Int. J. Food, Nutrition and Public Health (IJFNPH), Vol. 7, No. 1, 2014

PHYSICAL ACTIVITY DELIVERED IN WORKPLACE: A PILOT STUDY TO ASSESS THE HEALTH OUTCOMES AMONG EMPLOYEES AT WORK

Ewa Hammarberg*, Regina Papp, Andi Gaywood, Jean Pierre Ferraroli and Ihab Tewfik
University of Westminster, UK

University of Westminster, Department of Human and Health Sciences,
Faculty of Science and Technology,
115 New Cavendish Street, London W1W 6UW, UK
E-mail: ewa.hammarberg@gmail.com

ABSTRACT

Background: physical activity is a potentially cost-effective approach to reduce overweight/obesity and possible complications (Cardiovascular Disease (CVD), diabetes, cancers). Despite physical activity guidelines recommendations from government bodies and health organisations such as the National Institute for Health and Care Excellence (NICE), the American College of Sports Medicine (ACSM) and the American Institute of Cancer Research (AICR), UK adult obesity rates have significantly increased.

Aim: the present study investigated if these guidelines do enough to improve body composition and weight to prevent complications. We hypothesised that moderate/vigorous exercise following the above guidelines can significantly improve health status.

Methods: the study has completed three subsequent phases, each lasting five weeks. Presumable healthy participants were recruited between ages 20 and 65 years old. The effects of vigorous versus moderate physical activity on participants' health status were compared by using supervised/unsupervised interventions following the NICE, ACSM and AICR guidelines.

Results: Phase 1 was completed with a 21.4% attrition rate and there were statistically significant reductions in systolic BP (–6%, $p=0.018$); Triglycerides (TG) (–30.5%, $p=0.046$); LDL cholesterol (–14.4%, $p=0.021$). Phase 2 was concluded with a 14.3% attrition rate and statistically significant changes in systolic BP (–3.6%, $p=0.042$) and HDL cholesterol (+7.5%, $p=0.244$). In Phase 3, when participants were unsupervised, no comparable qualitative data was reported as only 50% of participants completed their final assessments.

Conclusion: the reported findings suggest that over a longer period, with consistent and regular physical activity, body composition can be improved and the markers of cardiovascular risk can be ameliorated. Therefore, in essence, applying the current physical activity guideline is valid. However, as compliance was significantly higher when physical activity sessions were supervised, a multi-factorial approach addressing behavioural changes and adherence could promote health status more efficiently. Using the word 'exercise' could be more appropriate as it is planned, structured and incorporates the significance of goal setting.

*Corresponding author

Keywords: physical activity; exercise; overweight; obesity; governmental guidelines; compliance.

Reference to this paper should be made as follows: Hammarberg, E., Papp, R., Gaywood, A., Ferraroli, J.P. and Tewfik, I. (2014) 'Physical Activity Delivered in Workplace: A Pilot Study to Assess the Health Outcomes among Employees at Work', *Int. J. Food, Nutrition and Public Health*, Vol. 7, No. 1, pp.41–52.

1 INTRODUCTION

Today more than ever, the pandemic of obesity has become a major challenge in the western world. It can have a negative impact on both mental and physical aspects of health. It is also associated with unfavourable amendments in serum cholesterol, blood glucose and blood pressure. If un-addressed it may lead to non-communicable diseases – NCDs: Cardiovascular Diseases (CVD), diabetes and certain cancers (Campbell et al., 2008). Development of NCDs depends both on the severity and duration of obesity (Abdullah et al., 2011). Sustained excess energy intake alone or combined with reduced energy expenditure, as commonly seen in today's sedentary lifestyles, is a recipe for overweight (BMI 25–29.9 Kg/m^2) and obesity ($>$30 Kg/m^2).

Alarming data released by National Health Service (NHS) showed that only 34% of men and 39% in women in the UK have a normal body mass index, which means a respective 7.4% point and a 10.1% point adverse change compared to 1993 (NHS, 2013). Even more, in 2011, 53% of obese men and 44% of obese women had high blood pressure. High blood pressure is an independent risk factor for cardiovascular events (NHS, 2013). CVD and certain type of cancers are declared to be the most common cause of death in males and females in the UK (Office for National Statistics, 2011). Intervening with an active lifestyle can reduce the development of fat deposits and reverse the chance of developing non-communicable diseases. Furthermore, WHO suggests that globally, physical inactivity is the fourth leading risk factor for mortality (World Health Organisation, 2013). Limiting the amount of time spent in a sedentary behaviour may act as a protective factor against progression of fat accumulation and associated complications (Warren et al., 2010).

In clinical settings, when risk factors for NCDs are first identified (e.g. CVD), drugs such as statins and antiplatelet agents are often prescribed (Dehghan et al., 2012; Moreno and Mitjavila, 2003). These drugs decrease cholesterols and platelets which are associated with cumulative risk of lipid plaques and CVD. However, underlying problems often remain when the patient fails to understand the reflective relationship between diet, physical activity and the progression of the NCDs (Söderlund et al., 2009).

Physical activity has the ability to inhibit the formation of oxidised lipid-containing plaques which can form deposits in blood vessel walls blocking or partially constricting them and lead to hypertension and ruptures. Such plaque progression increases the risk for myocardial infarction and death by reducing oxygen and nutrient delivery to the brain or heart (Campbell et al., 2008). Therefore, prescribing physical activity has the potential to be a cost effective approach compared to drug administration.

Currently, there are limited data on the effect of solely physical activity on body composition in overweight and non-overweight UK subjects. However, several studies have concluded that only minor changes in body composition may occur with physical activity interventions alone without alterations in diets (Caudwell et al., 2009; Söderlund et al., 2009).

Health authorities are challenged in terms of issuing the right guidelines to help people become more active. Our study probed the guidelines developed by National Institute for Health and Care Excellence (NICE) for maintenance of a healthy lifestyle. Within these directives, the recommendation for the UK adult population for lifestyle changes for primary and secondary prevention of NCDs (e.g. CVD) is at least 30 min of moderate intensity physical activity, five days a week or 150 min per week (National Institute for Health and Care Excellence, 2010). In the USA, the recommendations from the American Institute of Cancer Research (AICR) states that the more vigorous physical activity the better when advising for optimal health and reducing risk of NCDs (World Cancer Research Fund/American Institute for Cancer Research, 2007). However, the recommendations of the American College of Sports Medicine (ACSM) agree with the NICE guidelines: moderate activity for 150 min per week (American College of Sports Medicine, 2011), but used the term 'exercise'.

The present study has set out to investigate the following: Are the outcomes of these guidelines satisfactory to improve physical fitness, body composition/weight and prevent complications associated with overweight/obesity? We hypothesised that moderate/vigorous exercise following the above guidelines (whether in UK or USA) can significantly improve health status. Furthermore, we compared results of the AICR guidelines recommending higher intensity training. The hypotheses were based on the above-mentioned guidelines and 95% certainty was required to determine if the null hypothesis (there is no effect) could be rejected.

2 METHODS

The Stay Active this Summer (SAS) project was conducted within the University of Westminster premises over the summer breaks of three consecutive phases (i.e. SAS-2011, SAS-2012 and SAS-2013). SAS recruited healthy adults, employed by the University, between ages 20 and 65. Recruitment was voluntary and participants consented to the conditions of the study by e-mail. Applicants were asked to report any preexisting and existing chronic conditions. If, due to these, they were considered to be under risk, they were not accepted to enroll on the study.

Participants agreed to attend two assessments: pre and post-intervention. The tests included physiological and physical measurements: height, weight, body composition (using COSMED BodPod), systolic/diastolic blood pressure, fasting serum lipids and glucose.

Biochemical indices such as total, LDL and HDL cholesterol and Triglyceride (TG) were evaluated from finger prick blood samples: using a CardioCheck PA device and YSI 2300 STAT Plus. Glucose and Lactate Analyser was used to measure fasting serum glucose concentration. The study spanned over three phases as following:

2.1 Phase 1 (SAS-2011), comparing moderate (UK) versus vigorous (USA) physical activity with supervision

Commencing in June 2011, 14 reportedly healthy participants from different ethnic origins (eight females and six males between ages 20 and 60 years old) were assigned randomly into two groups with seven participants in each. No dietary advice or conditions were attached and participants were asked that the only exercise they did was that involved in the parameters of the study. The intensity of the activity was determined by age related heart rate (220 bmp minus age). The physical activity sessions took place in the exercise laboratory of the university, using treadmills, cross-trainers and cycle ergometers, five times a week, lasting 30 min each episode. Heart rate monitors were used to observe heart rate ranges for participants. The participants signed Physical Activity Readiness Questionnaires (PARQ) and sessions were supervised by coordinators to ensure safety. Participants were asked to meet a coordinator before commencing exercise, so that the correct functioning of the equipment can be checked and heart rate monitors could be handed out. The coordinator was available throughout the sessions to assist with any technical or physical difficulty participants might face.

The first group exercised at moderate intensity for two weeks (55–65% of maximal heart rate), the second group exercised at high intensity (above 75% of maximal heart rate). These two weeks were followed by a one week of 'washout' period, where no physical activity was performed.

The measurements were repeated and the two groups were asked to cross over to the lower versus higher intensity sessions for further two weeks. The experiment was concluded by taking the same physiological and physical measurements as the end of the interventions (see Table 1).

2.2 Phase 2 (SAS-2012) moderate physical activity following the NICE guidelines (for five weeks with supervision)

Phase 2 took place in July–September 2012 and lasted for five weeks. Recruitment and conditions were identical as seen in Phase 1 (SAS-2011) with the supervision of a coordinator. However no 'washout' period was applied and the 14 healthy participants (2 males and 12 females, between ages 20 and 60) exercised only at moderate level (i.e. employing the NICE guideline but for longer period compared to phase 1).

In both phases 1 and 2, the results of the initial and final assessment were recorded individually and were shared with the participants, highlighting any indices that were not within the acceptable range (Table 1).

Table 1 **Summary of the study findings using two tailed *T*-test by SPSS and MS excel statistics. The table compares the effect of the different interventions in Phases 1 and 2 on the physical and physiological measurements used. *P*-values were determined for 95% confidence level**

	Summary of SAS findings														
	PHASE 1. Moderate two weeks					*PHASE 1. Vigorous two weeks*					*PHASE 2. Moderate five weeks*				
	Mean values		*change +/−*	*change %*	*p value*	*Meanvalues*		*change +/−*	*change %*	*p value*	*Mean values*		*change +/−*	*change %*	*p value*
	before	*after*				*before*	*after*				*before*	*after*			
Weight (kg)	68.15	67.89	−0.26	−0.4%	0.479	72.08	71.45	−0.63	−0.9%	0.092	70.36	69.96	−0.41	−0.6%	0.108
Body fat (%)	25.34	25.58	0.24		0.984	26.67	26.18	−0.49		0.111	34.4%	34.2%	−0.002		0.585
Blood glucose (mmol/L)	4.70	4.90	0.20	4.3%	0.322	4.75	4.87	0.10	2.1%	0.279	4.27	4.33	0.06	1.5%	0.717
Systolic BP (mmHg)	117.00	110.00	−7.00	−6.0%	0.018	123.82	119.45	−3.43	−2.8%	0.139	117.43	113.14	−4.29	−3.6%	0.042
Diastolic BP (mmHg)	78.00	73.43	−4.57	−5.9%	0.052	83.09	80.45	−2.23%	−2.7%	0.261	80.54	78.64	−1.89	−2.4%	0.276
Total cholesterol (mmol/L)	5.04	4.63	−0.41	−8.1%	0.190	5.17	4.33	−0.65	−12.7%	0.016	4.09	4.31	0.23	5.6%	0.285
HDL cholesterol (mmol/L)	1.81	1.65	−0.15	−8.5%	0.042	1.77	1.67	−0.08	−4.5%	0.227	1.58	1.70	0.12	7.5%	0.244
LDL cholesterol (mmol/L)	2.72	2.59	−0.13	−4.9%	0.587	2.86	2.14	−0.41	−14.4%	0.021	1.92	2.17	0.25	13.1%	0.466
Triglycerides (mmol/L)	1.12	0.85	−0.27	−24.1%	0.025	1.17	0.72	−0.36	−30.5%	0.046	0.81	1.05	0.24	30.3%	0.085

2.3 Phase 3 (SAS-2013) moderate physical activity following the NICE guidelines (for five weeks without supervision)

Phase 3 followed in July–August 2013, corresponded to the principles applied in phases 1 and 2. However, phase 3 differed in that participants exercised without any supervision. Post-initial measurements, subjects were free to start their exercise regime in their own time. Gym facilities were available at the university campus and/or individuals could exercise outside the university. Participants choosing not to use the exercise laboratory were asked to record the type of activity they had performed. Unlike in the first two phases, post participation interviews were conducted which explored the subject's perception of the challenges in complying/adhering with the provided guidelines. Questions in the interview included: 'Was it difficult to follow the NICE guidelines?' or 'Will you continue to stay active in the future?'

3 RESULTS

Table 1 compares the changes in the physiological, physical and biochemical indices following the interventions in the first two phases of the study.

The following changes were observed

3.1 Phase 1

Phase 1 was completed with 11 participants out of 14 returning for the post-intervention assessment. Initially, 11 participants were normal weight (BMI$<$25 kg/m^2), one overweight (25 kg/m^2 $<$BMI$<$30 kg/m^2) and two participants were obese (BMI$>$30 kg/m^2). Although the average mean weight reduction was 0.26 Kg (–0.4%), it was not statistically significant ($p=0.479$). Percentage (%) body fat increased by 0.24% and average plasma glucose concentration increased by 0.2 mmol/L (i.e. 4.3%).

After two weeks of moderate physical activity, a 6% (–7 mmHg; $p=0.018$) average reduction was seen in the participants' systolic blood pressure. Diastolic BP went down by 5.9% (4.47 mmHg).

The reduction in total cholesterol (–8.1%) was mainly due to the reduction in HDL cholesterol (–8.5%, $p=0.042$) and TG (–24.1%, $p=0.025$). The reduction in LDL cholesterol was not statistically significant (0.13 mmol/L or 4.9%, $p=0585$).

These findings were in contrast with the changes observed after two weeks of vigorous exercise, which showed a small but not statistically significant reduction (3.43 mmHg or 2.8%) in systolic blood pressure with 2.7% or 2.23 mmHg lower diastolic blood pressure but showed a 12.7% (0.65 mmol/L) drop in total cholesterol ($p=0.016$) which was mainly due to the 14.4% ($p=0.021$) decrease in LDL cholesterol and 30.5% ($p=0.046$) decrease in TG. Participants' average serum glucose increased by 0.1 mmol/L (2.1%), however this was not statistically significant ($p=0.271$). The average change in body composition was shown in a reduction in body weight (–0.63 kg or 0.9%) and body fat by 0.49%, which were twice the reductions seen after two weeks of moderate exercise.

3.2 Phase 2

In Phase 2, 12 of the 14 participants returned for the post-intervention assessment.

Initially, seven participants were normal weight, six overweight and one participant was obese. The change in the average body composition of participants was negligible but a small reduction in body weight was observed (0.41 kg or 0.6%).

A 4.29 mmHg or 3.6%, statistically significant reduction ($p=0.042$) was observed in the average systolic blood pressure and 1.89 mmHg or 2.4% decrease in diastolic blood pressure.

It was the systolic BP only which showed a consistent and statistically significant reduction across the first two phases as in response to moderate physical activity (Figure 1).

Average total cholesterol increased by 5.6% (or 0.23 mmol/L) due to higher TG (0.24 mmol/L or 30.3%), LDL (0.25mmol/L or 13.1%) and HDL cholesterol (0.12 mmol/L or 7.5%) in comparison to the averages of the initial assessment. However only the increase in TG was statistically significant ($p=0.085$).

3.3 Phase 3

Out of the initial 20 recruited subjects, 10 fully completed the five weeks intervention. As previously stated, Phase 3 was based on a more qualitative analysis in contrast to the quantitative observations recorded in the previous phases. Subjects reported a minimum level of physical

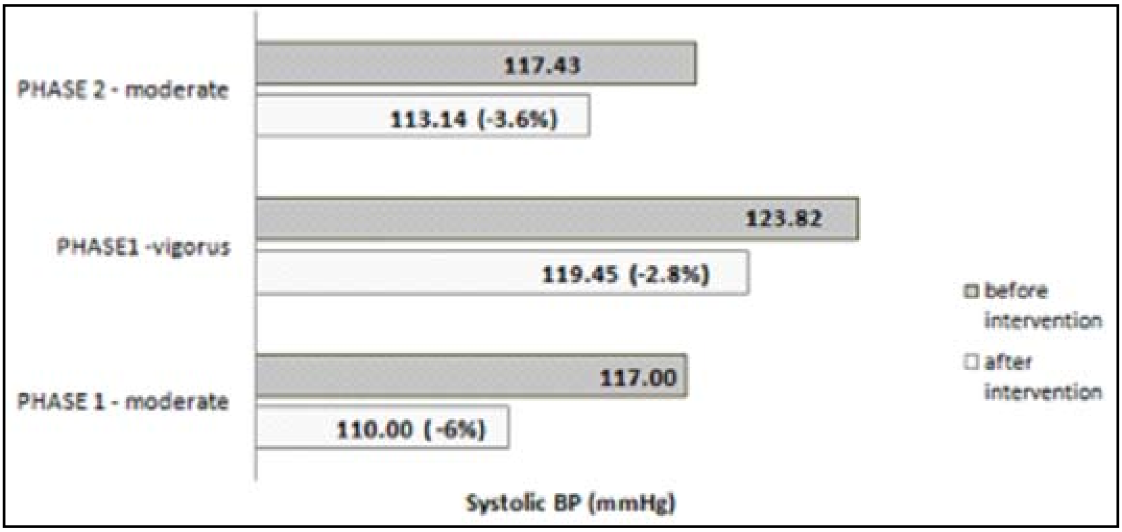

Figure 1 Comparison of average systolic BP (mmHg) reductions in Phases 1 and 2

activity (engaging in physical activity less than once per week) before enrolling in the study.

Individual motivation, thus efficacy levels differed amongst Phase 3 subjects. Some participants failed to comply with the study stating that they felt they were 'lacking creativity in the type of activities'. Others expressed their wish to 'stay active in the future' due to increased motivation developed during the intervention. Moreover, people liked the fact that they had the option to exercise in their own personal space, which was in contrast to Phases 1 and 2. Having the availability of the gym facility in the work environment worked as a great advantage since the majority of the participants viewed it as a 'good incentive' to perform any exercise. Individuals who failed to comply stated that the NICE guidelines were difficult to fit into a busy daily routine, while others found the 30 min exercise easy to manage. During the conducted interviews, participants also highlighted that having a supervisor/coach to motivate them would be a great advantage.

4 DISCUSSION

4.1 Blood glucose and glycogen

The majority of the subjects did not have significant improvement in their fasting plasma glucose concentration post intervention (observed in both Phases 1 and 2). There was a slight increase across the first phase 1 (moderate versus vigorous) and 2 (4.3%, 2.1% and 1.5%, respectively, Table 1) but the average values were still healthy and the increases were not statistically significant ($p=0.322$; 0.279; 0.717) which shows that the subjects already had a normally functioning plasma glucose regulatory system.

According to the statistics of Diabetes UK, more than 1 in 20 people in the UK have diabetes (diagnosed or undiagnosed) (Diabetes UK, 2012). The number of type 2 (adult onset) diabetics make up 90% of these cases, which is particularly alarming, as this can be prevented or managed by lifestyle changes.

This has been also shown in a study investigating two exercise intensities on obese and type 2 diabetic obese individuals (Kang et al., 1996). They reported no significant improvement in glucose tolerance in non-diabetic individuals post the seven day intervention. A greater insulin sensitivity following higher intensity (over 70% of VO_2 max) was observed and explained by the authors to be due to greater muscle glycogen utilisation (Kang et al., 1996).

Indeed, an increased activity of Glucose Synthase (GS) was seen after a single bout of 40-min of intense exercise (70% VO_2) (Jensen et al., 2012). This can potentially explain the positive effect of exercise on insulin sensitivity and plasma glucose disposal as the hormone activates GS.

Incorporating physical activity into a healthy lifestyle is advantages to acute plasma glucose concentrations. Even single bouts of exercise at a sub-maximal level (high intensity, below calculated maximum heart rate) may decrease plasma glucose levels by utilising the fuel into working skeletal muscles, lasting up to 48 hr (Goodwin, 2010). Hence, individuals in need of blood glucose control should be advised to have no more than two consecutive resting days.

Chronically engaging in exercise (150 min/week) along with a reduction of 5–7% in weight is a cost effective method for the prevention of abnormal plasma glucose concentrations and possible development of diabetes type 2.

On the other hand, overweight/obese individuals might be unable to engage in higher intensity physical activity due to factors such as movement restriction. Yet, chronically engaging in less intense exercise does have positive effects on weight loss and adipocyte depositing. This is because lower intensity (up to 50% of VO_2 max) exercise is highly reliant on beta-oxidation whereas higher intensity relies upon carbohydrate oxidation. Decreasing visceral fat storages surrounding abdominal organs such as the intestines and liver would promote better insulin sensitivity (Colberg et al., 2010).

4.2 Blood pressure and exercise

All participants in both Phases 1 and 2 started their exercise regime with normal blood pressure or stage 1 hypertension. We found that in Phase 1, the average reduction in systolic and diastolic BP after two weeks of moderate and vigorous physical activity 6%/5.9% and 2.8%/2.7%, respectively. In Phase 2, after five weeks of moderate physical activity BP was reduced by 3.6% and 2.4% (Figure 1). This, on its own means a risk reduction in cardiovascular complications. Blood Pressure UK suggests that for anyone whose blood pressure is between 90/60 and 179/99 mmHg should be safe to start increasing physical activity (Blood Pressure UK, 2008). This will contribute to maintenance of normal BP or lower hypertension. In the UK, 32% of men and 29% of women have hypertension and approximately 5 million in the whole UK remain undiagnosed (British Heart Foundation, 2012).

Aerobic exercise, utilising several muscle groups such as walking, dancing, jogging, cycling, is ideal. ACSM suggested that regular moderate physical activity lowers both systolic and diastolic blood pressure by 5 to 7 points (American College of Sports Medicine, 2011). This can be seen after three–four weeks of regular moderate physical activity for at least 30 min per day. The findings of the current study are in-line with this, as both Phases 1 and 2 interventions resulted in systolic BP reduction as shown above. The dose dependent effect of incremental training in addition to normal daily activities has also been tested (Ishikawa-Takata et al., 2003). It was concluded that 60–90 min of incremental exercise per week was enough to reduce blood pressure. Increasing this to 150 min additional training did not bring significant added benefits, hence the amount of exercise necessary to reduce BP should be easily achievable for the hypertensive population.

4.3 Blood lipids (Cholesterol, LDL, HDL and TG)

Another major marker of the increased risk for cardiovascular events is elevated cholesterol and TG as previously mentioned.

The following changes were seen in participants' blood lipid profiles.

Phase 1, moderate then vigorous exercise brought an 8.5% and 14.4% reduction in LDL cholesterol and 24% and 30.5% in TG, respectively. On the contrary in Phase 2, the average LDL and TG increased by 13.1% and 30.3%, respectively. Although individual diets were not evaluated in this study, the increase in the subjects' TG/LDL levels might be on effect of the following: consumption of food products with high saturated fat content prefinal assessment and/or the Excess Post-exercise Oxygen Consumption (EPOC). EPOC stands for excess post-exercise oxygen.

EPOC is the increase of internal oxygen consumption post-physical activity which restores and replenishes bodily processes, bringing them back to a resting state. The EPOC is further affected by a raised need for fuel replenishment. In response to this, fat stores are broken down and lipids are released into the blood stream. The duration of EPOC's effect may be applicable up to 48 hr as suggested by many authors (Wu and Lin, 2006). Our subjects' raised lipid values might therefore be a result of EPOC as they were likely to have had performed physical activity one or two days before the final assessment.

The intake of fatty meals produces an internal effect, which increases/alters serum triglyceride concentrations. Postprandial TG values increase along with minor HDL decrease due to lipid proteins being converted from HDL to less favourable lipids. Such alterations are necessary to fit metabolic changes when going from a fasting to a feeding state (Langstedt et al., 2008) Triglyceride values peak between the 3rd and the 5th hr post-food consumption (Nigam, 2011). It has been shown that as a result of meals with high fat content (>30 g), circulating levels of chylomicrons, chylomicron remnants and VLDL increases (Bravo et al., 2010). Another explanation to the higher TG and LDL values (Phase 2) might be the possibility that some subjects did not apply a 12-hr fast before final assessments. The lack of compliance from some participants therefore might have led to the under estimation of the interventions' success.

4.4 Compliance with physical exercise regime

In the current study, Phases 1 and 2 required participants to exercise at the premises of the university in presence of their supervisors. In Phase 2, as seen in individual cases, some physiological measurements not only remained unchanged after five weeks of moderate exercise, but deranged (Table 1). These might have been due to temporary dietary changes, as explained above. In Phase 3, attendance was 50% likely to be due to participants completing unsupervised training outside of the university.

Comparing the attrition rates and results of Phases 1 and 2 with Phase 3 (21.4% and 14.3% versus 50% attrition), it is obvious that the quality of the interventions (supervised versus unsupervised) had a great impact on the outcome.

4.5 Challenges and possible practice

Today, there are two major issues in the community: Firstly, there are still many people who are inactive. Secondly, those who are active may not adhere to their programs, as they either exercise irregularly or do not exercise at the required level of intensity.

By definition, physical activity is 'any bodily movement produced by skeletal muscles that requires energy expenditure' (World Health Organisation, 2013).

Whereas exercise is "a subset of physical activity that is planned, structured, and repetitive that has a final or intermediate objective the improvement or maintenance of physical fitness" (Caspersen et al., 1985).

Despite the amount of evidence available between increased risks of mortality in adult onset chronic diseases due to sedentary behaviour, these have not been overcome (Rodgers and Sullivan, 2001).

Prevention or management of chronic conditions require adherence to prescribed or voluntary exercise programs. There are several factors which affect this: motivation, past experience, self-perception, socioeconomic and cultural elements. Bandura (1994) suggested one's self-efficacy to be the major predictor of exercise adherence. He defined self-efficacy as the belief in one's ability to achieve a certain outcome. More positive self-perception is therefore necessary for the success of health behaviour changes. In addition, it has been found that low self-efficacy results in avoidance of exercise or decreased adherence to it (Cohen et al., 2008). Negative self-perception may prevent an overweight person to exercise whereas someone who is more confident may enjoy exercise to a greater extent.

Assuming that the findings of SAS project are representative of a population, the major determinants that have been previously discussed may act as actual barriers to the success of governmental interventions. Lower socio-economic status, cultural and religious differences all play a role when determining self-efficacy as a predictor to exercise adherence. Predictive factors (e.g. socio-economic aspect) may lessen the activity level of individuals due to perception of gym or group sessions being unaffordable.

In SAS's project case, unless most employers are able to offer affordable gym memberships as part of employee benefit packages, this will continue to be a major setback.

As a result of possible low self-efficacy people starting to exercise need support and encouragement from their environment by receiving regular positive reinforcement. Therefore, joining group sessions and/or choosing a training companion could improve compliance. A supportive environment enhances the enjoyment and social experience of being physically active. Furthermore, feeling pressure from a group regarding regular attendance may play a role in increased consistency in a group setting (Schwarzer et al., 2008).

A possible answer could be the development of a new scheme of 'health buddy'-ing, which can be implemented in the working place. Set goals could be shared with a colleague or friend and the 'health buddies' support each other and attend gyms or group sessions together and regularly discuss progress.

In a previous study, it has been suggested that motivated adults prefer to exercise alone (Burke et al., 2008). However, others, especially older adults might have a preference for exercising in groups where participants are of similar age (Rodgers and Sullivan, 2001). This has already been documented in 2005 in a review by NHS.

Supporting initiatives whereby employers and local authorities make exercise facilities more affordable and available could facilitate greater success of interventions. Increasing physical activity in a community setting may be efficient in supporting medium and long term behavioural changes, especially if people are thought skills by exercise specialists and can tailor these to individual needs (National Health Service, 2005).

The importance of goal setting has been highlighted previously. Low adherence to long term physical activity is affected by the lack of targeted outcomes set by individuals before commencing an exercise regimen (Clifford, 2009).

4.6 The importance of a multidisciplinary approach

Findings of the SAS study were in keeping with previous research. The greatest weight loss was the result of interventions using a multidisciplinary approach including exercise, dietary modifications, and behaviour change. The interventions treating overweight only with physical activity did not predict significant weight loss. Studies showing a consistent weight loss were the ones that used the three above-mentioned factors (Söderlund et al., 2009).

The SAS study has added to the understanding of the successfulness of governmental guidelines in UK subjects, yet the study is not without limitations. The three phases were conducted during relatively short time periods (five weeks). Short durations may not indicate better long-term health as adaptions to exercise may take longer than five weeks. Furthermore, diets were not analysed, therefore this was an external factor which might have affected the outcome.

5 CONCLUSION

The current study revealed some significant changes in participants physical and biochemical profiles the first two separate five weeks exercise interventions. Such findings suggest that over a longer period, with consistent and regular physical activity/exercise, weight can be reduced in overweight and obese individuals. However, as the difference in compliance between the first two phases (supervised exercise) and the last phase (unsupervised exercise) was remarkable, we suggest that physical activity guidelines to raise awareness of complications of overweight and obesity likewise address behavioural changes. Recommending 'exercise' instead of 'physical activity' might be more appropriate in addressing the complication as 'exercise' incorporates the key aspects of the possible solution: goal setting and regularity. Future research is therefore recommended to elucidate different interventions of supervised exercise programs, testing how participants' compliance changes with realistic individual goal setting.

ACKNOWLEDGEMENTS

We wish to thank various people for their contribution to this research project; Jean-Pierre Ferraroli for his valuable technical support. The authors further thank the University of Westminster for providing their facilities for the project. Also, to all the Phase 3 team members (Alexandra Bak, Martina Dezio, Stuart More, Nastazia Solomonidou and Jessica Zaccaria) who helped us in handling subjects and collecting data. Special thanks should be given to Dr. Ihab Tewfik, SAS-projects Director for his professional guidance and invaluable support with feedback during this research.

REFERENCES

Abdullah, A., Stoelwinder, J., Shortreed, S., Wolfe, R., Stevenson, C., Walls, H., de Courten, M. and Peeters, A. (January 2011) 'The duration of obesity and the risk of type 2 diabetes', *Public Health Nutrition*, Vol. 14, No. 1, pp.119–126.

American College of Sports Medicine (2011) *Exercise Your Way to Lower Blood Pressure*, Retreived on 21st of August 201, Available at: http://www.acsm.org/docs/brochures/exercising-your-way-to-lower-blood-pressure.pdf.

Bandura, A. (1994) *Self Efficacy*, in V.S. Ramachaudran (Ed.). *Encyclopedia of Human Behaviour*, pp.71–81, New York: Academic Press.

Bravo, E., Napolitano, M. and Botham, K.M. (2010) 'Postprandial lipid metabolism: The missing link between life-style habits and the increasing incidence of metabolic diseases Western Countries?' *The Open Translational Medicine Journal*, Vol. 2, pp.1–13.

Burke, S.M., Carron, A.V. and Shapscott, K. (September 2008) 'Cohesion in exercise groups: an overview', *International Review of Sport and Exercise Psychology*, Vol. 1 No. 2, pp.107–123.

Blood Pressure UK (2008) *What kinds of Activity are useful for Lowering Blood Pressure?* Retrieved on 6th of June 2013, Available at: http://www.bloodpressureuk.org/Blood Pressure and you/Your lifestyle/Being active/What kinds.

British Heart Foundation (2012) *Coronary Heart Disease Statistics 2012*, Retrieved on 24th of October 2013, Available at: http://www.bhf.org.uk/publications/view-publication.aspx?ps=1002097.

Campbell, N., Reece, J., Urry, L., Cain, M., Wasserman, S. and Minorsky, P. (8th edition) (2008) *Biology*, pp.912–915, San Francisco, USA: Person Education Inc.

Caudwell, P., Hopkins, M., King, N.A., Stubbs, R.J. and Blundell, J.E. (September 2009) 'Exercise alone is not enough: weight loss also needs a healthy (Mediterranean) diet?' *Public Health Nutrition*, Vol. 12, No. 9A, pp.1663–1666.

Caspersen, C.J., Powell, K.E. and Christenson, G.M. (1985) 'Physical activity, exercise and physical fitness', *Public Health Reports*, Vol. 100, pp.125–131.

Clifford, A. (2009) *Self-Efficacy and Exercise Adherence among Adults Completing a 10k Running/Walking Event. Ohio State University*, Retrieved on 10th of August 2013, Available at: https://kb.osu.edu/dspace/bitstream/handle/1811/36505/A_Clifford_Undergraduate_Honors_Thesis.pdf.

Cohen, B., Vittinghoff, E. and Whooley, M. (15 February 2008) 'Association of socio economic status and exercise capacity in adults with coronary heart disease (from the Heart and Soul study)', *The American Journal of Cardiology*, Vol. 101, No. 4, pp.462–466.

Colberg, S., Sigal, R., Fernhall, B., Regensteiner, J., Blissmer, B., Rubin, R., Chasan-Taber, L., Albright, A. and Braun, B. (2010) 'Exercise and Type 2 Diabetes The American College of Sports Medicine and the American Diabetes Association: joint position statement', *Diabetes Care.*

Dehghan, M., Mente, A., Teo, K., Gao, P., Sleight, P. and Dagenais, G. (December 2012) 'Relationship between healthy diet and risk of cardiovascular disease among patients on drug therapies for secondary prevention: a prospective cohort study of 31 546 high-risk individuals from 40 countries', *Circulation*, Vol. 4, No. 126(23), pp.2705–2712, Circulation is the name of the Journal.

Diabetes UK (2012) *Diabetes in the UK: Key Statistics on Diabetes*, Retreived on 28th of August 2013, Available at: http://www.diabetes.org.uk/Documents/Reports/Diabetes-in-the-UK-2012.pdf.

Goodwin, M. (May 2010) 'Blood glucose regulation during prolonged, submaximal, conscious exercise: A guide for clinicians', *Journal of Diabetes Science and Technology*, Vol. 1, No. 4(3), pp.694–705.

Ishikawa-Takata, K., Ohta, T. and Tanaka, H. (August 2003) 'How much exercise is required to reduce blood pressure in essential hypertensives: A dose-response study', *American Journal of Hypertension*, Vol. 16, No. 8, pp.629–633.

Jensen, J., Tantiwong, P., Stuenaes, J., Molina-Carrion, M., DeFronzo, R. and Sakamoto, K. (July 2012) 'Effect of acute exercise on glycogen synthase in muscle from obese and diabetic subjects', *American Journal of Physiology: Endocrinology and Metabolism*, Vol. 1, No. 303(1), pp.E82–E89.

Kang, J., Robertson, R., Hagberg, J., Kelley, D., Goss, F. and DaSilva, S. (April 1996) 'Effect of exercise intensity on glucose and insulin metabolism in obese individuals and obese NIDDM patients', *Diabetes Care*, Vol. 19, No. 4, pp.341–349.

Langstedt, A., Freiberg, J. and Nordestgaard, B. (November 2008) 'Fasting and non fasting lipid levels. Influence of normal food intake on lipids, lipoprotein, apolipoproteins, and cardiovascular risk prediction', *Circulation*, Vol. 11, No. 118(20), pp.2047–2056.

Moreno, J.J. and Mitjavila, M.T. (April 2003) 'The degree of unsaturation of dietary fatty acids and the development of atherosclerosis (Review)', *Journal of Nutritional Biochemistry*, Vol. 14, No. 4, pp.182–195.

National Health Service (NHS) (2013) *Statistics on Obesity, Physical Activity and Diet: England, 2013*, Retrieved on 6th of September 2013, Available at: http://www.bhfactive.org.uk/userfiles/Documents/obes-phys-acti-diet-eng-2013-rep.pdf.

National Health Service, Health Development Agency (NHS) (2005) *The Effectiveness of Public Health Interventions for Increasing Physical Activity Among*

Adults: A Review of Reviews, Retrieved on 25th of October 2013, Available at: http://www.nice.org.uk/nicemedia/documents/physical_activity_adults_ebsummary.pdf.

National Institute for Health and Care Excellence (NICE) (2010) *Lipid Modification: Cardiovascular Risk Assessment and the Modification of Blood Lipids for the Primary and Secondary Prevention of Cardiovascular Disease*, Retrieved on 31st of July 2013, Available at: http://www.nice.org.uk/nicemedia/live/11982/40675/40675.pdf.

Nigam, P.K. (January 2011) 'Serum Lipid Profile: Fasting or Non-fasting?' *Indian Journal of Clinical Biochemistry*, Vol. 26, No. 1, pp.96–97.

Office for National statistics (2011) *Leading Causes of Death in England and Wales, 2009*, Retrieved on 31st of July 2013, Available at: http://www.ons.gov.uk/ons/rel/subnational-health1/leading-causes-of-death/2009/leading-causes-of-death-in-england-and-wales---2009.html.

Rodgers, W.M. and Sullivan, M.J. (July 2001) 'Task, coping and scheduling self efficacy in relation to frequency of physical activity', *Journal of Applied Social Psychology*, Vol. 31, pp.741–753.

Schwarzer, R., Luszczynska, A., Ziegelmann, J.P., Scholz, U. and Lippke, S. (January 2008) 'Social – Cognitive Predictors of physical exercise adherence: three longitudinal studies in rehabilitation', *Health Psychology*, Vol. 27 (1 Suppl), pp.S54–S63.

Söderlund, A., Fischer, A. and Johansson, T. (May 2009) 'Physical activity, diet and behavior modification in the treatment of overweight and obese adults: a systemic review', *Perspective in Public Health*, Vol. 129, No. 3, pp.132–142.

Warren, T., Barry, V., Hooker, S., Sui, X., Church, T. and Blair, S. (May 2010) 'Sedentary behaviors increase risk of cardiovascular disease mortality in men', *Medical Science Sport Exercise*, Vol. 42, No. 5, pp.879–885.

World Cancer Research Fund/American Institute for Cancer Research (2007) *Food, Nutrition, Physical Activity, and the Prevention of Cancer: A Global Perspective,* Washington, DC: AICR.

World Health Organisation (WHO) (2013) *Health Topics; Physical Activity,* Retrieved on 14th of October 2013, Available at: http://www.who.int/topics/physical_activity/en/.

Wu, B. and Lin, J.C. (2006) *Effects of Exercise Intensity on Excess Post-Exercise Oxygen Consumption and Substrate Use After Resistance Exercise*, Retrieved on 21st of October 2013, Available at: http://www.scsepf.org/doc/281206/04-JESF-0402.pdf.

BIOGRAPHICAL NOTES

Ewa Hammarberg is a Member of The Association for Nutrition Society, UK and holds a first class honours BSc in Human Nutrition from the University of Westminster. One of her latest projects evaluated human subject's physiological responses to meal replacement shakes that were aimed for weight loss. After University, she started working within the food industry and a well established company. However, now working as a Medical Information Professional, she utilises her nutritional scientific background to provide accurate and rightful information to various healthcare sectors around the world.

Regina Papp holds a First Class honours BSc degree from the University of Westminster. After having worked as a financial analyst for years, her attention turned to health and nutrition. Currently working for Action for Blind People, her focus of research is how nutrition can help prevent or slow sight loss with further interest in how nutrition influences health outcomes and health risks to individuals and communities. She is an Associate Nutritionist registered with the Association for Nutrition.

Andi Gaywood been employed as a Family Cards Worker and Social Work Instructor he went on to work in the field of IT and banking. During this time he developed a keen interest in nutrition, obesity and healthy living which motivated him to undertaking, and achieving a first class honours in a human nutrition degree. He has been a vegan for over 25 years and used to be a contact for the national Vegan Society helping others who are interested in veganism and its many intricacies. In the future he wants to investigate affordable food for people living on the breadline and to implement healthy living interventions in populations where money and time are scarce.

Jean Pierre Ferraroli worked as a Registered General Nurse – RGN with Medecins Sans Frontieres (Doctors Without Border) in war zones, refugees camp, famine area and development project from Central America to East Africa. He then Graduate with an MSc in Public Health with the University of Nancy (France). He worked at the University of Westminster for many years as a Senior Technician in Biomedical Sciences covering subjects as Haematology, Immunology and Blood Transfusion. For the last five years he has moved to the Nutrition and Exercise Physiology department. He is also involved in research program with prediabetic subjects and run a private consultancy in body composition testing with the Bod Pod method (a method for determining the lean body mass).

Dr. Ihab Tewfik is the Programme Leader of Human Nutrition (UG), Department of Life Sciences, University of Westminster. Besides his biochemistry background, he holds Master and Doctorate in Public Health, Nutrition department, University of Alexandria in addition to PhD from London South Bank University. He is a Registered Practitioner in Higher Education – UK, as well as Fellow of the Royal Society of Public Health (FRSPH). He has carried out 11 research projects for UNICEF-UN in aspects of public health nutrition and food safety and has published a number of publications in refereed journals and international conferences. As a Registered Public Health Nutritionist, he has organised several international conferences, workshops, CPD and short training courses on Nutrition related diseases and Public Health. He is Member of the Editorial Advisory Board of various international scientific journals.