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Poster Presentation: Session 1

Prediction of Impact Force Using Kinematic Data during Running

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Background: Distance running is a popular sport around the world. In Hong Kong, for example, the number of participants in the Standard Chartered Hong Kong Marathon has increased 74 times over the past two decades and it reached a record high 74,000 in 2019 (Hong Kong Amateur Athletic Association, 2019). Despite a number of potential health benefits, running-related injuries (RRI) are extremely common. An epidemiological reported that up to 92.4% of distance runners incur an RRI in a given year.[1] In order to promote pain-free and sustainable running, RRI prevention is still a big challenge in sports medicine. Emerging evidence suggests strong association between RRI and impact force during running.[2-3] However, measurement of the impact force requires expensive force measuring instruments and therefore it is usually confined to a laboratory setting.

Objective: Theoretically, impact force is related to the sum of segmental masses and acceleration. Hence, this proposed project aims to establish a mathematical solution to predict impact force based on running kinematics.

Methods: Twenty recreational runners (10 females and 10 males) will be recruited in this study. They will be invited to run on an instrumented treadmill (Advance Mechanical Technology Inc., MA, USA) at five different speeds (i.e., preferred speed, ±10% and ±20% of the preferred speed) using both rearfoot and non-rearfoot strike patterns, which have been shown to affect impact force.[4-5] Kinematics of full-body segments will be captured using an 8-camera motion capture system (Vicon Nexus, Oxford, UK). Each running condition will last 3 minutes and kinematic data for each condition will be collected at 200 Hz in the last minute. Synchronized kinetic data will be collected at 1,000 Hz. Testing sequence will be randomized and at least 5 minutes between conditions will be arranged to avoid fatigue. The same shoe model will be assigned to all runners to minimize shoe effect.

Data will be processed using Visual 3D (C-Motion Inc., Germantown, MD, USA). Acceleration of each segment will be obtained by double differentiation of its positional data in the time domain. Mass of each segment will be calculated according to the Dempster's regression model.[6] Segmental force will be calculated using segmental mass (m_i) multiplying by acceleration (a_i). The impact force (F) will be estimated by summarizing all segmental forces and the equation is as follow:

$$F = \sum (m_i \times a_i)$$

The estimated impact force will be evaluated against the ground truth i.e., impact force measured using force plates. Linear regression analysis will be conducted to calculate R^2 for quantifying the agreement between the estimated and measured impact force. Root mean square errors will also be calculated to determine the absolute error of the two measurements.

Potential implication: The project is expected to stage a specific mathematic equation for estimating the impact force using only running kinematics of full-body segments, and demonstrate the accuracy of the estimated impact force in comparison to the ground truth. Broadly, it would allow runners to easily undertake sophisticated biomechanical assessment even in a non-laboratory setting.

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Effects of Moderate and Vigorous Aerobic Exercise on Alleviating Depression in Older Adults: A Pilot Randomized Controlled Trial

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Background

Depression in later life is a common psychiatric disorder among older adults that diminishes their quality of life. Almost 14% of people worldwide over the age of 55 have depression including 2% with major depression. [1, 2] Exercise intervention is reported to be an effective treatment for depression with relatively low cost compared with antidepressant medications and psychotherapy. [3] Besides, exercise intervention is also associated with improved cardiovascular health, while cardiovascular diseases are the leading cause of death among individuals with depression, pointing to the role of aerobic exercise in improving depression-related death. [4] Among different exercise modalities, aerobic exercise has been mostly studied and suggested for people with depression. [5] On the other hand, WHO has published the global physical activity recommendations, and it suggests at least 75 minutes of vigorous-intensity aerobic exercise or 150 minutes of moderate-intensity aerobic exercise or a equivalent combination of the two throughout the week for decreasing the risk of depression. [6] However, to the best of our knowledge, no studies to date have examined this guideline for improving depression in older adults.

Objectives

The objective of this study is to investigate and compare the effects of moderate-intensity aerobic exercise and vigorous-intensity aerobic exercise on clinically diagnosed depression in older adults.

Methods

In this project, the following outcome measures will be conducted at baseline and after 12 weeks of the intervention for assessment:

Primary Outcome

The Beck Depression Inventory (BDI). BDI is a 21-item questionnaire for evaluating the severity of depression in both normal and psychiatric populations. [7]

Secondary Outcomes:

Other mental health outcomes. Other mental health-related outcomes including anxiety and insomnia will be assessed using self-reported questionnaires.

Cardiorespiratory Fitness. VO2max test will be conducted using a calibrated motor-driven treadmill (h/p/COSMOS 150/50 LC, Germany) by continuous metabolic VO2 measurement using a COSMED Quark Series telemetric gas analysis system.

Brain-derived neurotrophic factors (BDNF). BDNF is associated with a number of neural processes such as neurodevelopment and homeostatic maintenance of nervous system with aging. [8] BDNF level will be assessed at baseline and after 12 weeks of the intervention by venous blood samples to compare the effects of different intensities of aerobic exercise.

Potential implication

This study will provide evidence in evaluating *WHO PA Guideline* in alleviating depression in older adults with clinically diagnosed depression. Results of the present study would potentially add more public health value on exercise for improving depression and overall health in depressed older adults.

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Effects of Wearable Sensor-Based Gait Retraining in Novice Runners

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Objectives

The popularity of distance running is growing worldwide. Unfortunately, running-related injuries (RRIs) are common among novice runners, with an incidence rate of 17.8 per 1,000 hours of training (1). Gait retraining has been studied extensively for its effectiveness in mitigating RRI risk through modifying faulty movement patterns.

In a large-scale randomized controlled trial, a group of novice runners completed a 2-week gait retraining on an instrumented treadmill for impact reduction (2). The training group was instructed to land softer and observe their performance through the real-time ground reaction force (GRF) curve. Trained runners reduced their vertical loading rate (VLR), a key biomechanical marker identified to be associated with RRIs (3). Additionally, the rate of RRIs during the 12-month follow-up was found to be 62% lower than the control (2). Together with other studies, gait retraining was considered an effective intervention for modifying movement patterns in favor of reducing RRI risk.

However, a major shortcoming of the existing gait retraining protocols was the requirement of sophisticated equipment such as instrumented treadmill or 3-D motion capture systems for feedback. Such equipment may not be available within clinical settings. Additionally, the effect of treadmill-based training may not be fully translated to in-field running (4). In view of such limitations, the potential of using wearable sensors for gait retraining has been explored. As there is a strong association between VLR and tibial shock (TS) (5), which can be measured by an inertial measurement unit (IMU) at the distal tibia, it is possible to provide real-time feedback to runners outside of the lab environments.

Hence, the objective of this study is to examine the VLR before and after a 2-week sensor-based gait retraining. Furthermore, this study also aims to compare the occurrence of RRI within a 12-month against the aforementioned randomized controlled trial (2).

Methods

Twenty novice runners with less than 2 years of running experience and TS $\geq$ 8 g will be recruited for this study (2,4). During baseline assessment, participants will run on a self-paced instrumented treadmill (AMTI force sensing tandem treadmill, Watertown, MA, USA) for 5 minutes. GRF data will be sampled at 1,000 Hz for the last minute of the running bout. The VLR will be obtained from the vertical GRF by the algorithm reported previously (2,3).

Baseline TS will be measured based on a 400 m track running (6). A wireless IMU will be affixed onto the right distal tibia (Figure 1) and set to sample the vertical acceleration at 200 Hz. TS will be measured as the acceleration peak during the early stance of a gait cycle. Participants will then undergo eight sessions of gait modification over two weeks based on the protocol reported previously. The training will be conducted in a standard 400 m running track and participants will be asked to reduce their TS to below 80% of the baseline. A ‘beep’ sound will be provided to alert runners if the threshold is exceeded.

Participants will be reassessed after the training, with the same protocol as the baseline assessment. In addition, participants will be required to report medically diagnosed RRIs incurred 12 months after the training.

Potential implication

Nowadays, with sensors being wireless and lightweight, they could be used to measure an array of running metrics in a runners’ natural training environment. Wearable sensors have a great potential in replacing bulky

and expensive equipment used for gait retraining in labs. This proposed study will assess an in-field gait retraining using affordable IMU sensors by examining biomechanical changes related to RRIs. Furthermore, clinical evaluation of the training will be assessed by comparing the RRI risk in the trained runners with previous lab-based training protocols.

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Figure 1. A wireless IMU will be positioned above the right medial malleolus by an adjustable strap.

Effectiveness of Different Exercise Intensities and Volumes of Aerobic Exercise on Improving Cognitive Function in Older Adults with Mild Cognitive Impairment: A Pilot Randomized Controlled Trial

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a) Background: The increasing prevalence of mild cognitive impairment (MCI) in ageing population prompts the need of devising effective interventions to prevent development of cognitive impairment and delay progression to dementia[1]. Beneficial effects of aerobic exercise on cognitive function in older adults with MCI are well-documented[2-5]. However, exercise prescriptions are highly heterogeneous in current literatures[6]. It's crucial to build up standardized exercise prescription or to test effectiveness of current well-established exercise guidelines on improving cognitive function in MCI population. World Health Organization (WHO) recommends adults and older adults to perform 150-min moderate-intensity or 75-min vigorous-intensity aerobic exercise, or an equivalent combination of moderate- and vigorous-intensity activity every week to gain health benefit. For additional health benefits, adults should increase moderate-intensity physical activity to 300 minutes per week, or 150 minutes of vigorous-intensity physical activity per week, or an equivalent combination of moderate- and vigorous-intensity activity. However, few studies have determined the effectiveness of this WHO Global Recommendations on Physical Activity for Health guideline (WHO PA Guideline) on improving cognitive function in older adults with MCI.

b) Objectives

To examine the effectiveness of 24-week *WHO PA Guideline* in practice on improving cognitive function in older adults with MCI.

c) Methods

In this project, the following outcome measures will be conducted at baseline, 24 week and 48 week post-baseline measurement:

Primary Outcome: MCI diagnosis using Mayo Clinic Criteria: Age and education corrected Hong Kong Montreal Cognitive Assessment (HKMo-CA) [7].

Secondary Outcomes:

1. Neurocognitive tests: Memory, attention and executive function will be measured

2. Cardiorespiratory fitness: VO2max test will be conducted using a calibrated motor-driven treadmill (h/p/COSMOS 150/50 LC, Germany) by continuous metabolic VO2 measurement using a COSMED Quark Series telemetric gas analysis system.

3. Body composition: Body fat mass, lean mass and bone mass will be measured by dual-energy X-ray absorptiometry (DXA).

4. Balance & physical performance: The balance ability will be measured by single-leg stand test and Berg Balance Scale. Short physical performance battery (SPPB) will be used to assess the physical performance.

d) Potential implication

This study will provide evidence in evaluating *WHO PA Guideline* in improving cognitive function in older adults. Our study will also provide timely evidence for guideline amendment as *the Practice Guideline for Mild Cognitive Impairment 2017 of American Academy of Neurology* addressing studies

focusing on single exercise modality with longer session duration are warranted to unveil the effectiveness of certain exercise modality on improving cognitive function.

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Effects of Different Exercise Intensities and Frequencies of Walking Exercise on Sleep and Mood in Older Adults with Comorbid Chronic Insomnia and Depressive Symptoms

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Background: Exercise is an effective treatment for depression (1) and insomnia (2). Previous epidemiological data showed that a high rate of comorbidity exits between chronic insomnia and depression (3). However, limited longitudinal studies have examined the therapeutic effects of exercise on individuals with comorbid depressive symptoms and chronic insomnia.

Objective: The purpose of this study is to compare the training effects of walking exercise under different exercise frequencies (i.e., regular exercise pattern vs. weekend warrior) and intensities (i.e., moderate-intensity vs. vigorous-intensity) in older adults with comorbid insomnia and depressive symptoms.

Methods: Eighty older adults (age ≥ 50yrs) with chronic insomnia and depressive symptoms will be recruited and randomly allocated into five groups: 1) attention control group (stretching exercise), 2) moderate-intensity walking exercise performed thrice weekly (MI×3/wk), 3) moderate-intensity walking exercise performed once weekly (MI×1/wk), 4) vigorous-intensity walking exercise performed thrice weekly (VI×3/wk), and 5) vigorous-intensity walking exercise performed once weekly (VI×1/wk). The intervention will be maintained for 12 weeks. The outcome measures will be conducted at baseline, after 6 weeks, after 12 weeks of intervention.

Main outcome and measures: Primary outcomes including depression symptoms (measured by Hospital Anxiety and Depression Scale) and remission rate of chronic insomnia (measured by brief insomnia questionnaire).

Secondary outcome and measures: Secondary outcomes including objective sleep quality and pattern (measured by accelerometer), subjective sleep quality (measured by insomnia severity index and Pittsburgh sleep quality index), daytime sleepiness (assessed by Epworth sleepiness scale), anxiety status (measured by hospital anxiety and depression scale and generalized anxiety disorder 7-item), quality of life (measured by 12-item short form survey), attention (measured by attention network task), exercise enjoyment (measured by physical activity enjoyment scale), habitual physical activity level (measured by international physical activity questionnaires and Actigraphy), aerobic fitness (assessed by the maximal oxygen uptake during maximal exercise test), body adiposity (measured by dual-energy X-ray absorptiometry), and blood biomarkers (hormones related to mood, stress, and sleep) will be measured in this study.

Potential implication: This study will provide evidence for the treatment effectiveness of different exercise frequencies and intensities on mood and sleep in older adults with comorbid depressive symptoms and chronic insomnia. We expect that the weekend warrior exercise strategy is a practical approach to improve mood and sleep with less frequent bouts of exercise weekly.

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Efficacy of Strengthening Exercises on Chronic Low Back Pain

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Background and Objective: It is well known that chronic low back pain (CLBP) would lead to functional disability, physical inactivity and poor quality of life (1-4). In Hong Kong, back pain was the second most common chronic pain site for people aged ≥ 50 (5). Although strengthening exercises are always recommended in managing the back problems (6), little is known about their impacts on the local elderly. Therefore, the aim of this study is to investigate whether strengthening exercises can reduce pain and disability for local older adults with CLBP.

Methods: This is a single group cohort study. Data and exercise programme are administrated by "Mus-Fit Action" project in six batches. Participants aged ≥ 50 can join the programme by submitting online applications, unless they are/have (a) currently in unstable medical conditions or have comorbidities within 6 months, (b) in acute orthopedics conditions, (c) in deteriorated neurological conditions, (d) severe visual impairment or blindness, (e) difficulty in sitting or walking. Eligible participants will complete on-line health survey and on-site assessments at baseline. Participants having back complaints in the last 3 months, with or without other bodily pains in neck, shoulder or knee, are included in the study (7).

The programme consists of six lessons emphasizing muscle strengthening exercises, e.g., inclined plank and squat. Classes are guided by the trained ambassadors and held biweekly within 3 months. The ambassadors would advise on the individualized exercise prescriptions with postural education based on participant's exercise capacity. A Smartphone App including exercise demonstration videos can act as a reminder and incentive provider to enhance exercise adherence (7).

Primary outcomes are measured by pain and disability levels. They are assessed by 36-item Short Form Health Survey (SF-36) and Roland Morris Disability Questionnaire (RMDQ) after 3 months from baseline. The former is widely used to evaluate health-related quality of life (8-9), while the latter has a good validity and reliability to detect changes of physical functions with back problems (10).

The estimated sample size is 57 (a 95% confidence level, effect size=0.5 and power level=0.95, 2-tailed test). SPSS is used for statistical analysis and a Wilcoxon signed-ranks test is employed.

Between-group comparisons in genders, age groups, BMI and the numbers of pain sites and exercise adherence are also analyzed.

As of November 1, 2019, the study has recruited 19 participants. Preliminary data are summarized. (n=19):

	Count	*%*
Genders		
Female	17	89.5
Male	2	10.5
No of pain sites		
1 *(LBP only)*	8	42.1
2+ *(LBP +other pain sites)*	11	57.9

	Mean	*Std. Dev*
Age *(Years)*	63.2	7.8
BMI *(kg/m²)*	24.4	4.0
RMDQ *(0-24)* *(higher scores, higher disability)*	6	5.9
SF-36 *(0-100)* *(higher scores, lesser pain & disability)*		
Pain	54.5	25.6
Physical Functioning	64.5	16.3

Timeline: Participant recruitment is on-going. Post-intervention data will be collected via telephone interviews by February 2020. Data analysis will be completed in March 2020 and the results will be released in April 2020.

Limitations: First, the study lacks a control group due to the small sample size. Thus, a randomized controlled trial cannot be used to generate valid inferences about the effects of exercise intervention. Second, evaluation of the core and back muscle strength is not available in this study as the equipment for measurement is expensive.

Potential Implications: The findings can help physiotherapists, physical fitness trainers and health service providers to design the strengthening programme for older adults with different demographic backgrounds in the future. Also, further assessments at 6th and 12th month should be warranted if the long-term efficacy of the intervention is to be examined.

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Comparison of the Use of Ice Pack and Cold Spray in Cooling Effect and Landing Biomechanics in Healthy Ankle Joint

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Objective: The use of cryotherapy in the management of ankle sprain are widely used on the sports field. It is commonplace for athletes to return to play shortly after application of cryotherapy. It aids to optimize athletes recovery after an ankle sprain by pain reduction, inflammation inhibition and edema control.[1] However, previous research has shown cryotherapy may lead to higher injury risk owing to a short term reduction in nerve conduction velocity, muscle strength and proprioception sense.[2] Numerous modalities of cryotherapy are now available on the market, yet the best form of modalities is still not well-investigated. Since both ice pack and cold spray are commonly used on the sports field, the purpose of this study is to compare the use of ice pack with cold spray in cooling effect and landing biomechanics.

Methods: Fifteen subjects will be recruited. Ice pack or cold spray will be applied to their ankle joint, then they are instructed to perform a single-leg drop jump landing for 3 trials at 4 time points (pre-intervention, immediate post-intervention, 15 minutes later and 30 minutes later). A week later, they are invited to perform the same test except the intervention will change to another one. Skin temperature data will be collected via infrared thermometer; the proprioception sense and landing kinematic data will be collected via Vicon Motion Systems and force plate. The primary outcomse are the skin temperature change, vertical ground reaction force, ankle dorsiflexion/inversion angles. These parameters are associated with loading injury risk, ankle stiffness and ankle inversion sprain risk respectively. The secondary outcome are the changes in proprioceptive sense and knee flexion/valgus angles. Proprioceptive sense is measured by position test. It requests subjects to mimic the exact amount of dorsiflexion of uninvolved ankle when blindfolded[3], and the difference will be captured by Vicon Motion Systems. Measuring proprioceptive sense changes may help us in interpreting findings in our primary outcomes. Knee flexion/valgus angles are included since they are associated with anterior cruciate ligament injury risk.

Potential implication: The result may provide insight for athletes in choosing a better cooling modalities in managing ankle sprain in view of cooling effect and injury prevention.

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A Wearable Sensor to Analyse Skill Levels of Squash Players

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Introduction

Squash is a popular sport in Hong Kong. With the advancement of wearable sensor technology, it is possible to use a wearable inertial measurement unit (IMU) to provide coaching cues and feedbacks for performance enhancement.

Objectives

This is a foundation study aiming to collect raw IMU data from elite, sub-elite and novice squash players during a set of standard manoeuvres. We will then build a machine-learning algorithm to recognize specific squash manoeuvre and differentiate players at different skill levels based on the IMU data.

Methods

We will recruit 30 right-hand dominant male squash players, including 10 elite, 10 sub-elite and 10 novice squash players. Elite players are defined as those who participated in more than two international competitions in the past 5 years. Sub-elite players are those who have regular training (i.e., >8 hours/ week) for more than 2 years. Novice players should have less than 2-year experience.

After obtaining written consent, an IMU will be firmly affixed onto subject's right wrist using a wristband. They will be asked to perform a set of squash manoeuvres, including straight drive, volley, lob service, overhead service), and figure of eight in a standardized squash court. The test sequence for each task will be randomized and we will collect 20 successful attempts for each manoeuvre.
A machine-learning data processing method will then be used to recognize the task and classify the players' skill levels. Specifically, the dataset will be split to 80% of training data and 20% of validation data. We will examine the accuracy of the algorithm using R^2 and RMSE.

Potential implication

Quantifying sport activities is of great interest since it allows the coaches to assess athletes' performance. As for the skill assessment system, we hope to test samples from elite players precisely and identify elite players by observing their strokes. This study builds an important foundation for future mobile coaching technology. In the future using this system, we could compile a database of squash action movements from players at different levels, which can then be used by sports scientists and professional coaches for further study and research.

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Comparisons of Compensated Turnout in Pre-professional Classical Ballet and Contemporary Dancers and its Association with Lower Extremity Injuries

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Background: "Turnout" is a fundamental dance technique that has a substantial importance in different forms of dance. It refers to the external rotation at the hip resulting in a position where both feet and knees are facing sideways. However, not many dancers possess the anatomic structural advantages to perform a "perfect" turnout of 180°, so they may adopt different compensatory strategies to force their turnouts for a greater external rotation. Yet, a forced turnout greater than the available range of motion at the hip may indicate a higher risk of injury, which impairs the functional capacity and performance in dancers.

Objectives: This study aims to compare the degree of compensated turnout among classical ballet and contemporary dancers in Hong Kong. It also investigates the relationship between compensated turnout and lower extremities injuries.

Methods: 30 pre-professional classical ballet and contemporary dancers in Hong Kong are recruited respectively. The degrees of static total active turnout (TAT) in the first position and total passive turnout (TPT) of the subjects are measured using a goniometer. The angle difference between TAT and TPT is known as the compensated turnout (CTO).

Each subject is required to complete an injury logbook for 2 months. Information regarding any incidence of injury is recorded in the logbook during the study period. Injury details such as the site of injury and pain intensity using the Numeric Rating Scale (0-10) are also collected.

Potential implication: Acknowledging that different dance styles have their specific training regimes and requirements on the use of turnout in terms of quality (degree of turnout) and quantity (frequency of use), dancers may acquire dissimilar biomechanical control on turnout, thus differences in the prevailing injury sites. The proposed research allows direct CTO comparison between ballet and contemporary dancers using the same goniometric turnout measurement.

Second, instead of using a retrospective self-reported questionnaire, the proposed research collects prospective data of dancers' injury information, this helps to understand the role of CTO in association with lower extremity injuries.

Lastly, this research provides turnout measurements in the Asian population. This contributes to the establishment of norms, particularly for CTO, to determine a value that indicates an elevated risk of injury for dancers. It is in hope that students and dancers can acknowledge the impact of CTO and reduce their risks of injury by minimizing the use of forced turnout.

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Whole-body Angular Momentum during Stair Ascent and Descent in Individuals with and without Knee Osteoarthritis

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Objective

Knee osteoarthritis (OA) is a common lower extremity joint disease affecting locomotion. It was reported that 34% of the Chinese elderly had knee OA (Zhang et al., 2001). While the elderly population was estimated to increase by more than double in the next decades, the prevalence for knee OA was increasing (Ferrucci et al., 2008; Fransen et al., 2011; Lawrence et al., 2008). This growing population warrants our attention to look into the impacts of the disease.

78% of individuals with knee OA experienced difficulty in stair walking (Lin et al., 2010). Stair walking is a locomotion activity of great biochemical challenges as the centre of mass (COM) has to be raised and lowered during stair ascent and descent (Silverman et al., 2014). On the other hand, up to 63% of older adults with knee OA had at least one episode of fall in a year (Tsonga et al., 2015). Fall on stairs accounted for around 10% of fatal fall accidents (Startzell et al., 2000). Given the frequent occurrence of fall and fatal consequence of fall on stairs, we are interested to look into the potential mechanism leading to fall on stairs.

Impacts of knee OA including knee joint malalignment and stiffness, muscle strength deficit and knee pain affect balance. A meta-analysis has reported that individuals with knee OA showed consistent balance deficits in static standing (Hatfield et al., 2016). Yet, little information is available for the dynamic balance control during stair walking in patients with knee OA.

Whole-body angular momentum has been used as a quantitative measurement tool to reflect dynamic balance. It is the sum of all rotational momenta of the body segments acting on the resultant body COM (Kent et al., 2019). It is highly regulated and small, despite large and substantial body segment momenta balance and cancel out each other (Herr & Popovic, 2008). Studies have revealed that balance-impaired populations showed a larger range in whole-body angular momentum (Pickle et al., 2014; Vistamehr et al., 2016). Failure to constrain angular momentum may increase risk of falls (Pijnappels et al., 2004). Therefore, in this study, we will examine how individuals with and without knee OA regulate the whole-body angular momentum during stair walking.

This study aims to compare the whole-body angular momentum during stair ascent and descent between individuals with early stage of knee OA and the characteristic-matched healthy controls. Individuals with knee OA are expected to demonstrate larger range in whole-body angular momentum during stair ascent and descent.

Methods

10 individuals with early stage of knee OA (Grade I/II in Kellgren-Lawrence grading system) and 10 characteristic-matched healthy individuals will be recruited. Subjects will be instructed to climb up and down on a staircase at a fixed cadence of 80 steps per minute cued by a metronome. Gait kinematics and kinetics will be captured by a 10-camera motion analysis system and force plates embedded staircase. Whole-body angular momentum will be calculated using Visual3D. Ranges (peak to peak values) of whole-body angular momentum will be compared using independent t-test if the data match the criteria for parametric test.

Potential implication

Through this study, we hope (1) to quantitatively examine the dynamic balance of individuals with knee OA during stair walking, (2) to provide insight for wearable sensor to assess dynamic balance for individuals with

knee OA during stair walking and (3) to inspire future studies on training to reduce falls on stairs in individuals with knee OA.

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The Effectiveness of an Exercise Buddy Program as an Aid for the Promotion of Physical Wellness in a University Campus

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Objective

Physical inactivity has been identified as the 4th leading risk factor for mortality, accounting for 3.2 millions of deaths globally in 2008 (WHO, 2014). To tackle this problem, HKSAR has implemented the School Physical Fitness Award Scheme in primary and secondary schools since 1990 to encourage students to exercise regularly (HKU, 2015). However, there is no exercise scheme for universities, which may account for the decline in physical fitness in adulthood (HKSAR, 2013).

According to Dailey, Romo & Myer et al. (2018), having an exercise buddy could significantly improve the effectiveness of a weight loss program, resulting in greater reduction in BMI and waist circumference. Rackow, Scholz & Hornung (2015) found that an exercise buddy helped improve the self-efficacy of exercising individuals. Therefore, an exercise buddy program may be an antidote to the aforementioned physical fitness decline. To investigate the effectiveness of an exercise buddy program in promoting university students' and staffs' physical wellness, Office of Counselling and Wellness of the Hong Kong Polytechnic University (PolyU) initiates a pilot exercise buddy scheme, "Exercise is Medicine on Campus" (EIM-OC), a global health initiative managed by the American College of Sports Medicine (ACSM).

Method

Study Design

This will be a single group longitudinal study. 30 subjects will be recruited by convenience sampling.

Participants

Subjects will be recruited via mass emails sent within PolyU server. EIM-OC ambassadors will be recruited from the undergraduates of the Bachelor of Science (Hons) in Physiotherapy, Department of Rehabilitation Sciences, who are equipped with expertise knowledge in fitness assessment and training.

Procedures

The program will begin with an individual consultation session hosted by 2 EIM-OC ambassadors. During the consultation, the subject's physical fitness, including body composition, aerobic fitness, muscle endurance and flexibility will be assessed. Then, the EIM-OC ambassadors will formulate exercise plan with the subject according to the assessment findings and the subject's goals. By the end of the session, the subject will be recommended to pair up with the EIM-OC ambassadors who will be the exercise buddies of the subject, exercising with and monitoring the progress of the subject.

If the pair-up succeeds, the ambassadors will exercise with the subject twice a week for 8 weeks in the fitness room of PolyU. A logbook will be filled up by the ambassadors at the end of each training session for evaluation and modification of exercise plan. If the subject completes the exercise program, a health tracking watch will be given to the subject as a gift to ensure subject compliance.

Outcome measures

Demographic data including gender, age, height, weight will be collected before the exercise programme. Body composition will be measured by Bioelectric Impedance Analysis (BIA) while aerobic fitness, muscle

endurance, muscle strength, and flexibility will be tested by 3-minute step test, 1-minute sit up test, hand grip strength test, and sit-and-reach test respectively. All physical fitness outcomes will be measured before(T1) and after(T2) the 8-week buddy exercise programme. Actigraphs will be used to measure the weekly physical activity and sleep quality of subjects before and after the scheme.

Data analysis

Demographic data and other major outcomes will be performed using descriptive statistics presented in mean and standard deviation. Data normality will be analysed with Shapiro-Wilk test. Within-group differences at T1 and T2 will be analyzed by paired T-test. A p-value less than .05 will be considered as statistically significant. All analyses will be performed with IBM SPSS statistics 20.

Potential implication

The EIM-OC program can potentially improve the physical fitness of students and staffs in PolyU. If this pilot study yields significant results, it will serve as a reference for other universities in Hong Kong.

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Quantification of Upper Trapezius Muscle Stiffness in Office Workers with and without Neck Pain Using Supersonic Shear Imaging, and its Association with Scapular Muscle Strength and Psychological Factors

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Background:
Neck pain is a common musculoskeletal condition, particularly among office workers (1); and neck pain causes significant socio-economic burden due to work-loss and medical costs (2,3). The aetiology of non-specific neck pain is multifactorial (4) of which, increasing stiffness of the trapezius muscle due to sustained muscle activation during prolonged tasks (5), scapular muscles weakness (6), and adverse psychosocial conditions at work have been proposed to be the pathophysiological mechanisms (7). Higher activities and shorter rest period in the upper trapezius muscle were recorded by electromyography (EMG) in subjects with neck pain in previous ergonomic studies (8–10).

Supersonic shear imaging (SSI) is an imaging technique which allows real time visualization of viscoelastic properties of soft tissue. SSI estimates the shear elastic modulus of the soft tissue by calculating the propagation speed of the acoustic radiation generated by the ultrasonic probe (11). Here we will measure shear modulus using SSI as an index of muscle stiffness/tension (12). Previous study demonstrated muscle shear elastic modulus is linearly related (R^2 = 0.86 - 0.98) to muscle torque over the entire range of isometric contraction (13). Limited studies have investigated on the relationship between objective measure of muscle stiffness and neck pain and its association with scapular muscle strength and psychological factors.

Objective:
In view of the high incidence of neck pain among office worker the aims of the study are: 1) to compare the difference in upper trapezius muscle stiffness between office worker with and without neck pain with SSI; and 2) to investigate its association with scapular muscle strength and psychological factors.

Methods:
40 office workers aged 18 or above who worked with display screen equipment for a minimum of 4 hours per day will be recruited. They will be allocated into neck pain group if they have 1) non-specific discomfort or pain over the shaded area over Fig 1. with numeric pain rating scale (NPRS) over 3 (14); 2) neck pain of more than 3 months; and 3) Chinese version Northwick Park Neck Questionnaire score over 40% (15). Participants who reported no or occasional pain ≤ 2 on the NPRS will be allocated to the control group. Participants with history of whiplash injury, cervical spine fracture, cervical spine surgery, previous surgery and previous clinical treatment for a neck/upper limb injury within the last 12 months will be excluded.

Demographic data such as age, gender, height, weight, dominant hand and affected side will be recorded and compared. Besides, the duration of screen time per day, year of office work experience will be recorded.

Each subject's upper trapezius, middle and lower trapezius muscle will be scanned with an ultrasound scanning system (SuperSonic Imagine, Aix-en-Provence, France). The scanning site will be based on an established protocol (16). Scapular muscle strength of upper, middle and lower trapezius will be measured using a handheld dynamometer according to an established protocol (17). Psychological components will be assessed by Chinese version Fear-Avoidance Beliefs Questionnaire (18).
All statistical analyses will be conducted with IBM SPSS Statistics. Data will be tested for normal distribution using the Shapiro-Wilk test. Between groups differences in upper trapezius stiffness will be tested with independent t-test if parametric criteria fulfilled otherwise Mann-Whitney *U* test will be used.

For correlation analysis, Pearson correlation will be used if parametric criteria fulfilled otherwise Spearman correlation will be used.

Potential Implication:
To objectively quantify upper trapezius muscle stiffness in office workers with and without neck pain. To investigate any potential contributing factors if there is difference in upper trapezius muscle stiffness between the two groups, thus future treatment can be targeted for various contributing factors in causing non-specific work-related neck pain.

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Poster Presentation: Session 2

Improving the Methodology of Return to Play Decision Making in Team Sport Athletes

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Background

Australian Football is one of the most popular sports in Australia but unfortunately has a high injury rate due to nature of the sports.[1] Return to play (RTP) in sports is complex, as various biopsychosocial factors may influence the outcome. To return to play (RTP), injured athletes are often required to progress through a graded rehabilitation program and receive clearance from medical professionals. It is crucial to understand how to measure RTP progression objectively and appropriately make RTP decisions, whilst accounting for this complexity. However, research evidence to support methodology in above areas is scarce.

Objective

To improve existing methodology of RTP decision making in team sport athletes using a complex systems approach.

Method

The proposed research will consist of four sequential studies.

Study 1 will be a review of current methodology in measuring return to play (RTP) progression. The study aims at identifying current methodology and characteristics of successful RTP (progression, measurement, decision making, what is the baseline and normal.) Outcome of the study is recommendation for best practice approach for measuring RTP progression.

Study 2 will be using retrospective data (2016-2019) from an Australian Football League (AFL) club where methodology for measuring RTP progression with physical performance metrics will be proposed. It aims to demonstrate how units would interact with each other and combinations of units that maybe meaningful and have implication to a measuring tool. This study will illustrate importance of establishing baseline, how to track progression in rehabilitation, interaction between units and non-linearity nature of recovery.

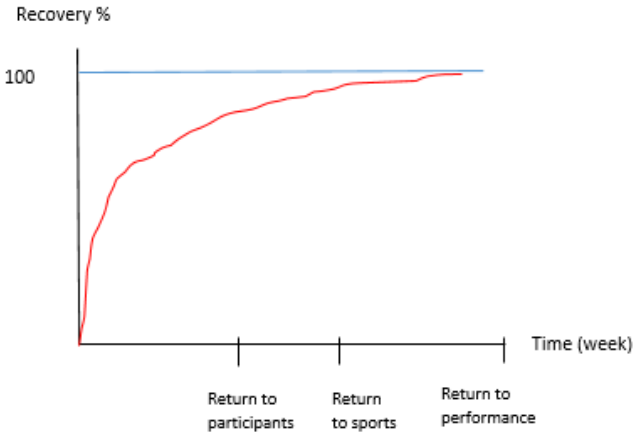

Figure 1: Example of trend analysis of one of the units

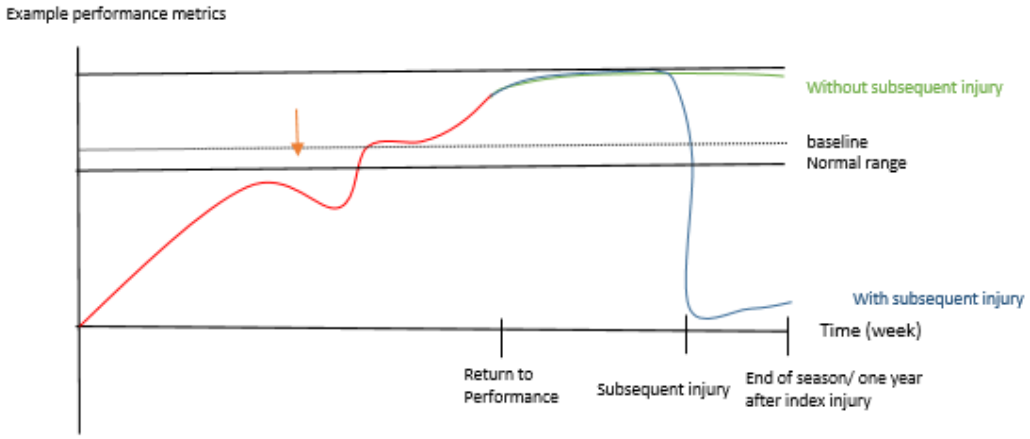

Figure 2 Example of how physical performance metrics may change with time.

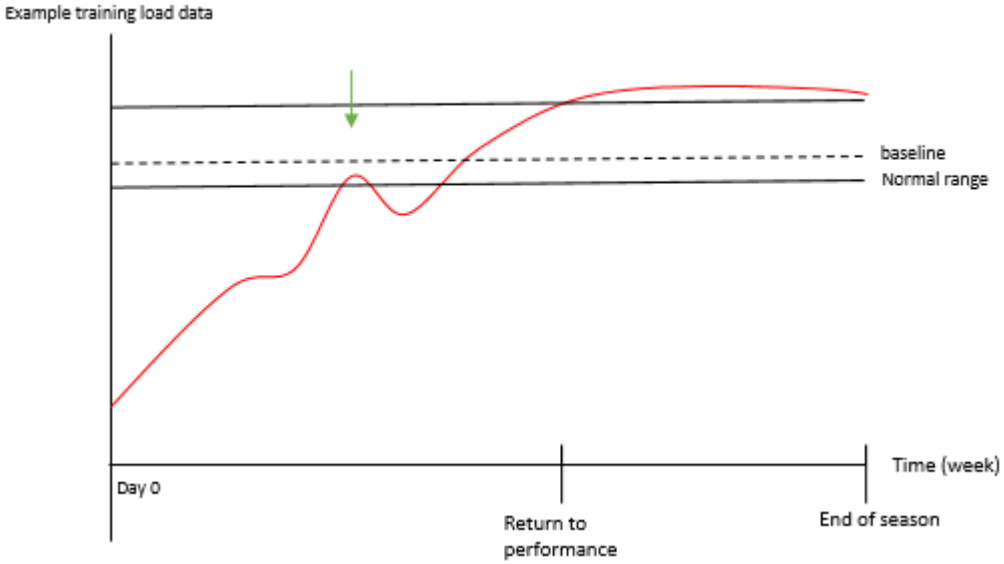

Figure 3 Example of how change in training load or training duration may affect RTP progression in figure 2.

Study 3 will build on the methodology foundation illustrated in study 2, while adding more complexity to the RTP scenario. Data will be collected prospectively from the same club, which will include physical performance metrics, subjective wellness measurement and individual characteristics. Rule base machine learning techniques will be introduced to understand how changes in units would affect the dynamic nature system and identify combination of units that is favorable to a successful RTP. Key confounding variables, effect modification, interaction and mediation among the demographics variables (age and playing experience) will be explored. This study will reassemble more closely with the complexity nature of real-world.

Study 4 aims to compare RTP decision made by human and machine learning techniques in clinical vignettes. Specifically, the study will identify within-clinician and inter-clinicians' reliability and consistency of human decision. Secondary, to identify the differences in RTP decision made by machine learning techniques and human decision, including its ability to measure and predict progression. This study will explore the differences in making decision regarding RTP by human and machine learning techniques, including the flaws and limitations of different models. Ultimately, it will sharpen the

methodology for RTP decision making and recommend methodology for RTP progress measurement and decision making.

Practical application

The research outcome could help practitioner understand and quantify the rehabilitation progression, and thus empowering them to make informed and optimal decision in RTP. While not all athletes may have similar access to rehabilitation resources as in this AFL club, the significance of this study is to propose an improved methodology in measuring RTP progression and demonstrate capacity of machine learning in supporting RTP decision. The study outcome will improve methodology for measuring RTP progression and may support decision making.

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The Effects of Enhancing Pre-Opeartive Quadriceps Strength via Whole Body Vibration Therapy on the Outcomes of Anterior Cruciate Ligament Reconstruction

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a) **Background:** Approximately 35% patients with anterior cruciate ligament (ACL) injury cannot return to their pre-injury level of sports despite a successful ACL reconstruction (ACLR). Persistent quadriceps weakness is an important factor for the failure of return to sports. The pre-operative quadriceps strength was demonstrated as a prognostic factor of ACLR, so increasing pre-operative quadriceps strength maybe effective to improve the outcomes of ACLR. Evidence showed that strengthening exercise is ineffective in part of patients with ACL injury, and adverse effects such as pain and swelling have also been reported. Thus, it is necessary to establish a more effective and safer way to enhance quadriceps strength for patients with ACL injury. Whole body vibration (WBV) has been demonstrated as an effective and safe way to increase quadriceps strength in ACLR patients, but whether it is effective in increasing pre-operative quadriceps strength in patients with ACL injury is unknown as well as post-operative outcomes of ACLR.

b) **Objectives:** 1) To investigate the effectiveness of WBV on enhancing quadriceps strength in patients with ACL injury. 2) To investigate if patients with greater strength improvement before surgery can get better outcomes of ACLR.

c) **Methods:** A randomized controlled trial will be conducted. A total of 56 patients with primary unilateral ACL rupture scheduled for hamstring autograft ACLR will be recruited. The patients will be randomly allocated into either control group (quadriceps strength training only) or WBV group (strength training +WBV). Before the surgery, all of the participants need to complete an identical 5-week, 2 times/week strengthening exercise protocol either with or without a WBV platform. Isometric quadriceps strength will be measured by Biodex System 3 dynamometer; functional outcomes will be assessed by questionnaires including IKDC Scale, Tegner Activity Level Scale and ACL-RSI Scale; symptoms will be assessed by Visual Analogue Scale and measurement of knee girth before surgery, 3-months and 9 months post-ACLR respectively. Repeated measures of ANOVA will be used to compare the difference in all outcomes measured and the level of significance will set a $p<0.05$.

d) **Potential implication:** Clinicians and physiotherapists should assess pre-operative quadriceps strength for patients scheduled for ACLR and patients with severe quadriceps weakness should be advised to take strengthening exercises to achieve symmetrical strength prior to ACLR. In addition, strengthening exercises combined with whole body vibration therapy is a recommended way to enhance quadriceps strength for patients with ACL injury.

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Application of Bone Morphogenetic Protein-2 (BMP-2) Surface Modification on Polyethylene Terephthalate (PET) Artificial Ligament

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Anterior cruciate ligament (ACL) injury is a common sports injury [1]. Since 1970s, autografts and allografts are main choices for ACL reconstruction (ACLR) but these grafts show disadvantages including donor site morbidity and disease transmission [2]. With its excellent mechanical properties, PET artificial ligament has been used, which enables patients to resume exercise earlier after surgery without the need of sacrificing a healthy tendon autograft or preventing infectious diseases [3]. However, bone tunnel enlargement after PET reconstruction is still challenging [4]. We have demonstrated that functionalization of biomaterials with BMP-2 can lead to enrichment of endogenic BMP-2 in the vicinity of the implanted biomaterials [5], inducing osteogenesis between the biomaterial and the tunnel side. In order to achieve a better osteo-integration between PET and the bone tunnel, the same functionalization technology will be applied to the commercially available PET artificial ligament, and the functionalized ligament will be used for ACL reconstruction in rats. Each animal will undergo reconstruction with either native PET (n = 3) or PET with BMP-2 binding peptides (n = 3). At 2 and 6 weeks after surgery, the ligament will be assessed by histology and micro–computed tomography. With preclinical data of the treatment effects of functionalized PET artificial ligament for ACLR, new patents and clinical use of tissue-inducing artificial ligament is anticipated.

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Effects of Exercise Frequency on Cognitive Outcomes in Older Adults with Mild Cognitive Impairment (MCI): A Pilot Randomized Controlled Trial

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Objectives
The present study aims to examine the effects of exercise frequency on the cognitive function in older adults with mild cognitive impairment (MCI). In 2010, the World Health Organization (WHO) suggested, in the *Global Recommendations on Physical Activity for Health*[1], that adults aged 18 – 64 should engage in 75 minutes of vigorous-intensity physical activity throughout the week, or 150 minutes of moderate-intensity physical activity throughout the week, or an equivalent combination of moderate- and vigorous-intensity physical activity for general health benefits. In 2018, the American Academy of Neurology (AAN) updated their MCI practice guidelines, stating that exercise intervention lasting for at least 6 months and exercising twice a week may provide cognitive benefits for patients with MCI[2]. However, little evidence exists regarding the effects of low-frequency exercise on the improvement in cognitive outcomes. Hence, the present study aims to find out whether once-a-week exercise is equally efficacious as exercising across the week, as per the WHO recommendations, regarding cognitive health.

Methods
The intervention of the present study will last for 6 months. Subjects will be randomized into one of the three intervention arms. The details of the intervention of each arm are as follows:

	Once-a-week Exercise (1x/wk)	Thrice-a-week Exercise (3x/wk)	Usual care control (CON)
Frequency	1 session per week	3 sessions per week	1 session per week
Intensity	6 Metabolic Equivalents (METs)		N/A
Time (per session)	75 minutes	25 minutes	75 minutes
Type	Brisk walking on a 400m track		Health talk

Subjects in the 1x/wk and 3x/wk groups will walk at heart rates corresponding to 6 METs, determined by a graded exercise test as part of the baseline measurement. The CON group will be given weekly 75-minute health talks regarding the benefits of exercise on cognitive and overall health.

The primary outcome of the present study is global cognition, which will be measured by the Montreal Cognitive Assessment (MoCA). Secondary outcomes will include executive function, working memory, brain connectivity, cardiorespiratory fitness, depression and anxiety traits, sleep quality, as well as quality of life. In particular, brain connectivity will be measured by electroencephalography (EEG) during the cognitive tests and the familiarization session.

The sample size of the present study will be 54, based on a significance level of 0.05, a power of 0.8, an effect size of 0.24 as suggested by Northey et al.[3], and a dropout rate of 15%. Each group will thus contain 18 subjects. Subjects must be older than 50 years old and scoring below 22 in the MoCA (HK version)[4] to qualify for the present study. Those already diagnosed with dementia or cannot walk independently will be excluded.

Potential implication

The present study aims to determine whether frequency is a factor affecting exercise-induced improvements in cognitive health. It has been suggested that future studies should focus on refining prescription variables[3]. Standardizing the weekly volume in accordance with the WHO guidelines might be a promising step in reducing heterogeneity in the current literature.

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Is Stationary Bike Exercise Program as Effective as Strengthening Program on Patients with Knee Osteoarthritis for Clinical Symptoms and Functions, and the Change in the Levels of Myokines

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Objectives

1) To find out whether there is any difference in terms of clinical outcomes between patients with knee osteoarthritis undergoing aerobic and strengthening exercise training respectively.
2) To find out the change of serum myokine concentration after a course of strengthening and aerobic exercise program in patients with knee osteoarthritis

Methods

Twenty subjects with knee OA are recruited and randomly assigned by drawing names from box in to strengthening and aerobic exercise group. Baseline assessments including serum myokine concentration, isokinetic quadriceps strength, knee range of motion, scores of functional outcome measure (Knee Injury and Osteoarthritis Outcome Score, KOOS), pain score (numeric pain rating scale) and anthropometric and body measurements, will be obtained before and after the exercise program. Two groups of subjects will undergo a twelve-week exercise program with the frequency of three times per week. Call reminder for attending exercise training is provided to ensure a better compliance. Strengthening exercise program consists of the combination of hip abductor, knee extensor and core strengthening exercise with three different levels of difficulty, which depends on the capability of subjects. Aerobic exercise program will be conducted in form of 40-minute stationary bike exercise with achieving moderate intensity (forty to sixty percent of heart rate reserve according to the American College of Sports Medicine guidelines). Two-ways repeated measures ANOVA will be used to compare the change of outcome measures between two exercise groups as well as the change in both groups before and after the exercise training.

Potential implication

Knee osteoarthritis (knee OA) is one of the most common degenerative musculoskeletal disorder and leading cause of chronic pain & disability in adult population [1]. Both strengthening and aerobic exercise program are core treatments of non-surgical interventions for patients with knee OA [2]. However, there is no any direct comparison in between both types of exercise program [3]. Meanwhile, level of serum myokine concentration such as interleukin 6 (IL-6), irisin and myostatin has been well established to be correlated with the severity of knee OA according to the Kellgren Lawrence Classification for Knee Osteoarthritis [4-6]. Myokines are also shown to be responsive to exercise training in healthy subjects [7] Yet, there is limited evidence in the change of myokine concentration after exercise therapy for patients with knee OA, who have abnormal baseline serum myokine concentration, and, the direct comparison between aerobic and strengthening program. This research project aims to fill this research gap. Exercise therapy is the major intervention delivered by physiotherapists for patients with knee OA [8]. The major exercise group physiotherapist commonly prescribe is strengthening exercise and rarely aerobic exercise. This research can also help provide a reference for physiotherapist in the choice and combination of exercise program to deliver to patients. Furthermore, the possible change of myokine concentration may contribute to the mechanism of how aerobic exercise reduces the clinical symptoms and improve functions in patients with knee OA, as well as the possible outcome measure to monitor the effectiveness of exercise program.

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Effectiveness of Deep Water Running in Improving Cardiovascular Fitness, Gait and Quality of Life

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a. Objective(s)

Deep Water Running (DWR) as an aquatic aerobic exercise, shares multiple physiological effects (Reilly, Dowzer, & Cable, 2003). A recent RCT examines trunk muscle activation in DWR (So et al., 2019). Previous researches provide insights for further study, yet little evidence is found on application of DWR for various population according to underlying physiological effects. This review aim to (1) investigate effectiveness of DWR in improving cardiovascular fitness, gait and quality of life, and (2) describe the DWR techniques used in exercise programs.

b. Methods

Search strategy

The review will be guided by The Preferred Reporting Items for Systematic reviews and Meta-analysis (PRISMA) guidelines (Moher, Liberati, Tetzlaff & Altman, 2009). Six databases will be used for literature search from January 1999 to October 2019 using main search terms (Table 1). Reference list checking and citation tracking of included articles and relevant review articles will be completed to unveil complex sources in obscure locations (Greenhalgh & Peacock, 2005). This proposed systematic review is registered in PROSPERO (ID: 54988).

Selection criteria

Interventional studies investigating effect of DWR in adults will be included if they report measurement of gait (i.e. running or walking performance), cardiovascular capacity (e.g. resting heart rate, VO2, or other related outcomes), or quality of life. Publications will be included from peer-reviewed academic journals written in English.

Animal studies and studies without intervention but only physiological outcomes will be excluded. Participants under 18 years of age will be excluded in association with immature musculoskeletal system. Intervention which combine other interventions with DWR will be excluded.

Data extraction

Data including characteristics of participants (age, sex, height, weight, health conditions), interventions (technique, frequency, duration, intensity, modifications, instructions & equipment used), outcome, pool environment (pool temperature and depth) and rationale for use will be extracted by two independent reviewers. Any discrepancies will be resolved with a third reviewer.

Quality and risk of bias assessment

Each study will be rated by selected components from a checklist measuring study quality based on Downs and Black by two independent reviewers. The checklist is of good test-retest and inter-rater reliability, in

assessing methodological quality of both randomized controlled trials and non-randomised studies (Downs and Black, 1998). Five subscales, including reporting, external validity, internal validity in bias and confounding, and power, will be assessed. Discrepancies will be resolved by a third reviewer if necessary.

Data analysis

Qualitative analysis of outcomes of interest and program parameters in specific populations will be grouped together for analysis. Standardized mean difference (SMD) and 95% confidence intervals (CIs) will be calculated using final outcome scores measured. Missing SDs will be imputed from other available data, e.g. CIs, t values or standard errors. Effect size thresholds will be classified as SMD of small (0.2), medium (0.5), or large (0.8), with non-significant results indicated by 95% CI that included zero. Meta-analysis will be performed only if more than 2 studies reported on same outcome with similar interventions in similar population.

c. Potential implication

DWR is utilised for athletic cardiovascular conditioning and recovery (Reilly, Dowzer & Cable, 2003). Despite extensive physiological rationale related to immersion and exercise and value as non-weight bearing exercise, DWR effectiveness and training parameters have not been examined in a systematic review and the extent of use in rehabilitation is unknown. The implications of current systematic review and meta-analysis are stated below:

(1) Evaluate the effects of DWR in improving cardiovascular fitness, gait and quality of life
(2) Reveal knowledge gaps for future studies
(3) Formulate recommendations for an effective standardised DWR training protocol and technique for healthy and athletic populations
(4) Determine considerations for modifying DWR for rehabilitation.

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Appendix

Table 1. Search strategy

Databases	Main search terms
SPORTDiscus, MEDLINE, CINAHL,	‘deep water run*’ or ‘deep water jog*’ or ‘aqua jog*’ or ‘aqua run*’ or ‘running under water’ or ‘running in water’ or ‘jogging under water’ or ‘jogging in water’.

AMED, Embase, and The Cochrane Library	No terms relating to 'outcome measures' or 'comparisons' will be searched to avoid excessive exclusion of studies in an area where limited research has been conducted.

Table 2. Selected components from Downs and Black's Checklist for measuring study qualit

Subscale	Items
Reporting	1. Is the hypothesis/aim/objective of the study clearly described?
	2. Are the main outcomes to be measured clearly described in the intro or methods section?
	3. Are the characteristics of the patients included in the study clearly described?
	4. Are the interventions of interest clearly described?
	5. Are the distributions of principal confounders in each group of subjects to be compared clearly described?
	6. Are the main findings of the study clearly described?
	7. Does the study provide estimates of the random variability in the data for the main outcomes?
	10. Have actual probability values been reported(e.g. 0.035 rather than <0.05) for the main outcomes except where the probability value is less than 0.001?
External validity	11. Do the subjects asked to participate represent the population?
	12. Do the subjects in the study represent the populations?
Internal validity -Bias	15. Was an attempt made to blind those measuring the main outcomes of the intervention?
	18. Were the statistical tests used to assess the main outcomes appropriate?
	20. Were the main outcome measures used accurate (valid and reliable)?
Internal validity - Confounding	23. Were study subjects randomised to intervention groups?
	24. Was the randomised intervention assignment concealed from both patients and health care staff until recruitment was complete and irrevocable?
	26. Were losses of patients to follow-up taken into account?
Power	27. Did the study have a power calculation?

Gait Retraining In Novice Runners Using Wearable Sensor To Lower Impact Loading

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Introduction

Running is a popular sport globally, which can be reflected by the increasing number of runners and distance running events across the globe[1]. Running-related injuries are common, with the incidence rate of lower extremity musculoskeletal injuries up to 79.3%[2]. When compared to experienced runners, novice runners are even more injury prone[3].

A large-scaled randomized controlled trial was carried out to examine the effectiveness of a lab-based gait retraining program on injury prevention of novice runners[4]. Participant was asked to land softer while running on an instrumented treadmill. Using visual biofeedback, participants were shown to successfully reduce vertical loading rate (VLR), which is an important biomechanical marker for running injury[5]. More importantly, runners following gait retraining demonstrated a 62% reduction of injury risk in 12-month follow-up than the controls[4].

However, the accessibility of laboratories with complex biomechanics equipment is usually very limited. With the recent technological advancement, wearable sensor could be feasible for measurements of impact loading in the wild[6]. A strong association between VLR and tibial shock (TS) was found in previous study[7]. Hence, a wireless inertial measurement unit (IMU) can be used to quantify impact loading.

The overall objective of the present study is to examine the VLR and TS before and after a 2-week gait training using wearable sensors in novice runners.

Method

Twenty novice runners aged 18-50 years who run > 8 km/week for < 6 months will be recruited. Participants should have less than 2-year running experience and never participate in any 10-km event or half/full marathon. Participants should be free from any injury for at least six months upon enrollment.

A wireless IMU will be fixed on right distal tibia. Participants will run on an instrumented treadmill in 3 testing speeds (8 km/hr, 12 km/hr and a self-selected training speed) for 5 minutes after standardized warm-up exercise[9]. IMU and kinetics data will be sampled at 200 Hz and 1,000 Hz respectively for the last minute of the running. A lowpass filter at 50 Hz will be used to filter the raw ground reaction force[8]. The VLR will be calculated as the maximum slope of the line passing through the 20% and 80% point of the vertical impact peak of the vertical ground reaction force curve. VLR will be normalized to the body mass and averaged across all footfalls in the observation period. TS will be measured as the maximum positive vertical acceleration during the early stance of a gait cycle[8].

Participants will undergo a 2-week gait retraining program established in previous studies[4,8]. There will be eight sessions of gait training over two weeks (four sessions per week). During the training, participants will run on a standardized 400-m track at usual speed, TS will be measured simultaneously. They have to “run softer” such that the TS of each footfall is below 80% of the baseline[10]. If TS exceeds the target value, a smartphone app connected to the IMU will generate a ‘beep’ sound. The training time will increase gradually from 15 to 30 minutes over the eight sessions while the feedback will be progressively eliminated in the last four sessions[4]. A post-training assessment will be conducted within one week after the completion of training with testing procedure identical to pre-training assessment[4].

Shapiro–Wilk test will be used to test normality. Paired t tests will be used to compare the VLR and TS before and after gait retraining.

Potential implications

Novice runners may retrain their running gait using wearable sensors, which is a potential viable solution to prevent running injury for a much larger population of runners.

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The Effectiveness of Mus-Fit Action Muscle Strengthening Exercise Program in Age Over 50 Years Old Elderly with Neck Pain in Hong Kong

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Objective: Neck pain is a common health problem in both men and women, and also one of the leading causes of disability in the world (Chiu TW, 2012) (E. M. C. Lau, 1996). The Global Burden of Disease Studies reported that the total global disability-adjusted life-years (DALYs) due to neck pain had increased by 21.4% to 28.6 million in 2017 (Lancet, 2018). Repetitive activities such as looking down at a smartphone and poor posture when sit and stand, the upper back muscle was getting loose that was putting excessive pressure on the neck. Moreover, degenerative diseases such as cervical spondylitis, osteoarthritis, or rheumatoid arthritis are the general neck pain risk factor in the elderly (Health, 2019).
Some studies stated that regular exercise might have benefits in reducing the severity of pain. Muscle-strengthening exercise is mainly to keep good postural control in the elderly and relieve the unfavorable mechanical stress on musculoskeletal tissues. (Michele Sterling, 2019)

The programs were recommended to include active exercise in a minimum of three times a week for 30 to 60 minutes. It helps strength development and reduce pain and disability. An effective exercise program should last between 6 and 12 weeks with encouragement to continue life-long exercise to maintain long-term benefits (Cliona O'Riordan, 2014). However, the number of elderlies participating in physical activity or regular exercise is low.

Mus-Fit action was a specific exercise program for the elderly, which consists of a series of exercise workouts in circuit training targeted for relieving the musculoskeletal problem. And the program also trained peer leaders to deliver the program to other elderly, and It conducted into introductory phases and self-exercise phases. The purpose of this study was to determine whether a Mus-Fit Action muscle strengthening exercise program was effective in reducing the severity of neck pain for age over 50 years old elderly.

Method: There are 20 or more subjects suffered neck pain recruited from the Mus-Fit Action project, which ages over 50 years old with history or current neck pain. The subject conducted an active range of motion tests by using goniometer, self-assessment questionnaires in Visual analog scale (VAS), Neck Pain and Disability Scale (NPAD), and Health Survey (SF-36) to measure pain, evaluate neck-specific problem, and ask about general health status (Whitcroft KL, 2010) (Victoria Misailidou, 2010).
Data collected in pre-program assessment and post-program evaluation, also obtained by the original Mus-Fit project. A paired T-test was used to test for the differences between baseline and follow-up measurement for active ROM. A Sign Test or Wilcoxon Signed-rank Test was conducted to test for the differences between baseline and follow-up measurement for VAS, NPAD, and SF-36.

Potential implication: Mus-Fit action was a muscle strengthening exercise program to promote a healthy lifestyle for the elderly by using rubber-band. By researching the relationship between the exercise program effectiveness and the level of pain, the elderly in Hong Kong should be encouraged to participate more in exercise at home or in groups. While exercise helps to maintain posture, strengthen the muscles that support the spine, and adapt better to prevent neck strain and also lower the risk of falling injury.

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