Optical Device Monitoring in Green

Health Practice Culture among

Working Adults

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1. Introduction

Cardiovascular diseases (CVD) are the leading cause of mortality and disability that challenges human kind in both health and wealth (Beaglehole et al., 2007, Yach D, Hawkes C, Gould CL, Hofman KJ 2004). Cardiovascular diseases are an outcome of the risk factors such as hypertension, diabetes, dyslipidemia, obesity and smoking that directly influence the body fitness and health among adults (Johnson & Wolinsky, 1993; Malmberg et al., 2005; Malmberg J et al., 2002). Lack of physical fitness is the main cause for cardiovascular risk factor development (Katzmarzyk & Janssen, 2004), and regular physical activity significantly contributes in managing the health status (Chodzko-Zaiko et al., 2009). Overcoming the sedentary lifestyle by engaging in sustainable daily physical activity is a practical approach in reducing the risk of developing cardiovascular diseases and postponing premature mortality at any age (Chodzko-Zaiko et al., 2009).

The economic growth in Malaysia has been linked to ongoing lifestyle changes of urbanization including improper diets and reduced physical activity especially among young adults (Olayinka et al., 2015; Adediran et al., 2012; Okeahialam et al., 2012; Catrine et al., 2011) Urbanization in Malaysia vastly adopting modern life styles and preference for office related and modern jobs such as computer scientist, data analyst and many others (WHO infobase 2004; Olayinka, 2004; Adediran, 2012). Even though there are many different types of health management program and activities initiated by both government and NGO’s, there are very limited responses from the public. The two main obstacles commonly highlighted by the public are the time factor and the effective health performance outcome measurement techniques. Many different approaches have been adopted by both healthcare providers and researchers from various fields in identifying the best exercising method for the working adults. Walking which has been a part of our daily life converted into a workout is one of the inexpensive and easily adopted methods proposed for working adults.

Setting a baseline is an important aspect of walking being a workout, as such by starting to walk three times a week at a stroll for 20 minutes suggested by Courtenay Schurman, author of The Outdoor Athlete book. As an outcome of the challenges in monitoring the time and frequency a device call pedometer which has been introduced in 1780 by Abraham-Louis Perrelet of Switzerland who created the first pedometer, measuring the steps and distance while walking with the intention to power a self-winding watch (Richard Masmanus, 2004) has become a popular alternative.

The pedometer technology adopted into steps recorder for walking exercise has increased the participation and discipline among the urban population towards walking as an exercise activity. A number of research by many different teams have recommended 7500 to 10000 (Bravata et al., 2007; Tudor & Bassett, 2004; Tudor & Lutes, 2009) steps a day as the baseline for pedometer usage in monitoring walking as an exercise. Particularly, when physical activity increases, blood pressure and weight decrease as a result of participating in a pedometer-based intervention. An improved acceptance of the unique measurement and inspired properties of pedometers has behaviour-change tools that will assist researchers and practitioners to maximize the benefits (Tudor et al., 2009).

The next challenge of measuring and monitoring the change in terms of vascular health which will provide the inside or structural change in the vessel beds has potential to be addressed by introducing photoplethysmogram base developed fitness index. Photoplethysmogram (PPG) is a simple, low cost, and operator independent optical based device that records the blood volume change commonly from index finger (Allen, 2007). PPG has two significant components, AC and DC that has been used in various monitoring applications. A higher frequency pulsatile component (‘AC') represents physiological changes associated with cardiac synchronous and slow varying (‘DC’) baseline that represents the respiration, heart rate, depth of anaesthesia, cardiac cycle, hypo-and hypervolaemia changes. The ‘AC’ component widely used in exploring the potential of monitoring cardiovascular risk related changes in arterial bed since PPG has significant changes over and cardiovascular diseases and risk factors in relation to age (Allen, 2007; Takazawa et al., 1998; Elgendi, 2014; Nitzan, Turivnenko, Milston, Babchenko & Mahler Y, 1996a; Nitzan et al., 1996b).

In this paper authors have adopted both pedometer and PPG technology as an approach in addressing the barriers faced by the working adult in monitoring their exercise activity by espouse walking as the exercise mode. Both the simple, low cost and operator independent technology expected to provide a user-friendly environment to encourage increasing working adult participate in championing walking as an exercise among Malaysian population in managing cardiovascular related diseases and risk factor as a part of the national agenda for people to experience an improving living condition.

**2.0 Cardiovascular Health**

**3.0 Green Health Practice**

Cardiovascular disease (CVD) is still the main cause of mortality in Malaysia (Khoo et al., 1991). According to the Health Indicator 2012, the MOH 2011 Hospitals’ survey noted that there were 8,150 deaths due to heart diseases and diseases of pulmonary circulation followed by 5,590 cancer-related deaths and 4,162 deaths due to cerebrovascular disease. Among the CVD, more than 50% were due to ischaemic heart disease (IHD). Twenty three per cent of these patients were less than 50 years. Most of the acute coronary syndromes (ACS) cases involved men (Wan Ahmad & Sim, 2010). The increased in IHD prevalence may be due to increase in CVD risk factors such as dyslipidaemia, obesity, smoking, hypertension, diabetes mellitus and physical inactivity (Haskell et al., 2007a). To reduce the burden of CVD within the community and increasing trend of sedentary occupations, secondary prevention programs such as self-monitoring pedometer based exercise are offered.

Community-based health promotion programmes at workplace requires programme planning, implementation and evaluation with the aim of empowering employers to gain control over the determinants of health. Walking is a form of exercise that is very acceptable to many people and may be integrated easily into daily routine. In recent years, pedometers have been used widely in campaigns at national, community and worksite level to promote walking (Bravata et al., 2007; Ogilvie et al., 2007; Bjork Petersen et al., 2012; Thomas & Williams, 2006). Pedometers are simple to use, low-cost and demand less resources rather than previous traditional face-to-face approaches. Pedometers also give immediate feedback to the users and this self-monitoring method may help individuals to develop self-regulatory skills for behaviour change. It does not require specialized equipment or any formal training and can be undertaken in an individual's own locality and time. It may involve varying levels of exercise. The Centre for Disease Control and Prevention (CDC) and the American College of Sports Medicine (ACSM) also recommended adults 10,000 steps/day on most days of the week. These recommendations have been shown to promote and maintain health and significantly reduce the risk of coronary artery disease (CAD) (NICE, 2006; Haskell et al., 2007b; O’Donovan et al., 2005).

In Malaysia, currently there is insufficient evidence to recommend the promotion of organised walking schemes, and that the effects of low levels of exercise are poorly documented. Besides that, there is limited data on pedometer workplace exercise among Malaysian employees with even less information on young men. There are gaps in evidence in relation to the effects of varying doses of exercise using pedometers in interventions compared to a recent study done by other countries likes Australia or Finland (Norton, Norton & Lewis, 2015; Mutikainen et al., 2015). Thus, the aim of the present study is to assess pedometer-based walking intervention programme among working adults in reducing cardiovascular risk factors.

4.0 Photoplethysmogram (**Refer to Dr Amilia's thesis**)

5.0 Photoplethysmogram in Health Monitoring **(I will write)**

6.0 Community Participation

6.1. Subjects

Subjects were recruited from Institute of Vocational Skills for Youth (IKBN Hulu Langat). IKBN Hulu Langat is a one of community partner with KTP Community project. Subjects were randomly assigned to two groups either a control (CG) or pedometer group (PG). The research was approved by the Research and Ethics Committee of Universiti Kebangsaan Malaysia (FF-2014-139). All measurements were done in Universiti Kebangsaan Malaysia Medical Center, Cheras and Physiology Department, Universiti Kebangsaan Malaysia Medical, Kuala Lumpur.

The inclusion criteria were young men aged 20-40 years old, sedentary lifestyle with less than 5000 steps per day (Tudor Locke & Bassett, 2004) and have 2 or more cardiovascular risk factors (cardiovascular high risk group) such as dyslipidaemia, smoking, hypertension, abdominal obesity, and family history (FH) of CVD. Exclusion criteria were those with established diabetes mellitus and other chronic disease such as CVD, inflammatory disease, peripheral vascular disease, lung disease and liver disease. Diabetes mellitus was excluded since this disease is equivalent to CAD and subjects may have advanced vascular damage compared to other CV risk factors (Stone, Bilek & Rosenbaum, 2005). Criteria for young Malaysian males for various CV risk factors was observed as per reference given to each of the following: 1) Hypertension: systolic blood pressure ≥140 and/or diastolic ≥90 or on antihypertensive medication (Chobanian et al., 2003). 2) Diabetes mellitus: fasting plasma glucose (FBG) ≥7mmol/L (Alberti & Zimmet, 1998) 3). Smokers: a habit of daily smoking continued at the time of recruitment for the study (Chin et al., 2012). 4) Abdominal obesity: waist circumference >90 cm (Tan, Ma, Wai, Chew & Tai, 2004). 5) Family history (FH) of premature CAD: when parents had CAD at <55 (father) or <65 (mother) of age (Stone et al., 2005). 6) Dyslipidemia: when TC >6.2mmol/L, TG >1.7mmol/L, LDL >4.2mmol/L, or HDL <1.04mmol/L (Alberti, Zimmet & Shaw, 2006). In this study, a total of eligible 70 young men (20 - 40 years) from IKBN who were sedentary, achieving less than 5000 steps/day in a casual walking with 2 or more cardiovascular risk factors were recruited.

6.2. Pedometer-based workplace programme

The protocol as well as the potential risks and benefits of participating in this programme were explained to each subject before written consent was obtained.

Once enrolled in the programme, subjects underwent a complete medical history and physical examination to ensure that they were deemed safe for the exercise intervention. During the initial phase, each subject was exposed to the self-monitoring pedometer programme which needs a full commitment from each subject. The subjects were informed that the programme involved a self-monitoring based pedometer intervention, and they were expected to give full commitment and must be mentally and physically prepared to go through the next phases.

In the first week of trial, the subjects will be instructed to assess their average number of daily steps with a pedometer (Yamax Digi-Walker SW-200) for five days including four working and one non-working day. The average number of daily steps is used as the baseline for the further step goals. Subjects with less than 5000 steps per day were recruited in this programme. Subjects were divided randomly (Excel, Microsoft 2007) into pedometer group (PG) and control group (CG).

The PG underwent a 4-week trial whereby subjects were required to gradually increase their walking by 1000 steps/day over 4 weeks. At the end of the trial phase, they should achieve a mean daily step count of 3000 steps/day above their baseline on at least 5 days of the week, so that a total minimum number of 8000 steps/day is needed before the start of the actual intervention phase.

Subsequently, those subjects assigned to the PG followed a 12 week pedometer-based walking programme. The number of steps initiated by them from wake-up to bedtime every day (five days per week) was recorded in a standardised diary book provided to all PG members.

Subjects assigned to the CG were instructed to maintain their habitual lifestyle and not to change their activity throughout this programme.

There were two sessions of cardiovascular markers assessments: at baseline, at 6 weeks and at 12-week intervention (post intervention).

6.3. Measurement of body anthropometry

Height was measured by a wall-mounted stadiometer (SECA, Hamburg, Germany) and weight was measured by using a digital scale (SECA, Hamburg, Germany). Body mass index was then calculated as weight (kg) /height (m2). Waist circumference was measured by a measuring tape on the horizontal plane, midway between the anterior superior iliac spine and lower rib after normal expiration (Alberti et al., 2006).

6.4. Measurement of blood parameters

About 10 ml of blood was withdrawn from the antecubital vein after fasting for a minimum of 8 hours. Blood samples were then sent to the Gribbles pathology laboratory (Selangor, Malaysia) for further analysis of lipid profiles and glucose. The serum TG, HDL cholesterol, and TC were measured using enzymatic methods (Advia 2400 Chemistry Analyzer, Siemens, Tokyo, Japan). The blood glucose was measured by enzymatic method using the hexokinase and glucose-6-phosphate dehydrogenase enzymes (Advia 2400 Chemistry Analyzer, Siemens, Tokyo, Japan). For lipid profile, the inter-assay coefficient of variation (CV) ranged from 1.4-3.5%. This laboratory obtained International Organization of Standardization (ISO: MS ISO 15189) in compliance with the standard quality.

6.5. Statistical analysis

A visual inspection of the histogram (plotted as the distribution frequencies) and acceptable level of sickness (-1 to 1) and kurtosis (-1 to 1) were used to determine the normality of the data. All the data were normally distributed. The differences in cardiovascular parameters between groups were compared by general linear model (GLM) repeated measures. The significant results were accepted at p<0.05. All the data were analysed using the Statistical Package for Social Sciences Version 20 (SPSS Inc., Chicago, IL, USA).

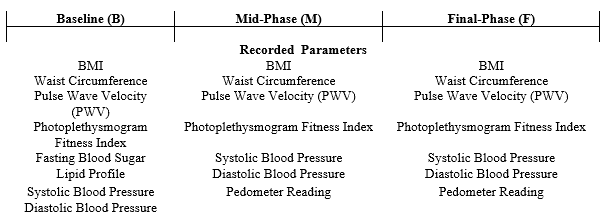
**7.0 Optical Technology Intervention in Cardiovascular Health Monitoring**

7.1. Subjects

The prospective randomized controlled trial study was conducted in the IKBN Hulu Langat. The 35 participants were selected randomly among their male staff and student who are aged between 20 to 40 years old with at any two or more cardiovascular risk factors which include dyslipidaemia, smoking, hypertension, abdominal obesity, and family history of CVD. The selected participants are currently undergoing sedentary lifestyle with less than 5000 steps per day. As part of the study criteria, subjects with established diabetes mellitus and other chronic disease such as CVD, inflammatory disease, peripheral vascular disease, lung disease and liver disease were excluded with the assumption that would interfere with physical activity.

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7.2. Recording Parameters



7.3. Procedure

Participants were randomly allocated into one of the two groups by the random approach: pedometer

Group (PG, n=19), and a control group (CG, n=16). A preliminary session of getting used to with a pedometer (Tudor LC, Ainsworth BE, Thompson RW, Matthews CE 2002) and the briefing was given to all the participants in the PG group were given to all the subjects about handling and placement of the pedometer (Tudor LC et al 2002). No dietary adjustments were advised for this intervention. Baseline readings of all the parameters in all the subjects were collected before randomization. For the first week of trial, subjects’ step baseline data collection was conducted to assess the subjects’ average daily steps for 5 days, including four working days and one non-working and subjects with less than 5000 steps per day were recruited to

Participate in the program. Hence the subjects were divided randomly into the pedometer group and a control group.

For the pedometer group undergo a 4week trial as a starter, which subjects were to gradually increase their steps by 1000 steps per day for 4 weeks. Thus, for the trial week, subjects should achieve an average daily steps of 3000 steps per day, that was above their baseline for at least 5 days a week with a total minimum of 8000 steps per day was needed before the intervention took place.

As for the control group, subjects were to maintain their sedentary lifestyle throughout the program.

7.4. Statistical Analysis

Paired t test was used within the groups to compare mean ± SD for all the parameters at baseline, 6 weeks and at the end of 12 weeks. Differences between the groups were compared using error plot. In this study p-value less than 0.05 has been considered as statistically significant

**8.0 Intervention Analysis**(**Refer Dr Suhana's KTP paper's Result followed by Rosa's paper result**)

The subjects’ characteristics for the whole and each group are summarized in Table 1. They were young males (n=70), with mean BP, WC, lipid profile, blood sugar and PWV within normal range except for triglyceride level which was above normal. Seventy four percent of them were smokers and the prevalence of hypertension was 4.0%, abdominal obesity 51%, dyslipidemia 67% and FH of CAD 10%. None of them had diabetes mellitus or pre diabetes (6.1mmol/L, <FBG <7mmol/L).

Following the intervention, the number of steps for PG significantly increased for time and the group effect (p<0.05). No change was seen in CG (Table 2). In terms of the physical parameters, after pedometer-based interventions for 12 weeks, the body weight and waist circumference were significantly decreased for PG (time and group effect, p<0.05). In addition, there was significant improvement in lipid profile in the PG (Table 3).

**Table 1:** Subjects characteristics

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | **Pedometer Group (N=36)** | **Control Group (N=34)** | **p-value** |
| **Age (years)** | 26.17 ± 6.68 | 26.62 ± 7.39 | 0.94 |
| **Weight (kg)** | 73.32 ±18.47 | 68.94 ± 14.15 | 0.27 |
| **Height (m)** | 1.67± 0. 056 | 1.68 ± 0. 056 | 0.82 |
| **BMI (kg/m2)** | 26.13± 5.99 | 24.49± 4.54 | 0.20 |
| **Waist circumference (cm)** | 86.56± 15.09 | 83.75±14.01 | 0.42 |
| **SBP rest (mmHg)** | 120.22± 8.97 | 122.12±8.23 | 0.36 |
| **DBP rest (mmHg)** | 64.70± 8.84 | 67.52± 8.31 | 0.17 |
| **HR rest (bpm)** | 70.81±12.09 | 70.32± 14.20 | 0.88 |
| **Cholesterol level (mmol/L)** | 5.01± 0.80 | 5.10 ± 1.26 | 0.73 |
| **TG level (mmol/L)** | 1.81 ± 0.90 | 1.82±1.24 | 0.93 |
| **HDL level (mmol/L)** | 1.17± 0.17 | 1.18± 0.19 | 0.72 |
| **LDL level (mmol/L)** | 3.07±0.76 | 3.28± 1.04 | 0.31 |
| **FBG level (mmol/L)** | 4.94± 0.85 | 4.77± 0.42 | 0.29 |

\*Data is presented as mean± SD

**Table 2:** Number of steps per day following intervention

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Pedometer group (N=36)** | | **Control group (N=34)** | |
| Week 1 | Week 12 | Week 1 | Week 12 |
| **STEPS/DAY** | 4996 ± 805 | 10128 ± 511\*\*# | 4983 ± 366 | 5697 ± 407 |

\*\* p< 0.01 (Time\*group interaction) # p<0.05 (time effect)

**Table 3:** Changes in characteristics of the subjects following intervention

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Pedometer group**  **(N=36)** | | | **Control group**  **(N=34)** | | |
| Week  1 | Week 6 | Week 12 | Week 1 | Week 6 | Week 12 |
| **Weight (kg)** | 73.32± 18.47 | 72.62± 18.37\*\* | 71.35± 16.47\*\*# | 68.94± 14.15 | 69.71± 13.47 | 69.69± 13.69 |
| **BMI (kg/m2)** | 26.13± 5.99 | 25.88± 5.93\*\* | 25.43± 5.27\*\*# | 24.49± 4.54 | 24.56± 4.51 | 24.54± 4.57 |
| **Waist circumference (cm)** | 86.56± 15.09 | 84.87± 13.94\*\* | 83.62± 13.53\*\*# | 83.75±14.01 | 84.46±13.79 | 84.01± 13.11 |
| **SBP rest (mmHg)** | 120.22± 8.97 | 116.39± 9.71\* | 116.33± 9.62\*\*# | 122.12±8.23 | 118.62±10.57 | 118.71± 10.63 |
| **DBP rest (mmHg)** | 64.70± 8.84 | 63.89± 8.83 | 63.83± 8.73\* | 67.52± 8.31 | 67.44± 9.69 | 67.82± 6.68 |
| **HR rest (bpm)** | 70.81±12.09 | 67.92± 12.50 | 66.89±10.83\* | 70.32± 14.20 | 71.18±14.33 | 71.23± 12.87 |
| **Total cholesterol (mmol/L)** | 5.01± 0.80 | 4.92 ± 1.02 | 4.62± 1.08\* | 5.10 ± 1.26 | 5.17± 1.11 | 5.29± 1.08 |
| **TG**  **(mmol/L)** | 1.81 ± 0.90 | 1.31± 0.91\* | 1.16± 0.59\*\*# | 1.82±1.24 | 1.75± 0.69 | 1.77± 1.31 |
| **HDL (mmol/L)** | 1.17± 0.17 | 1.24± 0.21\* | 1.29± 0.24\*\*# | 1.18± 0.19 | 1.17± 0.16 | 1.16 ± 0.16 |
| **LDL (mmol/L)** | 3.07±0.76 | 3.05±0.82 | 2.87± 0.85\* | 3.28± 1.04 | 3.35±0.82 | 3.6± 1.35 |
| **FBG (mmol/L)** | 4.94± 0.85 | 4.99± 0.98 | 4.84 ± 0.83 | 4.77± 0.42 | 4.61±0.34 | 4.68± 0.53 |

\*p< 0.05 (Time\*group interaction)

\*\* p< 0.01 (Time\*group interaction)

# p<0.05(time effect)

The pedometer is a validated instrument to measure steps, and it encourages increased physical activity effecting health-related quality of life (Tudor-Locke & Myers, 2001; Ogilvie *et al.,* 2007; Norton, Norton, Lewis & Dollman, 2011). Pedometers allow ambulatory populations to track their steps, which influences motivation through goal-setting. The current study noted better compliance and more accumulated steps in the subjects treated with pedometers and a daily step-recording log. This study also provided additional data for information among the urban young men with cardiovascular risks working in an area near Kuala Lumpur.

In the present study, we have evaluated the efficacy of pedometer-based walking in reducing CVD risk factors. The results of our study suggest that the interventions decrease body weight, BMI, WC, triglycerides, total cholesterol, increases high-density lipoproteins (HDL), decrease low-density lipoproteins (LDL) and lower blood pressure. The current study did not produce significant changes in fasting blood glucose (FBG). The lack of changes in FBG in the current study may have been attributed due to baseline values that were in normal range. The blood lipid results from our study compliment prior studies that have shown that physical activity effectively decreases TG, total cholesterol and LDL and increases HDL. Jerry et al. (2010) reported that 12 weeks physical activity in 37 sedentary males’ with mean age 44.5 ± 1.5 years significantly reduced TG, cholesterol and LDL but no change in HDL (Shearman, Micklewright, Handcastle, Hamlin & Draper, 2010). Our study showed a much larger 10% overall increase in HDL for PG. The difference in HDL results may be due to the lower value of baseline in this study and thus a greater improvement was seen following increased physical activity.

Resting systolic blood pressure (SBP) decreased by 4.0 mmHg in our study as early as 6 weeks and maintained after 12 weeks intervention. Norton et al. (2015) found about 2 mmHg SBP reductions after a walking exercise intervention for 6 weeks in sedentary (mean aged 44.25 ± 12.30), overweight males and females (Norton et al., 2015). Hypertension is a common CVD risk factor, and our results suggest that exercise prescription with pedometer-based interventions effectively lowered overall blood pressure which is consistent with prior studies. It is possible that our study observed greater changes in resting SBP at 6 weeks due to the pedometer daily log, as the participants were younger and were also asked to report their steps each day with a minimum report for five days of the week. Therefore, the physical activity may have been increased in our study compared to other studies that only included fewer than five days per week of physical activity.

The findingswere restricted to young men, and notapply to women or older age groups.

Total 35 participants were recruited and all participants completed the study. The physiological parameters and blood profile mean and standard deviation according to the participant group are present in Table 1 (a) and Table 1 (b). Figure 2 and 3 representing the plot for PPGF and PWV the two parameters of interest in this paper which has noninvasive measuring methods.

Table 1 (a): Pedometer Group

|  |  |  |  |
| --- | --- | --- | --- |
|  | **PEDOMETER** | | |
| **B** | **M** | **F** |
| **\*BMI** | 27.11 ± 5.50 | 26.84± 5.45 | 26.47±5.03 |
| **\*WC** | 89.42±12.60 | 88.63±12.15 | 86.84±11.40 |
| **\*PWV** | 7.47±0.91 | 7.05±0.91 | 6.53±1.02 |
| **\*PPGF** | 56.31±8.71 | 60.99±10.34 | 61.94±7.79 |
| **FBS** | 5.11±1.05 | 5.21±1.23 | 5.0±1.05 |
| **SBP** | 123.26±9.68 | 119.58±8.80 | 119.47±8.65 |
| **DBP** | 68.32±9.34 | 66.32±9.02 | 66.21±8.86 |
| **TG** | 2.00±1.25 | 1.63±1.17 | 1.37±0.68 |
| **HDL** | 1.00±0.00 | 1.11±0.32 | 1.21±0.42 |
| **LDL** | 3.32±0.89 | 3.37±0.76 | 3.05±0.91 |

\* p<0.01

Both PPGF and PWV showing similar trend, where there is a significant change after 6 weeks and further improvement in the next 6 weeks. Changes in PPGF were higher in the first 6 weeks and PWV has more consistent change in first and second 6 weeks. The observation based on the other seven different parameters selected to be discussed in this paper; we observe that BMI, waist circumference and lipid profile has consistently reduced over the six weeks and 12 weeks of walking intervention.

Table 1(b): Control Group

|  |  |  |  |
| --- | --- | --- | --- |
|  | **CONTROL** | | |
| **B** | **M** | **F** |
| **BMI** | 24.31±4.39 | 24.37±4386 | 24.44±4.34 |
| **WC** | 83.38±12.96 | 84.00±13.01 | 83.81±12.01 |
| **PWV** | 7.25±0.78 | 7.31±1.19 | 7.31±1.01 |
| **PPGF** | 59.06±9.66 | 60.37±10.09 | 59.80±8.88 |
| **FBS** | 4.87±0.72 | 4.69±0.48 | 4.50±0.52 |
| **SBP** | 122.06±5.76 | 120.37±9.87 | 120.81±9.52 |
| **DBP** | 67.38±7.34 | 68.94±9.62 | 68.50±9.77 |
| **TG** | 1.75±0.86 | 1.75±0.93 | 1.81±1.60 |
| **LDL** | 3.31±1.14 | 3.50±0.82 | 3.62±1.46 |
| **HDL** | 1.00±0.00 | 1.06±0.24 | 1.11±0.32 |

*BMI(Body Mass Index), WC (Waist Circumference), PWV (Pulse Wave Velocity), PPGF (Photoplethysmogram Fitness), FBS (Fasting Blood Sugar), SBP (Systolic Blood Pressure), DBP (Diastolic Blood Pressure), TG (Triglyceride), LDL (Low-density Lipoprotein), HDL (High Low-density Lipoprotein)*

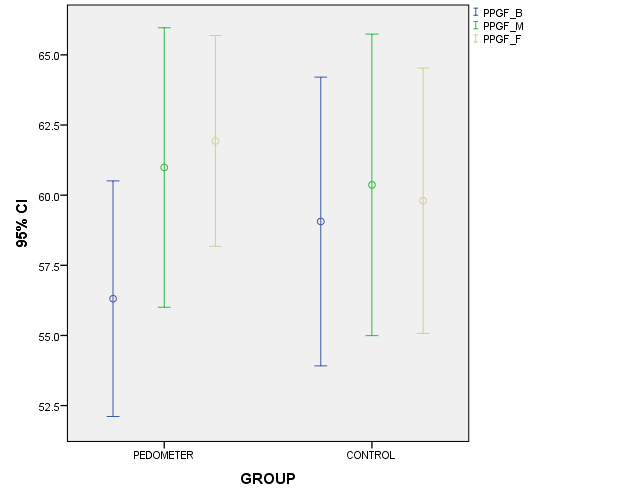


Figure 2: PPGF results

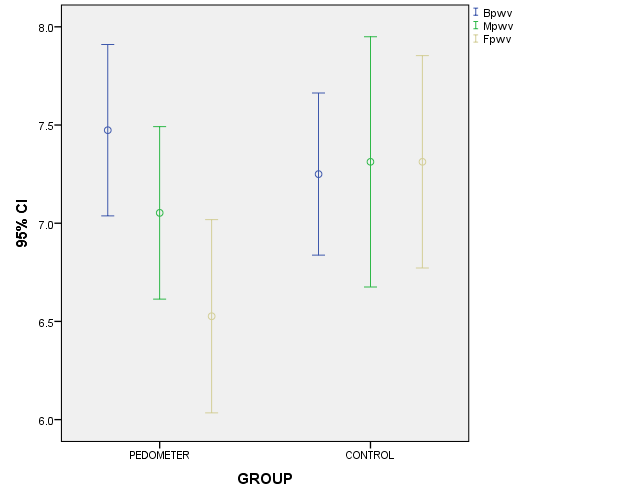


Figure 3: PWV results

Both SBP and DBP found to be reduced in the first 6 weeks and maintained over the second six weeks. The physical conditioning achieved by regular walking exercise decreases the heart rate and blood pressure at rest and at a given level of exercise. Consequently, the workload on the heart is reduced and angina symptoms may be alleviated. Regular exercise also improves muscle function and increases the cardiac patient’s ability to take in and use oxygen. This is commonly referred as the maximal oxygen consumption or aerobic capacity. As the body’s ability to transport and deliver oxygen improves, the patient has added energy and less fatigue. This benefit is important for patients with cardiovascular risk whose aerobic fitness is typically less than that of healthy adults of similar age. Moreover, the greatest improvements often occur among the most unfit. Walking exercise training programs can result in modest decreases in body weight and fat stores, blood pressure (particularly in persons with elevated resting blood pressure), serum triglycerides, and low-density lipoprotein cholesterol, and increases in the “protective” high density lipoprotein cholesterol. Although the effect of an exercise program on any single risk factor may generally be small, the effect of continued, moderate exercise on overall cardiovascular risk, when combined with other lifestyle modifications (such as proper nutrition, smoking cessation, and medication use), can be dramatic. In terms of PWV and PPGF, walking exercise improved indices of arterial stiffness and wave reflection significantly. The study showed that some forms of walking exercise may be associated with beneficial effect on arterial stiffness. Therefore, further studies are required to investigate the effect of walking exercise alone, or in combination with other types of exercise, on indices of arterial stiffness and wave reflection.

9.0 Health Maintenance Model **(I will write)**

10.0 Conclusion **(I will write)**

A pedometer-based walking programme in the workplace may be an effective strategy for promoting increased daily physical activity which improves lipid profile after 12 weeks and thus improve cardiovascular health. Findings from this study will provide future direction for community based physical activity. Physical health and work performance of the employee are directly related. A healthy work environment will help in improving productivity.

# The study concludes that, pedometer based walking activity for 5 days a week has the potential to improve the quality of life. Motivation with a pedometer has addressed the first challenge in maintaining the sufficient amount of exercise by target step counts and improves quality of life. The second challenge which was the exercise outcome measuring has positive outcomes in BMI, waist circumferences, systolic and diastolic blood pressure measurement, PWV and the newly proposed PPGF index are significant in being a measure for the improved lifestyle based on pedometer walking. This result indicates that PPGF is a potential marker to monitor cardiovascular risk which needs further investigation.

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