energy expenditure, estimated on the YPAS activities checklist, was 66% lower than that reported in a sample of North Americans of the same age (2 583 ± 3 027 kcal/week v. 7 613 ± 4 506 kcal/week, respectively).[15] Similarly, the summary index score was approximately 60% lower than that reported in the North American study (19.6 ± 10.5 v. 48.7 ± 2.9, respectively). The greatest differences in indices of physical activity between the South African and American samples were found in respect of high-intensity activities; summary scores for activities of low intensity such as sitting, standing or moving were similar between the groups. These differences may be related to the fact that the majority of people in the South African sample live in multigenerational households and therefore may have more assistance with household tasks such as cleaning. There may also be fewer opportunities for leisure-time physical activity in this community, given a paucity of facilities. On the other hand, the differences may simply reflect different perceptions of health benefits associated with physical activity. When questioned about perceived factors relating to their longevity, only 8.5% of subjects attributed their longevity to being active and taking regular exercise.[32] The findings of the present study suggest a need for health education on behaviour modification in this age group, particularly with regard to the high prevalence of hypertension, diabetes and obesity (in women) identified in the baseline survey.[24,33,34]

Although the PAR, calculated by means of the adapted YPAS, did not differ between men and women, men reported higher expenditure associated with yardwork and exercise while women had greater energy expenditure associated with care-giving responsibilities and housework. A large inter-individual variation in energy expenditure is demonstrated by the large standard deviations and ranges of response.

Contrary to the findings of the American YPAS study,[15] which demonstrated a significant negative association between reported total weekly energy expenditure (kcal/week) and diastolic blood pressure ($r = -0.47$; $P < 0.01$), no association between either systolic or diastolic blood pressure and reported activity was found in the cohort of the present survey.

Studies of older Dutch women have demonstrated body weight to be between 5 kg[35] and 12 kg[36] greater in sedentary compared with physically active subjects of the same age. However, in the present study, a higher BMI was associated with higher physical activity, which may reflect a difference in current health status rather than be a direct result of increased habitual activity patterns. However, the negative association between BMI and age (reported elsewhere[34]) may be confounding the relationship between activity and blood pressure in this sample. Previous intervention studies have demonstrated reductions in both systolic and diastolic blood pressure with increased physical activity in hypertensive[11,37] and normotensive[38] elderly subjects.

Generally, body weight and waist/hip ratio were lower in survivors after the 2-year follow-up period, which indicates a disproportionate loss of weight from the abdominal region relative to the hips, particularly in women. Mean weight change in the present study was higher than that reported for a cohort of Hong Kong Chinese elderly who were followed up for the same time period (1.2 ± 6.3 kg v. 0.3 ± 2.6 kg, respectively).[39] Over the 2-year period, the drop in both systolic and diastolic blood pressure was associated with a weight loss of more than 2 kg in men. Current reported physical activity levels did not predict change in blood pressure in survivors.

Mortality data

The only baseline factors found to be independently predictive of 2-year mortality in this sample were low serum albumin and raised serum ferritin concentrations in men, and a high waist/hip ratio and the presence of diabetes in women. Age at entry to the study was not associated with

2-year mortality in either sex, which suggests that a healthy survivor effect was introduced at recruitment for the baseline survey. A healthy survivor effect may, at least partly, explain the lack of an association between physical activity levels and blood pressure at follow-up.

A U-shaped curve has been proposed as representative of the relationship between weight and/or BMI and mortality in adults[17-21] across all ages; however, this association increases with age. In the present study, men with a BMI in the lowest tertile had a greater risk of mortality at 2 years than subjects in the other two BMI tertiles. However when logistic regression analyses, which accounted for potential confounding, were used, this association was lost. Similarly, men who had died during the follow-up period had a significantly lower body weight at baseline than the surviving men. Weight loss or low body weight may be a marker of a subclinical or undiagnosed disease or of nutritional deficiencies. Possible biases of the study are that the duration of follow-up may have been too short to assess other predictors of mortality, and that the presence of underlying disease and levels of functional dependence at baseline were not controlled. Another possible bias is that subjects lost to follow-up were assumed still to be alive since, at follow-up, family members reported on the death of an older study subject. Uncontrolled differences between traced subjects and those lost to follow-up in terms of age, sex and general health status may exist, which would further bias the findings.

Recent research has focused not only on the health risks associated with being overweight but on risks associated with regional body fat distribution. In the Nurses' Health Study[40] mortality from coronary heart disease was associated more with the ratio of waist to hip circumference than with BMI. In a previous analysis of this cohort at baseline, upper-segment fat distribution (centralised fat stores) ($P < 0.001$) and body mass ($P < 0.05$) were both significant risk factors for diabetes.[33] These relationships were, however, confounded by gender and age. In men, the association between waist/hip ratio and diabetes increased with age, whereas in women, those under 70 years with increased body mass and waist/hip ratio had the highest risk of diabetes (Fig. 5). Both men and women in the present follow-up study had a central body fat distribution, which is generally associated with increased risk of chronic diseases (waist/hip ratio > 0.90). This finding, together with findings from the baseline survey, suggest that women in this population present with diabetes earlier than men, which indicates the importance of early detection and effective management of the disease.

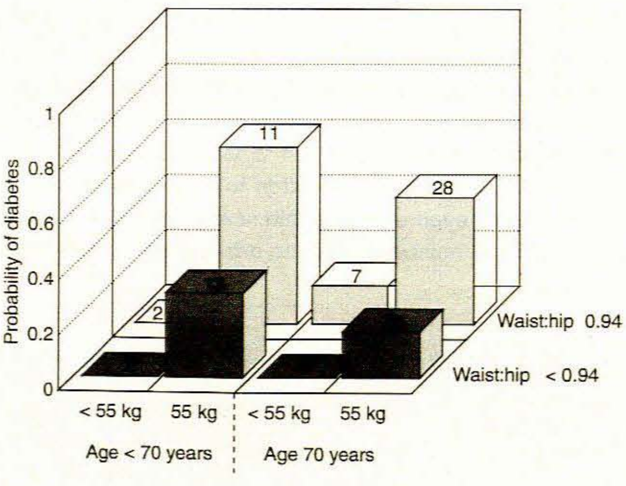

Fig. 5. Probability of diabetes in the baseline study, according to risk factor profiles by age: women.[33]

Serum albumin is known to be an indicator of the general health and nutrition of an individual.[41] Albumin levels are associated with protein-energy malnutrition, liver and renal disease, acute and chronic illnesses, inflammation, surgical stress and trauma.[42-44] In studies of hospitalised patients, low albumin levels are predictors of prolonged hospital stay, and an increased rate of complications and all-cause mortality.[44-45] An inverse association between albumin levels and mortality has also been demonstrated in healthy, community-dwelling older persons.[46] Corti *et al.*[22] demonstrated a graded increase in mortality rate over 3.7 years of follow-up with decreasing albumin levels in subjects aged 71 years and older, after controlling for age, race, education, chronic conditions and disability status.

The significant association between serum ferritin concentrations and increased 2-year mortality in men may be explained by ferritin as a potential marker of chronic alcohol abuse. Although ferritin is an acute-phase protein and is typically elevated in cases of infection, inflammation and malignancy,[47-49] excessive alcohol consumption is associated with hyperferritinaemia.[48] The mechanism through which alcohol causes or exacerbates hyperferritinaemia is not clear. However, the findings of the present study suggest that alcohol may have been a major factor in this regard, since iron overload was frequently accompanied by macrocytosis (58%) and, to a lesser degree, by folate deficiency (17%).[50] Further, in the baseline study a high prevalence of raised gamma-glutamyltransferase was found in subjects with raised serum ferritin levels.

Conclusions

The findings of this 2-year follow-up study have yielded important information for incorporation in the planning and provision of health services, particularly health promotion activities, to older adults. The sample of older historically disadvantaged South Africans, previously shown to have a high prevalence of chronic diseases, has low habitual physical activity levels. Predictors for mortality at 2 years in men include a BMI lower than 22 at baseline, raised serum ferritin and low serum albumin concentrations. In women, the presence of diabetes and a high waist/hip ratio are independent risk factors for mortality, while there was a tendency for serum albumin concentrations to be associated with reduced mortality risk. Simple anthropometric assessments of older adults, together with serum albumin determinations, may be useful to screen the general health risk of older adults at primary care level and give indications as to the need for medical or social intervention. The findings suggest that strategies for the early detection and effective management of diabetes, particularly in women, may reduce premature mortality. Finally, raised serum ferritin concentrations in men in this population and an apparent association with increased mortality risk warrant further investigation of the underlying causes.

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