PHYSICAL ACTIVITY AND MINDFULNESS

A 12-week community-based physical activity and mindfulness intervention: health outcomes and markers of autonomic nervous system function (Sweet Hearts biokinetics pilot study)

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ABSTRACT

The prevalence of non-communicable diseases (NCDs) has reached epidemic proportions in South Africa, coinciding with high levels of sedentary behaviour, urbanisation and stress. The nexus between stress, physical inactivity and non-communicable diseases may be regulated, in part, by changes in the autonomic nervous system (ANS). ANS function may be measured using a proxy of heart rate variability (HRV). Regular physical activity, controlled breathing and stress reduction have been shown to alter HRV. This paper presents preliminary data from a community-based biokinetics physical activity and mindfulness intervention (Sweet Hearts) on HRV. The study's findings demonstrated favourable changes in measures of heart rate variability (HRV) – specifically in the low frequency (LF) spectrum that is associated with baroreflex function. The implications of these changes, in terms of health outcomes, along with efforts at addressing scalability and sustainability of community-based health promotion interventions may be important targets for future study. SAHeart 2019;16:304-308

INTRODUCTION

The South African Stress and Health study (SASH) identified that stress is endemic within the South African population.[(1)] Stress refers to a multitude of factors that disturb an individual's homeostasis and is becoming increasingly prevalent within our modern, industrialised lifestyles. Stress is a complex phenomenon, which is often exacerbated by socio-economic conditions and occupational demands.[(2)]

Traditional approaches to lower rates of NCDs typically address poor nutrition, physical inactivity and various modifiable disease risk factors such as alcohol consumption and cigarette smoking.[(3)] These approaches have faced challenges in reach and scalability, resulting in NCDs disproportionately affecting people in low- and middle-income countries where more than 3 quarters of global NCD deaths – 32 million – occur.[(4)] This statistic speaks to the importance of ongoing research that aims to identify methods of primary prevention for NCDs.[(5)] One such method is ANS modulation and its potential effect on disease.[(6)]

There is evidence that stress may be systemically measured through changes in the functioning of the autonomic nervous system (ANS). Excessive stress, often characterised by increased sympathetic nervous activity (SNA), is associated with increased risk for certain non-communicable diseases (NCDs).[(7,8)] NCDs such as cardiovascular disease are non-infectious, chronic conditions that are typically lifestyle-related.[(9)] Evidence for the link between stress and cardiovascular disease was provided by the INTERHEART study, which demonstrated that the presence of psychosocial stressors is associated with increased risk of acute myocardial infarction in 24 767 people from 52 countries – including South Africa.[(10)]

The present study shares preliminary data relating to changes in these markers after a community-based health promotion intervention, involving physical activity and mindfulness training, along with brief behavioural change counseling.

METHODS

Research Design

In this pilot, participants were enrolled in a 12-week physical activity and mindfulness intervention programme. The study was conducted with approval from the Faculty of Health Science's Human Research Ethics Committee (HREC REF 214:2012), University of Cape Town, South Africa. Participants were assessed at baseline and once more at a 12-week follow-up.

INTERVENTION

A total of 27 exercise sessions, 60 minutes in duration, were conducted over the 12-week intervention. Sessions were held every Monday and Wednesday evening. All sessions were planned and conducted by intern biokineticists completing their final year of practical training and were supervised by 2 qualified biokineticists. Each session was of a moderate intensity (approximately 40% - 59% oxygen uptake reserve) and contained a combination of strength, cardiovascular and flexibility training. Basic equipment such as cones, skipping ropes, elastic resistance bands and medicine balls were used. Sessions took place on an enclosed sports field. Examples of exercises prescribed included push-ups, squats, elastic rows, pelvic bridges, repeat sprints, agility drills, medicine ball throws, and hamstring stretches. Biokineticists were trained in basic life support and a medical doctor was on site or on emergency call.

Brief behavioural counseling[11] was conducted during warm up and cool down periods. This component of the session addressed pertinent lifestyle issues such as physical inactivity, stress reduction, smoking and eating behaviours. Furthermore, participants were taught a method of controlled breathing. This technique involved controlled inspiration and expiration over approximately 10 seconds (6 breaths per minute), corresponding to a breathing rate of ~0.1Hz. Slow and deep breathing at this resonant frequency has been shown to improve baroreflex gain and measures of HRV.[12]

Measurements

The present study's protocol and results have been reported previously.[13] This paper's results will focus solely on the Stroop Task. Participants performed the Stroop cognitive task on a standard PC. The task is designed to elicit a stress response in participants. The increased level of attention during the Stroop Task has been shown to act as an efficient laboratory cardiac stressor.[14] The test in its entirety lasted approximately 15 minutes.[15] Whilst performing the Stroop Task, participant's ECG and respiratory recordings were taken, the methods of which were replicated from Prinsloo, et al. (2011).[16]

Statistics

Statistical analysis using Statistica 12[17] software was conducted. The Shapiro-Wilk normality test was used to evaluate if data were parametric. LF and HF power in the cardiac spectrogram were log-transformed to normalise the data. Inferential statistics (student t-tests) were performed on normally distributed data. HRV and respiration analyses were performed on constant two-minute segments of data. Frequency-domain methods of HRV analysis were preferred to the time-domain methods, as the frequency-domain has greater validity when investigating short-term recordings.[6] A minimum attendance rate of 60% of the physical activity intervention was required for participants to be included in the final analysis. The alpha level was set at $p<0.05$.

RESULTS

Subject characteristics

A total of 25 individuals were initially enrolled in the study with an average attendance of 56% of all group sessions. Of these, 10 female participants made themselves available for post-testing with an average attendance of 72%. Incomplete data for two participants resulted in their exclusion from the HRV and respiratory analysis; hence these results are based upon a total of eight participants (Table 1).

TABLE I: General characteristics of participants.

Variable	Value (n=8)
Age (years)	35.1 ± 13.0
Height (cm)	163.1 ± 5.9
Body Mass Index (kg/m^2)	26.2 ± 23.0
Income Group*	5.6 ± 3.0
Smokers (%)	25%
Medical aid members (%)	75%

Values reported as Mean ± SD.
**Income groups: 1 = No monthly income; 2 = R1 - R2 499; 3 = R2 500 - R4 999; 4 = R5 000 - R7 499; 5 = R7 500 - R9 999; 6 = R10 000 - R15 000; 7 = R15 000 or more.*

TABLE II: Resting and Stroop-specific heart rate variability & respiration changes at baseline and post-intervention.

Variable	Baseline			Post-Intervention			
	Rest	Stroop	Change	Rest	Stroop	Change	p value
STD RR (ms)	38.84 ± 29.13	35.84 ± 24.86	3.00 ± 15.78	37.17 ± 10.98	28.97 ± 13.09	8.20 ± 9.64	0.46
Mean Heart Rate (beats/min)	79.69 ± 16.27	84.05 ± 15.81	−4.35 ± 4.26	76.83 ± 10.87	82.74 ± 9.65	−5.90 ± 7.31	0.54
Log LF (logms)	5.58 ± 0.90	6.00 ± 0.93	−0.41 ± 0.39	6.44 ± 0.96	5.66 ± 1.00	0.78 ± 1.33	0.02
Log HF (logms)	6.34 ± 2.06	5.81 ± 1.99	0.53 ± 1.07	5.82 ± 1.18	5.40 ± 1.55	0.42 ± 0.68	0.8
Log LF + Log HF (logms)	11.92 ± 2.85	11.81 ± 2.87	0.12 ± 1.38	12.26 ± 1.31	11.06 ± 2.27	1.20 ± 1.33	0.11
Respiratory rate (breaths.min^{-1})	12.81 ± 1.65	16.00 ± 3.19	−2.93 ± 3.11	10.31 ± 3.27	17.50 ± 4.27	−7.00 ± 5.02	0.13

Values reported as mean ± SD. Change in variables calculated by subtracting Stroop value from Resting value (i.e. Rest – Stroop).
STD RR = Standard deviation of R-R interval.

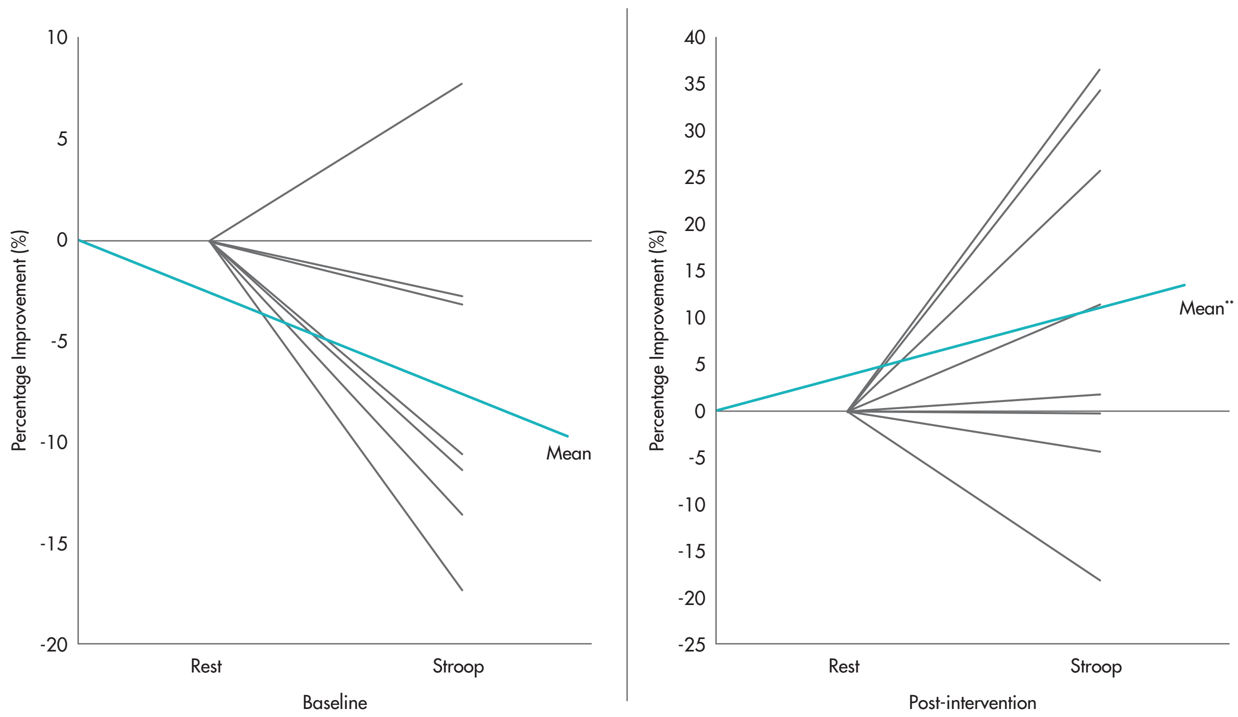

FIGURE 1: Individual percentage improvement (n=8) of low frequency power (logarithmic) from rest to Stroop Task, baseline and post-intervention.

***Denotes significant mean difference between baseline and post-intervention (p≤0.02).*

Variables at baseline were equivalent between those presenting for post-testing versus those who did not; except for a significantly higher resting heart rate (p=0.01) and significantly lower resting breathing rate (p=0.04) in those who could not attend the post-testing session.

Heart rate variability and respiration

At baseline, log LF power increased by 0.41 ± 0.39 logms^2 from rest to the Stroop Task. This significantly (t(7) = 2.9, p=0.02) reversed post-intervention with an overall decrease from rest to Stroop Task, decreasing by 0.78 ± 1.33 logms^2 (Table II & Figure 1).

DISCUSSION

In this study we aimed to document changes in ANS functioning in persons attending a community-based physical activity and mindfulness intervention. Measures of HRV, specifically in the low frequency spectrum, changed significantly post-intervention. An increased level of physical activity may help to modify autonomic balance and hence may be able to partly explain the observed reduction in physiological markers of participant's SNA.[18,19]

Changes in HRV were significant in the LF component of the cardiac spectrogram, which is associated with baroreflex function.[20] At baseline, log LF power increased by 0.41 ± 0.39 logms^2 from rest to the Stroop Task. This significantly reversed post-intervention, with an overall decrease in log LF power from rest to Stroop Task, decreasing by 0.78 ± 1.33 logms^2. The decrease in log LF power at follow-up may reflect more effective stress reactivity (i.e. an increase) to meet the demands of the cognitive task.

It was hypothesised that participants were more relaxed at rest during post-intervention testing. While completing the Stroop Task, participants had a more efficient withdrawal of vagal input, evident through lowered log LF power and increased breathing rates. This response would allow for increased bodily up-regulation and mental concentration required to successfully attend to the Stroop Task.[21] As such, stress reduction techniques adopted during this intervention, such as regular exercise and controlled post-exercise breathing, may have enabled participants to better regulate their autonomic responses.

STUDY LIMITATIONS

Although the study demonstrated favourable results, the inferences that can be made with a small, female only sample and lack of a control group are limited. Despite this limitation, and a small sample size (n=8), the intervention showed measurable changes in participant proxy measures of the ANS ($p \leq 0.05$). It is important to note that this intervention was a pilot study, conducted to facilitate future research.

CONCLUSION

The role of excessive stress and the concomitant rises in sympathetic nervous activity is a significant factor in the increasing prevalence of NCDs. Community-based exercise interventions may result in changes in certain HRV measures that may be associated with better autonomic nervous system regulation.

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