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EFFECTS OF A WORKPLACE EXERCISE INTERVENTION ON CARDIOMETABOLIC HEALTH: RANDOMIZED CONTROLLED TRIAL

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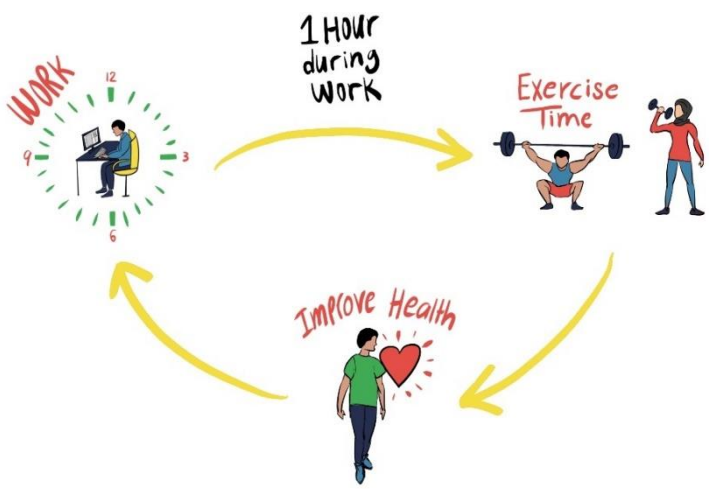

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This dissertation is submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Public Health

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Cover image: Workplace exercise intervention aiming to improve health.

(Image: Drawn by Noora Moosa)

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Declaration of Original Work

I, Ali Muneer Mohamed Al Rahma, the undersigned, a graduate student at the United Arab Emirates University (UAEU), and the author of this dissertation entitled "*Effects of a Workplace Exercise Intervention on Cardiometabolic Health: Randomized Controlled Trial*", hereby, solemnly declare that this dissertation is my own original research work that has been done and prepared by me under the supervision of Dr. Javaid Nauman, in the College of Medicine and Health Sciences at UAEU. This work has not previously formed the basis for the award of any academic degree, diploma or a similar title at this or any other university. Any materials borrowed from other sources (whether published or unpublished) and relied upon or included in my dissertation have been properly cited and acknowledged in accordance with appropriate academic conventions. I further declare that there is no potential conflict of interest with respect to the research, data collection, authorship, presentation and/or publication of this dissertation.

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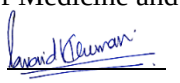
   Signature  Date 12/6/2022

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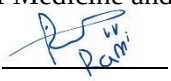
   Signature  Date 14/6/2022

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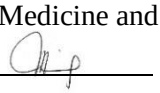
   Signature  Date 13/6/2022

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Abstract

Brief Introduction: The worldwide rising levels of physical inactivity, especially in the United Arab Emirates (UAE) and the Eastern Mediterranean region, are alarming. The UAE reports one of the highest rates of mortality due to non-communicable diseases, and insufficient physical activity is a major underlying cause. Therefore, action is required to reduce physical inactivity using evidence-based strategies.

Aims: To evaluate the effect of a 12-week workplace structured exercise intervention on cardiometabolic risk factors and to determine whether the workplace exercise intervention improves physical activity levels four weeks post-intervention.

Methods: This is a pragmatic parallel, randomized controlled trial with a 1:1 allocation ratio to the intervention group and delayed intervention group (control group). A total of 130 participants were recruited from a semi-government telecommunications company in Dubai, UAE, after fulfilling the eligibility criteria. The intervention group received two hours of weekly exercise during working hours for 12 weeks (maximum one hour per day) under the supervision of a certified exercise trainer. At the end of 12-weeks (intervention period), the delayed intervention group received two hours of weekly exercise time from working hours for four weeks. The main outcome measure was the change in the cardio-metabolic risk factors, i.e., systolic or diastolic blood pressure, waist circumference, fasting plasma glucose, high-density lipoprotein cholesterol, and triglycerides from baseline to the end of the intervention. The secondary outcome was to examine the workplace exercise intervention effect on physical activity levels four weeks post-intervention.

Results: We did not find a statistically significant change in our primary outcomes between the two groups. However, the within-group mean change in the intervention group at week 12 was statistically significant for fasting plasma glucose [−3.3 mg/dL (95% CI, −6.5 to −0.02)], HbA1c [0.3% (95% CI, 0.2 to 0.4)], HDL cholesterol [2.2 mg/dL (95% CI, 0.6 to 3.8)], waist circumference [−4.5 cm (95% CI, −6.1 to −2.9), body fat percentage [−1.1% (95% CI, −2.1 to −0.1), WHO Wellbeing score [2.8 (95% CI, 1.6 to 3.9)], and vigorous physical activity [9.8 minutes (95% CI, 1.3 to 18.3)]. For the secondary outcomes, the mean changes in the intervention group at week 16 were statistically significant compared with baseline: sitting time [−1.1 hour (95% CI, −1.8 to −0.3) and vigorous physical activity [11.8 minutes (95% CI, 1.9 to 21.5)]. Significant Contributions: To provide exercise time at the workplace and during working hours can improve employees' cardiometabolic health and physical activity levels. Gap Filled: This study addresses a critical public health issue related to the health of workers in an office setting. Applying a multilevel health-promoting approach in the workplace environment enhances employees' health conditions.

Trial Registration: ClinicalTrials.gov ID NCT04403789

Keywords: Workplace exercise, exercise, health benefits of exercise, physical activity, randomized controlled trial, cardiovascular diseases, cardiometabolic risk factors, and heart disease risk factors.

Title and Abstract (in Arabic)

تأثير التدخل الرياضي في مقر العمل على عوامل الاختطار القلبية: تجربة عشوائية مضبوطة

الملخص

مقدمة موجزة: إن المستويات المتزايدة من الخمول البدني في جميع أنحاء العالم، وخاصة في دولة الإمارات العربية المتحدة والشرق المتوسط ، تنذر بالخطر. كما تبلغ في دولة الإمارات العربية المتحدة أحد أعلى معدلات الوفيات من الأمراض الغيرالسارية، ويُعد قلة النشاط البدني سببًا رئيسيًا لها. ولذلك، من الضروري اتخاذ إجراءات مدعومة بالأدلة العلمية لتقليل الخمول البدني.

الأهداف: تتمثل أهداف الدراسة في تقييم أثر التدخل المنظم لمدة 12 أسبوعاً في مقر العمل على عوامل الاختطار القلبية لدى الموظفين وقياس ما إذا كان التدخل الرياضي في مقر العمل سيحسن من مستويات النشاط البدني بعد مرور أربعة أسابيع من انتهاء التدخل.

منهجية الدراسة: هذه تجربة عشوائية مضبوطة وموازية، مع نسبة تقسيم 1:1 لمجموعة التدخل ولمجموعة التدخل المؤجل. تم تعيين 130 مشاركًا من شركة شبه حكومية في مجال الاتصال في دبي (دولة الإمارات العربية المتحدة) بعد استيفاء استيفائهم لمعايير الدراسة. تلقت مجموعة التدخل على ساعتين لممارسة النشاط البدني من ساعات العمل في كل أسبوع ولمدة 12 أسبوع (بحد أقصى ساعة واحدة يوميًا). كما أنه تم تعيين المشاركين في هذه المجموعة لحضور جلسات جماعية مع مدرب رياضة مرخص طوال فترة التدخل. بعد انتهاء مدة التدخل، تلقت مجموعة التدخل المؤجل على ساعتين من ساعات العمل كل أسبوع ولمدة أربعة أسابيع لممارسة النشاط البدني. مقياس النتائج الرئيسية في الدراسة هو التغيّر في عوامل الاختطار القلبية، مثل ضغط الدم الانقباضي أو الانبساطي ومحيط الخصر وجلوكوز البلازما الصوم وكوليسترول البروتين الدهني عالي الكثافة والدهون الثلاثية من بداية التدخل وحتى نهايته. وأما مقياس النتائج الثانوية هو مدى تأثير التدخل الرياضي في مكان العمل على مستويات النشاط البدني بعد أربعة أسابيع من انتهاء التدخل.

النتائج: تُشير النتائج الرئيسية على عدم وجود تغيير ذو دلالة إحصائية بين المجموعتين. ولكن تُشير النتائج على وجود تغيير ذو دلالة إحصائية في مجموعة التدخل في الأسبوع الثاني عشر في كل من النتائج التالية: جلوكوز البلازما الصوم [3.2− mg/dL (6.5− الى 0.02− مدى الثقة 95%)]، الهيموغلوبين السكري A1C [0.3% (0.2 الى 0.4 مدى الثقة 95%)]، كوليسترول البروتين الدهني عالي الكثافة [2.2 mg/dL (0.6 الى 3.8 مدى الثقة 95%)]، محيط

الخصر[4.5− سم (6.1− الى 2.9− مدى الثقة 95%)]، نسبة الدهون في الجسم [1.1%− (2.1− الى 0.1− مدى الثقة 95%)]، مؤشر العافية (منظمة الصحة العالمية) [2.8 (1.6 الى 3.9 مدى الثقة 95%)] و النشاط البدني القوي [9.8 دقائق (1.3 الى 18.3 مدى الثقة 95%)]. كما تُشير النتائج الثانوية على وجود تغيير ذو دلالة إحصائية في مجموعة التدخل في الأسبوع السادس عشر في كل من النتائج التالية: وقت الجلوس [1.1− ساعة (1.8− الى 0.3− مدى الثقة 95%)] و النشاط البدني القوي [11.8 دقائق (1.9 الى 21.5 مدى الثقة 95%)]. مساهمة الدراسة المهمة: يؤدي تخصيص الوقت لممارسة الرياضة في مقر العمل الى تحسين عوامل الاختطار القلبية وزيادة مستويات النشاط البدني للموظفين. سد الفجوة: تعتبر هذه الدراسة مهمة في مجال الصحة العامة لتركيزها على تحسين صحة الموظفين في العمل المكتبي. كما يؤدي تطبيق دراسة متعددة المستويات كهذه الى تعزيز الصحة في مقر العمل وتحسين الحالة الصحية للموظفين.

رقم تسجيل التجربة: ClinicalTrials.gov ID NCT04403789

مفاهيم البحث الرئيسية: الرياضة في مقر العمل، الرياضة، الفوائد الصحية من الرياضة، النشاط البدني، تجربة عشوائية مضبوطة، أمراض القلب والأوعية الدموية، عوامل الاختطار القلبية، عوامل الخطر لأمراض القلب.

Author's Contribution

The contribution of Ali Al Rahma to the dissertation was as follows:

I. Participated in planning of the work, had main responsibility for the intervention work, data collection and processing, and evaluation of results.

II. Responsibility for writing up the thesis dissertation draft.

Author Profile

Ali Al Rahma is currently a full-time PhD student, working as a graduate teaching assistant in the Institute of Public Health, College of Medicine and Health Sciences, UAE University. In addition, he has been teaching and supervising medical students in public health clerkship. Furthermore, he is teaching Master of Public Health (MPH) students in the Health Promotion and Disease Prevention course. His first-author publication was in the BMJ Open, where he published the protocol for this randomized controlled trial. Ali is also one of the founding and board of directors members for the Emirates Public Health Association. He was assigned to the secretary-general role in the association in 2019. Ali also has experience as a senior health educator in Dubai Health Authority (DHA) for almost six years. He worked on several projects that aimed to improve community health in the emirate of Dubai, UAE. Some of the DHA projects he worked on include Tobacco Free Dubai, Happiness Prescription (lifestyle intervention), Diabetes Prevention Framework, and Smart Clinics (virtual). Ali was awarded in the “You Are Our Pride” program for DHA in the category: Special Honorary Reward in 2018. He was also recently certified as a project management professional (PMP) by the Project Management Institute, United States. Finally, Ali is also a certified trainer from DHA and Alpha UK Training, where he can conduct health and non-health-related workshops.

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Finally, I would like to thank my beloved family, especially my parents and my wife, who have supported me from the beginning and have helped me stay strong and patient throughout this journey, a huge thank you to them.

Dedication

To Allah, for his bountiful blessings. To my beloved parents, wife, and children.

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List of Abbreviations

CRF	Cardio-Metabolic Risk Factor
DI	Delayed-Intervention Group
ENWHP	European Network for Workplace Health Promotion
HDL	High-Density Lipoprotein
IN	Intervention Group
IPAQ	International Physical Activity Questionnaire levels
LDL	Low-Density Lipoprotein
MAR	Missing at Random
PA	Physical Activity
SEM	Social-Ecological Model
UAE	United Arab Emirates
WHO	World Health Organization

Chapter 1

Chapter 1: Introduction

1.1 Overview

The rising levels of physical inactivity in the Eastern Mediterranean region (43%) and in the United Arab Emirates (38%) are alarming and are comparable with the global levels of insufficient physical activity (PA) (31%) (Guthold et al., 2018; WHO, 2016). Low levels of PA are associated with various diseases and morbidities (Kyu et al., 2016; Virtanen et al., 2018). In contrast, PA participation lowers the risk of cardio-metabolic diseases and improves general health status (Guo et al., 2015).

One of the most prominent factors affecting PA is the environment that surrounds the individuals (Dowell & Farley, 2012). For example, the World Health Organization (WHO) Global Action Plan on Physical Activity (GAPPA) 2018-2030 considers the workplace environment as a factor that could promote PA (WHO, 2018).

The increase in sedentary occupations has contributed to the total rise in physical inactivity levels in most countries (Bauman et al., 2012). Therefore, interventions to increase PA in the workplace are recommended. This dissertation reported the results obtained from an exercise intervention trial in the workplace. The findings are of great importance for public health and to the UAE government as it is aligned with the UAE Vision 2021 National Agenda along with Dubai's Crown Prince, His Highness Sheikh Hamdan bin Mohammed bin Rashid Al Maktoum initiatives for PA (Hamdan bin Mohammed, 2019; The United Arab Emirates' Government portal, 2019).

1.2 Statement of the Problem

Overwhelming evidence shows that insufficient PA is associated with many chronic diseases such as circulatory diseases, depressive disorders, musculoskeletal diseases, diabetes, breast cancer, and diseases of the digestive system, and contributes to a financial burden on health systems and on individuals worldwide (Das & Horton, 2016; Ding et al., 2016; Kyu et al., 2016; Piercy et al., 2018; Virtanen et al., 2018; WHO, 2020; Wisloff & Lavie, 2017). On the contrary, regular PA may serve as an effective and cost-effective non-pharmacological therapy that improves health by reducing the prevalence of different co-morbid conditions, including hypertension, overweight, and obesity, as well as lowering the risk of death from cardiovascular disease (CVD), and improving the quality of life and mental health (Fletcher et al., 2018; Kraus William E. et al., 2015; Piercy et al., 2018; Wisloff & Lavie, 2017). The workplace environment is a vital arena that could promote PA and improve overall health (WHO, 2009, 2018, p. 20). Therefore, the objective of this dissertation is to implement a workplace exercise intervention to improve cardio-metabolic risk factors (CRF) and PA levels.

1.3 Research Questions

Primary Question:

Does receiving exercise time during working hours in the workplace improve cardio-metabolic health?

Secondary Question:

Does receiving exercise time during working hours in the workplace continue to improve physical activity?

1.4 Research Hypotheses

Primary Hypothesis 1

Null: There are no statistically significant mean changes in the cardiometabolic risk factors between the groups.

Alternative: There are statistically significant mean changes in the cardiometabolic risk factors between the groups.

Primary Hypothesis 2

Null: There are no statistically significant mean changes in the cardiometabolic risk factors within the intervention group.

Alternative: There are statistically significant mean changes in the cardiometabolic risk factors within the intervention group.

Secondary Hypothesis

Null: There are no statistically significant mean changes in the physical activity levels within the intervention group.

Alternative: There are statistically significant mean changes in the physical activity levels within the intervention group.

1.5 Research Objectives

Primary objective

To evaluate the effect of a 12-week workplace structured exercise intervention on CRFs.

Secondary objective

To determine whether the workplace exercise intervention can improve PA levels four weeks post-intervention.

1.6 Literature Review

1.6.1 Physical Activity and Health

Regular moderate-to-vigorous PA is associated with many health benefits. These benefits are sometimes attained immediately or require weeks and months. For example, some of these immediate health benefits of PA include reduced blood pressure and lowering of anxiety, along with improvements in insulin sensitivity and sleep. In contrast, an increase in muscular strength and cardiorespiratory fitness, prolonged reduction in blood pressure, and decreases in depression symptoms may require weeks or months of PA engagement. In addition, increasing PA and reducing sitting time reduces all-cause mortality, as shown in Figure 1 (Bull et al., 2020; Ekelund et al., 2016; U.S. Department of Health and Human Services, 2018; WHO, 2020).

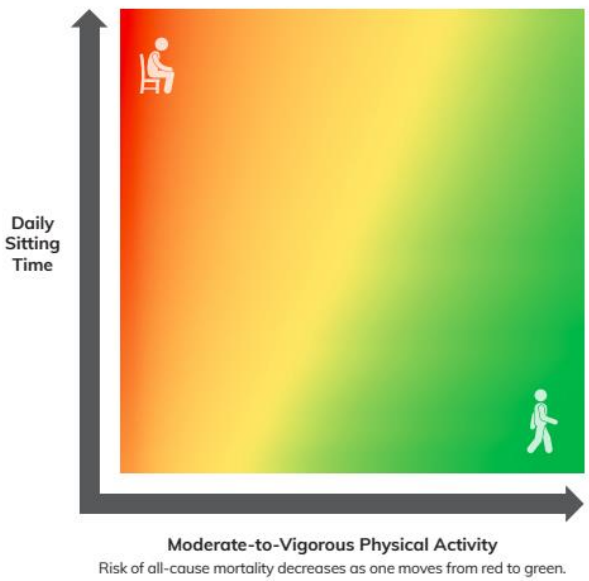

Figure 1: Relationship of Physical Activity, Sitting Time, and All-cause Mortality Risk in Adults.

Reused with permission (Ekelund et al., 2016; U.S. Department of Health and Human Services, 2018).

Moreover, the minimum PA recommendations for adults aged 18-64 years are 150-300 minutes of moderate-intensity aerobic PA or 75-150 minutes of vigorous-intensity aerobic PA per week. An equivalent combination of moderate and vigorous intensities per week is also sufficient (Bull et al., 2020; U.S. Department of Health and Human Services, 2018; WHO, 2020). For additional health benefits, adults are advised to add two or more days per week for muscle-strengthening activities that involve all major muscle groups (with moderate or greater intensity). For further benefits, aerobic PA can be extended to more than 300 minutes of moderate-intensity and more than 150 minutes of vigorous-intensity per week (or an equivalent of both) (Bull et al., 2020; WHO, 2020).

Furthermore, PA's highest impact on health benefit gains is notably significant for those currently doing low activity levels, as illustrated in Figure 2. The health benefits also proportionally improve per every additional minute of PA. Therefore, the more time a person is physically active, the more health benefits (UK Government Department of Health and Social Care, 2019).

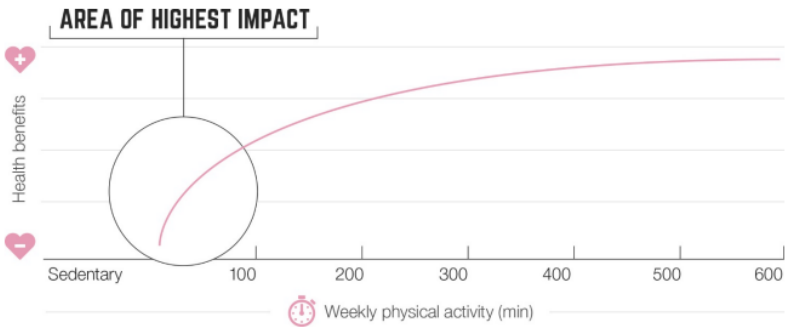

Figure 2: Dose-response Relationship between Weekly Physical Activity and Health Benefits.

Reused with permission (UK Government Department of Health and Social Care, 2019)

1.6.2 Cardio-metabolic Risk Factors and Physical Activity

CRFs are a group of risk factors that increase the risk of chronic non-communicable diseases (e.g., diabetes, cardiovascular diseases) (Cannon, 2007; Nichols, 2017). CRFs include but are not limited to elevated waist circumference, elevated blood pressure, reduced high-density lipoprotein (HDL) cholesterol, and pre-diabetes (elevated fasting plasma glucose) (Alberti et al., 2009; Cannon, 2007; Grundy Scott M. et al., 2018a, 2018b; Klein et al., 2007; Nichols, 2017; WHO, 2008).CRFs are illustrated in Figure 3. PA is vital in improving the outcome of these risk factors. The findings of interventional studies have clearly shown a beneficial effect of PA in clinical or community settings (Arija et al., 2017; Heath et al., 2012; Marcus Bess H. et al., 2006). For instance, one of the community setting studies was a multicentred, randomized controlled community trial involving 364 patients in four different primary care centers (Arija et al., 2017). The study's intervention consisted of 120 minutes per week of walking and other social-cultural activities once a month for nine months for the intervention group (Arija et al., 2017). The

study reported a significant beneficial change in systolic blood pressure, low-density lipoprotein (LDL) cholesterol, and total cholesterol (Arija et al., 2017). In contrast, there is limited evidence for the effectiveness of PA interventions in worksite settings where individuals spend the majority of their waking hours. In addition, a study in the UAE with a sample of 390 participants showed that the major self-reported barriers to PA were disease burden (32%), lack of time to exercise (29%), cultural reasons (29%), and other reasons (Al-Kaabi et al., 2009). The study concluded that interventions should aim to overcome these barriers to increase PA. Reis et al. (2016) stated that there is a demand for improving programs, policies, places, and systems that encourage people to sustain active lives. In addition, authorities should implement multilevel and multisectoral interventions to increase PA levels (Reis et al., 2016).

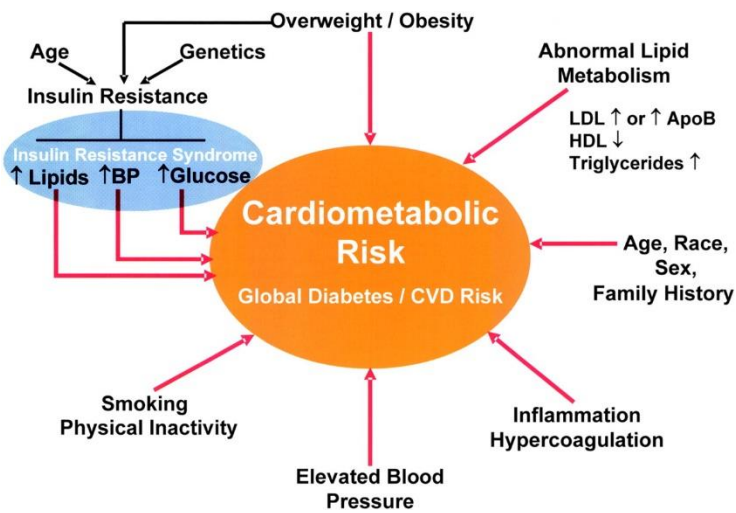

Figure 3: Factors that Predict Cardiovascular Diseases and Global Diabetes Mellitus.

ApoB= apolipoprotein B; BP= blood pressure. Reused with permission (Kahn, 2007)

1.6.3 Physical Inactivity in the Workplace

The environment is considered an important factor that affects PA (Dowell & Farley, 2012). An environment could include the workplace, school setting, public places (beaches, neighborhoods, and parks), sports facilities, family and community centers (WHO, 2018). The WHO's 2018-2030 Global Action Plan on Physical Activity considers the workplace environment a vital arena that could promote PA (WHO, 2018, p. 20). In addition, the WHO stated that the workplace is an ideal setting to provide planned and structured activities for employees to improve their overall health (WHO, 2009).

A systematic review relating to workplace PA interventions included four narrative reviews and one meta-analysis related to the workplace (Heath et al., 2012). The findings showed that the majority of studies included in the narrative reviews were of poor methodological quality (Chau et al., 2010; Engbers et al., 2005; Proper et al., 2002, 2003), showed inconclusive results (Proper et al., 2003), or focused on analyzing sitting time instead of low levels of PA (Chau et al., 2010). The meta-analysis included PA interventions with various study designs, showed the lack of randomized clinical trials in the workplaces, and reported that objective measurements were rare among the studies included. In addition, the meta-analysis found that only 27% of the included studies had supervised exercise sessions for the participants (Conn et al., 2009). Furthermore, a worksite intervention investigated daily walking time between employees that used treadmill workstations (intervention group) and sit-stand desks (Bergman et al., 2018). The study reported that although the primary goal was not met, there was a significant increase in daily walking time in the intervention group (an increase of 18 minutes from baseline to 13 months) (Bergman et al., 2018). However, data remain

scarce for PA intervention studies in the workplace, and there is a need for more evidence-based interventions in the workplace that examine their effect on metabolic risk factors (Proper et al., 2002).

The European Network for Workplace Health Promotion (ENWHP) recommends a set of criteria for promoting PA in the workplace (Guazzi et al., 2014). The criteria include implementing approaches that encourage PA during working hours, weekends, and non-working hours. In addition, the ENWHP recommends providing easily accessible PA facilities and programs in the workplace or at least in external sports facilities. The final recommendation is to raise employees' awareness through extensive information about the importance of PA (Guazzi et al., 2014).

Furthermore, health behavior models such as the Social Ecological Model (SEM) are used to understand the multidimensional and interactive effects of different factors on behavior (UNICEF, 2004). The model identifies organizational and behavioral relationships for health promotion interventions within an organization. There are five levels of the SEM. They include the following: 1) individual level, 2) interpersonal level, 3) community level, 4) organizational level, and the 5) policy/enabling environment level (UNICEF, 2004). UNICEF (2004) stated that the most effective public health prevention and control approach should use a combination of all levels of the SEM.

Moreover, the UAE government advocates the importance of PA and a healthy lifestyle. For instance, in the National Agenda Vision 2021, the UAE aims to promote healthy and long life not only through health services but also through prevention and awareness of healthy lifestyle behaviors (United Arab Emirates, 2010). In addition, the National Agenda aims to prevent disease through early interventions that lead to behavior

change and consequently improve general health status and quality of life (United Arab Emirates, 2010). For example, the UAE has a set of key performance indicators, such as reducing the number of deaths per 100,000 for cardiovascular diseases and decreasing the prevalence of diabetes and obesity among children (United Arab Emirates, 2019). These indicators show that preventing cardiovascular diseases and diabetes is one of the top priorities in Vision 2021. Moreover, the Crown Prince of Dubai, Sheikh Hamdan bin Mohammed bin Rashid Al Maktoum emphasized that all sectors should launch new & innovative initiatives that promote a healthy lifestyle and PA in Dubai. Sheikh Hamdan views these initiatives as part of the UAE's vision of a happy and healthy society (Hamdan bin Mohammed, 2019).

Therefore, as Kohl et al. (2012) reported, the urge for system-based approaches (e.g., that focus on populations) is the way forward to increase PA. These approaches focus on several correlates of physical inactivity when compared to individually-focused approaches, which concentrate on behavioral science mainly (Kohl et al., 2012). As a result, we aim to conduct a randomized clinical study following the ENWHP recommendations and SEM model aspects to examine the effects of a workplace exercise intervention on cardio-metabolic health and PA.

Chapter 2

Chapter 2: Research Methods

2.1 Research Design

The study is a pragmatic parallel, randomized controlled trial with a 1:1 allocation ratio to the intervention group (IN) and control (delayed intervention- DI) group. Participants' enrolment started on the 28th of March 2021, and the study ended on the 30th of November 2021.

2.2 Study Setting

The study was conducted in the headquarters building of a semi-government telecommunications company in Dubai, UAE (du, Emirates Integrated Telecommunications Company, PJSC). The headquarters building includes a gym, health center, and a swimming pool (6.14 meters in length and 4.10 meters in width). The gym is dedicated for du employees only. It includes a wide range of exercise equipment and facilities such as free weights, weight machines, rowing machines, treadmills, cycle ergometers, and space for group classes. The workplace gym facility was the only study site. In addition, the company's employees have a dedicated health center for them in the du headquarters. The health center provides both preventive and curative services. Preventive services include screening, vaccination, and health education. Curative services include managing all acute and chronic illnesses from consultation to blood tests and writing prescriptions (licensed family medicine clinic).

2.3 Eligibility Criteria

The eligibility criteria for participants to join the workplace intervention included (inclusion criteria):

1. Participants must be an employee in the company and have a waist circumference of ≥94 cm (≥90 cm for South and East Asians) for males and ≥ 80 cm for females.
2. Aged 18 to 59 years old.
3. Available for the study duration.
4. Participants were willing to commit to the intervention until the end.
5. Signed written consent to participate.

Exclusion criteria include:

1. Severe injury in the joints or the back or any medical condition prevented them from exercising, or the participant was advised not to exercise by a doctor.
2. Pregnant.
3. Any planned major surgical procedures during the intervention period.
4. Self-reported cardiovascular disease, lung disease, or cancer.
5. Currently participating in another health promotion program.

(Finucane et al., 2010; Tjønna et al., 2018)

2.4 Recruitment

An email invitation to attend two information sessions was sent to all of the company's employees in Dubai, UAE. The invitation emphasized that participation is voluntary and that they can withdraw at any time without giving any reason. The first information session was held on the 2nd of February 2021. This session promoted the study and discussed the importance of nutrition and PA. Personal trainers were also involved in the first session to answer PA and nutrition-related questions. The second

information session discussed all the details of the study (e.g., eligibility criteria, study overview, and intervention details), and all questions were answered during the session. All employees who wanted to participate and were eligible were given an appointment in the worksite health center to complete the required baseline health measurements. During the health center appointments, the trained nurses and researchers distributed participant information leaflets and explained the study details. The information leaflet contained the purpose of the study, eligibility criteria, participation benefits, and facilitators' contact details. If the participant agreed to participate in the study, they were required to sign a consent form. A sample of the consent form and the participant information leaflet are found in Appendix A.

Furthermore, we did not offer any monetary compensation to participants. However, we offered free (non-monetary) sports gift vouchers and participation certificates to improve the low recruitment rates. The vouchers were also used to encourage participants to complete the post-study health measurements. The winners were announced via an email sent to all participants.

2.5 Intervention

The intervention duration was 12 weeks and provided exercise time of two hours per week during working hours. The two hours were used on two separate days per week (a maximum of one hour per day), either in the middle or at the end of the working hours. The intervention duration was chosen based on recommendations from previous studies that showed that 12 weeks were adequate to observe significant changes in the selected cardiometabolic outcomes (Finucane et al., 2010; Heath et al., 2012). The certified exercise trainers conducted and supervised the exercise sessions for the IN group in the workplace. In addition, outlook

calendar invitations and WhatsApp broadcast reminders were sent to the IN group to remind them to attend the sessions.

Furthermore, the exercise types and durations in the exercise sessions were based on the American College of Sports Medicine recommendations (Klika & Jordan, 2013). In every exercise session, all major muscle groups were targeted. Each one-hour session was conducted as a moderate to high-intensity interval training and started with 5 minutes of warm-up exercises, then 50 minutes of resistance and aerobic exercises, and finally ended with 5 minutes of cool-down exercises. For example, some of the resistance/aerobic exercises include goblet squat, push-ups, band pull-a-part, overhead press, lateral raise, box dips, band curls, hollow-body holds, and glute bridge. The certified trainers supervised the resistance and aerobic exercises in 7 to 10-minute bouts (Klika & Jordan, 2013). The DI group was asked to maintain their usual lifestyle. However, when the 12-week intervention period ended, the DI group received two hours of exercise time per week from working hours for four weeks.

2.5.1 Comparators

Intervention Group: The duration of the intervention is 12 weeks, and certified exercise trainers supervised the group sessions during working hours.

Delayed Intervention Group (active comparator): usual routine during the period of 12-weeks, and after this period, this group was given two hours of exercise per week for a 4-week duration during working hours. However, certified trainers did not supervise their sessions.

The main difference between the IN group and the DI group is the timing and duration of the intervention. In addition, the certified trainers were only available for the IN group. The purpose of the DI group was to

encourage participants to participate in the study regardless of their group allocation.

2.6 Sample Size Calculation

Previous studies relating to PA and CRFs used 80% to 91% power and effect sizes ranging between 0.51 and 1.82 to find a significant difference between groups (Irving et al., 2008; Molmen-Hansen et al., 2012; Tomeleri et al., 2016, 2018). There were various reasons for choosing these articles for sample size calculations. For example, one study used a 12-week PA intervention that involved healthy adult participants (Tomeleri et al., 2018). In addition, the articles cited were concerned with the effect of exercise on specific metabolic risk factors. These metabolic risk factors were waist circumference, systolic blood pressure, fasting glucose, and lipid profiles (Irving et al., 2008; Molmen-Hansen et al., 2012; Tomeleri et al., 2016, 2018). For the present study, it was estimated that 124 participants were required at 80% power. It was also planned that a further 20% more participants would be added because it is expected that participants might drop out during the intervention. Therefore, the recruitment of a total of 150 participants was anticipated. During the period between the 28th of March 2021, and the 19th of May 2021, we recruited a total of 130 participants who fulfilled the eligibility criteria. Further efforts were made to attract more participants to enroll in the study through email invitations, internal announcements, and displaying information leaflets in the elevators, parking areas, restaurants/cafes in the building, and upon no substantial interest from the potential participants, we decided to end the recruitment phase of the trial.

2.7 Allocation Sequence Generation

Enrolled eligible participants were randomized 1:1 to IN group (n=65) and DI group (n=65). The randomization sequence was computer

generated using statistical software Stata for Windows (Version 15.1, StataCorp LLC, Texas, USA) and was stratified by sex and age using random block sizes of 4 and 6 to minimize selection bias. Stratification cut-off values in sex were male and female and 22-36 (1^{st} percentile) and 37-52 (2^{nd} percentile) in age groups. A biostatistician was responsible for this task and was not related to any part of the study.

2.8 Allocation Concealment Mechanism

In order to minimize allocation bias, the biostatistician concealed the allocation sequence using computerized random block sizes as mentioned above. Therefore, the study assessors were not involved in the allocation generation and allocation sequence. Instead, the assessors were only involved in the implementation of the assignments.

2.9 Blinding

Single blinding was used to minimize performance bias. The IN group was renamed Group A and the DI group as Group B to blind participants from the intervention. Participants were strongly encouraged not to disclose their allocation status during the health measurement assessments. In terms of un-blinding participants, it was not required for this study.

2.10 Outcomes

The primary outcomes in the study included the following CRFs: elevated waist circumference, elevated blood pressure, reduced HDL cholesterol, elevated triglycerides, and pre-diabetes (elevated fasting glucose). The secondary outcome was the PA levels measured both through responses to questionnaires and through accelerometry. The measurement of CRFs were for both groups before and after the intervention period. However, four weeks after completing the

intervention, only PA levels were assessed for the third time for the IN group.

2.11 Measurements

Trained nurses in the workplace's health center conducted the measurements related to anthropometric data (age, weight, height, waist circumference), questionnaire-based data, clinical measurements, and performed the phlebotomy. The primary health outcomes and their criteria are shown in Table 1. The secondary outcomes are shown in Tables 2 and 9 (Table 9 in Appendix B).

2.11.1 Anthropometry Data

Waist circumference was measured in centimeters using a measurement tape. The nurses placed the tape above the participants' hipbones in a standing position. The measurement was taken when the tape was not compressed on the skin and after breathing out. A body composition machine measured body mass in kilograms, height in centimeters, body fat percentage, and skeletal muscle mass in kilograms (Inbody 230, Korea; with built-in height measurement tool BSM370, Korea). The participants had to empty their pockets and remove their shoes for the body composition measurements.

2.11.2 Clinical Measurements

A butterfly needle was used to collect blood samples for HbA1c, fasting blood glucose, and lipid profiles after 12-hours of fasting. The drawn blood samples were then stored in a −20°C or colder freezer and sent to analysis (Automated HbA1c analyzer FORA A1C100, UAE; Glucose and Cholesterol meter SD LipidoCare, South Korea). In addition, resting diastolic and systolic blood pressure (Omron, Japan) was measured

once after the participants sat for at least 5 minutes on a chair with back support.

2.11.3 Questionnaire-based Data

The validated WHO-5 Well-Being Index questionnaire, as well as other questionnaires that measure the frequency of food consumption, eating habits, and PA [International Physical Activity Questionnaire (IPAQ)] were used at baseline and post-study (Cheikh Ismail et al., 2020; International Physical Activity Questionnaire, 2005; Topp et al., 2015). However, the IPAQ was also used for the third time, 4-weeks post-study for the IN group. IPAQ cut-off points are illustrated in Table 9 in Appendix B. All questionnaires were completed using Samsung tabs at baseline, post-study, and 4-weeks post-study measurements. Appendix A displayed all of the surveys mentioned above.

2.11.4 Accelerometer

Furthermore, for objective PA measurements, all participants wore the tri-axial accelerometer (AX3 Axivity, UK) on the dominant wrist (hand used to write) for eight consecutive days (baseline and post-intervention), similar to previous studies (Doherty et al., 2017; Kim et al., 2019). The IN group only wore the accelerometer once more, at 4-weeks post-study measurements. The accelerometer devices were configured to capture three-dimensional acceleration at 100 Hz with a dynamic range of ±8 g. In addition, the devices were programmed to record data at the pre-specified start and finish times. Participants were informed about the specifications of the accelerometer and instructions on how to use it.

Table 1: Measurement Criteria for Cardio-metabolic Risk Factors

Health Outcome	Criteria
Elevated Waist circumference (cm)	≥ 94 cm for Europid, Middle Eastern, Sub-Saharan African males ≥ 90 cm for Asian, Ethnic Central and South American males ≥ 80 cm for females
Elevated Blood Pressure (mmHg)	Systolic blood pressure ≥ 130 mm Hg OR Diastolic blood pressure ≥ 85 mm Hg
Reduced HDL-cholesterol (mg/dL)	< 40 mg/dL in males and < 50 mg/dL in females.
Elevated Triglycerides (mg/dL)	≥ 150 mg/dL
Pre-diabetes – Elevated Fasting glucose (mg/dL)	≥ 100 mg/dL

(Alberti et al., 2009)

Table 2: Measurement Criteria for Physical Activity

Measurement	Criteria	
AX3 Axivity accelerometer cut-points	Sedentary	< 1.5 METS
	Light	> 1.5 METS and < 3.99 METS
	Moderate	> 4.0 METS and < 6.99 METS
	Vigorous	> 7 METS

(Open Movement, 2021)

Table 2 shows the cut-point criteria to categorize the AX3 Axivity user's time spent in a specific PA intensity. The unit, Metabolic Equivalent of Task (METS), represents the different PA intensities. One MET is calculated as 3.5 ml O_2 . kg^-1 . min ^-1, the rate of energy produced per unit surface area of an average person seated at rest (Open Movement, 2021).

2.12 Statistical Analysis

Analyses of the collected data are in-line with the CONSORT statement, and we used the 'intention-to-treat' principle to analyze our primary outcomes. Moher et al. (2010) recommended that randomized-

controlled trials need to apply two conditions of intention-to-treat analysis to preserve the huge benefits of randomization. The first condition is to include all randomized participants in the analysis (including dropouts). The second condition is to retain the groups to which the participants were allocated initially (Moher et al., 2010). This study ensured the integration of the two conditions for the intention-to-treat analysis.

For comparison between IN and DI arms of the 12-week change in outcomes, the paired t-test illustrated within-group differences and the independent t-test for between-group differences. The above analysis and accepted regression modeling methods such as multiple binary logistic regression and multiple linear regression were used to explore the intervention effects on our primary objective. The regression models were adjusted using prognostic variables. In addition, backward elimination was used to support the adjustment process in the regression with a stopping rule for the p-value set as ≥ 0.2 as recommended (Chowdhury & Turin, 2020). IBM SPSS Statistics 28.0 was used to perform the statistical analyses.

The clinical significance of the intervention effect is elaborated with magnitude-based inferences, confidence intervals, and confidence levels (Hopkins & Batterham, 2016). Multiple imputation techniques (20 imputations) were used for missing data and to assess the sensitivity of the analyses based on the missing at random (MAR) assumption. Tan et al. (2021) reported that MAR is often considered the most reasonable assumption to analyze primary outcomes. MAR assumes that missing data is associated with the observed data but not the unobserved data. Therefore, with the MAR assumption, the unobserved outcomes are modeled from those who remain in the intervention with similar characteristics (Tan et al., 2021). Finally, significance tests at 5%, with t-

tests or chi-squared tests, were used to compare those with complete data (per-protocol analysis).

2.13 Accelerometer Data Processing and Analysis

Raw accelerometry data were calibrated to 1g of local gravity and filtered to eliminate machine noise using a fourth-order Butterworth low-pass filter (set at a cut-off frequency of 20 Hz) (Doherty et al., 2017; Kim et al., 2017). Euclidean Norm Minus One (ENMO) was used to calculate the vector magnitude of the acceleration axes (x,y, and z) minus one gravitational unit (1g) (any negative values were truncated to zero) (Doherty et al., 2017; Kim et al., 2017). Non-wear time was identified as time periods of at least 60 minutes, where all three-dimensional axes have a standard deviation of less than 13 mg. In addition, moderate-to-vigorous PA was defined as ENMO values of more than 125 milli-g and was expressed as minutes day^{-1} (Doherty et al., 2017; Kim et al., 2017). All participants who wore the accelerometers had a wear time of more than 72 hours per ENMO of 500 milli-g, and therefore, none were excluded from the analysis (Doherty et al., 2017; Kim et al., 2017). Data for six days were used in the analysis, and missing data were imputed through multiple imputations techniques using IBM SPSS Statistics 28.0. Lastly, the Open Movement software was used to analyze the accelerometry data.

2.14 Process Evaluation

At the end of the study, a realistic evaluation was used to evaluate the process and implementation elements. Therefore, a questionnaire was sent via email and Whatsapp to all participants after study completion. As presented in Appendix A, the questionnaire includes three major components of realistic evaluation such as context, mechanisms, and outcomes of the intervention (Flynn et al., 2019).

2.15 Research Ethics Approval

The investigators ensured that this study was conducted according to the Declaration of Helsinki principles, and the conduct was in full conformity with relevant regulations and the ICH Guidelines for Good Clinical Practice (CPMP/ICH/135/95) July 1996. Any research conducted in the emirate of Dubai must be submitted to the Dubai Scientific Research Ethics Committee (DSREC) in Dubai Health Authority. Therefore, the research protocol, informed consent form, participant information leaflet, questionnaires, and any proposed advertising material were submitted to the DSREC. The study received ethical approval from this committee with the reference number DSREC-SR-08/2019_02.

Chapter 3

Chapter 3: Results

3.1 Overview of the Main Findings

The number of participants who joined and were randomized in the study was 130. All participants were analyzed using intention-to-treat analysis for the primary outcomes, as shown in Figure 4. Tables 3 and 11(in Appendix B) indicated no statistically significant differences in all baseline characteristics, IPAQ scores, eating habits, and nutrition characteristics except for fruit consumption, which was higher in IN group. There are no statistically significant changes in the between-group primary outcomes, as shown in Table 5. The only statistically significant between-group mean change at 12-weeks is the WHO Wellbeing score [2.9 (95% CI, 1.1 to 4.8)]. However, the primary within-group mean change at 12-weeks was statistically significant for fasting plasma glucose [−3.3 mg/dL (95% CI, −6.5 to −0.02)], HbA1c [0.3% (95% CI, 0.2 to 0.4)], HDL cholesterol [2.2 mg/dL (95% CI, 0.6 to 3.8)], waist circumference [−4.5 cm (95% CI, −6.1 to −2.9)], body fat percentage [−1.1% (95% CI, −2.1 to −0.1)], WHO Wellbeing score [2.8 (95% CI, 1.6 to 3.9)] and vigorous PA [9.8 minutes (95% CI, 1.3 to 18.3)] for the IN group. In addition, for the secondary outcomes, the within-group mean changes in sitting time [−1.1 hour (95% CI, −1.8 to −0.3)] and vigorous PA [11.8 minutes (95% CI, 1.9 to 21.5)] were statistically significant at week 16 for the IN group as displayed in Table 8. These primary and secondary outcomes indicated a favorable intervention effect within the intervention group except HbA1c.

3.2 Descriptive Statistics

3.2.1 Participant Flow

Among the 2900 company employees who received the email invitation to join the study, 248 responded, of which 130 met the eligibility criteria. The CONSORT 2010 flow diagram is illustrated in Figure 4. The health measurements were conducted between the 28th of March 2021 and the 19th of May 2021. After completing the health measurements for 130 participants, they were randomized into the IN (n=65) and DI (n=65) groups. The allocation of the participants was not changed, and there were no exclusions after the randomization process. As shown in Figure 4, approximately 19% of the participants did not complete the post-study health measurements for various reasons. However, all 130 randomly assigned participants were analyzed based on intention-to-treat analysis for the primary outcome (65 IN and 65 DI groups). In contrast, 51 randomly assigned participants were included only as per-protocol analysis for the secondary outcome.

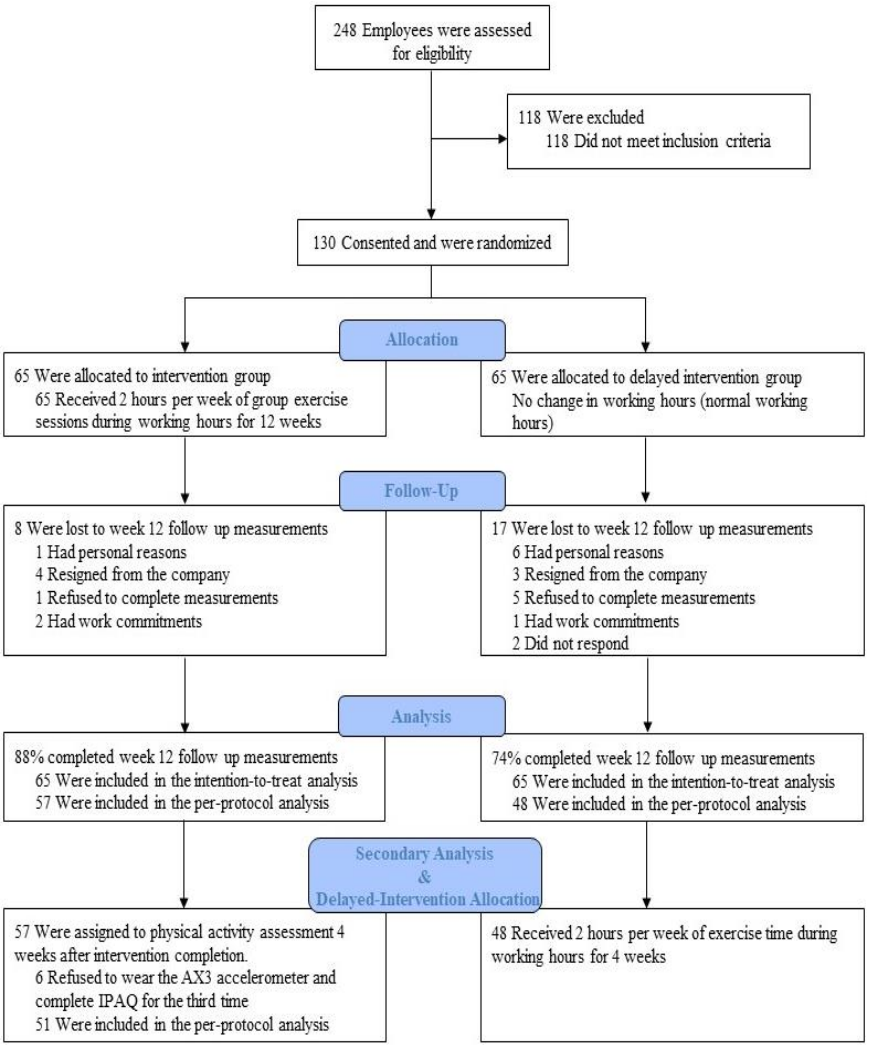

Figure 4: CONSORT (Consolidated Standards of Reporting Trials) Flow Diagram.

3.2.2 Baseline and Post Study Characteristics

3.2.2.1 Baseline Characteristics and IPAQ Score

As shown in Table 3, there are no statistically significant differences in all baseline characteristics. The mean age for the IN group is

37.3 and 36.7 for the DI group. In terms of sex, both groups include 75% male participants and 25% female participants. The highest percentage of nationalities was Indian, comprising 41% and 46% in the IN and DI groups, respectively. In contrast, the Emiratis' presence in the study was low, representing 3% (4 out of 130) of the sample. IPAQ scores were the same for both groups in vigorous activity (26%) but slightly higher for moderate activity (45% and 40%) in the IN group compared to the DI group. However, there is a slight increase in vigorous activity for the IN and the DI groups post-study (38% and 32%), as shown in Table 10 in Appendix B.

3.2.2.2 Cardio-metabolic Risk Factors

Baseline CRFs shown in Table 3 were not statistically significant between the groups. However, overall, the IN group has higher percentages of CRFs at baseline. For example, reduced HDL cholesterol (52% IN, 43% DI), elevated triglycerides (28% IN, 25% DI), and elevated fasting glucose (22% IN, 20% DI) are higher in the IN group compared to the DI group. Elevated blood pressure is the only exception (52% IN, 58% DI). In addition, elevated waist circumference is the highest CRF in both groups because of the eligibility criteria required for the study (e.g., ≥ 80 cm for females and ≥94 cm, or ≥90 cm for males depending on ethnicity).

In contrast, the post-study data in Table 10 in Appendix B showed that the IN group has lower CRFs percentages than the DI group, except for reduced HDL cholesterol (38% IN, 35% DI). For instance, the IN group has better outcomes for elevated waist circumference (88% IN, 89% DI), elevated blood pressure (48% IN, 51% DI), elevated triglycerides (28%, 35%), and elevated fasting glucose (20%, 22%) compared to the DI group.

3.2.2.3 Eating Habits

Furthermore, Table 3 showed that the IN and DI groups consumed mainly 3-4 meals (48% IN, 48% DI) and 1-2 meals (48% IN, 41% DI) per day. In addition, the DI group skipped meals more than the IN group (63% DI, 55% IN), and the most common reason to skip meals was to lose weight (46% DI, 52% IN). Both groups' water consumption was high for the 5-7 cups per day category (52% IN, 46% DI). In comparison, in Table 10 in Appendix B, post-study data showed that the number of participants skipping meals reduced (45% IN, 46% DI), and water consumption of 8 or more cups per day increased (48% IN, 41% DI).

Table 3: Participants' Baseline Characteristics

	Baseline		***P***
	IN Group (n=65)	**DI Group (n=65)**	
Age (years)	37.3 (6.6)	36.7 (6.1)	0.55
Sex			
Males	49 (75%)	49 (75%)	
Females	16 (25%)	16 (25%)	
Nationality			0.66
Indian	27 (41%)	30 (46%)	
Pakistani	12 (18%)	13 (20%)	
Filipino	3 (5%)	6 (9%)	
Emirati	3 (5%)	1 (2%)	
Other Nationalities	20 (31%)	15 (23%)	
Physical Activity Category (IPAQ)			0.82
Low	19 (29%)	22 (34%)	
Moderate	29 (45%)	26 (40%)	
Vigorous	17 (26%)	17 (26%)	

Data are means (SD) or number of participants (%).
IPAQ = International Physical Activity Questionnaire.

Table 3: Participants' Baseline Characteristics (Continued)

	Baseline		***P***
	IN Group (n=65)	**DI Group (n=65)**	
Cardio-metabolic Risk Factors			
Elevated Waist circumference (cm)	65 (100%)	65 (100%)	NA
Elevated Blood Pressure (mmHg)	34 (52%)	38 (58%)	0.48
Reduced HDL- cholesterol (mg/dL)	34 (52%)	28 (43%)	0.29
Elevated Triglycerides (mg/dL)	18 (28%)	16 (25%)	0.69
Elevated Fasting glucose (mg/dL)	14 (22%)	13 (20%)	0.82
Number of Meals per Day			0.39
1-2 Meals	31 (48%)	27 (41%)	
3-4 Meals	31 (48%)	31 (48%)	
5 or More Meals	3 (4%)	7 (11%)	
Skipping Meals			0.37
Yes	36 (55%)	41 (63%)	
No	29 (45%)	24 (37%)	
Reason for Skipping Meals (if yes)			0.60
To Reduce Food Intake	6 (17%)	9 (22%)	
To Lose Weight	19 (52%)	19 (46%)	
Lack of Appetite	5 (14%)	9 (22%)	
Fasting	6 (17%)	4 (10%)	
Water Consumed per Day			0.78
1-4 Cups	14 (22%)	16 (25%)	
5-7 Cups	34 (52%)	30 (46%)	
8 or More Cups	17 (26%)	19 (29%)	

Data are number of participants (%).
IPAQ = International Physical Activity Questionnaire. NA = Not Applicable, no difference in baseline elevated waist circumference. IN, intervention, DI, delayed intervention.
The data for cardiometabolic risk factors and physical activity are as per the criteria presented in Tables 1 & 2.

3.2.2.4 Nutrition Characteristics

Moreover, all baseline nutrition characteristics had no significant difference except for fruit consumption, as illustrated in Table 11 in Appendix B. The IN group consumed more fruits than the DI group, especially in the once per day category (51% IN, 38% DI). The other food types' consumption had similar trends between the groups. However, bread/rice/pasta consumption in the 2-3 times per day category was notably higher in the DI group (46%) than in the IN group (23%). Table 12 in Appendix B showed post-study nutrition characteristics. Due to multiple imputations, the Chi-Square test cannot be applied for post-study data.

3.3 Primary Outcomes

3.3.1 Exercise Session Adherence

The IN group received a 12-week intervention, which included exercise time during working hours (two hours per week) under the supervision of a certified exercise trainer. Therefore, the intervention provided the participants with 24 one-hour exercise sessions throughout the 12 weeks. However, 55% of participants attended 0-5 exercise sessions, while 45% attended 6-24 sessions, as shown in Table 4.

Table 4: Number of Exercise Sessions Attended

Percentile	**Number of participants**	**Number of exercise sessions attended**
51%-100%	29 (45%)	6-24
0-50%	36 (55%)	0-5

3.3.2 Between-group and Within-group Differences

The main findings of the study are presented in Table 5. The illustrated measurements showed between-group differences at baseline

and 12-weeks. The WHO Wellbeing score [2.9 (95% CI 1.1 to 4.8)] is the only variable with a statistically significant between-group difference at 12-weeks. This difference indicated a positive intervention effect on the IN group's WHO Wellbeing score.

Furthermore, Table 5 also presents the within-group mean change between baseline and 12-weeks for each group. For instance, the following statistically significant mean changes at 12-weeks for the IN group were noted, fasting plasma glucose [−3.3 mg/dL (95% CI, −6.5 to −0.02)], HbA1c [0.3% (95% CI, 0.2 to 0.4)], HDL cholesterol [2.2 mg/dL (95% CI, 0.6 to 3.8)], waist circumference [−4.5 cm (95% CI, −6.1 to −2.9)], body fat percentage [−1.1% (95% CI, −2.1 to −0.1)], WHO Wellbeing score [2.8 (95% CI, 1.6 to 3.9)] and vigorous PA [9.8 minutes (95% CI, 1.3 to 18.3)]. In contrast, the DI group's only statistically significant mean changes at 12-weeks were HbA1c [0.4% (95% CI, 0.2 to 0.6)] and waist circumference [−3.7 cm (95% CI, −6.2 to −1.2)]. All statistically significant measurements showed a favorable within-group intervention effect except for HbA1c.

3.3.2.1 *Per Protocol Analysis Comparison*

The CONSORT 2010 guideline stated that per-protocol analysis is often considered flawed, and therefore, the study results should not be based on this type of analysis (Moher et al., 2010). However, we present the per-protocol analysis results in Table 13 in Appendix B to compare them with our main findings. Our main findings (based on intention-to-treat analysis) are presented in Table 5. Overall, all statistically significant outcomes observed in Table 5 were also significant in Table 13, with a few exceptions. For example, per-protocol analysis for within-group differences did not have statistically significant vigorous PA in the IN group. However, sitting time [−0.7 hours (95% CI, −1.5 to −0.006)] in the

IN group and HDL cholesterol [0.3 mg/dL (95% CI, 0.2 to 0.4)] in the DI group were statistically significant. In addition, the between-group differences were statistically significant for baseline light PA [61.8 minutes (95% CI, 8.3 to 115.3)].

Table 5: Within-group and Between-group Differences at Week 12 are Compared with Baseline Measurements for All Outcomes.

	Within-group differences		Between-group differences
Measurement	**IN Group (n=65)**	**DI Group (n=65)**	
Baseline Fasting Plasma Glucose (mg/dL)	96.3 (92.3 to 100.4)	98.8 (90.9 to 106.7)	−2.5 (−11.3 to 6.2)
Difference at 12 weeks	−3.3* (−6.5 to −0.02)	0.8 (−6.4 to 4.8)	−4.9 (−15.8 to 5.9)
Baseline HbA1c (%)	5.4 (5.2 to 5.5)	5.4 (5.2 to 5.7)	−0.05 (−0.3 to 0.2)
Difference at 12 weeks	0.3* (0.2 to 0.4)	0.4* (0.2 to 0.6)	−0.1 (−0.6 to 0.3)
Baseline Total Cholesterol (mg/dL)	202.1 (192.2 to 212)	197.0 (187.9 to 206.1)	5.1 (−8.2 to 18.4)
Difference at 12 weeks	−2.3 (−10.2 to 5.5)	2.3 (−10 to 14.5)	0.5 (−16.3 to 17.3)
Baseline HDL Cholesterol (mg/dL)	45.6 (42 to 49.2)	44.7 (41.7 to 47.8)	0.9 (−3.8 to 5.5)
Difference at 12 weeks	2.2* (0.6 to 3.8)	2.0 (−0.1 to 4.2)	1.1 (−3.6 to 5.8)
Baseline LDL Cholesterol (mg/dL)	135 (126.5 to 143.6)	129.9 (122.1 to 137.4)	5.1 (−6.3 to 16.6)
Difference at 12 weeks	−4.5(−10.8 to 1.8)	0.9 (−9.7 to 11.6)	−0.3 (−15 to 14.4)

Table 5: Within-group and Between-group Differences at Week 12 are Compared with Baseline Measurements for All Outcomes (Continued).

	Within-group differences		Between-group differences
Measurement	**IN Group (n=65)**	**DI Group (n=65)**	
Baseline Triglycerides (mg/dL)	117.7 (102.9 to 132.3)	123.5 (106.8 to 140.2)	−5.8 (−27.8 to 16.1)
Difference at 12 weeks	3.6 (−9.5 to 16.7)	8.7 (−11.4 to 28.9)	−10.9 (−37.8 to 15.8)
Baseline Waist Circumference (cm)	102.5 (99.8 to 105.1)	104.2 (101.2 to 107.1)	−1.7 (−5.7 to 2.2)
Difference at 12 weeks	−4.5* (−6.1 to −2.9)	−3.7* (−6.2 to −1.2)	−2.6 (−7.4 to 2.3)
Baseline Weight (kg)	87.1 (83.4 to 90.8)	88.2 (84 to 92.4)	−1.1 (−6.7 to 4.4)
Difference at 12 weeks	−0.04 (−0.8 to 0.6)	1.7 (−0.8 to 4.4)	−2.9 (−8.6 to 2.7)
Baseline BMI (kg/m2)	29.3 (28.4 to 30.2)	30 (28.9 to 31)	−0.7 (−2.1 to 0.7)
Difference at 12 weeks	−0.02 (−0.3 to 0.3)	0.2 (−0.2 to 0.6)	−0.9 (−2.4 to 0.6)
Baseline Skeletal Muscle Mass (kg)	32 (30.2 to 33.8)	32.8 (31.2 to 34.5)	−0.8 (−3.3 to 1.6)
Difference at 12 weeks	0.6 (0.07 to 1.1)	0.8 (−0.1 to 1.8)	−1.1 (−3.7 to 1.5)
Baseline Body Fat Percentage (%)	34.7 (32.7 to 36.7)	34.9 (32.9 to 36.9)	−0.2 (−3 to 2.6)
Difference at 12 weeks	−1.1* (−2.1 to −0.1)	−1.1 (−2.6 to 0.4)	−0.2 (−3.1 to 2.7)

Table 5: Within-group and Between-group Differences at Week 12 are Compared with Baseline Measurements for All Outcomes (Continued).

	Within-group differences		**Between-group differences**
Measurement	**IN Group (n=65)**	**DI Group (n=65)**	
Baseline Systolic BP (mmHg)	125.9 (122.9 to 128.9)	125.7 (121.8 to	0.2 (−4.6 to 5.1)
Difference at 12 weeks	−1.9 (−5.6 to 1.7)	−1.2 (−7.2 to 4.9)	−0.5 (−7.6 to 6.6)
Baseline Diastolic BP (mmHg)	82.2 (79.6 to 84.7)	82 (79.5 to 84.6)	0.2 (−3.4 to 3.8)
Difference at 12 weeks	0.9 (−1.7 to 3.5)	0.6 (−3.4 to 4.6)	0.4 (−4.1 to 5)
Baseline Sitting Time (hours) – IPAQ	8.8 (8.2 to 9.5)	8.9 (8.3 to 9.4)	−0.01 (−0.9 to 0.8)
Difference at 12 weeks	−0.6 (−1.4 to 0.2)	−0.2 (−1.1 to 0.8)	−0.4 (−1.5 to 0.7)
Baseline WHO Wellbeing (score)	15.5 (14.4 to 16.6)	15 (13.7 to 16.3)	0.5 (−1.2 to 2.2)
Difference at 12 weeks	2.8* (1.6 to 3.9)	0.4 (−1.3 to 2)	2.9* (1.1 to 4.8)

Table 5: Within-group and Between-group Differences at Week 12 are Compared with Baseline Measurements for All Outcomes (Continued).

	Within-group differences		Between-group differences
Measurement	**IN Group (n=65)**	**DI Group (n=65)**	
Baseline Sedentary Time (minutes) – AX3 Accelerometer	7225.3 (7121.7 to 7328.8)	7413.2 (7305.8 to 7520.5)	−187.9 (−335.6 to −40.2)
Difference at 12 weeks	24.9 (−141.2 to 191)	−16.2 (−313.6 to 281.3)	−146.8 (−491.2 to 197.5)
Baseline Light PA (minutes) - AX3 Accelerometer	510.6 (471.7 to 549.5)	452.2 (421.3 to 483.1)	58.4 (9.2 to 107.6)
Difference at 12 weeks	−7.9 (−48.5 to 32.6)	0.2 (−55.7 to 56.1)	50.3 (−26.1 to 126.6)

Table 5: Within-group and Between-group Differences at Week 12 are Compared with Baseline Measurements for All Outcomes (Continued).

	Within-group differences		Between-group differences
Measurement	**IN Group (n=65)**	**DI Group (n=65)**	
Baseline Moderate PA (minutes) - AX3 Accelerometer	885.5 (812.8 to 958.2)	745.8 (665.3 to 826.3)	139.7 (32.3 to 247.1)
Difference at 12 weeks	−26.5 (−92.2 to 39.2)	6.6 (−87.7 to 100.9)	106.6 (−27.3 to 240.4)
Baseline Vigorous PA (minutes) - AX3 Accelerometer	18.8 (13.3 to 24.3)	20.8 (11.9 to 29.6)	−2 (−12.3 to 8.3)
Difference at 12 weeks	9.8* (1.3 to 18.3)	7.2 (−4 to 18.4)	0.6 (−12.5 to 13.7)

PA, physical activity; Data are mean difference (95% Confidence Interval) unless stated otherwise. Within-group differences at week 12 are compared with the baseline measurement. Between-group differences are at each timepoint. IPAQ = International Physical Activity Questionnaire, AX3 Accelerometer data obtained from AX3 Axivity wearable devices. * = statistically significant p-values in Within-group differences: Intervention group (IN): Fasting plasma glucose p-value = 0.049, HbA1c p-value = 0.001, HDL cholesterol = 0.007, Waist circumference p-value = 0.001, Body fat percentage p-value = 0.028, WHO Wellbeing score p-value = 0.001, and Vigorous physical activity p-value = 0.024. Delayed-Intervention group (DI): HbA1c p-value = 0.001, Waist circumference p-value = 0.04. Between-group differences: WHO Wellbeing score p-value = 0.002.

3.3.3 Number of Exercise Sessions and Cardio-metabolic Risk Factors

Multiple binary logistic regression was used to explore the intervention effect (e.g., number of exercise sessions) on CRFs, as shown in Table 6. No statistically significant effect was noted in all of the cardio-metabolic risk factors.

Table 6: Multiple Binary Logistic Regression Analysis for the Relationship between Number of Exercise Sessions and Cardio-metabolic Risk Factors.

Primary Outcome	**OR (95% CI) [1]**	**OR (95% CI) [2]**	**OR (95% CI) [3]**
Elevated Waist circumference (cm)	1.0 (0.9 to 1.1)	1.0 (0.9 to 1.2)	1.2 (0.8 to 1.7)
Elevated Blood Pressure (mmHg)	0.9 (0.9 to 1.1)	0.9 (0.9 to 1.1)	0.9 (0.9 to 1.1)
Reduced HDL-cholesterol (mg/dL)	0.9 (0.9 to 1.1)	0.9 (0.9 to 1.1)	0.9 (0.9 to 1.1)
Elevated Triglycerides (mg/dL)	0.9 (0.9 to 1.1)	1 (0.9 to 1.2)	0.9 (0.8 to 1.1)
Elevated Fasting glucose (mg/dL)	0.9 (0.9 to 1.1)	0.9 (0.9 to 1.1)	0.9 (0.8 to 1.2)

OR, odds ratio; CI, confidence interval.
Model 1 is adjusted for age and sex.
Model 2 is adjusted for model 1 + post-intervention measurements of the variables.
Model 3 is adjusted for model 1 + model 2 + baseline measurements.
Dependent variable is the cardio-metabolic risk factor, and the independent variable is the number of exercise sessions attended by the intervention group.

3.3.4 Number of Exercise Sessions and Post-study Measurements

Multiple linear regression was used to explore the intervention effect (e.g., number of exercise sessions) on post-study measurements, as shown in Table 7. There was no statistically significant effect noted in all of the post-study measurements.

Table 7: Multiple Linear Regression Analysis for the Relationship between the Number of Exercise Sessions and Post-study Measurements.

Primary Outcome	β (95% CI)[1]	β (95% CI)[2]	β (95% CI)[3]
Fasting Plasma Glucose (mg/dL)	−0.3 (−1.1 to 0.4)	−0.3 (−0.8 to 0.1)	−0.2 (−0.7 to 0.2)
HbA1c (%)	0.002 (−0.03 to 0.04)	0.01 (−0.009 to 0.03)	0.006 (−0.008 to 0.2)
Total Cholesterol (mg/dL)	−0.1 (−1.9 to 1.7)	−0.1 (−0.4 to 0.2)	−0.1 (−0.4 to 0.2)
HDL Cholesterol (mg/dL)	0.3 (−0.2 to 0.7)	0.1 (−0.1 to 0.3)	0.5 (−0.01 to 0.3)
LDL Cholesterol (mg/dL)	−0.2 (−1.7 to 1.4)	0.1 (−0.2 to 0.3)	0.05 (−0.2 to 0.3)
Triglycerides (mg/dL)	−0.9 (−3.1 to 1.3)	−0.2 (−1.7 to 1.3)	−0.4 (−1.9 to 1.1)
Waist Circumference (cm)	−0.1 (−0.5 to 0.3)	−0.1 (−0.3 to 0.2)	−0.1 (−0.3 to 0.1)
Weight (kg)	−0.2 (−0.7 to 0.4)	0.02 (−0.1 to 0.1)	0.002 (−0.1 to 0.1)

Table 7: Multiple Linear Regression Analysis for the Relationship between the Number of Exercise Sessions and Post-study Measurements (Continued).

Primary Outcome	β (95% CI)[1]	β (95% CI)[2]	β (95% CI)[3]
BMI (kg/m2)	0.001 (−0.2 to 0.2)	0.02 (−0.05 to 0.9)	−0.001 (−0.1 to 0.04)
Skeletal Muscle Mass (kg)	−0.2 (−0.4 to 0.2)	−0.04 (−0.2 to 0.1)	−0.03 (−0.1 to 0.05)
Body Fat Percentage (%)	0.2 (−0.1 to 0.4)	0.1 (−0.1 to 0.2)	0.03 (−0.1 to 0.2)
SBP (mmHg)	0.1 (−0.6 to 0.7)	0.4 (−0.1 to 0.8)	0.3 (−0.1 to 0.8)
DBP (mmHg)	−0.1 (−0.6 to 0.3)	−0.1 (−0.4 to 0.2)	−0.1 (−0.4 to 0.2)
WHO Wellbeing (score)	0.1 (−0.03 to 0.3)	0.1 (−0.01 to 0.3)	0.1 (−0.1 to 0.2)

Table 7: Multiple Linear Regression Analysis for the Relationship between the Number of Exercise Sessions and Post-study Measurements (Continued).

Primary Outcome	β (95% CI)[1]	β (95% CI)[2]	β (95% CI)[3]
Sedentary Time (minutes)	−6.4 (−33.9 to 21.2)	−0.4 (−22.1 to 21.4)	1.8 (−17.2 to 20.8)
Light PA (minutes)	1.4 (−6.1 to 9)	−1.2 (−7.3 to 4.9)	−2.3 (−7.7 to 3.2)
Moderate PA (minutes)	4.5 (−8.9 to 17.9)	2 (−8.4 to 12.4)	−2.5 (−11.4 to 6.3)
Vigorous PA (minutes)	−0.7 (−1.9 to 0.6)	−0.8 (−2 to 0.3)	−0.7 (−1.8 to 0.5)

SBP, systolic blood pressure; DBP, diastolic blood pressure; PA, physical activity; CI, confidence intervals
Model 1 is adjusted for age and sex.
Model 2 is adjusted for model 1 + post-intervention measurements of the variables.
Model 3 is adjusted for model 1 + model 2 + baseline measurements.
Dependent variable is the post-study measurement, and the independent variable is the number of exercise sessions attended by the intervention group.

3.4 Secondary Outcomes

3.4.1 Physical Activity Within-group Differences at Weeks 12 and 16

The main findings for the secondary outcome are presented in Table 8. The illustrated PA measurements showed the mean change between baseline, 12-weeks, and 16-weeks. The data given in Table 8 are for the IN group only and for those who completed the three PA measurements (at baseline, week 12, and week 16). There were no statistically significant mean changes at 12-weeks. However, the mean changes in sitting time [−1.1 hour (95% CI, −1.8 to −0.3)] and vigorous PA [11.8 minutes (95% CI, 1.9 to 21.5)] were statistically significant at 16-weeks in comparison with baseline. These mean changes illustrated a favorable within-group intervention effect subjectively (sitting time) and objectively (vigorous PA) for the secondary outcomes.

Table 8: Within-group Differences at Weeks 12 and 16 Compared with Baseline Measurements for the Intervention Group (Physical Activity Measurements only).

Measurement	**Intervention Group (n=51)**
Baseline Sitting Time (hours) – IPAQ	9.1 (8.4 to 9.8)
Difference at 12 weeks	−0.6 (−1.3 to 0.1)
Difference at 16 weeks	−1.1* (−1.8 to −0.3)
Baseline Sedentary Time (minutes) – AX3 Accelerometer	7181.3 (7064.2 to 7298.5)
Difference at 12 weeks	63.6 (−8.8 to 135.9)
Difference at 16 weeks	−31.4 (−121.4 to 58.6)
Baseline Light Physical Activity (minutes) - AX3 Accelerometer	527.5 (483.9 to 571.2)
Difference at 12 weeks	−22.3 (−55.3 to 10.7)
Difference at 16 weeks	−1.5 (−33 to 30.1)
Baseline Moderate Physical Activity (minutes) - AX3 Accelerometer	911.4 (828.1 to 994.6)
Difference at 12 weeks	−48.8 (−100.7 to 3.0)
Difference at 16 weeks	−0.3 (−58.4to 57.8)
Baseline Vigorous Physical Activity (minutes) - AX3 Accelerometer	19.8 (12.9 to 26.6)
Difference at 12 weeks	7.5 (−1.9 to 16.9)
Difference at 16 weeks	11.8* (1.9 to 21.5)

Data are the mean difference (95% confidence interval) unless stated otherwise. Within-group differences at weeks 12 and 16 are compared with the baseline measurement. IPAQ = International Physical Activity Questionnaire, AX3 Accelerometer data obtained from AX3 Axivity wearable devices. * = statistically significant p-values in Within-group differences. Difference at 16 weeks: sitting p-value = 0.01 and vigorous physical activity p-value = 0.02. Secondary data presented in this table is analyzed per-protocol analysis.

3.5 Process Evaluation (Realistic Evaluation)

The questionnaire was sent via email and WhatsApp to 130 participants. However, 87 participants only completed the questionnaire,

of which 54 (62%) were from the IN group and 33 (38%) from the DI group. Figure 5 showed that approximately 98% of the participants experienced benefits from joining the study, and the highest benefit experienced was the improvement in health and fitness (27%). In addition, 74% reported that the study positively affected their friends, families, partners/spouses, or relatives, as shown in Figure 9 in Appendix C. In addition, Figure 6 showed that the participants considered the study motivating to increase PA (6.4 out of 7 ratings). Moreover, the participants were asked to rate different study components and their usefulness to motivate them to do more PA. Figure 11 in Appendix C showed that the scores ranged between 5.9 to 6.6 out of 7 for the study components. These components included the accelerometer (6), health measurement results (6.6), exercise time in the workplace (6.4 IN group only), equipment availability (5.9 IN group only), and supervised exercise sessions (6.3 IN group only).

Figure 7 displayed the study's aspects that facilitated exercising (A), increased engagement (B), created barriers (C), or caused difficulties to exercise (D). For example, 20% reported that the timing and location of the exercise were facilitators to exercise in the workplace. In addition, most IN group participants (44%) reported that the trainers and facilitators helped them stay engaged and motivated to exercise in the workplace. In contrast, the main barrier that prevented the IN group participants from exercising in the workplace was work commitment (44%). Also, most participants (54%) reported no difficulties in continuing with the study. Finally, when asked about the possible suggestions for improving this study, 33% had no suggestions, 16% wanted the study to continue, 14% requested more locations and timings for the exercise sessions, and 7% wanted more focus on nutrition (Figure 14 in Appendix C).

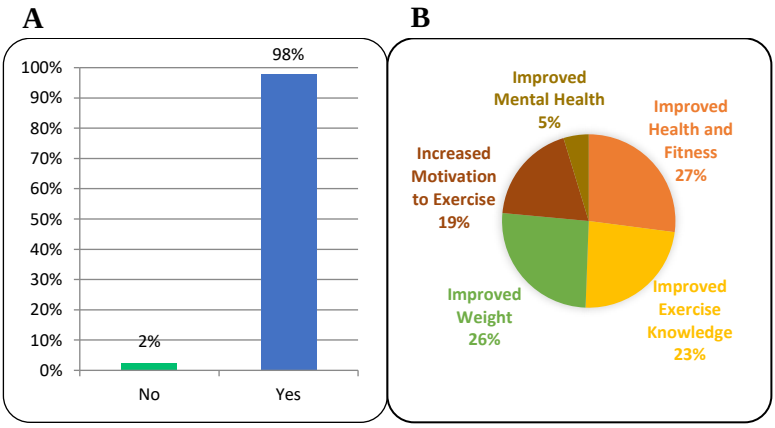

Figure 5: Process Evaluation Benefits of Participation Q2.

Q2. Have you experienced any particular benefits as a result of participating in this program? (A) If yes, please specify: (B)

Figure 6: Process Evaluation Motivation Rating from 1 to 7, Q4.

Q4. Do you feel this program increased your motivation to become more physically active?

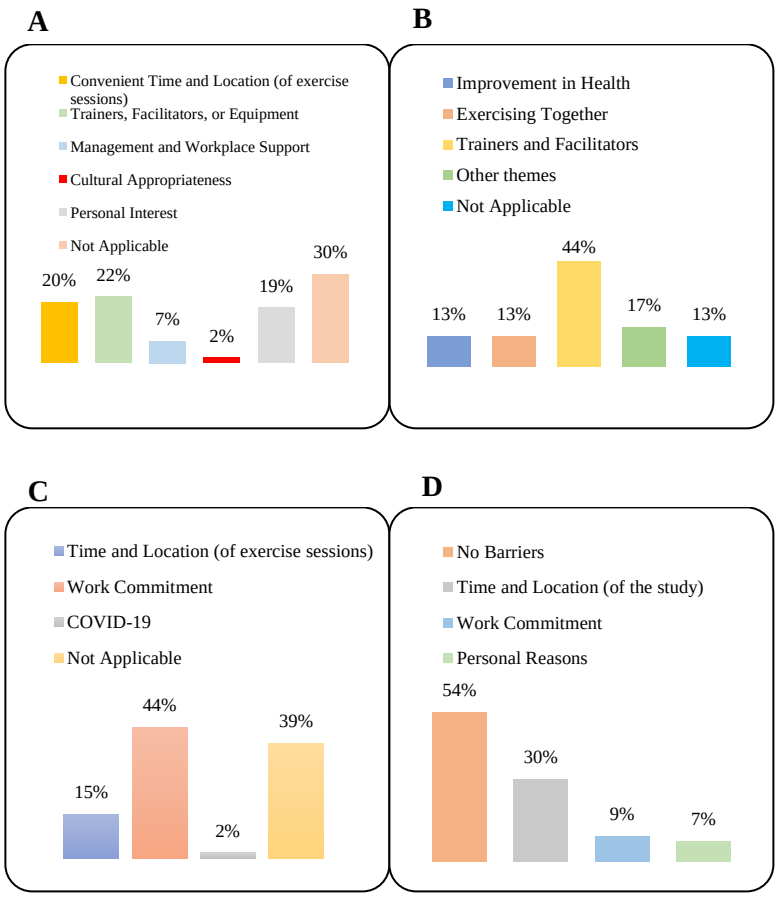

Figure 7: Process Evaluation Facilitators, Engagement, Difficulties, and Barriers Q9-Q12.

Q9. Were there any factors that facilitated you participating in exercise at the workplace? Please specify**:** (A) Q10. Were there any factors that helped to keep you engaged and motivated to participate in exercise at the workplace? Please specify: (B) Q11. Were there any barriers that prevented you from exercising at the workplace? Please specify: (C) Q12. Were there any factors which made it difficult for you to continue with the study? Please specify: (D). Q10-12 are questions applicable for the intervention group only.

3.6 Harms or Unintended Effects in Each Group

One participant in the IN group reported back pain at his first exercise session. After further investigation, the facilitators found that the participant's back pain existed before joining the intervention and therefore informed the certified trainers about taking extra care to avoid any injury. There were no further issues reported after this incident.

Chapter 4

Chapter 4: Discussion

4.1 Summary of Findings

WHO (2010) stated that the expenditure of energy during working hours is associated negatively with leisure-time PA. Therefore, it is important to have interventions and policies that support workplace exercise to increase PA levels. In our study, employees who received time to exercise during working hours improved their within-group cardiometabolic health outcomes and other outcomes. However, the WHO wellbeing score was the only between-group improvement. A systematic review that examined PA interventions in the workplace observed similar well-being improvements (Abdin et al., 2018). Some of the studies in the systematic review used the same tool that was used in our study (e.g., WHO Wellbeing index) (Abdin et al., 2018). In addition, similar studies and a meta-analysis that investigated PA as the primary outcome in a workplace setting did not find between-group differences (Bergman et al., 2018; Jung & Cho, 2022).

Moreover, improvements were notable primarily in the within-group comparisons for the IN group (e.g., fasting plasma glucose, HDL cholesterol, waist circumference, body fat percentage, and vigorous-intensity PA). These findings support the evidence that PA lowers the risk of cardio-metabolic diseases and mortality (Chow et al., 2022). In addition, for the outcome studies at week 16, levels of vigorous-intensity PA improved, and a decrease in sitting time was observed. Similarly, Jung & Cho (2022) reported that the intervention group (within-group difference) had statistically significant PA improvement [standardized mean difference (SMD) 0.22 (95% CI, 0.03 to 0.41)] along with subgroup analysis that enhanced PA such as walking activity [SMD 0.70 (95% CI, 0.21 to 1.19)], using a multicomponent program [SMD 0.19 (95% CI, 0.05

to 0.33)], and use of objective measurements [SMD 0.58 (95% CI, 0.05 to 1.10)]. In contrast, Bergman et al. (2018) reported no statistically significant effects on body composition, anthropometric measures, and metabolic functions in their study. Another workplace study and a systematic review reported similar findings regarding results related to metabolic outcomes, which are not statistically significant (Commissaris et al., 2016; Thompson et al., 2014). For example, Commissaris et al. (2016) reported that among the 40 studies included in the systematic review, evidence was either conflicting or insufficient for intervention effects on lipid and metabolic profiles. In addition, Thompson et al. (2014) stated that the intervention effect was noted in weight and percent body fat but not in metabolic measures. In the present study, improvements in PA and cardio-metabolic measurements were observed in the IN group only (within-group).

Another meta-analysis investigating PA interventions in a primary care setting reported statistically significant PA improvements for studies with self-reported PA measurements (Kettle et al., 2022). For instance, Kettle et al. (2022) reported statistically significant results for trials that used self-measurements of PA only. However, trials that used devices to measure PA showed no statistically significant group difference in PA (Kettle et al., 2022). In the present study, AX3 accelerometers were used to measure PA. The results of this study were similar to the results of between-group differences in the meta-analysis.

4.2 Methodological Considerations and Generalizability

4.2.1 Internal Validity

The facilitators adopted various measures to maintain the internal and external validity of the study. For instance, information bias and

confounding factors are common issues in such studies. In our study, information bias is possible due to the participants recalling their PA levels, food intake, and mental health status in the past days or weeks (to answer the questionnaires). The facilitators used validated questionnaires (e.g., IPAQ and WHO Wellbeing Index) available in Arabic and English to address this issue. In addition, AX3 Accelerometers were used, which provide objective measurements of PA.

Furthermore, multiple methods such as restriction, randomization, and statistical modeling controlled the confounding factors in the study. For example, the participants were not eligible if they did not meet the waist circumference criteria or were involved in any health promotion program. These eligibility criteria restricted participants with relatively good health conditions from entering the study. This restriction is necessary because the intervention effect might not be significant in this category of healthy participants (Bailey, 2005; Bergman et al., 2018). In addition, the effect of randomization in this study helped balance the participants' baseline characteristics between the IN and DI groups. Finally, the study used regression models that were adjusted for various prognostic variables to control confounding factors further.

4.2.2 External Validity and Generalizability

Moher et al. (2010) reported that external validity depends on the characteristics of the participants and is often a matter of judgment. For example, some of these characteristics may include the trial setting, outcomes assessed, and the treatment regimens tested (Moher et al., 2010). Therefore, for this study, recruitment was open for all working ages (e.g., 18-59), both sexes, those with office or non-office job positions, and all nationalities. In addition, the broad spectrum of characteristics allowed the

study to be representative of workplaces with similar settings (e.g., 9 to 5 working hours and availability of gym workplace).

Another aspect of external validity is the percentage of eligible participants who refused to join the study (Moher et al., 2010). For instance, 248 participants showed interest in the study and were assessed for eligibility. However, only 130 were eligible, and 118 were not. Therefore, the study excluded those who were ineligible (e.g., 118) because they did not meet the eligibility criteria and not due to them refusing to enter the study. As a result, none of the eligible participants refused to enter this study, indicating a favorable preference and acceptability for the intervention.

Finally, the process evaluation is another factor that could reflect the study's external validity (Moher et al., 2010). The applied process evaluation investigated various aspects of this study. For example, the evaluation was concerned with the benefits of the study, the different study components that may motivate PA participation, and perspectives on barriers/facilitators. Overall, the majority of the 87 participants who responded to the process evaluation surveys reported positive findings, as shown previously. Therefore, it is reasonable to assume that the study's benefit could be generalizable to workplaces with similar settings.

4.3 Strengths and Weaknesses of the Study

4.3.1 Trial Design

One of the study's many strengths is its prospective, single-blinded randomized controlled trial design. In addition, the study is adequately powered using an intention-to-treat analysis. Therefore, the participants lost to follow-up from the IN and DI groups, as illustrated in Figure 4, were all analyzed using multiple imputation techniques. This analysis

ensured that the study results were robust and powered adequately, as shown in similar structured studies (Robertson et al., 2017).

4.3.2 Social-Ecological Model (SEM)

The study has adopted various aspects of the SEM. The SEM was used in the planning stage to understand the multidimensional and interactive effects of various factors that determine behavior. The different SEM levels, such as the individual level, interpersonal level, organizational level, and policy/enabling environment level, were enforced in this UAE based-study.

The individual level of SEM was achieved through the health measurements (e.g., AX3 accelerometer and clinical measurements) and the certified trainers' sessions. These aspects of the study focused on enhancing the participant's knowledge, attitude, and behavior towards PA. The process evaluation also showed a 23% increase in knowledge (Figure 5). In addition, during the supervised exercise group sessions, the IN group participants formed relationships with their colleagues and trainers. As reported in the process evaluation, this social network (especially with the trainers) has dramatically affected participants' engagement and motivation toward PA (Figure 7).

The most prominent aspects of the organizational level are the accessibility to the gym equipment and the clinic in the headquarters building. These facilities enabled the participants to be motivated to exercise, as shown in Figure 11 in the Appendix. Finally, the policy/enabling environment level is reflected upon this intervention when the company permitted exercise time for their employees during working hours. As a result, granting exercise time required higher management and line managers' collaboration and empowerment despite work

commitments. This level of the SEM is of great importance because, without providing exercise time during working hours in the workplace, the intervention will not be possible. In Figure 7, the process evaluation showed that work commitment was the highest reported barrier (44%), which further emphasizes the role of the management. Therefore, we can conclude that the SEM is appropriate and applicable to the UAE setting.

4.3.3 ENWHP Alignment

Another strength in this study is the alignment of the intervention with the ENWHP recommendations. For example, the intervention provided accessible and motivational PA sessions during working hours. Certified exercise trainers supervised the sessions to ensure intervention compliance. In addition, frequent reminders such as the outlook calendar invitations and WhatsApp broadcasts were also sent to the IN group participants.

4.3.4 Session Attendance

Despite all the efforts to retain attendance and compliance, the IN group's adherence to the exercise sessions remained low (55% attended 0-5 sessions only). This intervention's reported attendance or dropouts is similar to other studies (Commissaris et al., 2016). Commissaris et al. (2016) reported that 10 out of the 40 studies in the systematic review were personalized behavior intervention studies. These studies reported withdrawals and dropouts from the intervention ranging between ≤60% to 100% (Commissaris et al., 2016). Therefore, the attendance stated in the present study is to be expected in such interventions.

4.3.4.1 COVID-19

Another possible reason for the low attendance in the exercise sessions could be the COVID-19 pandemic during the intervention period (May to August 2021). For example, in May, WHO designated the Delta variant as a variant of concern (WHO, 2022a). In addition, the weekly COVID-19 cases remained high and ranged between 7,715 to 14,820 in the UAE during the intervention period (WHO, 2022b). The facilitators informed the participants through emails and WhatsApp messages that all safety measures were applied. For instance, a maximum of 15 participants were allocated per session, physical distancing between every participant (1 meter), and sanitizing all equipment with Isopropyl Alcohol 70% solution after every session. Throughout the intervention period, there was one positive COVID-19 case. The trainer and participants in the same exercise session were traced and informed not to attend any session if they developed symptoms. In addition, they were asked to perform a Polymerase Chain Reaction test before their next session. However, despite these challenges, the study still showed a favorable intervention effect for the within-group measurements due to the commitment of the other 45% (attended 6-24 sessions).

4.3.5 Physical Activity Measurements

Using objective measurements (AX3 Accelerometer) for PA alongside the subjective measurements (e.g., IPAQ) provided more valid and reliable data (Kettle et al., 2022). In addition, Kettle et al. (2022) reported that studies that used devices to measure PA compared to self-reported PA had a larger effect on total PA [0.53, (95% CI 0.14 to 0.92)] than self-reported total PA [0.17, (95% CI 0.11 to 0.24)]. In comparison, the accelerometers used in our study measured PA at three different time points for the IN group: baseline, post-study, and 4-weeks post-study. The

third measurement (4-weeks post-study) assessed whether the intervention effect on PA remained. This measurement is important because it reflects the long-term benefit of the intervention.

4.3.6 Recruitment

Although the recommended number of participants (e.g., 150) was not met, the study is still adequately powered with 130 participants. However, many efforts were made to meet the recommended sample size. For example, a marketing plan was initiated four months before the intervention phase. The plan included conducting two information sessions in February 2021 before the recruitment phase. In addition, information leaflets were sent and displayed through emails, elevators, parking areas, and restaurants/cafes in the building before and during the recruitment phase (February until May 2021). Non-monetary sports gift vouchers and participation certificates were also provided to encourage employees. Despite all these efforts, 130 participants were recruited, and the recruitment phase ended on the 19th of May 2021.

4.3.7 Contamination

Participants were strictly advised not to discuss their allocated group. However, the risk of contamination remained due to the nature of our study. For example, some participants were colleagues or friends and therefore unavoidably knew the allocated group.

4.3.8 Other Important Factors

Our study did not investigate participants' smoking and medication status as factors that could affect the primary outcomes. However, smoking status was acknowledged as a CRFs, as shown in Figure 3. Ussher et al. (2014) stated that exercise has the potential to moderate

psychological withdrawal cravings and symptoms. In addition, exercise seems to reduce the weight gain from post-smoking cessation in the long term (Ussher et al., 2014). The weight gain prevention benefit is more important to female smokers who smoke to control their weight (Ussher et al., 2014). Therefore, it is necessary to include the participant's smoking status in future studies.

Furthermore, the medication status is also essential because of its effect on CRFs. For example, a meta-analysis that included 28 randomized controlled trials have shown that weight-loss medications are associated with modest reductions in fasting blood glucose –4.0 mg/dL (95% CI, –4.4 to –3.6) and waist circumference –3.3 cm (95% CI, –3.5 to –3.1) (Khera et al., 2018). The effects of the medications varied among the drugs (e.g., Phentermine-topiramate, Liraglutide, Naltrexone-bupropion), however, none of the drugs improved all CRFs (Khera et al., 2018). Given the relatively healthy profile of participants in our study, it is unlikely that these participants would be on any weight-loss medications. Nevertheless, the medication status of participants may affect the CRFs and, therefore, should be investigated in future studies.

4.4 Future Directions

4.4.1 Negative Outcomes

It is important to report negative outcomes, especially when related to the primary outcomes (Duggan et al., 2014; Robertson et al., 2017). In the current study, the only notable statistically significant non-primary negative outcome was the increase in HbA1c 0.3% (95% CI 0.2 to 0.4) in the IN group, as shown in Table 5. Boniol et al. (2017) conducted a meta-analysis of randomized controlled trials for PA and change in HbA1c/Fasting glucose, including 76 studies. The findings showed that an

increase of at least 100 minutes of PA per week was associated with reductions of −0.14% (95% CI −0.18; −0.09) in HbA1c (Boniol et al., 2017). In addition, the findings showed that statistically significant reductions in Hb1Ac were noted in interventions with supervised PA compared to interventions with unsupervised PA. In comparison, most of our participants (55%) in the IN group attended 0-5 supervised PA sessions only. Therefore, the majority of the IN group participants did not achieve 100 minutes of PA per week and eventually did not reduce HbA1c. Furthermore, the meta-analysis reported that 60 studies had a significantly higher decrease in HbA1c in studies with prediabetes and type 2 diabetes subjects than in those without diabetes (Boniol et al., 2017). However, for the present study, the mean HbA1c at baseline for the IN group was 5.4% (95% CI 5.2 to 5.5), indicating that most participants do not have diabetes or prediabetes. Finally, HbA1c is not a completely stable measurement as it could increase over time and up to 1% of the baseline value per year (Meigs et al., 1996).

4.4.2 The Delayed-intervention Group Outcome

The only statistically significant positive DI group outcome reported in the study is the waist circumference mean change of −3.7 cm (95% CI −6.2 to −1.2) at week 12. In addition, this within-group reduction in the DI group is lower than the change in waist circumference of IN group and could be mainly due to the Hawthorne effect. McCambridge et al. (2014) defined the Hawthorne effect as the "participants' change of behavior due to participation in the study and awareness of being studied" and reported that 12 out of the 19 studies included in the systematic review provided evidence for the existence of this effect.

Furthermore, many factors may have triggered the Hawthorne effect for the DI group. For example, Waters et al. (2011) stated that

behavioral assessments and mode of measurement administration are some factors that may cause an improvement in PA levels for the control group. Waters et al. (2011) used the term 'measurement reactivity' to explain the effect of measurements on control group outcomes. This term refers to the situation where baseline measurements for the control group improve the participants' awareness or sensitivity toward the intervention. This improvement eventually leads to a drive to change behavior. The other factor that was reported in this systematic review is the mode of administrating the measurements. Waters et al. (2011) stated that studies with interview-based measurements (e.g., face-to-face) had more frequent control group improvements than the self-administered measurements studies.

In the present study, the assessors performed face-to-face baseline and post-study measurements for all participants. These measurements may have motivated all participants to increase their PA levels. For example, the responses to process evaluation questions showed that most participants were motivated by the study. As a result, as noted in Table 5, the DI group, representing the control group, had improved PA measurements (e.g., sedentary, light, moderate, and vigorous PA) despite being not statistically significant. A similar effect was also reported in eight out of 29 studies in a systematic review (Waters et al., 2011). The eight studies reported improved PA levels in the control group. Waters et al. (2011) stated that the eight studies' weekly physical activity improvements in the control group ranged between 60 to 84 minutes. In addition, five out of the eight studies elaborated that the physical activity improvements in the control group were not statistically significant between the groups (Waters et al., 2011). However, according to the systematic review's criteria, the improvements were still considered clinically meaningful. Therefore, the improvement in PA in our DI group

could be one of the main reasons waist circumferences also improved. Future studies must carefully plan the type and mode of measurements to minimize the Hawthorne effect and avoid undesirable effects on the control group.

4.5 Implications for Public Health

The study has applied important principles such as the ENWHP criteria, CONSORT 2010 guideline, and the SEM during the planning stage. These principles created an adequately designed randomized controlled trial. Therefore, as illustrated in the results, the study showed a favorable within-group intervention effect. The results justify the need to grant employees exercise time during the workplace. In addition, the accessibility and convenience of a workplace gym are necessary for employees to maintain PA. Commissaris et al. (2016) reported that the constraints set by work tasks or workstations could limit PA substantially in the workplace. Therefore, granting exercise time in the workplace is vital to improving employees' health.

Another important aspect is to consider participants' suggestions to improve the intervention. The analyses of the responses to the process evaluation questions demonstrate that the most requested suggestions were to extend this study (16%) and provide more exercise session options regarding timing and location (14%). Therefore, it would be interesting to implement micro-exercises during working hours for future interventions. Micro-exercises are brief and simple (typically 10 minutes, three times a week) strengthening exercises that strengthen the main muscles (Andersen et al., 2022). In addition, these exercises can be performed using an elastic resistance band with other coworkers at the workplace. Therefore, micro-exercises are convenient because employees do not need to go to the gym, change clothes, or shower afterward (Andersen et al., 2022). As a result,

Andersen et al. (2022) reported that such exercises have been shown to reduce the risk of long-term sickness absence during working hours (HR 0.86, 95% CI 0.77 to 0.96).

Furthermore, validated cardiovascular risk prediction models such as the 2008 Framingham model, 2008 office-based Framingham model, and the 2013 Pooled Cohort Risk Equation model could be used to evaluate the effectiveness of future interventions (Al-Shamsi et al., 2020). However, Al-Shamsi et al. (2020) concluded that these models were inaccurate in predicting cardiovascular disease risk among Emiratis. In contrast, our study included only 3% Emirati participants, which means we might have different accuracy levels for these models. In addition, a UAE-based pilot study could also validate these models among a multinational sample (similar to our study) before applying them to evaluate intervention effectiveness.

Finally, nutrition was also important for the participants (7%), as reported in the process evaluation, which could have significantly affected the results of this study. Kettle et al. (2022) reported that one of the studies initially included in the meta-analysis was later removed (sensitivity analysis) because the study contained an intensive diet replacement intervention. The diet intervention had a substantially greater effect on weight compared to other studies (Kettle et al., 2022).

4.6 Conclusion

In conclusion, the study's favorable within-group results indicated the importance of this study from a public health perspective. Therefore, it is recommended to provide exercise time and an accessible gym in the workplace to improve employees' cardiometabolic health and physical activity. An employee with a good health condition is a benefit for every

workplace. In addition, the study showed an increase in vigorous PA in the primary and secondary findings. Increasing PA in office-based workplaces is necessary to reduce sedentary time and other risk factors. Companies should therefore enforce policies that support health promotion in the workplace. Future studies need to investigate further the effectiveness of this intervention using different workplace settings and working conditions. For instance, workplaces without a gym, government sector workplaces, and workplaces with different working hours. Finally, future studies could also evaluate these workplace interventions with productivity (e.g., sick leaves), the company's key performance indicators, and cardiovascular risk prediction models, which could interest stakeholders and policymakers.

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Alrahma, A. M., Habib, M. A., Oulhaj, A., Loney, T., Boillat, T., Shah, S. M., Ahmed, L. A., & Nauman, J. (2021). Effects of a workplace exercise intervention on cardiometabolic health: Study protocol for a randomised controlled trial. BMJ Open, 11(11), e051070. https://doi.org/10.1136/bmjopen-2021-051070

Appendix A

Consent Form - Arabic [2 pages]

استمارة موافقة

عنوان البحث: دراسة علمية في مقر العمل في دبي لتحسين عوامل الاختطار القلبية

أنا الموقع/الموقعة أدناه أقر:
بأني قرأت وفهمت ورقة المعلومات للمشاركين بتاريخ _____/__/__ ، للدراسة المذكورة أعلاه، وقد سنحت لي الفرصة الكافية للاستفسار عن أي تساؤلات.

- بأن مشاركتي في هذه الدراسة تطوعية، ويمكنني الانسحاب منها متى شئت
- بأن انسحابي لن يؤثر علي من الناحية الوظيفية.
- أن جميع المعلومات الخاصة بي سوف تعامل ضمن إطار السرية التامة .
- بأن مشاركتي في الدراسة لن تتطلب مني أي دفع/تكلفة.
- بناء على ما سبق ذكره:
  - أوافق على المشاركة في هذه الدراسة.
  - أوافق على السماح للباحثين باستخدام المعلومات المأخوذة من الفحوصات الطبية من أجل الدراسة.
  - كما أوافق على إعطاء المعلومات التالية:

رقم الهاتف المتحرك:
البريد الإلكتروني:
اسم المشارك/المشاركة (الثلاثي):
التاريخ: _____/__/__
التوقيع: _____

الباحث المساعد/الباحث المشارك فقط

اسم الشخص المخول بالحصول على موافقة المشاركة: _____ التاريخ: __/__/_____ التوقيع _____ :

اسم الشاهد (في حالة عدم قدرة المشارك/المشاركة على القراءة والكتابة): _____ التاريخ: __/__/_____ التوقيع:

رقم تعريف المشارك/المشاركة المستخدم في الدراسة (للاستعمال الرسمي فقط):

اسم الباحث الرئيسي :

د. جافيد نعمان، أستاذ مساعد، معهد الصحة العامة، كلية الطب والعلوم الصحية، جامعة الإمارات العربية المتحدة.

أسماء وعناوين جميع الباحثين في هذه الدراسة:

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Consent Form - English [2 pages]

CONSENT FORM

Research Title: A Workplace Exercise Intervention in Dubai to Improve Cardio-metabolic Health

By signing this form, I confirm that:

• I have read and understood the participant information sheet dated _____/ ____/ ____ for the above study and have had the opportunity to ask questions.

• I understand that my participation is voluntary and that I can withdraw anytime.

• I understand that if I withdraw from the study, this will not affect my employment.

• I understand that my participation in the study will not require from me any payment/cost.

• I understand that my data will be kept confidential.

• Based on that, I agree to: 1. Take part in this study. 2. I allow the researcher to use my data from the medical tests for research purpose. I agree to give the below information:

Mobile:

Email:

Name of participant: _____ _____ _____

Date: __/__/____

Signature: _____

Research Assistant/ Associate ONLY

Name of person taking consent: _____
Date: __/__/____ Signature: _____

Name of witness: _____ (if participant unable to read/write)
Date: __/__/____ Signature: _____

Study Identification Unique Code (SUIC):

Name of Principal Investigator:

Dr. Javaid Nauman, Assistant Professor, Institute of Public Health, College of Medicine & Health Sciences, United Arab Emirates University.

Names and Contacts of All Project Researchers

Researcher Name	Title	Place of Work	Email	Telephone
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Participant Information Leaflet -Arabic [2 pages]

ورقة المعلومات للمشاركين

التاريخ: 22/ 02/ 2021

عنوان الدراسة

دراسة علمية في مقر العمل في دبي لتحسين عوامل الاختطار القلبية

الدعوة:

توفر ورقة المعلومات هذه تفاصيل حول الدراسة التي سيتم إجراؤها في شركة دو، يرجى قراءة المعلومات التالية بعناية لتحديد ما إذا كنت ترغب في المشاركة أم لا. يرجى عدم التردد في السؤال عما إذا كان هناك شيء غير واضح أو إذا كنت ترغب في المزيد من المعلومات.

ما هو هدف الدراسة؟

تهدف هذه الدراسة إلى تقديم الدليل العلمي على أنه إذا كانت بيئة العمل تشجع على تغيير نمط السلوك المتبع، فإن ذلك قد يؤدي لزيادة مستويات النشاط البدني وبالتالي تتحسن صحة الأفراد. إذا كنت تستوفي معايير الدراسة وقررت المشاركة فيها، فسيتم تعيينك في إحدى المجموعتين: المجموعة التجريبية أو المجموعة الضابطة. سيحصل المشاركين الذين تم تعيينهم في المجموعة التجريبية على ساعتين لممارسة النشاط البدني خلال ساعات العمل. أما المشاركين الذي يتم تعيينهم في المجموعة الضابطة لن يكون لديهم أي تغيير لساعات العمل. كما انه سيتم تعيين المشاركين من المجموعة التجريبية لحضور جلسات جماعية مع مدرب في الصالة الرياضية التابعة لمقر العمل. مدة الدراسة 12 أسبوع. كما أنه سيتم مقارنة النتائج الصحية لكلتا المجموعتين قبل وبعد الدراسة للكشف عن أي فروق بين المجموعتين. وبعد 4 أسابيع من فترة الدراسة، سيتم قياس مستويات النشاط البدني فقط وللمرة الثالثة للمجموعة التجريبية.

ما هي معايير اختيار المشاركين؟

1. يجب أن يكون المشارك موظفاً في الشركة ويكون محيط الخصر 94 سم (90 سم لجنوب وشرق آسيا) أو أكثر للذكور و80 سم أو أكثر للإناث
2. يجب أن يكون المشارك على رأس عمله في الشركة خلال فترة الدراسة.
3. أن يكون المشارك مستعداً للالتزام حتى النهاية.
4. أن يتراوح عمر المشارك من بين 18 الى 59 سنة.
5. أن يتم التوقيع على استمارة الموافقة.
6. أن لا تكون لديه إصابة خطيرة في المفاصل أو الظهر أو أي حالة طبية تمنعهم من ممارسة الرياضة أو أن الطبيب قد نصح المشارك بعدم ممارسة الرياضة.
7. يجب أن لا تكون المشاركة حامل
8. يجب أن لا يكون للمشارك أي مخططات لإجراء عمليات جراحية خلال فترة الدراسة
9. وأن لا يكون لديه أي من الأمراض التالية: أمراض القلب والأوعية الدموية وأمراض الرئة والسرطان.

هل يجب علي المشاركة؟

هذه الدراسة اختيارية فأنت من يقرر ما إذا كنت ستشارك أم لا. وإذا قررت المشاركة، سيُطلب منك التوقيع على استمارة الموافقة. كما أنه إذا قررت أن تكون جزءًا من الدراسة وبعد ذلك غيرت رأيك، فيمكنك الانسحاب من الدراسة في أي وقت.

ماذا علي أن أفعل إذا شاركت؟

إذا وافقت على المشاركة، فسيُطلب منك:

1. أن توقع على استمارة الموافقة.
2. أن تحجز لك موعد في المركز الصحي في المبنى الرئيسي - برج السلام.
3. أن تكمل القياسات والفحوصات الصحية التي تشمل: محيط الخصر ونسبة الهيموغلوبين السُّكَّري (HbA1c) ومستوى الغلوكوز أثناء الصيام ومستوى البروتين الدهني منخفض الكثافة (LDL) ومقياس ضغط الدم ومؤشر كتلة الجسم ومحيط الخصر ونسبة الدهون في الجسم. سيتم قياس هذه الفحوصات مرتين في فترات مختلفة (قبل الدراسة وبعدها).
4. أن تكمل استبيان مكون من 7 أسئلة حول النشاط البدني. سوف تتكرر هذه الخطوة 3 مرات أثناء الدراسة.
5. ستعطى ساعة لترتديها لمدة 6 أيام لقياس النشاط البدني. سوف تتكرر هذه الخطوة ايضاً 3 مرات أثناء الدراسة.

هل هناك أي تأثيرات سلبية أو مخاطر محتملة في حال مشاركتي؟

لن تسبب المشاركة في هذه الدراسة أي ضرر لك. كما أن خصوصيتك وسرية البيانات الخاصة بك هامة جدا لنا وسوف نحرص بكل جهدنا في المحافظة عليها بسرية تامة.

ما هي الفائدة من مشاركتي في هذه الدراسة؟

إذا تم تعيينك في المجموعة الضابطة، فستحصل على فحوصات صحية مجانية مرتين خلال فترة الدراسة. ولكن إذا كنت في المجموعة التجريبية، فستحصل على فحوصات صحية مجانية اضافةً الى ذلك سوف يتم تسجيلك في برنامج رياضي لمدة 12 أسبوع. وأخيرا، مشاركتك في هذه الدراسة قد تساعدنا في المستقبل على وضع سياسات تمنح الموظفين وقتًا لممارسة الرياضة أثناء ساعات العمل.

هل ستبقى معلوماتي سرية؟

سيتم الاحتفاظ بسرية تامة بجميع المعلومات التي يتم جمعها عنك أثناء الدراسة. وسوف نستبدل اسمك وأي معلومة أخرى يمكن أن تحدد هويتك برمز مرقم. أعضاء معينين فقط من أصحاب الدراسة يستطيعون الحصول على هذه الرموز. سيتم الاحتفاظ بمعلوماتك الصحية وبياناتك من الدراسة على أجهزة كمبيوتر آمنة.

ماذا لو حدث خطأ ما؟

من غير المحتمل أن يحدث أي خطأ أثناء مشاركتك في الدراسة. ولكن إذا تعرضت للأذى من خلال المشاركة في هذا البحث ، لا يوجد تعويض. وإذا تعرضت للأذى بسبب إهمال شخص ما، أو كان لديك أي مخاوف بشأن الطريقة التي تم التعامل بها معك أثناء هذه الدراسة ، يمكنك الاتصال بلجنة أخلاقيات البحث العلمي بدبي ، هيئة الصحة بدبي: 97142191961+ / 9714211965+ أو البريد الإلكتروني على DSREC@dha.gov.ae . كما إذا كنت ترغب في تقديم شكوى أو تعليق، فيمكنك التواصل مع الباحثين ايضاً:

السيد علي منير آل رحمه، مرشح للدكتوراه، معهد الصحة العامة، كلية الطب والعلوم الصحية، جامعة الإمارات العربية المتحدة. البريد الإلكتروني: 201890025@uaeu.ac.ae الهاتف النقال: 052-7642445
الدكتور جافيد نعمان، أستاذ مساعد، معهد الصحة العامة، كلية الطب والعلوم الصحية، جامعة الإمارات العربية المتحدة. البريد الإلكتروني: javaid.nauman@uaeu.ac.ae الهاتف: 97137137466+

Participant Information Leaflet -English [2 pages]

PARTICIPANT INFORMATION LEAFLET

Date: 22/02/2021

Study title

A Workplace Exercise Intervention in Dubai to Improve Cardio-metabolic Health

Invitation:

This information sheet provides details about a study that is going to be conducted in du. Please take time to read the following information carefully and decide whether or not you wish to take part. Please ask us if there is anything that is not clear or if you would like more information.

What is the purpose of the study?

This study aims to provide evidence that if the workplace environment promotes behaviour change then physical activity levels could increase and, therefore, improve health.

If you meet the eligibility criteria and decide to participate in the study, then you can be assigned into one of the two groups: an intervention group or a control group. The employees in the intervention group will be provided time for exercise during working hours. The control group will have no change in their workplace timing. The employees assigned to this intervention group will attend exercise sessions in the gym workplace. A personal trainer will supervise the exercise sessions. The intervention will be for a 12-week period. The health outcomes for both groups will be measured before and after the intervention to determine any difference between the groups. Finally, 4 weeks after the intervention period, only physical activity levels will be measured for the third time for the intervention group.

What are the eligibility criteria?

1. Participant must be an employee in the company and have a waist circumference of ≥94 cm (≥90 cm for South and East Asians) for males and ≥ 80 cm for females.
2. Available for the study duration.
3. The participant should be willing to commit to the intervention until the end.
4. Aged 18 to 59 years old.
5. Signed informed consent.
6. Does not have a severe injury in the joints or the back or any medical condition that would prevent them from exercising or participant advised not to exercise by a doctor.

7. Must not be pregnant
8. Must not have any planned major surgical procedures during the intervention period
9. Does not have cardiovascular disease, lung disease and cancer.

Do I have to take part?

It is entirely up to you to decide whether or not to take part. If you decide to take part, you will be asked to sign a consent form. If you decide you want to be part of the study and later on change your mind, you can withdraw from the study anytime you want to.

What should I do if I take part?

If you agree to take part you will be asked to:

1. Sign a consent form.
2. Book an appointment in the Du Headquarter Health Center – Al Salam Tower.
3. Complete health measurements that include: waist circumference, HbA1c, fasting blood glucose, low-density lipoproteins level, blood pressure, body mass index, waist circumference and percent body fat. These measurements will be measured twice at different periods (before the intervention and after the intervention).
4. Complete a 7-question questionnaire about physical activity. This process will be repeated 3 times during the study.
5. You will be given a watch to wear for 6 days to measure physical activity. This process will also be repeated 3 times during the study.

What are the possible disadvantages and risks of taking part?

Taking part in this study does not cause you any physical harm. Your privacy and the confidentiality of your data are very important to us and we will make every effort to protect them.

What are the possible benefits of taking part?

If you were allocated in the control group, you will get free health measurements twice during the intervention period. However, if you were in the intervention group, you will also get free health measurements but you will also be enrolled in an exercise program for 12 weeks. Also, participating in this study could help us create future policies that would grant employees exercise time during working hours.

Will my information be kept confidential?

All information which is collected about you during the course of the research will be kept strictly confidential. Your name and any other

information that could directly identify you from the data collected will be removed and replaced with a code number. Only certain members of the study group can access these codes. Your health information and research data will be kept on secure computers.

What if something goes wrong?

It is unlikely that anything will go wrong while you are taking part in the study. However, If you are harmed by taking part in this research project, there are no special compensation arrangements. If you are harmed due to someone's negligence, or have any concerns about any aspect of the way you have been approached or treated during the course of this study, you can contact Dubai Scientific Research Ethics Committee, DHA on +97142191961/+9714211965 or email on DSREC@dha.gov.ae . In addition, if you wish to make a complaint or have any feedback, then you can also contact the researchers:

Mr. Ali Muneer Al Rahma, PhD Candidate, Institute of Public Health, College of Medicine & Health Sciences, United Arab Emirates University. Email: 201890025@uae.ac.ae Mobile: 052-7642445

Dr. Javaid Nauman, Assistant Professor Institute of Public Health, College of Medicine & Health Sciences, United Arab Emirates University. Email: javaid.nauman@uaeu.ac.ae Telephone: +97137137466

Baseline Information -Arabic [2 pages]

Baseline Information- البيانات الأساسية

Name of Participant: اسم المشارك/المشاركة:
Gender: الجنس:
Nationality: الجنسية:
Mobile: رقم الهاتف:
Email: البريد الإلكتروني:

البرامج الصحية

الرجاء اختيار إجابة واحدة فقط لكل سؤال

السؤال	راضٍ للغاية	راضٍ	محايد	غير راضٍ	غير راضٍ للغاية
أنا راضٍ تماما عن البرامج المتعلقة بالصحة والعافية المتوفرة لي كموظف في شركة دو.	5	4	3	2	1
الأنشطة الصحية في شركة دو لها تأثير إيجابي على صحتي وعافيتي.	5	4	3	2	1
الأنشطة الصحية في شركة دو لها تأثير إيجابي على انتاجيتي.	5	4	3	2	1
الأنشطة الصحية في شركة دو لها تأثير إيجابي على سعادتي.	5	4	3	2	1

مؤشر العافية (منظمة الصحة العالمية)

الرجاء اختيار الإجابة الأقرب لشعورك خلال الأسبوعيين الماضيين لكل من العبارات الخمسة التالية. ملاحظة: كلما كان الرقم أعلى كان مؤشر عافيتك أفضل

في الأسبوعين الماضيين:	دائماً	أكثر الأحيان	أكثر من نصف الوقت	أقل من نصف الوقت	بعض الأحيان (نادراً)	بتاتاً
كنت سعيداً وبمزاج جيد	5	4	3	2	1	0
كنت أشعر بالهدوء والاسترخاء	5	4	3	2	1	0
كنت أشعر بالحيوية والنشاط	5	4	3	2	1	0
كنت أستيقظ نشطاً ومرتاحاً	5	4	3	2	1	0
كانت أيامي مليئة بأشياء تثير اهتمامي	5	4	3	2	1	0

التغذية

كمية استهلاك الطعام (الرجاء اختيار إجابة واحد فقط لكل مادة غذائية)

المواد الغذائية	4 مرات أو أكثر في اليوم	2-3 مرات في اليوم	مرة واحدة في اليوم	1-4 مرات في الأسبوع	بتاتاً
الفواكه					
الخضروات					
الحليب ومشتقات الحليب					
اللحم/ السمك/الدجاج					
الخبز/الأرز/ المعكرونة					
الحلوى/الحلويات					
الوجبات الخفيفة المالحة					
القهوة / الشاي					
المشروبات المحلاة					
مشروبات الطاقة					

عادات الطعام

1- عدد الوجبات في اليوم:

2-1 وجبات	4-3 وجبات	5 وجبات أو أكثر

2- هل تُفَوت وجبات الطعام؟

نعم	لا

3- سبب ترك الوجبة (إذا كانت الإجابة نعم على السؤال السابق):

لتقليل تناول الطعام	لتخفيف الوزن	فقدان الشهية	الصوم

4- كمية مياه الشرب المستهلكة في اليوم:

4-1 أكواب	7-5 أكواب	8 أكواب أو أكثر

Baseline Information -English [2 pages]

Baseline Information- البيانات الأساسية

Name of Participant:	اسم المشارك/المشاركة:
Gender:	الجنس:
Nationality:	الجنسية:
Mobile:	رقم الهاتف:
Email:	البريد الإلكتروني:

Wellness Programs
Please choose one option for every question

Question	Extremely Satisfied	Satisfied	Neutral	Dissatisfied	Extremely Dissatisfied
I am very satisfied with the health and wellness programs that are available to me as a Du employee.	5	4	3	2	1
The wellness activities in Du have a positive impact on my health & wellbeing.	5	4	3	2	1
The wellness activities in Du have a positive impact on my productivity.	5	4	3	2	1
The wellness activities in Du have a positive impact on my happiness.	5	4	3	2	1

WHO Well-being Index

Please indicate for each of the five statements which is closest to how you have been feeling over the last two weeks. Notice that higher numbers mean better well-being.

Over the last two weeks:	All the time	Most of the time	More than half of the time	Less than half of the time	Some of the time	At no time
I have felt cheerful and in good spirits	5	4	3	2	1	0
I have felt calm and relaxed	5	4	3	2	1	0
I have felt active and vigorous	5	4	3	2	1	0
I woke up feeling fresh and rested	5	4	3	2	1	0
My daily life has been filled with things that interest me	5	4	3	2	1	0

Nutrition

Frequency of food consumption (please tick one option for every food item)

Food items	4 or more times per day	2-3 times per day	Once per day	1-4 times per week	Never
Fruits					
Vegetables					
Milk/milk products					
Meat/fish/chicken					
Bread/rice/pasta					
Sweets/desserts					
Salty snacks					
Coffee/tea					
Sweetened drinks					
Energy drinks					

Eating habits

1- Number of meals per day:

1-2 meals	3-4 meals	5 or more meals

2- Do you skip meals?

Yes	No

3- Reasons for skipping meals (if the answer is yes to the previous question):

To reduce food intake	To lose weight	Lack of appetite	Fasting

4- Amount of drinking water consumed per day:

1-4 cups	5-7 cups	8 or more cups

IPAQ -Arabic [3 pages]

الصيغة المختصرة لاستبانة النشاط البدني الدولية، للاستخدام بواسطة التعبئة الشخصية

نحن مهتمون بمعرفة أنواع الأنشطة البدنية التي يقوم بها الأفراد كجزء من حياتهم اليومية. الأسئلة التالية ترتكز حول الوقت الذي قضيته في ممارسة أنشطة بدنية خلال الأيام السبعة الماضية. فضلاً أجب عن كل سؤال من الأسئلة التالية حتى وإن كنت تعتبر نفسك غير نشيط بدنياً. فكر في الأنشطة البدنية التي تمارسها خلال عملك، وكجزء من أعمالك المنزلية، وأثناء تنقلك من مكان لآخر، وتلك التي تقوم بها في وقت فراغك بغرض الترويح أو التمرين أو الرياضة.

الآن فكر في جميع الأنشطة البدنية التي تتطلب جهداً بدنياً مرتفع الشدة والتي قمت بممارستها خلال الأيام السبعة الماضية. الأنشطة البدنية مرتفعة الشدة هي تلك الأنشطة التي تجعل تنفسك أعلى بكثير من المعتاد، مثل رفع أشياء ثقيلة، أو حرث الأرض، أو ركوب الدراجة بسرعة عالية، أو الجري، أو ممارسة كرة القدم، أو كرة السلة، أو السباحة، أو نط الحبل. فكر فقط في الأنشطة البدنية مرتفعة الشدة التي قمت بممارستها لمدة 10 دقائق على الأقل في كل مرة.

1- خلال الأيام السبعة الماضية، كم يوماً مارست فيه نشاطاً بدنياً مرتفع الشدة؟

____ يوم في الأسبوع

☐ لا أقوم بأي نشاط بدني مرتفع الشدة. ← انتقل مباشرة إلى السؤال رقم 3

2- في المعتاد، كم من الوقت قضيته في ممارسة نشاط بدني مرتفع الشدة في أحد تلك الأيام؟

____ ساعة في اليوم

____ دقيقة في اليوم

☐ لا أدري/ أو غير متأكد.

الآن فكر في جميع الأنشطة البدنية التي تتطلب جهداً بدنياً معتدل الشدة والتي قمت بممارستها خلال الأيام السبعة الماضية. الأنشطة البدنية معتدلة الشدة هي تلك الأنشطة التي تجعل تنفسك أعلى من

المعتاد إلى حداً ما، ويمكن أن تتضـــمن رفع أشـــياء خفيفة، أو ركوب الدراجة بســـرعة عادية، أو ممارسة كرة الطائرة، أو ممارسة تنس الطاولة، أو كنس المنزل، أو غسل الملابس يدوياً، أو غسل السيارة. لا تحسب المشي ضمن هذه الأنشطة. مرة أخرى، فكر فقط في الأنشطة البدنية معتدلة الشدة التي قمت بممارستها لمدة 10 دقائق على الأقل في كل مرة.

3- خلال الأيام السبعة الماضية، كم يوماً مارست فيه نشاطاً بدنياً معتدل الشدة؟

_____ يوم في الأسبوع

☐ لا أقوم بأي نشاط بدني معتدل الشدة. ← انتقل مباشرة إلى السؤال رقم 5

4- في المعتاد، كم من الوقت قضيته في ممارسة نشاط بدني معتدل الشدة في أحد تلك الأيام؟

_____ ساعة في اليوم

_____ دقيقة في اليوم

☐ لا أدري/ أو غير متأكد.

الآن فكر في الوقت الذي قضيته في المشي خلال الأيام السبع الماضية، ويتضمن ذلك المشي إلى العمل، والمشـــي أثناء العمل، وفي البيت، وخلال انتقالك من مكان لآخر، أو أي نوع من أنواع المشي بغرض الترويح أو الرياضة.

5- خلال الأيام السبعة الماضية، كم يوماً مارست فيه المشي لمدة 10 دقائق على الأقل في كل مرة؟

_____ يوم في الأسبوع

☐ لا أقوم بممارسة المشي إطلاقا. ← انتقل مباشرة إلى السؤال رقم 7

6- في المعتاد، كم من الوقت قضيته في ممارسة المشي في أحد تلك الأيام؟

_____ ساعة في اليوم

_____ دقيقة في اليوم

☐ لا أدري/ أو غير متأكد.

الآن فكر في الوقت الذي قضـيته جالسـاً خلال الأيام السـبعة الماضـية. أحسـب وقت الجلوس في العمل، وفي المنزل، وفي الدراسـة، وفي الترفيه. من الممكن أن يتضـمن ذلك وقت الجلوس على المكتب، وأثناء العمل على الكمبيوتر، وأثناء زيارتك لصـديق، وأثناء القراءة، والجلوس أو الاستلقاء لمشاهدة التلفزيون.

7- خلال الأيام السـبعة الماضـية، كم من الوقت قضـيته جالسـاً في أحد هذه الأيام من غير أيام الإجازة الأسبوعية؟

_____ ساعة في اليوم

_____ دقيقة في اليوم

☐ لا أدري/ أو غير متأكد.

(نهاية الاستبانة، شكراً لمشاركتكم)

IPAQ -English [3 pages]

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the vigorous activities that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

1. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?

_____days per week

☐ No vigorous physical activities → Skip to question 3

2. How much time did you usually spend doing vigorous physical activities on one of those days?

_____ hours per day

_____ minutes per day

☐ Don't know/Not sure

Think about all the moderate activities that you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

_____ days per week

☐ No moderate physical activities → Skip to question 5

4. How much time did you usually spend doing moderate physical activities on one of those days?

_____ hours per day

_____ minutes per day

☐ Don't know/Not sure

Think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

5. During the last 7 days, on how many days did you walk for at least 10 minutes at a time?

_____ days per week

☐ No walking → Skip to question 7

6. How much time did you usually spend walking on one of those days?

_____ hours per day

_____ minutes per day

☐ Don't know/Not sure

The last question is about the time you spent sitting on weekdays during the last 7 days. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the last 7 days, how much time did you spend sitting on a week day?

_____ hours per day

_____ minutes per day

☐ Don’t know/Not sure

This is the end of the questionnaire, thank you for participating.

Process Evaluation (Realistic Evaluation) - [3 pages]

INTERVENTION PROGAM EVALUATION

(Realist Evaluation)

CONGRATULATIONS! You have finished all the requirements of the intervention. We would like to thank you for participating in the study. In order to further develop this intervention, we would like you to answer a few short questions about how you feel the research could be improved. We would really appreciate your feedback to help us improve future interventions.

GENERAL

Q1. What was your reason for volunteering for the study?

Q2. Have you experienced any particular benefits as a result of participating in this program?

Yes No

If YES, please describe benefits:

Q3. Has participation in this study had any effect (positive or negative) on your friends, family, partner/spouse, or relatives?

Yes No

If YES, please specify:

Q4.Do you feel this program increased your motivation to become more physically active?

Not at all			Somewhat			Very much so
1	2	3	4	5	6	7

Q5. Are you aware of what the Accelerometer (wrist-band) was measuring?

Please describe:

The Intervention

There were several aspects to the intervention and we would like to know which components you found most useful.

Q6. Please rate each component of the program in terms of its usefulness in motivating you to exercise more.

	Not at all Useful		Somewhat Useful				Very Useful
Accelerometer	1	2	3	4	5	6	7
Health Measurements Results	1	2	3	4	5	6	7
Exercise time in the Workplace (Intervention Group only)	1	2	3	4	5	6	7
Availability of Equipment (Intervention Group only)	1	2	3	4	5	6	7
Supervised Exercise Sessions (Intervention Group only)	1	2	3	4	5	6	7

Q7. How clearly was the intervention explained to you?

Not at all Clear			Somewhat Clear			Very Clear
1	2	3	4	5	6	7

Q8. Do you think the intervention has increased the amount of exercise you do?

Yes No

If YES, please describe the types of exercise you now do as a result:

Q9. Were there any factors that facilitated you participating in exercise at the workplace? (Intervention Group only). (Please specify)

Q10. Were there any factors that helped to keep you engaged and motivated to participate in exercise at the workplace? (Intervention Group only). (Please specify)

Q11. Were there any barriers that prevented you from exercising at the workplace? (Intervention Group only). (Please specify)

Q12. Were there any factors which made it difficult for you to continue with the intervention? (Intervention Group only) (Please specify)

Future Recommendations

Q13.Do you have any suggestions on how this intervention could be improved?

Thank you for your time.

Appendix B

Table 9: International Physical Activity Questionnaire levels

Measurement	Criteria
Category One: Low	This category is the lowest level of physical activity. Individuals who do not meet the criteria for categories two or three are considered low/inactive.
Category two: Moderate	Any one of the following criteria: • 3 or more days of vigorous-intensity activity of at least 20 minutes per day OR • 5 or more days of moderate-intensity activity or walking of at least 30 minutes per day OR • 5 or more days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving a minimum of at least 600 MET-min/week.
Category three: High	Any one of the following criteria: • Vigorous-intensity activity on at least 3 days and accumulating at least 1500 MET-minutes/week OR • 7 or more days of any combination of walking, moderate-intensity or, vigorous-intensity activities achieving, a minimum of at least 3000 MET-minutes/week

(International Physical Activity Questionnaire, 2005).

Table 10: Participants' Post-study Characteristics

	Post Study		***P***
	IN (n=65)	**DI (n=65)**	
Physical Activity Category (IPAQ)			NA
Low	9 (14%)	14 (22%)	
Moderate	31 (48%)	30 (46%)	
Vigorous	25 (38%)	21 (32%)	
Cardio-metabolic Risk Factors			
Elevated Waist circumference (cm)	57 (88%)	58 (89%)	NA
Elevated Blood Pressure (mmHg)	31 (48%)	33 (51%)	NA
Reduced HDL- cholesterol (mg/dL)	25 (38%)	23 (35%)	NA
Elevated Triglycerides (mg/dL)	18 (28%)	23 (35%)	NA
Elevated Fasting glucose (mg/dL)	12 (18%)	14 (22%)	NA
Number of Meals per Day			NA
1-2 Meals	32 (49%)	25 (39%)	
3-4 Meals	32 (49%)	34 (52%)	
5 or More Meals	1 (2%)	6 (9%)	
Skipping Meals			NA
Yes	29 (45%)	30 (46%)	
No	36 (55%)	35 (54%)	
Reason for Skipping Meals (if yes)			NA
To Reduce Food Intake	4 (14%)	9 (30%)	
To Lose Weight	18 (62%)	10 (34%)	
Lack of Appetite	3 (10%)	7 (23%)	
Fasting	4 (14%)	4 (13%)	
Water Consumed per Day			NA
1-4 Cups	9 (14%)	9 (14%)	
5-7 Cups	25 (38%)	29 (45%)	
8 or More Cups	31 (48%)	27 (41%)	

IN, intervention group; DI, delayed-intervention group; IPAQ, International Physical Activity Questionnaire.
Data are number of participants (%). NA = Not Applicable, Chi-Square test cannot be applied for post-study data due to the use of multiple imputations in IBM SPSS 28.0.
The data for cardiometabolic risk factors and physical activity are as per the criteria presented in Tables 1 & 2.

Table 11: Participants' Baseline Nutrition Characteristics

Intervention Group (n=65)					
Frequency of Food Consumption	≥4/day	2-3/day	Once/day	1-4/week	Never
Fruits*	0	15 (23%)	33 (51%)	13 (20%)	4 (6%)
Vegetables	0	22 (34%)	24 (37%)	19 (29%)	0
Milk and milk products	1 (2%)	16 (25%)	23 (35%)	21 (32%)	4 (6%)
Meat/fish/chicken	2 (3%)	10 (16%)	23 (35%)	24 (37%)	6 (9%)
Bread/rice/pasta	1 (2%)	15 (23%)	24 (37%)	23 (35%)	2 (3%)
Sweets/desserts	2 (3%)	8 (12%)	15 (23%)	33 (51%)	7 (11%)
Salty snacks	1 (2%)	9 (14%)	20 (30%)	28 (43%)	7 (11%)
Coffee/tea	8 (12%)	30 (46%)	19 (29%)	7 (11%)	1 (2%)
Sweetened drinks	1 (2%)	1 (2%)	9 (14%)	32 (49%)	22 (33%)
Energy drinks	0	0	3 (5%)	8 (12%)	54 (83%)
Delayed-Intervention Group (n=65)					
Frequency of Food Consumption	≥4/day	2-3/day	Once/day	1-4/week	Never
Fruits	0	9 (14%)	25 (38%)	29 (45%)	2 (3%)
Vegetables	0	19 (29%)	21 (32%)	24 (37%)	1 (2%)
Milk and milk products	2 (3%)	13 (20%)	25 (38%)	20 (31%)	5 (8%)
Meat/fish/chicken	1 (2%)	16 (24%)	27 (42%)	16 (24%)	5 (8%)
Bread/rice/pasta	1 (2%)	30 (46%)	20 (31%)	12 (18%)	2 (3%)
Sweets/desserts	2 (3%)	7 (11%)	17 (26%)	34 (52%)	5 (8%)
Salty snacks	1 (2%)	9 (14%)	18 (28%)	31 (47%)	6 (9%)
Coffee/tea	5 (8%)	36 (55%)	13 (20%)	5 (8%)	6 (9%)
Sweetened drinks	1 (2%)	3 (5%)	6 (9%)	33 (51%)	22 (33%)
Energy drinks	1 (2%)	0	2 (3%)	9 (14%)	53 (81%)

Data are number of participants (%). * = statistically significant chi-square test p-value. Fruit consumption (p-value = 0.25).

Table 12: Participants' Post-study Nutrition Characteristics

Intervention Group (n=65)					
Frequency of Food Consumption	≥4/day	2-3/day	Once/day	1-4/week	Never
Fruits	5 (8%)	16 (25%)	30 (46%)	13 (20%)	1 (1%)
Vegetables	5 (8%)	20 (31%)	27 (42%)	12 (18%)	1 (1%)
Milk and milk products	1 (1%)	19 (29%)	24 (37%)	16 (25%)	5 (8%)
Meat/fish/chicken	3 (5%)	8 (12%)	27 (42%)	21 (32%)	6 (9%)
Bread/rice/pasta	1 (1%)	11 (17%)	29 (45%)	20 (31%)	4 (6%)
Sweets/desserts	2 (3%)	1 (1%)	14 (22%)	42 (65%)	6 (9%)
Salty snacks	1 (1%)	2 (3%)	11 (17%)	39 (60%)	12 (19%)
Coffee/tea	7 (11%)	29 (45%)	18 (27%)	6 (9%)	5 (8%)
Sweetened drinks	0	2 (3%)	7 (11%)	25 (38%)	31 (48%)
Energy drinks	0	0	0	8 (12%)	57 (88%)
Delayed-Intervention Group (n=65)					
Frequency of Food Consumption	≥4/day	2-3/day	Once/day	1-4/week	Never
Fruits	4 (6%)	20 (31%)	18 (27%)	20 (31%)	3 (5%)
Vegetables	2 (3%)	21 (32%)	23 (35%)	16 (25%)	3 (5%)
Milk and milk products	3 (5%)	20 (31%)	19 (29%)	18 (27%)	5 (8%)
Meat/fish/chicken	1 (1%)	19 (29%)	18 (28%)	18 (28%)	9 (14%)
Bread/rice/pasta	4 (6%)	23 (36%)	25 (38%)	10 (15%)	3 (5%)
Sweets/desserts	3 (5%)	6 (9%)	20 (31%)	28 (43%)	8 (12%)
Salty snacks	1 (1%)	6 (9%)	16 (25%)	31 (48%)	11 (17%)
Coffee/tea	6 (9%)	27 (42%)	18 (28%)	8 (12%)	6 (9%)
Sweetened drinks	1 (1%)	4 (6%)	7 (11%)	26 (40%)	27 (42%)
Energy drinks	0	0	1	9 (14%)	55 (86%)

Data are number of participants (%). Chi-Square test cannot be applied for post-study data due to the use of multiple imputations in IBM SPSS 28.0.

Table 13: Within-group and Between-group Differences at Week 12 are Compared with Baseline Measurements for All Outcomes (Per Protocol Analysis)

	Within-group differences		**Between-group differences**
Measurement	**Intervention Group (n=57)**	**Delayed-Intervention Group (n=48)**	
Baseline Fasting Plasma Glucose (mg/dL)	95.7	92.7	3.1 (−2.31 to 8.4)
Difference at 12 weeks	−3.5* (−6.1 to −0.8)	0.3 (−3.9 to 4.5)	3.1 (−2.2 to 8.3)
Baseline HbA1c (%)	5.3	5.3	0.04 (−0.2 to 0.2)
Difference at 12 weeks	0.3* (0.2 to 0.4)	0.3* (0.2 to 0.4)	0.05 (−0.2 to 0.3)
Baseline Total Cholesterol (mg/dL)	199.9	198.5	1.5 (−13.7 to 16.6)
Difference at 12 weeks	−2.6 (−9.9 to 4.6)	3.4 (−5.2 to 12)	−4.5 (−19.1 to 10.2)
Baseline HDL Cholesterol (mg/dL)	45.4	43.5	1.8 (−3.4 to 7.1)
Difference at 12 weeks	2.6* (1 to 4.1)	2.8* (1.2 to 4.3)	1.7 (−3.4 to 6.8)
Baseline LDL Cholesterol (mg/dL)	133.8	131.5	2.3 (−10.6 to 15.2)
Difference at 12 weeks	−5 (−11 to 0.9)	2 (−4.9 to 8.9)	−4.8 (−17 to 7.5)

Table 13: Within-group and Between-group Differences at Week 12 are Compared with Baseline Measurements for All Outcomes (Per Protocol Analysis) (Continued).

	Within-group differences		**Between-group differences**
Measurement	**Intervention Group (n=57)**	**Delayed-Intervention Group (n=48)**	
Baseline Triglycerides (mg/dL)	115.6	128.9	−13.2 (−38.1 to 11.7)
Difference at 12 weeks	−0.7 (−11.9 to 10.5)	6.1 (−10.6 to 22.7)	−19.9 (−43.9 to 3.9)
Baseline Waist Circumference (cm)	102.4	103.8	−1.4 (−5.7 to 2.9)
Difference at 12 weeks	−4.8* (−6.9 to −3.3)	−3.6* (−5 to −2.3)	−2.5 (−6.9 to 1.9)
Baseline Weight (kg)	86.6	88.8	−2.2 (−8.2 to 3.8)
Difference at 12 weeks	−0.1 (−0.8 to 0.6)	0.9 (−0.6 to 2.5)	−3.3 (−9.2 to 2.7)
Baseline BMI (kg/m^2)	29.2	29.8	−0.6 (−2.1 to 0.9)
Difference at 12 weeks	−0.01 (−0.3 to 0.2)	0.2 (−0.08 to 0.5)	−0.8 (−2.4 to 0.7)
Baseline Skeletal Muscle Mass (kg)	32.1	32.8	−0.7 (−3.5 to 1.9)
Difference at 12 weeks	0.5 (−0.01 to 0.9)	0.7 (−0.01 to 1.4)	−0.9 (−3.7 to 1.7)

Table 13: Within-group and Between-group Differences at Week 12 are Compared with Baseline Measurements for All Outcomes (Per Protocol Analysis) (Continued).

	Within-group differences		Between-group differences
Measurement	**Intervention Group (n=57)**	**Delayed-Intervention Group (n=48)**	
Baseline Body Fat Percentage (%)	34.3	34.6	−0.3 (−3.6 to 2.9)
Difference at 12 weeks	−0.9* (−1.9 to −0.003)	−0.7 (−1.9 to 0.3)	−0.5 (−3.5 to 2.5)
Baseline Systolic Blood Pressure (mmHg)	126.5	125.2	1.3 (−4.1 to 6.6)
Difference at 12 weeks	−2.2 (−5.6 to 1.2)	−0.3 (−4.7 to 4.1)	−0.6 (−5.7 to 4.5)
Baseline Diastolic Blood Pressure (mmHg)	82.6	81.9	0.7 (−3.3 to 4.7)
Difference at 12 weeks	0.7 (−1.4 to 2.8)	1 (−2.5 to 4.5)	0.4 (−3.1 to 3.9)
Baseline Sitting Time (hours) – IPAQ	9.1	8.8	0.3 (−0.7 to 1.2)
Difference at 12 weeks	−0.7* (−1.5 to −0.006)	−0.2 (−1.1 to 0.7)	−0.3 (−1.2 to 0.8)
Baseline WHO Wellbeing (score)	15.5	15.2	0.3 (−1.6 to 2.2)
Difference at 12 weeks	3* (1.9 to 4.1)	0.4 (−1.9 to 2)	2.9* (1.3 to 4.6)

Table 13: Within-group and Between-group Differences at Week 12 are Compared with Baseline Measurements for All Outcomes (Per Protocol Analysis) (Continued).

	Within-group differences		**Between-group differences**
Measurement	**Intervention Group (n=57)**	**Delayed-Intervention Group (n=48)**	
Baseline Sedentary Time (minutes) – AX3 Accelerometer	7223	7408	−165.6 (−334.5 to 3.3)
Difference at 12 weeks	40.7 (−34.1 to 115.5)	−50.4 (−229.9 to 129.2)	−71.8 (−286.8 to 143.3)
Baseline Light Physical Activity (minutes) - AX3 Accelerometer	514.5	446.7	61.8* (8.3 to 115.3)
Difference at 12 weeks	−15.2 (−47.4 to 17)	−4.6 (−33.4 to 24.3)	50.7 (−6.7 to 108.2)

Table 13: Within-group and Between-group Differences at Week 12 are Compared with Baseline Measurements for All Outcomes (Per Protocol Analysis) (Continued).

	Within-group differences		**Between-group differences**
Measurement	**Intervention Group (n=57)**	**Delayed-Intervention Group (n=48)**	
Baseline Moderate Physical Activity (minutes) - AX3 Accelerometer	883.8	750.6	120.5 (−2.1 to 242.9)
Difference at 12 weeks	−33.6 (−86.1 to 18.8)	−20.7 (−70.6 to 29.2)	106.8 (−14.8 to 228.3)
Baseline Vigorous Physical Activity (minutes) - AX3 Accelerometer	18.7	24	−5.3 (−17.5 to 6.8)
Difference at 12 weeks	8.1 (−0.4 to 16.6)	−3.1 (−11.9 to 5.7)	5.8 (−5.6 to 17.4)

Data are mean difference (95% Confidence Interval) unless stated otherwise. Within-group differences at week 12 are compared with the baseline measurement. Between-group differences are at each timepoint. IPAQ = International Physical Activity Questionnaire, AX3 Accelerometer data obtained from AX3 Axivity wearable devices. * = statistically significant p-values in Within-group differences: Intervention group: Fasting plasma glucose p-value = 0.011, HbA1c p-value = 0.001, HDL cholesterol = 0.001, Waist circumference p-value = 0.001, Body fat percentage p-value = 0.049, Sitting Time p-value 0.048 and WHO Wellbeing score p-value = 0.001. Delayed-Intervention group: HbA1c p-value = 0.001, HDL cholesterol = 0.001 and Waist circumference p-value = 0.001. Between-group differences: Baseline Light Physical Activity = 0.024 and WHO Wellbeing score at 12 weeks p-value = 0.001.

Appendix C

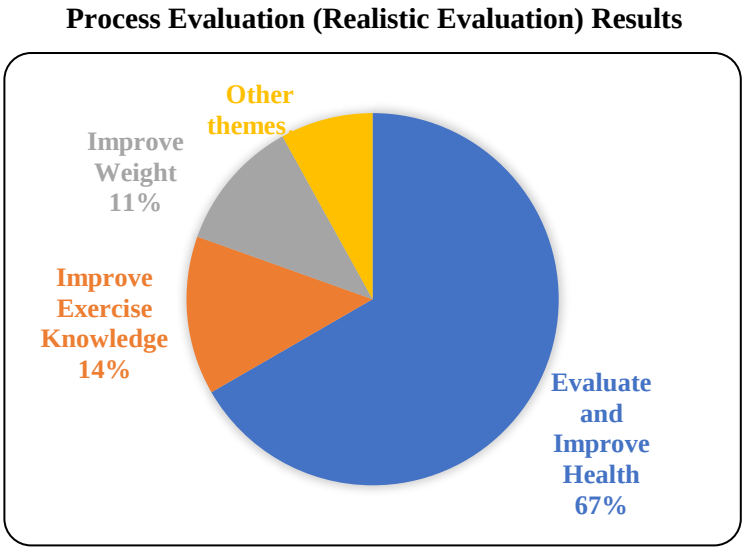

Figure 8: Process Evaluation Reason for Volunteering Q1.

Q1. What was your reason for volunteering for the study?

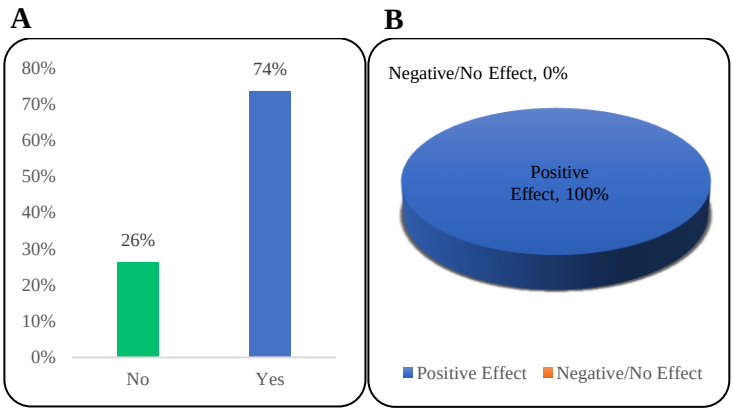

Figure 9: Process Evaluation Positive Effect Q3.

Q3. Has participation in this study had any effect (positive or negative) on your friends, family, partner/spouse, or relatives? (A) Q3. If yes, please specify: (B)

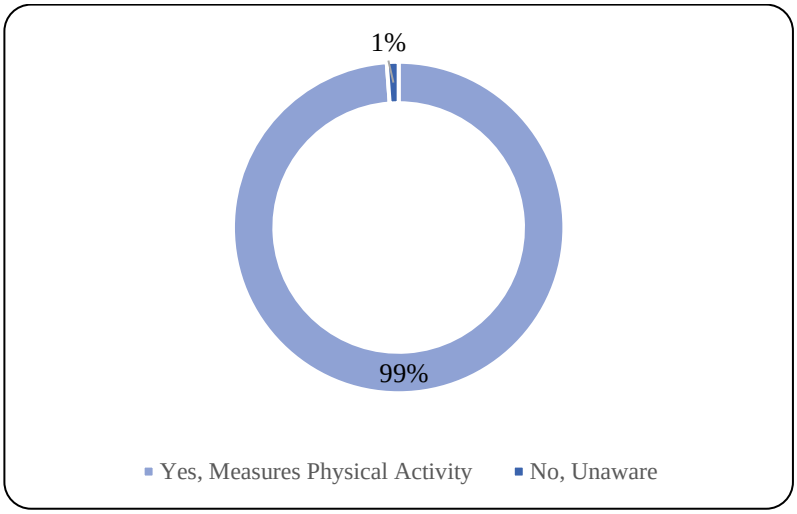

Figure 10: Process Evaluation Accelerometer Measurement Q5.

Q5. Are you aware of what the Accelerometer (wrist-band watch) was measuring? Please describe:

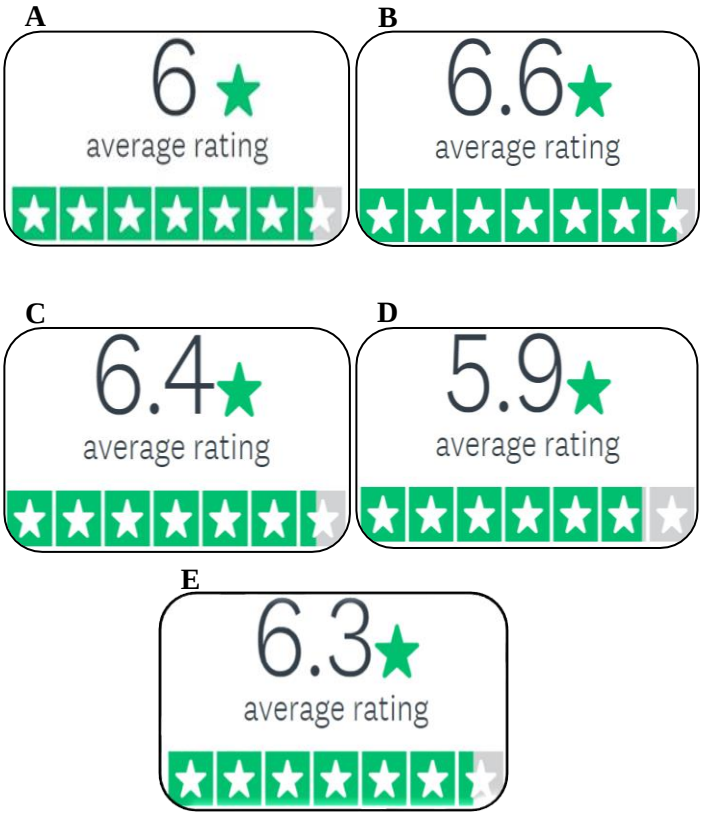

Figure 11: Process Evaluation Of Study Components Rating from 1 to 7, Q6.

Q6. Please rate each component of the program in terms of its usefulness in motivating you to exercise more: Accelerometer (A), Health Measurement Results (B), Exercise time in the Workplace (C), Availability of Equipment (D), and Supervised Exercise Sessions (E). Note: C, D, and E are only applicable for the intervention group.

Figure 12: Process Evaluation Clear Explanation of Study Rating from 1 to 7, Q7.

Q7. How clearly was the intervention explained to you? 6.7 out of 7.

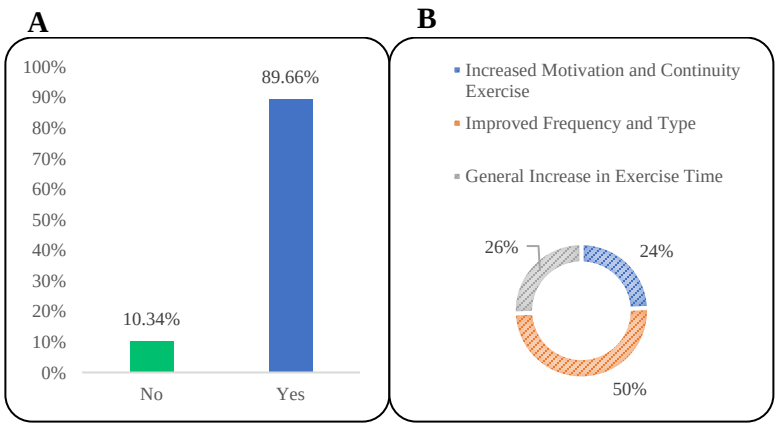

Figure 13: Process Evaluation Exercise Increase Q8.

Q8. Do you think the intervention has increased the amount of exercise you do? (A) Q8 If yes, please specify: (B)

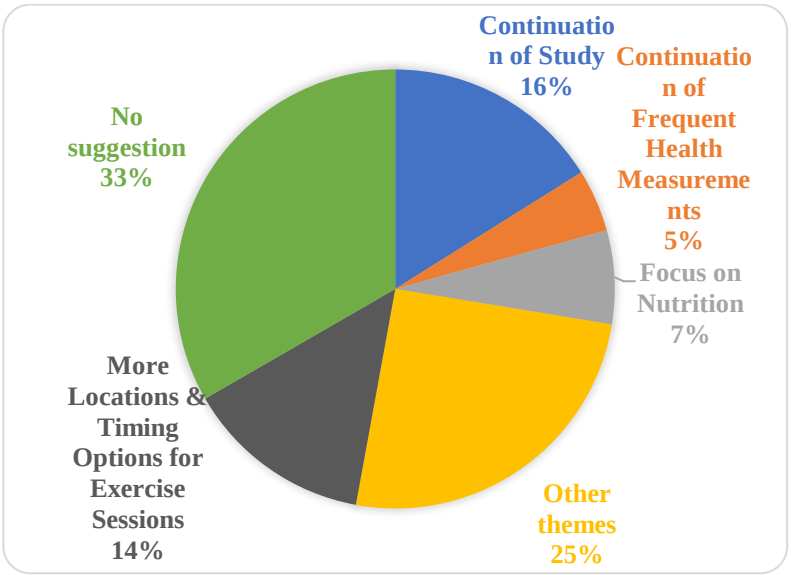

Figure 14: Process Evaluation Participants' Suggestions Q13.

Q13. Do you have any suggestions on how this study could be improved?

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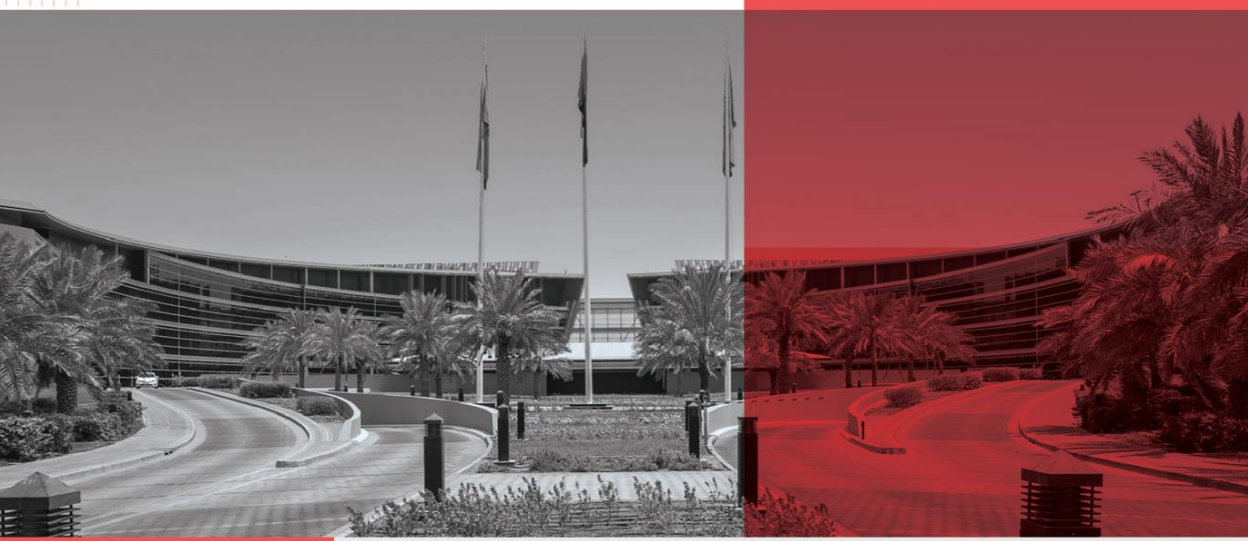

UAE UNIVERSITY DOCTORATE DISSERTATION NO. 2022:4

This randomized controlled trial evaluated the effect of a 12-week workplace structured exercise intervention on cardiometabolic risk factors and physical activity levels. The study's favorable within-group results indicated the importance of this study from a public health perspective.

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