Repeated Annual Health Risk Assessments With Intervention Did Not Reduce 10-year Cardiovascular Disease Risk: A 4-year Longitudinal Study in 13,737 Financial Sector Employees

Hene, Nceba MSc*; Wood, Paola DPhil; Schwellnus, Martin MBBCh, MSc, MD; Jordaan, Esme MSc; Laubscher, Ria BCom

Sport, Exercise Medicine and Lifestyle Institute (SEMLI) and Division of Biokinetics and Sports Science, Department of Physiology, Faculty of Health Sciences, University of Pretoria, South Africa (Mr Hene and Dr Wood); Sport, Exercise Medicine and Lifestyle Institute (SEMLI), Faculty of Health Sciences, University of Pretoria, South Africa (Dr Schwellnus); International Olympic Committee (IOC) Research Centre, South Africa (Dr Schwellnus); Biostatistics Unit, South African Medical Research Council, South Africa (Ms Jordaan and Ms Laubscher); Statistics and Population Studies Department, University of the Western Cape, South Africa (Ms Jordaan).

*Address correspondence to: Nceba Hene, MSc, 2993B Shrike Street, Thatchfield Hills, Centurion, 0157, South Africa (ncebahene@hotmail.com).

This work was supported by (i) Oglivy South Africa (partial funding), (ii) IOC Research Center (South Africa) (partial funding), (iii) South African Medical Research Council (partial funding, statistical analysis).

This publication was a requirement for Nceba Hene's PhD degree.

Author contribution: Nceba Hene (NH): study concept, study planning, data cleaning, data interpretation, manuscript (first draft), manuscript editing. Paola Wood (PW): study concept, study planning, data interpretation, manuscript (first draft), manuscript editing. Martin Schwellnus (MS): study concept, study planning, data interpretation, manuscript (first draft), manuscript editing, facilitating funding. Esme Jordaan (EJ): study planning, data analysis including statistical analysis, data interpretation, manuscript editing. Ria Laubscher (RL): study planning, data cleaning, data analysis including statistical analysis, data interpretation, manuscript editing.

Research Ethics Committee of the Faculty of Health Sciences of the University of Pretoria (REC numbers 754/2018).

The authors report no conflicts of interest.

Clinical significance: Repeat annual health risk assessments (RAHRAs) with intervention did not reduce the 10-year FRS for CVD. RAHRAs significantly reduced the prevalence of hypercholesterolemia but no other risk factors. Although RAHRAs provide valuable insights into the progression of non-communicable diseases (NCDs), the role of RAHRAs in NCD management requires further study.

ABSTRACT

Objective: To determine if repeat annual health risk assessments (RAHRAs) with intervention reduce 10-year cardiovascular disease (CVD) risk in financial sector employees. **Methods:** Retrospective analysis from RAHRAs in 13737 employees over 4-years. We report changes in 10-year Framingham risk score (FRS) for CVD (%) and risk factors after 1 (GR1), 2 (GR2) and 3 (GR 3) RAHRAs. **Results:** Mean FRS increased with RAHRAs (GR1: +0.4%; GR2: +0.7%; GR3: +0.8%) ($p<0.001$) and was higher for GR3 vs. GR1 ($p<0.001$) and GR2 (pairwise: $p<0.0355$). RAHRAs were associated with increased inadequate fruit/vegetable intake (GR1: +5.4%; GR2: +9.8%; GR3: +15.8%) (all pairwise: $p<0.001$) and overweight (GR1: +5.4% vs. GR2: +9.8%) ($p<0.001$) and only hypercholesterolaemia decreased (GR1; -4.4% vs. GR3; -9.6%) ($p<0.001$). **Conclusion:** RAHRAs did not reduce 10-year CVD risk in financial sector employees. Role of RAHRAs in chronic disease management requires further study.

Key words: lifestyle, risk factors, employees, health risk assessment, cardiovascular disease, Framingham Risk Score

INTRODUCTION

Non-communicable diseases (NCDs) are increasing globally, disproportionately affecting low- and middle-income countries (LMICs). [1] This imposes more constraints to an already overburdened health care system and hinders social and economic development.[2] South Africa (SA) is particularly affected by this increasing trend [3] and the percentage of deaths due to NCDs in SA have increased progressively from 42.9% in 2005 to 55.5% in 2015.[4]

Four primary NCDs (cardiovascular disease, cancers, chronic respiratory diseases, and diabetes mellitus) have been attributed to four modifiable risk behaviours: poor nutrition, insufficient physical activity, harmful use of alcohol and smoking.[5] While the quality of life and health of individuals is affected by NCDs, there is also a reported loss of work productivity due to absenteeism.[2] Therefore, a preventative approach to reduce the risk of NCDs in the workplace could be beneficial especially in countries, such as SA, where skilled labour is relatively scarce.[6] In order to reduce the increasing prevalence of NCDs in the work force, 76% of SA companies offer onsite Health Risk Assessments (HRAs) that are usually conducted on an annual basis. These workplace health programs are designed

to address and reduce NCD risk factors as companies recognise that future success can only be achieved with a healthy, skilled, and motivated workforce.[7]
A workplace-based literature review, using cross-sectional data, concluded that HRAs with feedback contributed towards positive lifestyle modification among employees.[8] With the gradual evolution of multiple modifiable risk factors and onset of NCDs, cross-sectional analyses are subject to systemic variance due to the use of a single measurement method and inability to compare within-individual difference over a period.[9] An analysis of longitudinal data can address these limitations by using repeat measures at different periods for the same individuals therefore providing insights into the evolution of the risk factors and their effects on NCDs.[9] Completing repeat annual health risk assessments (RAHRAs) over time allows for the comparison between assessments and to track change in health status and behaviours which may influence NCD risk.[8]

There is limited research determining if RAHRAs with an intervention, positively influence NCD lifestyle risk factors, specifically reducing the prevalence of NCD risk factors over time. A three year retrospective longitudinal study conducted on a random sample of American university employees (n=500) with reported NCD risk factors who had received a financial incentive for completing an RAHRA without intervention showed improvement in six of the eight NCD risk factors. [10] A Japanese manufacturing company (n= 1704) reported that employees with three follow-up HRAs with various wellness support programs decrease the prevalence number of NCD risk factor at high risk (5 or more risk factors) while increasing the percentage of employees in the low risk group (0-2 risk factors). [11] Although these studies demonstrate the potential health benefits of RAHRAs, researchers have highlighted the importance of using local data to tailor workplace promotional programmes for the targeted population.[7] To our knowledge, there are no workplace based studies that have examined the effect of multiple RAHRAs participation, with or without and intervention, on 10-year CVD risk and individual NCD risk factors within the South African workplace.

The main aim of this study was to determine if repeat participation (from one to three repeats) in annual HRAs with an intervention, changes the 10-year Framingham risk score (FRS) for CVD among SA financial sector employees. A secondary aim was to determine if RAHRAs with an intervention change the prevalence of individual NCD risk factors. This study can provide important evidence to guide the financial sector in effectively planning and scheduling RAHRAs to reduce the risk of NCDs.

METHODS

Settings and Participants

Study design

We conducted a retrospective analysis of data collected longitudinally among South African financial sector employees who voluntarily completed two or more RAHRAs over a 4-year period (1 January 2016 to 31 December 2019).

Setting

A private financial sector health insurer hosted annual wellness days for its employee groups at their 73 worksites in all nine provinces in South Africa over the 4-year period. The goal of the wellness days was for employees to gain a better understanding of NCD risk factors and subsequentially influence their NCD lifestyle behaviours so that they would make changes or maintain positive lifestyle measures. The wellness days included an HRA comprising a personal health risk assessment questionnaire, anthropometric and clinical measures.

All employees were invited to participate in the wellness days via email which included a booking link for the annual HRA (AHRA) ensuring that it did not interfere with their work.

Study participants

Financial sectors employees of a private South African financial sector health insurer between 18 and 63 years, who had completed at least two AHRAs between 1 January 2016 and 31 December 2019, were included. Of the entire population of 36074 employees, 22337 employees completed only a single annual HRA (not used for the analysis) and 13737 completed more than one assessment. These employees were the participants in this study and were divided into three groups (GR) as follows: GR1 (a baseline AHRA and one RAHRA) (n=8687), GR2 (a baseline AHRA and two RAHRAs) (n=3853) and GR3 (a baseline AHRA and three RAHRAs) (n=1197).

Annual Health Risk Assessment (AHRA)

At the wellness day, the employees completed an online PHA questionnaire before anthropometric and clinical measurements were conducted by a registered Nurse or accredited Biokineticist /Applied Exercise Physiologist.

Personal Health Assessment (PHA) Questionnaire

The PHA contained questions on participant demographics (age, sex), medical and family history and self-reported modifiable lifestyle behaviours. Participants reported their current smoking status by indicating whether they were non-smokers or current smokers. In addition, they reported their average

daily fruit and vegetable intake and their habitual physical activity by indicating the average number of fruits and vegetable servings per day and average minutes of moderate physical activity per week, respectively. During the study period, no change in the wording of questions in the PHA questionnaire was made.[12]

Anthropometrical and Clinical Measurements

Anthropometric measurements**:** Height, weight and waist circumference measurements were completed according to American College of Sport Medicine (ACSM) guidelines.[13] Height was measured to the nearest 0.1 cm, using a wall mounted ultrasound stadiometer (PUSH Stadiometer, InBody, California). A digital scale (Microlife WS 80 N, MicrolifeAG, Widnau, Switzerland) measured body mass to the nearest 0.1 kg. Body Mass Index (BMI) was calculated as body weight in kilograms (kg) divided by height in meters (m) squared (kg/m^2).[13] Waist circumference was measured (in centimetres) at the narrowest part of the torso (above the umbilicus and below the xiphoid process) with a non-stretch retractable tape measure.

Clinical measurements: An automated blood pressure machine (Microlife BP A2 Basic, Microlife AG, Widnau, Switzerland) was used to measure resting blood pressure. Blood pressure was measured twice after the participant remained seated quietly for five minutes. Random blood glucose concentration (mmol/L) and total cholesterol concentration (mmol/L) was obtained using finger-prick capillary samples (Accutrend GCT Monitor, Roche Diagnostics, Mannheim, Germany) either on the right- or left-hand according to appropriate guidelines for reliable finger-stick collection. [14]

Post Health Risk Assessment Intervention

On completing the AHRA, all employees received the following information from a registered Nurse or accredited Biokineticist: (1) verbal feedback regarding their overall results; (2) guidance to maintain or modify their lifestyle risk behaviours and (3) a comprehensive automated report email detailing their risk of NCD risk factors and offering general behavioural lifestyle modification advice. Employees identified as “increased” or “high” risk for NCDs (based on total cholesterol, blood pressure and blood glucose cut-off point values as described in Table 1) received a short message service (SMS) within 72 hours of completing the HRA advising them to consult their general medical practitioner. A reminder SMS was sent after 4 weeks by the Health Insurer to employees who had not yet consulted their general medical practitioner. A follow-up telephonic call was made after 12 weeks from the assessment date to those who had not yet consulted their general medical practitioner. Employees with general medical practitioner confirmed hypercholesterolemia, hypertension or diabetes mellitus were registered with the Disease Management Programme for access to chronic medication and follow-up consultations with their general medical practitioner for the ongoing management of the NCD(s).

Table 1: Risk factor classification and risk factor cut-off point of NCD risk

NCD risk factor classification	Risk factor cut-off points
Insufficient physical activity	Less than 150 minutes of moderate- to high-intensity physical activity per week [13]
Inadequate fruit and vegetable intake	Less than 5 servings of fruits and vegetables per day [18]
Smoking	Current cigarette smoker [1]
Overweight	BMI ≥ 25 kg/m^2 [19]
Central Obesity	Waist circumference >102 cm for men and >88 cm for women [13]
Hypertension	A systolic blood pressure ≥ 140 mmHg and/or a diastolic blood pressure ≥ 90 mmHg), or use of anti-hypertensive medication [13]
Hypercholesterolaemia	Total blood cholesterol concentration ≥ 5.2 mmol/l [13]
Diabetes mellitus	Random blood glucose concentration ≥ 6.4 mmol/l [19] or self-reported diagnosis of diabetes mellitus

Outcome measures

Framingham risk score and Risk Category

We used the non-laboratory-based Framingham risk score (FRS) to derive the 10-year risk of CVD (%). Framingham risk scoring uses age, gender (male/female), systolic blood pressure, BMI and smoking status (yes/no) and diabetes mellitus status (yes/no). [15]

The Framingham score (10-year absolute CVD risk as a percentage) was classified as low (< 10%), intermediate (10-20%), and high (> 20%) risk. [16] The prevalence (% participants) in each risk category was determined. The main outcome measure was the % change in the following variables after 1, 2 or 3 RAHRAs (GR1, GR2 and GR3): 1) the 10-year risk for CVD (non-laboratory based FRS and Framingham risk category) [17] and 2) the prevalence of eight NCD risk factors.

Changes in prevalence of NCD risk factors

Based on the HRA measurements, the change in prevalence of NCD risk factors (% of participants) is reported. The NCD risk factors were defined as shown in Table 1.

Statistical analysis

Statistical analysis was completed using StataSE15 (StataCorp, TX, USA). Risk factor data was categorised as described in Table 1. Results were presented as means, 95% confidence interval (CI) or standard deviation. The difference between a participant's end point value and the baseline value were used to assess change. Group difference were assessed by comparing the change between the last HRAs (2nd, 3rd or 4th) from baseline (1st HRA). Results were obtained by logistic regression for each outcome, adjusted for baseline age and gender. Significance was assessed at $p<0.01$ to account for multiple testing.

The 10-year Framingham risk score (FRS) was calculated using the non-laboratory formula.[12] Smoking status reported in the year 2017 was used as the baseline as it was not captured in 2016. Physical activity and fruit and vegetable intake were not captured for all the participants. The baseline of GR1 and 2 were not necessarily in the first year (2016), therefore as a "sensitivity" analyses, a subgroup was identified with those having their baseline in 2016 and their endpoint in 2019. As a control group, those with only one assessment in 2016 (n=4947) was used and compared against the endpoint values in 2019 of GR1 (n=986), GR2 (n=1428) and GR3 (n=1197). These results are presented in Appendix A.

Ethical considerations

Ethics approval for the study was obtained from the Research Ethics Committee of the Faculty of Health Sciences of the University of Pretoria (REC numbers 754/2018). In addition, the private health insurer provided permission for use of the data and all participants were deidentified to ensure confidentially.

RESULTS

Demographics of the study participants

Study participants who completed the baseline plus one to three RAHRAs between 2016 and 2019 are described by sex and age group in Table 2. Complete results for these three tables are in Appendix B.

Table 2: Demographics of the study participants (for sex and age groups) by AHRA frequency 2016 – 2019

	All employees	Employees completing only a baseline AHRA	Study participants (n=13737)		
			GR1 (Study participants completed baseline and 1 RAHRA)	GR2 (Study participants completed baseline and 2 RAHRAs)	GR3 (Study participants completed baseline and 3 RAHRAs)
All (N)	36074	22337	8687	3853	1197
Males, N (%)	12134 (33.6)	7809 (35.0)	2804 (32.3)	1139 (29.6)	382 (31.9)
Females, N (%)	23940 (66.4)	14528 (65.0)	5883 (67.7)	2714 (70.4)	815 (68.1)
Mean Age (SD), years	38.1 (10.0)	38.0 (10.0)	38.0 (10.1)	38.7 (9.9)	40.0 (10.0)
Females, Mean Age (SD), years	38.3 (10.1)	38.2 (10.1)	38.3 (10.1)	38.7 (10.1)	40.7 (10.2)
Males, Mean Age (SD), years	37.7 (9.8)	37.6 (9.8)	37.6 (10.0)	38.5 (9.4)	38.4 (9.4)

Of the 13737 study participants, 8687 (63.2%), 3853 (28.0%) and 1197 (8.7%) completed two, three or four RAHRAs respectively between 2016 and 2019 (Groups 1 to 3). More than two thirds of the group completing 1 (67.7%), 2 (70.4%) or 3 (68.1%) RAHRAs were females.

The ratio for females: males was highest for GR2 (2.38) and lower for GR1(2.10) and 3 (2.13). There were significantly more females than males only between GR1 and GR2 (p=0.003), with no significance between GR1 and GR3 (p= 0.800) and between GR2 and GR3 (p= 0.121).

The mean age for all three groups was 38 years or older, with GR3 being older than GR1 and GR2 (P<0.01).

Changes in the prevalence (%) of the Framingham risk score (FRS) and Framingham risk category

Table 3 reflects the mean FRS and the proportion of employees in each of the FRS categories between baseline and RHRA.

Table 3: The Framingham Risk Score (mean, 95%CI) and Framingham risk categories (%, 95%CI) and the changes in the FRS and FRS categories at RAHRAs.

	GR1			GR2			GR3			Differences of changes between groups p values		
	Baseline n=8687	**2nd HRA n=8687**	**Change 2nd baseline**	**Baseline n=3853**	**3rd HRA n=3853**	**Change 3rd baseline**	**Baseline n=1197**	**4th HRA n=1197**	**Change 4th baseline**			
	Mean/% (95% CI)	**Mean/% (95% CI)**	**Mean/% (95% CI)**	**Mean/% (95% CI)**	**Mean/% (95% CI)**	**Mean/% (95% CI)**	**Mean/% (95% CI)**	**Mean/% (95% CI)**	**Mean/% (95% CI)**	**GR1 vs GR2**	**GR1 vs GR3**	**GR2 vs GR3**
			p values			**p values**			**p values**			
Framingham Risk Score	4.5 (4.4,4.6)	4.9 (4.8,5.0)	0.4 (0.4,0.5)	4.5 (4.3,4.7)	5.2 (5,5.4)	0.7 (0.6,0.7)	4.9 (4.6,5.2)	5.7 (5.4,6.0)	0.8 (0.7,1.0)	**<0.001**	**<0.001**	**0.0355**
			<0.001			**<0.001**			**<0.001**			
Low risk (< 10%)	89.5 (88.9,90.1)	88.1 (87.4,88.8)	-1.4 (-1.9, -0.9)	89.3 (88.3,90.3)	87.0 (85.9,88.0)	-2.3 (-3.1, -1.6)	88.1 (86.1,89.8)	85 (82.8,86.9)	-3.1 (-4.4, -1.8)	0.042	0.019	0.323
			0.042			**0.019**			0.323			
Intermediate risk (10-20%)	7.6 (7.0,8.1)	8.8 (8.2,9.4)	1.2 (0.7,1.8)	7.9 (7.1,8.8)	10.1 (9.2,11.1)	2.2 (1.5,3.1)	9.4 (7.8,11.1)	12.4 (10.6,14.4)	3.0 (1.5,4.5)	**0.036**	**0.027**	0.403
			0.036			**0.027**			0.403			
High risk (> 20%)	2.9 (2.6,3.3)	3.1 (2.8,3.5)	0.2 (-0.1,0.5)	2.8 (2.3,3.4)	2.9 (2.4,3.4)	0.1 (-0.4,0.5)	2.6 (1.8,3.7)	2.7 (1.9,3.8)	0.1 (-0.7,0.9)	0.561	0.771	0.945
			0.561			0.771			0.945			

There was a significant increase in mean FRS as the number of RAHRAs increased: GR1 (0.4% increase; p<0.001), GR2 (0.7% increase; p<0.001), and GR3 (0.8% increase; p<0.001). This % increase was significantly higher for GR3 compared to GR1 (p<0.001) and GR2 (pairwise p<0.0355). The increase or decrease for the three groups were not significantly different for the FRS risk categories (p≥0.01).

As the number of RAHRAs increased (from GR1 to GR3), the % participants classified as low (< 10%), intermediate (10-20%), and high (> 20%) risk changed. There was a general decrease in the % participants in the low risk category as the number of HRAs increased. The % participants in the intermediate risk category generally increased as the number of HRAs increased and this was significant for GR1 (1.2%; p=0.036) and GR2 (2.2%; p=0.027). There was no significant change in the % participants in the high risk category as the number of HRAs increased.

Changes in *prevalence (%) of NCD risk factors as number of RAHRAs increased (from GR1 to GR3)*

The % changes in the prevalence of NCD risk factors in the participants that underwent RAHRAs (Groups 1 to 3) is illustrated in Tables 4a, 4b and 4c.

Table 4a: Change in prevalence (%) of NCD risk factors in GR1 (2 HRAs: baseline and 1 RAHRA; n=8687)

NCD Risk factor	Baseline	2nd HRA		
	% (95% CI)	% (95% CI)	% change (95% CI)	p-value
Smoker	n=5029	n=8687		
Yes	19.3 (18.2,20.4)	17.5 (16.8,18.4)	-1.8% (-2.5 to -1.2)	<0.001
Insufficient physical activity	n=4407	n=4656		
< 150 minutes per week	76.5 (75.3,77.8)	75.8 (74.6,77.0)	-1.0% (-2.5 to 0.5)	0.183
Inadequate fruit and vegetable intake	n=4162	n=4656		
< 5 servings of fruit and vegetable per day	88.8 (87.8,89.7)	94.8 (94.1,95.4)	5.4% (4.1 to 6.6)	<0.001
Overweight	n=8687	n=8687		
	65.2 (64.2,66.2)	68.3 (67.3,69.3)	3.1% (2.5 to 3.8)	<0.001
Hypertension	n=8687	n=8687		
BP ≥ 140/90 or Medication	18.7 (17.9,19.5)	19.3 (18.5,20.1)	0.6% (-0.3 to 1.5)	0.194
Central obesity	n=8687	n=8687		
High waist circumference (Men >102 cm, Women >88cm)	36.8 (35.8,37.8)	40.6 (39.6,41.7)	3.9% (3.1 to 4.7)	<0.001
Hypercholesterolemia	n=8687	n=8687		
High (>5.2 mmol/L)	22.5 (21.6,23.3)	18.0 (17.3,18.9)	-4.4% (-5.4 to -3.4)	<0.001
Diabetes mellitus	n=8687	n=8687		
Raised Blood Glucose (≥ 6.4 mmol/l)	19.0 (18.2,19.8)	19.9 (19.1,20.7)	0.9% (-0.2 to 2.0)	0.105

There was no significant change in prevalence of the following risk factors after one RAHRA: insufficient physical activity, raised blood glucose and hypertension ($p \geq 0.01$). After one RAHRA, there was a significant increase in the prevalence (poorer outcome) of inadequate daily fruit and vegetable intake (5.4%, $p<0.001$), overweight (3.1%; $p<0.001$) and central obesity (3.9%; $p<0.001$). One RAHRA was associated with a significantly reduced prevalence (improved outcome) of smoking (1.8%, $p<0.001$) and hypercholesterolemia (4.4%; <0.001).

Table 4b: Change in prevalence (%) of NCD risk factors in GR2 (3 HRAs: baseline and 2 RAHRAs: n=3853)

NCD Risk factor	Baseline	3rd HRA		
	% (95% CI)	% (95% CI)	% change (95% CI)	p-value
Smoker	n=1190	n=3853		
Yes	17.4 (15.3,19.7)	15.1 (14.0,16.3)	-1.9% (-2.9 to 0.9)	<0.001
Insufficient physical Activity	n=1870	n=2131		
< 150 minutes per week	74 (72.0,75.9)	73.6 (71.7,75.5)	-1.9% (-4.2 to 0.3)	0.091
Inadequate fruit and vegetable intake	n=1791	n=2081		
< 5 servings of fruit and vegetable per day	82.6 (80.8,84.3)	93.7 (92.5,94.6)	9.8% (8 to 11.7)	<0.001
Overweight	n=3853	n=3853		
BMI ≥ 25 kg/m^2	63.7 (62.2,65.2)	68.8 (67.3,70.2)	5.1% (4.1 to 6.1)	<0.001
Hypertension	n=3853	n=3853		
BP ≥ 140/90 or Medication	17.3 (16.1,18.5)	19.1 (17.9,20.4)	1.8% (0.4 to 3.3)	0.01
Central obesity	n=3853	n=3853		
High waist circumference (Men >102 cm, Women >88cm)	35.8 (34.3,37.3)	41.9 (40.4,43.5)	6.1% (4.9 to 7.3)	<0.001
Hypercholesterolemia	n=3853	n=3853		
High (>5.2 mmol/L)	24.2 (22.9,25.6)	17.8 (16.6,19.0)	-6.4% (-7.9 to -5.0)	<0.001
Diabetes mellitus	n=3853	n=3853		
Raised Blood Glucose (≥ 6.4 mmol/l)	18.1 (16.9,19.4)	21.2 (20.0,22.6)	3.1% (1.5 to 4.7)	<0.001

There was no significant change in the prevalence of insufficient physical activity in participants who completed two RAHRAs (p≥0.01). Two RAHRAs were associated with a significantly increased prevalence (poorer outcome) in several NCD risk factors including inadequate daily fruit and vegetable intake (9.8%; p<0.001), overweight (5.1%; p<0.001), hypertension (1.8%, p=0.01), central obesity (6.1%; p<0.001) and diabetes mellitus (3.1%, p<0.001). Two RAHRAs were associated with a reduced prevalence of smoking (1.9%, p<0.001) and hypercholesterolemia (6.4%; <0.001) significantly reduced (improved outcome).

Table 4c: Change in prevalence (%) of NCD risk factors in GR3 (4 HRAs: baseline and 3 RAHRAs: n=1197)

NCD risk factor	Baseline	4th HRA		
	% (95% CI)	% (95% CI)	% change (95% CI)	p-value
Smoker	n=1197	n=1197		
Yes	18.1 (16.0,20.4)	15.7 (13.8,17.9)	-2.4% (-4 to -0.8)	0.003
Insufficient physical activity	n=684	n=777		
< 150 minutes per week	72.8 (69.3,76.0)	68.7 (65.4,71.9)	-4.8% (-8.5 to -1.2)	0.009
Inadequate fruit and vegetable intake	n=667	n=767		
< 5 servings of fruit and vegetable per day	72.7 (69.2,76.0)	90 (87.6,91.9)	15.8% (12.8 to 18.8)	<0.001
Overweight	n=1197	n=1197		
BMI ≥ 25 kg/m^2	60.8 (58.0,63.5)	66.8 (64.0,69.4)	5.9% (4.2 to 7.7)	<0.001
Hypertension	n=1197	n=1197		
BP ≥ 140/90 or Medication	17.1 (15.1,19.4)	18.4 (16.3,20.7)	1.3% (-1.3 to 3.8)	0.331
Central obesity	n=1197	n=1197		
High waist circumference (Men >102 cm, Women >88cm)	32.6 (30.0,35.3)	38.8 (36.1,41.6)	6.3% (4.1 to 8.5)	<0.001
Hypercholesterolemia	n=1197	n=1197		
High (>5.2 mmol/L)	26.6 (24.1,29.1)	17.0 (14.9,19.2)	-9.6% (-12.2 to -7.0)	<0.001
Diabetes mellitus	n=1197	n=1197		
Raised Blood Glucose (≥ 6.4 mmol/l)	16.5 (14.5,18.8)	20.0 (17.8,22.3)	3.4% (0.5 to 6.3)	0.020

In participants who completed three RAHRAs, there was no significant change in the prevalence of hypertension and diabetes mellitus (p≥0.01). Three RAHRAs were associated with a decreased prevalence namely smoking (2.4%, p=0.003), insufficient physical activity (4.8%, p =0.009) and hypercholesteremia (9.6%, p<0.001) but an increased prevalence of inadequate fruit and vegetable intake (15.8%, p<0.001), overweight (5.9%, p<0.001) and central obesity (6.3%, p<0.001).

A summary of the changes in the prevalence (%) of NCD risk factors between groups (based on number of RAHRAs) is shown in Table 5.

Table 5: Changes in the prevalence (%) of NCD risk factors between groups (based on number of RAHRAs)

	GR1 % change (95% CI)	GR2 % change (95% CI)	GR3 % change (95% CI)	Differences of changes between groups* p values		
				GR1 vs GR2	GR1 vs GR3	GR2 vs GR3
Smoker	-1.8% (-2.5 to -1.2)	-1.9% (-2.9 to 0.9)	-2.4% (-4.0 to -0.8)	0.942	0.512	0.577
Insufficient Physical activity	-1.0% (-2.5 to 0.5)	-1.9% (-4.2 to 0.3)	-4.8% (-8.5 to -1.2)	0.499	0.057	0.183
Inadequate fruit and vegetable intake	5.4% (4.1 to 6.6)	9.8% (8 to 11.7)	15.8% (12.8 to 18.8)	<0.001	<0.001	<0.001
Overweight	3.1% (2.5 to 3.8)	5.1% (4.1 to 6.1)	5.9% (4.2 to 7.7)	0.001	0.003	0.406
Hypertension	0.6% (-0.3 to 1.5)	1.8% (0.4 to 3.3)	1.3% (-1.3 to 3.8)	0.157	0.646	0.689
Central obesity	3.9% (3.1 to 4.7)	6.1% (4.9 to 7.3)	6.3% (4.1 to 8.5)	0.003	0.044	0.912
Hypercholesterolemia	-4.4% (-5.4 to -3.4)	-6.4% (-7.9 to -5.0)	-9.6% (-12.2 to -7.0)	0.023	<0.001	0.038
Diabetes mellitus	0.9% (-0.2 to 2.0)	3.1% (1.5 to 4.7)	3.4% (0.5 to 6.3)	0.024	0.106	0.854

*adjusted for age and gender

The number of RAHRAs did not significantly change the prevalence of the following risk factors: smoking (GR3: -2.4%; GR2: -1.9%; GR1: -1.8%, p≥0.01), insufficient physical activity (GR3: -4.8%; GR2: -1.9%; GR1: -1.0%, p≥0.01), hypertension (GR3: 1.3%; GR2: 1.8%; GR1: 0.6%, p≥0.01), and diabetes mellitus (GR3: 3.4%; GR2: 3.1%; GR1: 0.9%, p≥0.01). A greater number of RAHRAs was associated with a significant increase in inadequate fruit and vegetable intake (GR3: 15.8%; GR2: 9.8%; GR1: 5.4%; all pairwise p<0.001). The prevalence of overweight increased significantly more in employees who completed three RAHRAs compared to the group who completed two RAHRAs (GR3: 5.9%; GR1: 3.1%; pairwise p<0.003). Similarly, the prevalence of overweight increased significantly more for the group of employees who completed three RAHRAs compared to the group who completed two RAHRAs (GR2: 5.1%; GR1: 3.1%; pairwise p<0.001). The prevalence of hypercholesterolemia decreased more for the group of employees who completed three RAHRAs (GR3; -9.6%) compared to the group who completed one RAHRA (GR1; -4.4%; pairwise p<0.001).

Employees who completed three RAHRAs (GR3) had a significant higher inadequate fruit and vegetable intake compared to one RAHRA (GR1: p<0.001) or two RAHRAs (GR2: p<0.001). The prevalence of overweight increased significantly more for employees who completed two RAHRAs compared to the group who completed one RAHRA (GR2: 5.1%, GR1: 3.1%, pairwise p <0.001). Also, overweight prevalence increased significantly in employees who completed three RAHRAs compared to those for completed one RAHRAs (GR3: 5.9%, GR1:3.1%, pairwise p <0.001). The prevalence of central obesity was significantly higher only for the group of employees who completed two RAHRAs (GR2, 6.1%) as compared to one RAHRA (GR1, 3.9%; p=0.003). The prevalence of hypercholesterolaemia was significantly lower in the employees who underwent three RAHRAs (GR3), compared to two RAHRAs (GR2) or 1 RAHRA (GR1) (p<0.001).

DISCUSSION

The main finding of the study was that repeat annual health risk assessments (RAHRAs), coupled with an intervention, over a 4-year period did not result in a reduction, but rather an increase, in the mean FRS (10-year CVD risk) in financial sector employees. RAHRAs were associated with poorer outcomes for the following individual NCD risk factors: inadequate fruit and vegetable intake and overweight. The prevalence of smoking, hypertension, insufficient physical activity, and diabetes mellitus was not altered by RAHRAs. A reduction in the prevalence of hypercholesterolaemia was the only individual NCD risk factor that improved significantly with multiple RAHRAs.

Our first main finding on the effect of RAHRAs on the FRS has been investigated in two other studies. A significant 2% increase in mean FRS (from 15.5% to 17.5%, p < 0.001) was reported amongst participants from the general population residing in Norfolk, England (mean age: 58.0±8.9

yrs). [20] This increase between the baseline and second HRA, completed after 4-years, was observed following no intervention. [20] The increase in mean FRS was largely attributed to an increase in age of the study population. Notably, high risk participants were excluded from the study.[20] In the second study of 133 high risk employees (mean age 46.8±8.6 yrs) from the Vanderbilt University in America, HRA coupled with a 12 month disease management program focusing on nutrition, physical activity, stress management or smoking cessation resulted in a significant decrease in mean FRS after a RHRA one year later.[21] It was suggested that improved behavioural lifestyle, particularly an increase in physical activity, was responsible for the decreased mean FRS observed. [21] In our study, we show that RAHRAs were associated with an increase rather than a decrease in the mean FRS, which is a similar finding from the study in Norfolk (England), but different to that among high risk employees from Vanderbilt University. Methodological considerations may explain the differences observed. Firstly, participants in the Vanderbilt University study were classified as high risk whilst high risk participants were excluded in the Norfolk study. In our study, "high risk" participants were referred to a medical practitioner for management. Secondly, and probably most importantly, there are differences in the type of interventions offered. The university employees were offered a free workplace health promotional program that included access to the fitness centre and behavioural lifestyle workshops (nutrition, physical activity, smoking cessation, and weight management) for 12 months. In our study and that of Norfolk (England), participants were not offered free workplace health promotional programs between the baseline and RHRA over four years. These differences highlight the need to conduct further research to determine the efficacy of workplace interventions following RAHRAs.

Our second main finding is that we report a variable outcome for individual NCD risk factors after RHRAs with an intervention. Variable outcomes in individual NCD risk factors were also reported in two other studies. In the first study among employees who completed a second HRA after 4 years, but with no intervention between HRAs, the prevalence of insufficient physical activity, cholesterol, and smoking status decreased, whilst the prevalence of overweight and diabetes mellitus increased. [20] In one other retrospective three-year study among American university employees (n=500), three repeat HRAs without intervention improved systolic and diastolic blood pressure, total cholesterol, high-density lipoprotein, low-density lipoprotein, and triglycerides but there were no changes in body weight and glucose. [10] We specifically note that in both these studies, [10,20] there were no improvements in two specific NCD risk factors following RAHRA's – overweight / body weight and blood sugar / diabetes mellitus. In our study, we show that the prevalence of being overweight and inadequate fruit and vegetable intake significantly increased (poorer outcomes) despite RAHRA's – diabetes mellitus and raised blood sugar did not change and only hypercholesteremia decreased (improved outcome). Again, there are methodological differences between our study and the other two studies. Specifically, in the two other studies participants received a financial incentive for the

completion of a RHRA, and this may have contributed to the improvement of some individual NCD risk factors. Financial incentives are known to be effective in improving health outcomes and health related behaviours.[25]

Although our study was not designed to explore the precise reasons for a poorer outcome in the FRS and the majority of individual NCD risk factors despite RAHRA observation, we suggest that this finding may be due to several factors, specifically related to the intervention. Firstly, detailed RAHRA feedback was not provided on the overall health profile of each participant but rather on selected individual risk factors. The overall health, using a wellness score, was used for the generation of the RAHRA health profile report that was subsequently emailed to the employees. Incorporating overall health in RAHRA feedback using wellness scores such as the FRS is an effective tool to encourage and motivating employees to adopt healthy lifestyle behaviours and to manage future medical claims costs.[23] Secondly, only employees with specific diagnosed conditions such as hypercholesterolaemia, hypertension and raised blood glucose were identified as "increased" or "high" risk for NCDs and these participants were referred to medical practitioners for further management. Individuals with other lifestyle risk factors such as smoking, overweight/obesity and central obesity, but with no diagnosed condition, were not identified for the enrolment of the disease management programme despite there being a strong correlation between lifestyle risk factors and NCDs. [24] Finally, once referred, the intervention focused mainly on drug therapy rather than including other lifestyle interventions. Drug therapy with lifestyle intervention is known to significantly improve the 10-year CVD risk in high risk individuals. [22]

To improve outcomes following RAHRAs among financial sector employees, alternative assessment and intervention strategies should be considered. The use of wearable technologies, including smartphone applications and wearable sensors to improve disease management programs should be explored. Workplace health promotional programmes delivered via social media platforms such as Facebook and twitter may present and opportunity to reach and engage employees with risk factors for NCDs on an ongoing basis to modify their lifestyle behaviours. Employees receiving financial incentives (voucher or cash payment), [26] may contribute to the improvement of individual NCD risk factors and adoption of healthy lifestyles for those completing RAHR. [27] These recommendations may result in a comprehensive, multifaceted, and integrated intervention programme administered by the health insurer but designed collaboratively with the employer groups which could prevent and manage NCDs prevalence amongst financial sector employees.

STRENGTHS AND LIMITATIONS

A key strength of this study is that RAHRAs, coupled with an intervention, were conducted over multiple years amongst a large sample of financial sector employees. In addition, standardised measurement protocols were used over the four year study period which allows for direct comparisons of the NCD risk outcomes. Our study has limitations. Firstly, a low proportion of employees participated between the first and fourth visit at which risk factor measurements were done and, because participation in the program was voluntary, there may be selection bias. Secondly, some of the smoking information was missing in 2016, which required imputation. Such biases were overcome using methods such as multiple imputation that allowed individuals with incomplete data to be included in analyses. [28] Thirdly, we had limited data on the employees who participated in the intervention i.e., the disease management programme after completing the HRA. Therefore, we cannot rule out that the non-significant improvements may have been due to the lack of participation in the intervention. Fourthly, the baseline means/percentages for some of the outcome variables in the 3 groups differed and therefore regression to the mean could possibly have caused the bigger changes in some of the groups compared to other groups. Fifthly, while the testers were trained, qualified health professionals who underwent annual training on the measurement protocols and used the same calibrated equipment to minimise errors, measurement inaccuracies cannot be discounted Lastly, for this study we did not collect employee's socioeconomic status data (level of education, occupation, and income) and diabetes type information (Type 1 and Type 2). The data may have provided valuable insights in determining influence of socioeconomic status on NCD risk factors over time and establish the association of type 2 diabetes and lifestyle risk factors among South African financial sector employees. This data may have provided valuable insight in determining influence of socioeconomic status on NCD risk factors over time among South African financial sector employees.

SUMMARY AND RECOMMENDATIONS

Considering the escalating burden of NCD risk factors observed among financial sector employees, implementation of effective screening and intervention programmes is required to change unhealthy lifestyle habits. Our results suggest that the current practice in many institutions and corporates to conduct and RAHRAs (with an intervention) may not achieve the desired effect of reducing all NCD risk factors. We suggest that the strategy of RAHRAs, the design and implementation of subsequent interventions be revisited. Greater efforts should be made to develop and implement innovative strategies that are cost effective and accessible to reduce the risk for NCD diseases in the working population.

REFERENCES

1. World Health Organisation. Global status report on noncommunicable diseases 2014. Noncommunicable diseases and mental health; 2014. Available from: http://www.who.int/nmh/publications/ncd-status-report-2014/en/ accessed 11 December 2020
2. Pullar J, Allen L, Townsend N, Williams J, Foster C, Roberts N, Rayner M, Mikkelsen B, Branca F, Wickramasinghe K. The impact of poverty reduction and development interventions on non-communicable diseases and their behavioural risk factors in low and lower-middle income countries: a systematic review. PLoS One. 2018 Feb 23;13(2): e0193378.
3. Gyasi RM, Phillips DR. Aging and the rising burden of noncommunicable diseases in sub-Saharan Africa and other Low-and Middle-Income Countries: A Call for holistic action. The Gerontologist. 2020 Jul 15;60(5):806-11.
4. Statistics South Africa. Mortality and causes of death in South Africa, 2015: Findings from death notification. http://www.statssa.gov.za/publications/P03093/P030932015.pdf. accessed 19 June 2018
5. Ezzati M, Pearson-Stuttard J, Bennett JE, Mathers CD. Acting on non-communicable diseases in low-and middle-income tropical countries. Nature. 2018 Jul;559(7715):507-16.
6. Bhargava A. A longitudinal analysis of the risk factors for diabetes and coronary heart disease in the Framingham Offspring Study. Population health metrics. 2003 Dec 1;1(1):3.
7. Milner K, da Silva R, Patel D, Salau S. How do we measure up? A comparison of lifestyle-related health risk factors among sampled employees in South African and UK companies. Global health promotion. 2018 Mar;25(1):73-81.
8. Kolbe-Alexander TL, Lambert EV. Non-communicable disease prevention and worksite health promotion programs: a brief review. Occupational Medicine and Health Affairs. 2013 Nov 27;1(7):1
9. Shi Y, Sears LE, Coberley CR, Pope JE. The association between modifiable well-being risks and productivity: a longitudinal study in pooled employer sample. Journal of occupational and environmental medicine. 2013 Apr 1;55(4):353-64.

10. Sieck, C. J., & Dembe, A. E. (2014). A 3-year assessment of the effects of a self-administered health risk assessment on health care utilization, costs, and health risks. Journal of occupational and environmental medicine, 56(12), 1284-1290.
11. Pai, C. W., Hagen, S. E., Bender, J., Shoemaker, D., & Edington, D. W. (2009). Effect of health risk appraisal frequency on change in health status. Journal of occupational and environmental medicine, 51(4), 429-434.
12. Kolbe-Alexander TL, Buckmaster C, Nossel C, Dreyer L, Bull F, Noakes TD, Lambert EV. Chronic disease risk factors, healthy days and medical claims in South African employees presenting for health risk screening. BMC Public Health. 2008 Dec 1;8(1):228.
13. American College of Sports Medicine (ACSM). ACSM's Guidelines for Exercise Testing and Prescription. 9th ed. Philadelphia: Lippincott, Williams & Wilkins. 2013
14. Warnick GR, Leary ET, Ammirati EB, Allen MP. Cholesterol in fingerstick capillary specimens can be equivalent to conventional venous measurements. Arch Pathol Lab Med. 1994;118(11):1110-1114.
15. D'Agostino RB, Grundy S, Sullivan LM, Wilson P. Validation of the Framingham coronary heart disease prediction scores: results of a multiple ethnic groups investigation. Jama. 2001 Jul 11;286(2):180-7.
16. Ford ES, Giles WH, Mokdad AH. The distribution of 10-year risk for coronary heart disease among US adults: findings from the National Health and Nutrition Examination Survey III. Journal of the American College of Cardiology. 2004 May 19;43(10):1791-6.
17. Gaziano TA, Young CR, Fitzmaurice G, Atwood S, Gaziano JM. Laboratory-based versus non-laboratory-based method for assessment of cardiovascular disease risk: the NHANES I Follow-up Study cohort. The Lancet. 2008 Mar 15;371(9616):923-31.
18. Cook A, Roberts K, O'Leary F, Allman-Farinelli MA. Comparison of single questions and brief questionnaire with longer validated food frequency questionnaire to assess adequate fruit and vegetable intake. Nutrition. 2015 Jul 1;31(7-8):941-7.

19. Seedat YK, Croasdale MA, Milne FJ, et al. Guideline Committee, Southern African Hypertension Society; Directorate: Chronic Diseases, Disabilities and Geriatrics, National Department of Health. South African hypertension guideline 2006. S Afr Med J. 2006; 96:337–362
20. Chamnan P, Simmons RK, Sharp SJ, Khaw KT, Wareham NJ, Griffin SJ. Repeat cardiovascular risk assessment after four years: Is there improvement in risk prediction?. PloS one. 2016 Feb 19;11(2):e0147417.
21. Maron DJ, Forbes BL, Groves JR, Dietrich MS, Sells P, DiGenio AG. Health-risk appraisal with or without disease management for worksite cardiovascular risk reduction. Journal of Cardiovascular Nursing. 2008 Nov 1;23(6):513-8.
22. Lönnberg L, Ekblom-Bak E, Damberg M. Reduced 10-year risk of developing cardiovascular disease after participating in a lifestyle programme in primary care. Upsala journal of medical sciences. 2020 Jul 2;125(3):250-6.
23. Yen L, McDonald T, Hirschland D, Edington DW. Association between wellness score from a health risk appraisal and prospective medical claims costs. Journal of occupational and environmental medicine. 2003 Oct 1;45(10):1049-57.
24. LeFevre ML. Behavioral counseling to promote a healthful diet and physical activity for cardiovascular disease prevention in adults with cardiovascular risk factors: US Preventive Services Task Force Recommendation Statement. Annals of internal medicine. 2014 Oct 21;161(8):587-93.
25. Mantzari E, Vogt F, Shemilt I, Wei Y, Higgins JP, Marteau TM. Personal financial incentives for changing habitual health-related behaviors: a systematic review and meta-analysis. Preventive medicine. 2015 Jun 1;75:75-85.
26. Giles EL, Becker F, Ternent L, Sniehotta FF, McColl E, Adams J. Acceptability of financial incentives for health behaviours: a discrete choice experiment. PLoS One. 2016 Jun 17;11(6):e0157403.
27. Barleen NA, Marzec ML, Boerger NL, Moloney DP, Zimmerman EM, Dobro J. Outcome-based and participation-based wellness incentives: impacts on program participation and achievement of health improvement targets. Journal of occupational and environmental medicine. 2017 Mar;59(3):304.

28. Pedersen A, Mikkelsen E, Cronin-Fenton D, Kristensen N, Pham TM, et al. Missing data and multiple imputation in clinical epidemiological research. Clinical Epidemiology. 2017, 9:157