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Physical activity in relation to selected physical health components in employees of a financial institution

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Abstract

The aim of this study was to determine the relation between physical activity and selected physical health components. A total of 9860 employees of a financial institution in South Africa, between the ages 18 and 64 ($\bar{x}$ =35.3 ± 18.6 years), voluntary participated in the study. Health risk factors and physical activity was determined by using the Health Risk Assessment (HRA) and Monitored Health Risk (MHM). Assessment included a physical activity, diabetes risk and cardiovascular risk questionnaire, as well as Body Mass Index (BMI) and random peripheral blood glucose measurements. The majority of the study group show low physical activity participation (78.27%). Both men and women show an increased risk for diabetes, while high physical activity levels have a practically and statistically significant effect on the reduction of diabetes risk. The physical activity (PA) categories for both men and women show an increased average BMI (men = 26.46 kg/m^2 ± 6.18; women = 26.42 kg/m^2 ± 6.18. The mean for cholesterol in all groups were categorised as low risk. The men show higher cardiovascular risk than women. With regard to physical activity and cardiovascular disease risk, all three women groups show statistically significant differences compared to all three men's groups. There are also moderate practically significant differences between the women's and men's groups. Physical activity does not seem to have a significant effect on the cardiovascular disease risk of the women groups. However, regarding the men's groups, the low physically active men's groups show significant differences with the high physically active men group. Thus, it appears that the men participating in high levels of physical activity show the lowest risk for cardiovascular disease and therefore appears to be influenced by physical activity. In conclusion, high physical activity participation reduces the risk for diabetes in both men and women, and reduces the risk for cardiovascular disease in men.

Keywords: Physical activity, health, cardiovascular disease, diabetes, BMI, cholesterol.

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Introduction

In the modern world the prevalence of physical inactivity has increased. In many developed and developing countries, less than one third of the people are active to the extent that it can be beneficial for their health (Hardman & Stensel, 2009). This is mainly due to urbanisation, industrialisation and a Western lifestyle (Steyn, 2006; Puoane, Tsolekile, Sanders & Parker, 2008). In South Africa, 76%

and 86% of adult men and women, respectively do not participate in regular physical activity (SADHS, 2007). This trend of inactivity could have serious negative consequences for health (Sharkey & Glaskill, 2007).

Physical activity has become widely recognised as one of the most important health behaviours associated with reduced all-cause mortality and morbidity, as well as chronic disease related to lifestyle (Lambert & Kolbe-Alexander, 2006); to such an extent that exercise is even referred to as medicine (Pate, 2007). This is not a new concept because, physical activity and physical fitness have been linked with health and longevity since ancient times (Hardman & Stensel, 2009).

Studies have shown that regular physical activity can prevent and reduce the severity of chronic diseases such as hypertension, diabetes, obesity and high cholesterol (ACSM, 2010). These chronic conditions are also risk factors for the development of cardiovascular disease (ACSM, 2010). These chronic diseases are major contributors to the burden of chronic diseases in developed countries and are increasing rapidly in developing countries (Puoane *et al.*, 2008). Even in South Africa, chronic diseases account for more than one-third of all deaths (Kolbe-Alexander *et al.*, 2008). Therefore, it is vital to increase physical activity participation due to the fact that physical activity has been shown to have a meaningful positive impact on health and especially in the reduction of cardiovascular disease and other chronic diseases (Durstine, Peel, Lamonte, Keteyian, Fletcher & Moore, 2009; ACSM, 2010).

The aim of this study was to determine the relation between physical activity and selected health components that include: risk for diabetes, risk for increased cholesterol, risk for being overweight and obese, as well as the risk for cardiovascular disease of employees in a financial institution. Such information can help with the development of health promotion programmes in South Africa.

Methodology

Research design

The study was a cross-sectional observation survey. Participants were part of a non-random availability population who voluntarily participated.

Study population

A total of 9860 (men=3336; women=6524) employees of the same financial institution in South Africa voluntarily participated in the study. Their ages varied between 18-64 years ($\bar{x}$=35.3 ± 10.7).

Measurements

The assessment of selected health risk factors and physical activity was done by using the Health Risk Assessment (HRA) methodology developed by the company (Monitored Health Risk (MHM). It was developed for the medical aid of a financial institution.

Health Risk Assessment (HRA)

Each participant was asked to complete a Health Risk Assessment (HRA)form. The HRA comprised a questionnaire and selected measurements. The questionnaire includes the following; demographic information, history of chronic disease, information on coronary heart disease and associated risk factors as well as information on physical activity participation. Height, weight, random glucose test, random cholesterol tests and blood pressure measurements were taken. The HRA consisted of several sections to determine physical and psychological health. This HRA had been used in previous studies (Labuschagne, 2006; Marais, 2008).

Physical activity level

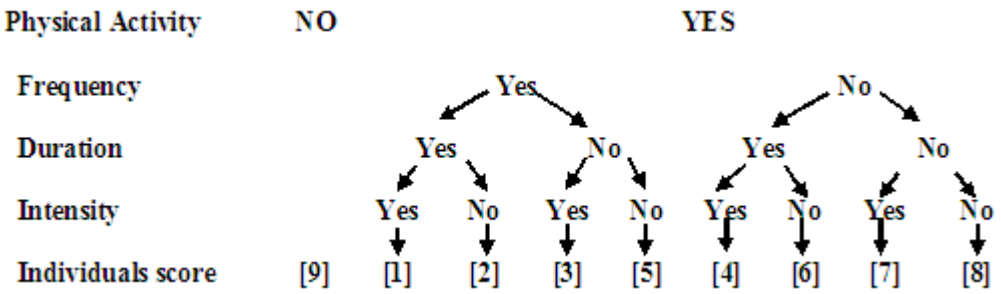
Physical activity levels were determined by using a questionnaire (with a YES/NO option) with the following questions:

- Do you participate in regular physical activity – YES or NO?
    - If the participants answered NO, they received an individual score of 9 for inactivity.
    - If the participant answered YES, questions with regards to frequenscy, duration and intensity were asked.
        - Do you exercise three times or more per week?
        - Does each exercise session last at least 30 minutes?
        - Do you ever exercise at a moderate to vigorous intensity (i.e. at a level that raises a sweat and you are able to talk, but not sing)?

The Monitored Health Risk Management (MHM) (2005) developed an algorithm by which the physical activity level is determined by using the answers derived from the above questions.

An individual score of 1-2 represents high physical activity, 3-4 indicates moderate physical activity, while 5-8 represents low physical activity. For the purpose of this study inactivity (9) was included as low, because low activity does not have the required health benefits.

The algorithm included the following:



Cholesterol

A random peripheral total cholesterol concentration was used to determine diabetic risk. The following classification was used: <5.2 mmol/L: desirable value; 5.2-6.2 mmol/L indicates borderline high and >6.2 mmol/L a high value (ACSM, 2010).

Diabetes risk

Diabetes risk was determined by a score system. The score was given as follows: Age 46-65 = 5 points; Age > 65 = 9 points; Body mass index > 25 = 5 points; Sibling(s) with Diabetes Mellitus = 1 point; Parents with Diabetes Mellitus = 1 point; Physical activity level > 1 = 5 points; Baby weight > 4kg or Gestational diabetes = 1 point and if Random blood glucose > 8 = 10 points. Using these points, the diabetes risk was determined by the following scale: 0-2 indicative of low risk, 2-10 indicative of moderate risk and 11-32 indicate a high risk for Diabetes Mellitus.

Body Mass Index (BMI)

Body Mass Index (BMI) was determined by the following equation: weight (kg)/[height (m)]^2. The ACSM (2010:28) BMI classification was applied: Underweight < 18kg/m^2; Normal 19-24kg/m^2; Overweight 25-29kg/m^2 and Obese >30kg/m^2.

Cardiovascular disease (CVD) risk

Cardiovascular disease risk was determined by the algorithm used by the Monitored Health Risk Management (MHM) (2005). The following factors were used in the calculation of absolute risk: sex, age, total cholesterol, systolic and diastolic blood pressure, diabetes risk and smoking habit. If an individual indicated that he/she received or is currently receiving treatment for the following: heart attack, coronary artery disease (angina), stroke, diabetes,

temporary stroke (TIA), intermittent claudication, or aortic aneurysm, the absolute risk is >20%, which is high risk.

Test procedure

Tests were performed by registered Biokineticists. The Biokineticists received the necessary training and were fully informed of the correct procedures and protocols as specified by Bankmed.

Ethics approval

Ethics approval was granted by Bankmed ethical committee. The ethical application number of the North-West University is NWU.00109-12-S1.

Informed consent

The test procedures were explained to each participant and they were asked to sign a document giving informed consent before the assessment.

Statistical analysis

The CSS: STATISTICA computer software (Statsoft, Inc. 2004) was used for the statistical analysis of the data. A one-way analysis of variance (ANOVA) was computed (Thomas *et al.*, 2011). The 95% level of confidence ($p \leq 0.05$) was applied as the minimum to interpret significant differences among sets of data. Demographic information was determined by frequency variance. One-way analysis of variance statistics was used. The *post hoc* test was applied to determine the significant differences (Thomas *et al.*, 2011). Practical significance was determine by means of Cohen's effect size (ES) calculations (Steyn, 2002)

Results

The study group ranges between the ages of 18 and 64 years ($\bar{x}$: 35.3 ± 10.7 years) individuals, which include 6 524 ($\bar{x}$: 35.1 ± 10.6) women and 3 336 ($\bar{x}$: 35.9 ± 10.9 years) men.

Table 1: Descriptive statistics of variables

Variables	n	$\bar{x}$	SD	Min	Max
Diabetes risk	9860	8.39	4.58	0.00	38.00
Body Mass Index (BMI)	9860	26.42	5.75	14.00	50.00
Total cholesterol	9860	4.41	0.91	2.00	10.00
Physical Activity Index (PAI)	9860	7.19	3.05	1.00	9.00

In this study, 82.41% of the women and 69.79% of the men reported low physical activity participation and 14.27% and 17.39% respectively reported high physical activity participation. The relationships between physical activity and selected health components are shown in Tables 2 - 5.

Table 2: Physical activity index (PAI) and diabetes risk

			Diabetic Risk (N)	
	PAI	**N**	**x̄**	**SD**
Women	Low (a)	4885	8.55 c***++, d***, f***++	3.98
	Moderate (b)	197	8.26 c***+, d**, f***++	4.03
	High (c)	846	5.18 a***++, b***+. d***++, e***++	4.64
Men	Low (d)	2019	9.21 a***, b**. c***++, f***++	4.73
	Moderate (e)	186	9.05 c***++, f***++	4.01
	High (f)	688	4.95 a***++, b***++. d***++, e***++	4.77

*Significant differences and practical significances with groups were indicated under the average means of each group by a group code of that group where the significance appears; Statistical significance (p<0.05) was indicated with a *,* (p<0.01) with ** and (p<0.001) with ***; *Practical significances are indicated as follows: Moderate practical significance + = (ES≥0.5) and highly practical significance ++ = (ES≥0.8).*

Table 3: Physical activity index (PAI) and body mass index (BMI)

			Body mass index (kg/m^2)	
	PAI	**N**	**x̄**	**SD**
Women	**Low (a)**	4885	26.52	6.28
	Moderate (b)	197	25.87	5.43
	High (c)	846	26.30	5.71
Men	**Low (d)**	2019	26.23	5.26
	Moderate (e)	186	25.99	4.26
	High (f)	688	25.89	4.50

*Significant differences and practical significances with groups were indicated under the average means of each group by a group code of that group where the significance appears; Statistical significance (p<0.05) were indicated with a *,* (p<0.01) with ** and (p<0.001) with ***; *Practical significances are indicated as follows: Moderate practical significance + = (ES≥0.5) and highly practical significance ++ = (ES≥0.8).*

Table 4: Physical activity index (PAI) and total cholesterol concentration

			Cholesterol (mmol/L)	
	PAI	**N**	**x̄**	**SD**
Women	**Low (a)**	4885	4.37 d***	0.90
	Moderate (b)	197	4.43	0.88
	High (c)	846	4.36 d***	0.89
Men	**Low (d)**	2019	4.54 a***, c***	0.98
	Moderate (e)	186	4.50	0.89
	High (f)	688	4.45	0.92

*Significant differences and practical significances with groups were indicated under the average means of each group by a group code of that group where the significance appears; Statistical significance (p<0.05) were indicated with a *,* (p<0.01) with ** and (p<0.001) with ***; *Practical significances are indicated as follows: Moderate practical significance + = (ES≥0.5) and highly practical significance ++ = (ES≥0.8).*

Discussion

The findings from this study indicate that the majority of both men and women have a moderate risk of developing diabetes. Studies have shown that this risk for developing diabetes can be reduced by participating in physical activity (Hsia *et al.*, 2005; Borodulin, Tuomilehto, Peltonen, Lakkas, Sundvall & Jousilahti, 2006; ACSM, 2010).

Table 5: Physical activity index (PAI) and Cardiovascular disease risk

			Cardiovascular risk (CVD)	
	PAI	**N**	**x̄**	**SD**
Women	**Low (a)**	4 885	2.67 d***+, e***+, f***	1.84
	Moderate (b)	197	2.65 d***+, e***+, f***	1.79
	High (c)	846	2.75 d***+, e***, f***	1.96
Men	**Low (d)**	2 019	4.63 a***+, b***+, c***+, f**	3.87
	Moderate (e)	186	4.71 a***+, b***+, c***	4.53
	High (f)	688	4.23 a***, b***, c***, d**	3.69

*Significant differences and practical significances with groups were indicated under the average means of each group by a group code of that group where the significance appears; Statistical significance (p<0.05) were indicated with a *,* (p<0.01) with ** and (p<0.001) with ***; *Practical significances are indicated as follows: Moderate practical significance + = (ES≥0.5) and highly practical significance ++ = (ES≥0.8).*

Borodulin *et al*. (2006) stated that higher levels of leisure-time physical activity were associated with decreased levels of fasting insulin and reduced risk of having impaired glucose tolerance and type 2 diabetes, independent of the level of abdominal obesity. According to Hu, Lakka, Kilpeläinen and Tuomilehto (2007), 30 minutes of moderate or high level of physical activity a day, avoiding excessive weight gain and a healthy diet is effective and safe way to prevent type 2 diabetes. In this regard, the results show that there is a significant statistical difference between the average means of the low and moderate physical activity groups with the high physical activity groups of both women and men, but no significant differences are seen between low and moderate physical activity groups (Table 3.2). However, the low and moderate physical activity women and men's groups show a practically significant difference with the high physical activity group of both men and women. Therefore, the results indicated that physical activity does contribute to the reduction of diabetic risk in both men and women groups. Different opinions are apparent in the literature on the optimal intensity of physical activity that is needed to achieve reduction in diabetic risk. Some studies suggested that any physical activity is better than no physical activity (Gill & Cooper, 2008; Brouwer, Van Der Graaf, Soedamah-Muthu, Wassink & Visseren, 2010). According to Brouwer *et al.* (2010), insufficient and sufficient physical activity is likely to improve health in high risk patients, leading to a lower risk of developing type 2 diabetes and new cardiovascular events. Gill and Cooper (2008) conducted a review of the literature and concluded that the majority of studies maintain that there is no clear minimum

threshold of activity that needs to be achieved to be beneficial – any level of activity above baseline appears to be beneficial.

In this study, all the physical activity groups of both men and women show an increased average BMI and therefore are considered to be an increased risk according to the classification stipulated by the study parameters. These increased values in BMI could have certain negative consequences on health and are associated with numerous chronic health conditions such as hypertension, diabetes, cholesterol and cardiovascular disease (Pleuss & Matfin, 2009). Studies have shown that physical activity has been indicated as a way to improve health and is essential in the prevention of overweight and obesity (Waller, Kaprio & Kujala, 2008; Mustelin, Silventoinen, Pietiläinen, Rissanen & Kaprio, 2009; Li *et al.*, 2010). Waller *et al.* (2008) conducted a 30-year follow-up study of habitual physical activity of 146 pairs of twins and found that persistent participation in leisure-time physical activity was associated with a decreased rate of weight gain and with a smaller waist circumference. Studies also indicate that physical activity reduces the influence of genetic factors to develop high BMI and waist circumference (Mustelin *et al*., 2009; Li *et al.,* 2010). As with the prevention of increased BMI, physical activity is an important part of the management and reduction of obesity. Aerobic exercise training increases energy expenditure by the activation of lipolysis and affects the reduction of body weight and body fat percentage (Chaudhary, Kang & Sandhu, 2010). The literature indicated that BMI increases with aging (Meeuwsen, Horgan & Elia, 2010). It is therefore important to implement preventative strategies like physical activity from an early age.

The means for cholesterol in all groups are categorised as low risk. No significant differences are seen between the women groups as well as between the different men's groups (Table 4). It is noted that only a random total cholesterol concentration was obtained in this study, and risk can thus not be ruled out. The average age of the study group is relatively young ($\bar{x}$ = 35.3 years) and therefore one would not expect to find elevated cholesterol levels. Even with favourable blood lipids, it is essential to be aware that regular physical activity has positive, longitudinal effects on plasma lipid levels associated with the risk of cardiovascular disease and can reduce cardiovascular disease (Teramota & Golding, 2009). Several studies indicated the positive effect of physical activity on lipids (Halverstadt, Phares, Wilund, Goldberg & Hagberg, 2007; Teramota & Golding, 2009; Carvalho, Marques, Ascensao, Magalhaes, Marques & Mota, 2010). Kelley and Kelley (2006) indicated that aerobic exercise is efficacious for an increase in HDL-C and decreasing TC, LDL-C and TG in women. According to Kelley and Kelley (2006), aerobic exercise can also increase HDL_2-C independent of changes in body weight. Halverstadt *et al.* (2007) found that a 24-week endurance exercise programme resulted in a significant increase in the HDL subfractions HDL_2-C and HDL_3-C, as well as a significant decrease in TC, TG and LDL-C, independent of diet and baseline and changes in body fat. Carvalho *et al.* (2010) found that after an 8-month exercise programme of

moderate intensity, there is an improvement in blood lipid profile which includes a significant decrease in TG and TC/HDL ratio and a significant increase in HDL-C.

The results show that men have a higher cardiovascular risk than women (Table 5). One should also consider the average age of the men in the study group, as at this stage of their lives, men are more prone to cardiovascular disease than pre-menopausal women (Wilders, 2002). This finding is concurrent with the literature, which indicates that men are more prone to cardiovascular disease (ACSM, 2010). The literature also states that cardiovascular risk can be reduced by participation in physical activity (Sundquist, Ovist, Johansson & Sundquist 2005; Rothenbacher, Koenig & Brenner, 2006). According to Sundquist *et al.* (2005), women and men who participate in physical activity at least twice a week have a 41% lower risk for developing CAD. In this regard, the results show no statistically significant differences between the PA categories of the women, however all three women groups show statistical significant differences with all three men groups. There are also moderate practical significant differences between the women and men groups. Therefore, in this study, physical activity does not seem to have a significant effect on the cardiovascular disease risk of the women groups. However, regarding the men groups, the low physical active men group show significant differences with the high physical active men group. Thus, in this study it appears that the men participating in high levels of physical activity show the lowest risk for cardiovascular disease and therefore appears to be influenced by physical activity. A study by Swain and Franklin (2006) showed that moderate physical activity is beneficial for protection against cardiovascular disease, but indicated that high intensity physical activity appears to convey greater cardio-protective benefits. Therefore, as stated, physical activity is important in the prevention and reduction of cardiovascular disease (Sundquist *et al*., 2005:224; Rothenbacher *et al.*, 2006:1320; ACSM, 2010). An increase in physical activity participation in individuals, who have or are at risk for CAD, can reduce their cardiovascular risk as well as certain risk factors (ACSM, 2010). Due to this cardio-protective effect of physical activity, consequently, physical inactivity or low participation in physical activity has been identified as a major risk factor for the development of cardiovascular disease and the development of certain risk factors for cardiovascular disease, which include hypertension, diabetes, cholesterol and increased BMI (ACSM, 2010; Widmaier, Raff & Strang, 2011). Changing form a sedentary to a more active lifestyle even later in adulthood can strongly decrease CAD risk (Rothenbacher *et al.*, 2006). D'Amore and Samia (2006) stated that 30 minutes of physical activity most days of the week have been associated with a 30-50% reduction in coronary events and coronary mortality.

Conclusion

The finding of this study revealed that majority of the groups participate in low levels of physical activity. Inactivity or low levels of physical activity are considered

a risk factor for the development of cardiovascular diseases (ASCM, 2010). Also, the study group show an increased risk for the development of diabetes and obesity. With regards to physical activity and chronic disease, both men and women that participate in high levels of physical activity, show a decreased risk in diabetes. Men that participate in high levels of physical activity also show a lower risk for the development of cardiovascular disease. No effect was noticed between physical activity and cholesterol or the risk for obesity (increased BMI). It is therefore important to move to a more preventative approach within health promotion. In this regard, intervention strategies should focus on the younger generation (18-28). Further research should include dietary patterns, stress management as well as other risk factors promoting optimal health.

References

American College of Sports Medicine (2010). ACSM's *Guidelines for Exercise Testing and Prescription* (8th ed.). Philadelphia: Lippincott Williams & Wilkins.

Borodulin, K., Tuomilehto, J., Peltonen, M., Lakkas, T.A., Sundvall, J. & Jousilahti, P. (2006). Association of leisure time physical activity and abdominal obesity with fasting serum insulin and 2-h post challenge plasma glucose levels. *Diabetic Medicine*, 23(9), 1025-1028.

Brouwer, B.G., Van Der Graaf, Y., Soedamah-Muthu, S.S., Wassink, A.M.J. & Visseren, F.L.J. (2010). Leisure-time physical activity and risk of type 2 diabetes in patients with established vascular disease of poorly controlled vascular risk factors. *Diabetes Research and Clinical Practice*, 87(3), 372-378.

Carvalho, J., Marques, E., Ascensao, A., Magalhaes, J., Marques, F. & Mota, J. (2010). Multicomponent exercise program improves blood lipid profile and antioxidant capacity in older women. *Archives of Gerontology and Geriatrics*, 51(1), 1-5.

Chaudhary, S., Kang, M.K. & Sandhu, J.S. (2010). The effects of aerobic versus resistance training on cardiovascular fitness in obese sedentary womens. *Asian Journal of Sports Medicine*, 1(4), 177-184.

D'Amore, S. & Mora, S. (2006). Gender-specific prediction of cardiac disease: Importance of risk factors and exercise variables. *Cardiology in Review*, 14(6), 281-285.

Department of Health & Medical Research Council (2007). Demographic and Health Survey 2003. Pretoria: Department of Health. 342p

Durstine, J.L., Peel, J.B., Lamonte, M.J., Keteyian, S.J., Fletcher, E. & Moore, G.E. (2009). Exercise is medicine. *ACSM's Exercise Management for Persons With Chronic Disease and Disabilities* (3rd ed.) (pp. 21-30). Champaign, IL: Human Kinetics.

Gill, J.M.R. & Cooper, A.R. (2008). Physical activity and prevention of type 2 diabetes mellitus. *Sports Medicine*, 38(10), 807-824.

Halverstadt, A., Phares, D.A., Wilund, K.R., Goldberg, A.P. & Hagberg, J.M. (2007). Endurance exercise training raises high-density lipoprotein cholesterol and lowers small low-density lipoprotein and very low-density lipoprotein independent of body fat phenotypes in older men and women. *Metabolism Clinical and Experimental*, 56(4), 444-450.

Hardman, A.E. & Stensel, D.J. (2009*). Physical Activity and Health: The Evidence Explained* (2nd ed.). London: Routledge.

Hsia, J., Wu, L., Allen, C., Oberman, A., Lawson, W.E., Torrens, J., Safford, M., Limacher, M.C. & Howard, B.V. (2005). Physical activity and diabetes risk in postmenopausal women. *American Journal of Preventive Medicine,* 28(1), 19-25.

Hu, G., Lakka, T.A., Kilpeläinen, T.O. & Tuomilehto, J. (2007). Epidemiological studies of exercise in diabetes prevention. *Applied Physiology, Nutrition and Metabolism*, 32(3), 583-595.

Kelley, G.A. & Kelley, K.S. (2006). Aerobic exercise and HDL_2-C: A meta-analysis of radomized controlled trails. *Atherosclerosis*, 184(1), 207-215.

Kodama, S., Tanaka, S., Saito, K., Shu, M., Sone, Y., Onitake, F., Suzuki, E., Shimano, H., Yamamoto, S., Kondo, K., Ohashi, Y. Yamada, N. & Sone, H. (2007). Effect of aerobic exercise training on serum levels of high-density lipoprotein cholesterol. *Archives of Internal Medicine*, 167(10), 999-1008

Kolbe-Alexander, T.L., Buckmaster, C., Nossel, C., Dreyer, L., Bull, F., Noakes, T.D. & Lambert, E.V. (2008). Chronic disease risk factors, healthy days and medical claims in South African employees presenting for health risk screening. *BMC Public Health*, 8, 228-238.

Labuschagne, R. (2006). Enkele gesondheidsaspekte by werknemers aan 'n finansiële instelling. Potchefstroom: Noordwes-Universiteit (M.A. dissertation), Potchefstroom: North-West University.

Lambert, E.V. & Kolbe-Alexander, T. (2006). Physical activity and chronic diseases of lifestyle in South Africa. In K. Steyn, J., Fourie & N. Temple (Eds.), *Chronic Diseases of Lifestyle in South Africa: 1995 - 2005*. Technical Report (pp. 23-32). Cape Town: South African Medical Research Council.

Li, S., Zhao, J.H., Luan, J., Ekelund, U., Luden, R.N., Khaw, K., Wareham, N.J. & Loos, R.J.F. (2010). Physical activity attenuates the genetic predispostion to obesity in 20000 men and women from EPIC-Norfolk prospective population study. *PLOS Medicine*, 7(8), 1-9.

Marais, W. (2008). The impact of physical activity on selected health risk factors and medical costs of employees working within a financial institution (M.A. Dissertation). Potchefstroom: North-West University..

Meeuwsen, S., Horgan, G.W. & Elia, M. (2010). The relationship between BMI and percent body fat, measured by bioelectrical impedance, in a large adult sample in curvilinear an influenced by age and sex. *Clinical Nutrition*, 29(5), 560-566.

Mustelin, L., Silventoinen, K., Pietiläinen, K., Rissanen, A. & Kaprio, J. (2009). Physical activity reduces the influence of genetic effects on BMI and waist circumference: A study in young adult twins. *International Journal of Obesity*, 33(1), 29-36.

Pate, R.R. (2007). Historical perspectives on physical activity, fitness and health. In C. Bouchard, S.N. Blair & W. Haskell (Eds.), *Physical Activity and Health* (pp. 21-36). Champaign, IL: Human Kinetics.

Pleuss, J. & Matfin, G. (2009). Alterations in nutritional status. In C.M. Porth & G. Matfin (Eds.), *Pathophysioloy: Concepts of Altered Health States* (pp. 982-1007). Philadelphia: Lippincott Williams and Wilkins.

Puoane, T., Tsolekile, L., Sanders, D. & Parker, W. (2008). Chronic non-communicable diseases. In P. Barron & J. Roma-Reardon (Eds.), *South African Health Review 2008* (pp. 73-87). Durban: Health Systems Trust.

Rothenbacher, D., Koenig, W. & Brenner, H. (2006). Lifetime physical activity patterns and risk of coronary heart disease. *Heart*, 92(9), 1319-1320.

SADHS *see* Department of Health & Medical Research Council.

Sharkey, B.J. & Gaskill, S.E. (2007). *Health and Fitness* (6th ed.). Champaign, IL: Human Kinetics.

Statistica (2004). *Data Analysis Software, Version 7.* www.statsoft.com. Statsoft Inc *see* Statistica.

Steyn Jr, H.S. (2002). Practical significant relationships between two variables. *South African Journal of Industrial Psychology*, 28(3), 10-15.

Steyn, K. (2006). Conceptual framework for chronic diseases of lifestyle in South Africa. In K. Steyn, J. Fourie & N. Temple (Eds.), *Chronic Diseases of Lifestyle in South Africa: 1995 - 2005*. Technical Report. Cape Town (pp. 1-22). South African Medical Research Council.

Sundquist, K., Ovist, J., Johansson, S. & Sundquist, J. (2005). The long-term effect of physical activity on incidence of coronary heart disease: A 12-year follow-up study. *Preventive Medicine*, 41(1), 219-225.

Swan, D.P. & Franklin, B.A. (2006). Comparison of cardioprotective benefits of vigorous versus moderate intensity aerobic exercise. *American Journal of Cardiology*, 97(1), 141-147.

Teramoto, M. & Golding, L.A. (2009). Regular exercise and plasma lipid levels associated with the risk of coronary health disease: A 20-year longitudinal study. *Research Quarterly for Exercise and Sport*, 80(2),138-145.

Thomas, J.R., Nelson, J.K. & Silverman, S.J. (2011). *Research Methods in Physical Activity* (6th ed.). Champaign, IL: Human Kinetics.

Waller, K., Kaprio, J. & Kujala, U.M. (2008). Association between long-term physical activity, waist circumference and weight gain: a 30-year longitudinal twin study. *International Journal of Obesity*, 32(2), 353-361.

Widmaier, E.P., Raff, H. & Strang, K.T. (2011). *Vander's Human Physiology: The Mechanism of Body Function* (12th ed.). New York: McGraw Hill.

Wilders, C.J. (2002). Fisieke aktiwiteit se verband met leefstyl, gesondheid en geestelike welstand by dames (Thesis – Ph.D). Potchefstroom: PU for CHE.