Efficacy of a motivational interviewing program to improve college students' physical activity engagement: a randomized controlled trial study

by

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Statement of Originality

I, CHEUNG, Fan Sang Vincent, hereby declare that I am the sole author of the thesis and the material presented in this thesis is my original work except those indicated in the acknowledgement. I further declare that I have followed the University's policies and regulations on Academic Honesty, Copyright and Plagiarism in writing the thesis and no material in this thesis has been submitted for a degree in this or other universities.

Abstract

Research in health related social-psychological approaches has demonstrated the effectiveness of motivational interviewing in physical activity enhancement among adult population. Adopting a randomized controlled design, this study aimed to examine the efficacy of motivational interviewing in enhancement of physical activity engagement among college students in Hong Kong.

This study examines the effect a 4-month psychosocial intervention on improvement of physical activity engagement among college students. Seventy-nine college students (males = 50, females = 29, M_{age} = 19.82, SD = 1.91) were randomly assigned to either an intervention group or control group after a baseline assessment. A motivational intervention consisting of one-on-one interviews was employed to affirm goals, strengths and/or behavior while inspiring new ideas, with each session lasting for 60 minutes and being conducted every fortnightly for 4 months. After the post-intervention assessment, there was a 2-month follow-up period, wrapped up with a follow-up assessment.

We employed General Linear Modeling to investigate the effects on students' (a) TTM constructs, (b) grit, (c) health-related quality of life and (d) direct-observed health fitness aspects. Comparing with the control group, participants in the treatment condition reported positive changes in Stage of Change and Decisional Balance. These findings demonstrate support for motivational strategies designed to aid physical activity enhancement among local college students.

Keywords: transtheoretical model, motivational interviewing, physical activity, college students, grit, health-related quality of life, randomized controlled trial

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List of Abbreviations

PA	Physical activity
TTM	Transtheoretical Model
MI	Motivational Interviewing
*t*0	Baseline Assessment
*t*1	Post-Intervention Assessment
*t*2	Follow-Up Assessment
Rx	Treatment Group
Ctrl	Control Group
Soc	Stage of Change
SE	Self-Efficacy
DB	Decisional Balance
PoC	Process of Change

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Chapter 1: Introduction

Physical inactivity (PIA) is an escalating public health issue (Bauman et al., 2012). The inactive lifestyle contributes to over 5 million deaths worldwide (Lee, Shiroma, Lobelo, Puska, Blair, Katzmarzyk, 2012), making it the fourth leading cause of fatality worldwide (Kohl et a1., 2012). Predominantly, PIA contributes to non-communicable diseases, such as coronary heart disease, high blood pressure, stroke, diabetes, depression, colon and breast cancer (George et al., 2012), and is related to higher risks of talking, tip or vertebral fractures and difficulty in body mass management (Bauman et al., 2012).

Furthermore, consistent evidence supports the migration of certain lifestyle patterns and health outcomes from adolescence to adulthood (Biddle & Mutrie, 2008). On the other hand, engaging in physical activity (PA) can assist in the transition phase, from late adolescence to adulthood, by promoting physical development, improving fitness and health, and by developing their confidence, self-regulation and perseverance (Duan, et al., 2015).

However, along with students' decrease of PA since senior secondary school years, lack of interest in sports activities, low awareness of health risks and the surging indulgence of online activities, the tendency toward sustained PIA increases (Fu, Guo, & Zang, 2012). Withdrawn from scheduled physical exercise, most local college students start leading a considerably sedentary style of living (Biddle & Mutrie, 2008), hence a discounted health-related quality of life (Keating et at., 2005). Around 48% of college students in Hong Kong and 43% of college students worldwide do not engage in any exercise, and have since become rather sedentary (Seo et al., 2011). Therefore, implementing effective PA interventions deems imperative to this population.

Limited studies on Hong Kong college student population yields far too insufficient evidence to corroborate the effectiveness of local PA interventions (Working Group on Diet and Physical Activity, 2010). Most PA studies on local and mainland Chinese populations are either non-interventional (Li & Chan, 2008) or cross-sectional (Duan et al., 2010). In addition, most local PA studies falls short of randomized controlled trials (RCT) to justify intervention effectiveness, thus in lack of the sensitivity to detect real effects (Rhodes & Pfaeffli, 2010). Apparently, the inadequacy in conceptual bases, in theoretical orientations and in empirical evidence among local practices makes it difficult to explain

how interventions enhance PA engagement. Therefore, the main purpose of this study is to investigate the efficacy of a theory-driven intervention study in enhancing regular PA engagement of local college students through a randomized controlled trial.

There exists a general consensus that all adults (aged 18-64) should meet an objective PA requirement, i.e. to accumulate a weekly minimum of 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity aerobic activity in order to maintain and improve health and well-being (Physical Activity Guidelines Advisory Committee, 2008; Department of Health, 2012). Other scholars add that even light-intensity PA contributes to one's well-being much more than just sitting around (Powell, Paluch, & Blair, 2011). Moreover, a gradual change of lifestyle activeness does count towards the PA behavioral change. PA of wider range of magnitudes seems helpful in reflecting the PA behavioral change, especially for the early stage participants. Therefore, this study not only focuses on moderate-to-vigorous physical activities (MVPA) despite MVPA's undisputed benefits (Parrish et al., 2013), but also includes the light-intensity PA or daily living activities which are low in caloric output yet physiologically beneficial, especially for the inactive population (Powell, Paluch, & Blair, 2011). Regarding the outcomes, changes in PA engagement is first and foremost to this study. Yet, psychological changes and physical improvement are also of interest hence treated as secondary outcomes. A recent pilot study and other studies reflected that certain psychological and physical changes even quite minute might happen within participants in initial change phases (Cheung, et al., 2015; Powell, Paluch, & Blair, 2011), thus supporting the inclusion of psychological and physical secondary outcomes.

Chapter 2: Literature Review

Transtheoretical Model (TTM)

Transtheoretical Model (TTM) is an eclectic health behavioral intervention framework with an assumption that people change their behaviors through dynamic and cyclical stages (Rhodes & Nigg, 2011). This model embodies an integration of social cognitive counselling and psychotherapy techniques to foster health behavioral changes, now specifically the engagement in regular PA in this study. Cochrane's systematic reviews reported positive effects of TTM intervention on enhancing PA and other health behaviors (Richards, Hillsdon, Thorogood & Foster, 2013). The four main elements of TTM comprises are:

a) Stages of Change (SoC) as the core organization construct,

b) Decisional Balance (DB) as the pros and cons of behavior change,

c) Self-Efficacy (SE) as the perceived ability level to overcome hardship (Rhodes & Nigg, 2011), and

d) Processes of Change (PoC) as a set of recognized mediators (Spencer et al., 2006).

*SoC, k*ey to TTM, focuses on both intention and action for a change in health behavior. TTM model suggests a five-stage progression of improvement, from inactive and with no intention to change (Pre-Contemplation), inactive and with intention to change (Contemplation), irregular PA (Preparation), doing enough PA (Action) and making PA a habit (Maintennance) (DiClemente & Marden-Velasquez, 2002). Movement through the stages is deemed to be recursive rather than linear (Prochaska, Clementi, & Norcross, 1992). The SoC represents the temporal dimension of behavioral change, in a progression of six stages and with a tier-like concept resembling growth paths (Velicer & Prochaska, 2008). Numerous studies investigated the construct validity of SoC, and found that the self-reported SoC was behaviorally valid as evidenced by both self-reported and pedometer recorded PA (Hellsten, Nigg, Norman, Burbank, Braun, Breger, . . . Kaplan, Robert M., 2008). Supporting validity evidence was found between SoC and moderate intensity PA and its frequency, especially in behavioral stages (Hellsten, et al, 2008).

Decisional Balance (DB) concerns the choice of gains and losses about PA behavior. DB highly discriminates SoC, e.g. Cons outweigh Pros the greatest in Pre-Contemplation. On the contrary, there

are more Pros than Cons from the Preparation stage and so on.

Self-Efficacy (SE) is determined by one's level of confidence in PA engagement (DiClemente & Marden-Velasquez, 2002). Visual memory and feedback on past or others performance boost SE for PA (Ashford, Edmunds & French, 2010). The construct of temptations, opposing that of SE, represents however the withdrawal mindset that people yield to hardship (Rhodes & Nigg, 2011).

Process of Change (PoC) stands for the ten constructs, which function as PA intervention strategies (Spencer et al., 2006). Stage-specific PoC strategies are adopted to boost participants' SE and to tip their DB positively in order to foster substantial changes in PA behavior (Marcus & Forsyth, 2009). PoC strategies come in two subgroups of processes, namely the cognitive processes and the behavioral processes, while the former focusing more on knowledge and awareness gains the latter more on PA execution (Papandonatos et al., 2012).

While the PA SoC questionnaire keeps track of students' behavioral changes, both attitudinal and behavioral, the PoC are meant to be a set of appropriate strategies people use to improve attitude and behavior for people at different stages toward health pursuits (Marcus, B. & Forsyth, L., 2009). When people show improvement in their attitudes and health behaviors, the score of PoC questionnaire increases (Marcus, B. & Forsyth, L., 2009).

Motivational Interview (MI) approach based on TTM

Guided by Motivational Interview (MI) spirits (Miller and Rollnick, 2012), including collaboration, acceptance, compassion and evocation, "MI is a collaborative conversational style for strengthening the client's motivation and commitment to change (Rollnick, 2013)". Characteristically, MI aims to discord reluctance to change directly by evoking the voice of change from the client (Hettema, Steele, & Miller, 2005). A meta-analysis revealed that MI was associated with a short-term (up to three-month follow up) between-group effect size of 0.77 regarding to enhancing treatment retention and adherence, reducing addictive behaviors and increasing health behaviors (Hettema, Steele, & Miller, 2005).

MI style complements TTM intervention strategies through identifying and mobilizing participants' intrinsic values and goals to elicit behavior change from their own resources through interpersonal interaction (Rubak et al., 2005). This style set is designed to evoke, clarify, and resolve PA-associated DB, hence to deal with resistance as well as sustaining PA changes (Miller & Rollnick, 2012; Rubak

et al., 2005).

To augment the outcomes without jeopardizing the generally accepted effects of the TTM, MI seems to fit in the PA counselling as an integral partner of TTM. Borrowing from the concepts of SoC construct of TTM, Miller & Rollnick (2012) identified clients' level for change in PA engagement by intrinsic motivation phase and commitment-to-change phase.

Intrinsic motivation phase, denoting the Pre-Contemplation and Contemplation stages of SoC, signifies a period when participants are getting ready for change with increased knowledge and accumulated risk awareness, hence sufficient motivation to enact behavioral change (Callaghan et al., 2010; Miller & Rollnick, 2012). In this stages, pros and cons of PA, the Self-Efficacy (SE) and Cognitive processes of PoC, namely Consciousness Raising, Dramatic Relief, Environmental Re-evaluation, Social Liberation and Self Re-evaluation, are key concerns in the intrinsic motivation phase (Miller & Rollnick, 2012). With MI style, counsellor listens to participants' values and actions reflectively, guides them to explore the pros and cons of PA engagement, evokes the discrepancy between their values and present behavior from them, affirm them with their coherent experience and mind-set, and facilitates them to explore possible next steps (Miller & Rollnick, 2012).

Commitment-to-change phase represents the period when participants are firm in overt behavioral improvement, concerning the Preparation, Action and Maintenance stages of SoC. In this phase, committed participants seem to benefit more from setting flexible and doable action plans, while planning to cope with foreseeable obstacles, in order to sustain the initial gains in PA (Marcus & Forsyth, 2009). In this stage, Self-Efficacy stands as the key concern. And, PoC behavioral processes, namely Stimulus Control, Helping Relationship, Counter Conditioning, Reinforcement Management and Self Liberation, give rise to be the key intervention instruments. In MI counselling style, participants receive 1) affirmation for their enacted attempts and 2) evocation to explore different forms of PA and different ways of planning. In a belief that once their interests have been aroused, they will be inspired to engage in PA more regularly (Sorensen et al., 2007).

Application of MI Approach to TTM based Intervention in PA

With identified SoC of clients, a set of stage-matched and TTM-based cognitive and behavioral skills, DB prompting strategies and SE strengthening techniques, are to be delivered in MI style (Miller &

Rollnick, 2012; Passmore, 2011).

In MI counselling style, participants receive 1) affirmation for their enacted attempts and 2) evocation to explore different forms of PA and different ways of planning. In a belief that once their interests have been aroused, they will be inspired to engage in PA more regularly (Sorensen et al., 2007).

In Pre-Contemplation stage, the unaware and unwilling clients are likely to be defensive or discouraged to defy PIA at first. The counsellor helps them identify specific reasons not considering PA, explore specific health benefits of PA in parallel with that of PIA, and think about how ordinary PA has instilled in their lifestyle and risks of PA and PIA. Then, barriers or costs in adopting or maintaining PA or PIA demand keen attention. A checking of the likelihood of being active in a spectrum of situations could help them re-assure their confidence for action (Kim, 2004). MI plays a role to create relationship through empathy and rapport, to increase importance awareness toward PA, to evoke verbalizing and expressing discrepancy between their values and current behavior patterns, to allow feeling listened, all the most to motivate them to think about making a change of their PA patterns more seriously (Miller & Rollnick, 2012; Passmore, 2011).

In Contemplation stage, clients acknowledge their PIA lifestyle defective, think seriously about PA, but yet to commit. Alongside with this process, MI helps clients tip the balance in favor of change, spells out what matters most while sorting out the association between problematic behavior and sensible goals (Miller & Rollnick, 2012), thereby increasing their commitment and confidence for change (Passmore, 2011). With a goal of "going for it", counsellor helps them consider the specific benefits and barriers of MVPA, set short- and long-term goal and increase lifestyle PA. The counsellor also helps them develop a list of solutions to overcome specific barriers, believe in one's ability to become a physically active individual in a variety of situations soon, express noticeably more benefits than barriers or costs of adopting or maintaining PA (Kim, 2004).

In Preparation stage, the goal is to prepare the motivated participants to be ready to commit in regular PA. Therefore, the strategies here are to help these intended participants, to set specific goals hence individualized PA prescription, and to learn how to plan in order to engage in PA in face of uncertain scenarios. After setting goals and plans, they deem to be more confident in engaging in PA in an array of adverse situations, to learn ways to keep and monitor daily PA log, and to make sure benefits

outweigh barriers or costs in adopting or maintaining PA (Kim, 2004). In partnership, MI boosts clients' confidence in their changes, checks the congruence between their future behavior and their beliefs, verifies clients' commitment to change, ensures readiness of emergency signaling mechanism, consequently their goals and planning matched and successfully materialized (Miller & Rollnick, 2012; Passmore, 2011).

In Action stage, clients who have just started overtly engaging in PA are facilitated to keep it going. Therefore, the counsellor facilitates them to re-establish or re-affirm their specific reasons for PA, to evaluate their current PA patterns and to adjust properly to exercise training. To increase clients' maintenance and coping confidence in PA or exercise, strategies are devised to use rewards, supports and contracts from self and/or others in order to sustain the positive change. In order to outweigh the shrinking barriers or costs in adopting or maintaining PA further, clients are invited to give fresh testimonies of PA benefits. At this stage, MI helps monitor and affirm small steps, explore next steps and build adequate efficacy toward lasting of the positive change (Passmore, 2011).

In Maintenance stage, clients whose PA patterns have lasted for at least 6 months are to consolidate their efforts and gains in order to secure PA a lifestyle habit. Intervention strategies include avoiding injury, keeping one's confidence, obtaining social support and continuous use of rewards or contracts. MI helps reminding of specific aims or reasons for establishing PA habits, evaluating current exercise pattern and plan ahead for difficult situations, restarting of exercise within 1-2 weeks if relapse occurs, to be solidly confident in being active in face of adversity, and to confirm PA with enormous benefits to shunt the barriers or costs.

In Relapse stage, clients may have built up pro-PIA thoughts or valued nature of PIA. To enhance treatment adherence and to decrease relapse period is to increase their motivation to change (Wade et al., 2009). Further, increasing clients' belief in one's ability to change seems relevant to bust relapses (Wade, Treasure, & Schmidt, 2011).

The Present Study

In view of the fact that local primary and secondary school students have yet to establish a sound habit of PA, Curriculum Development Council (2002) stressed the importance of deterring physical

inactivity in local education guidelines. Most local schools, however, delivery of physical education remained unchanged in a unanimous manner, in which sports experience and sports skills constitute the major focuses for teaching and learning process throughout the twelve years of compulsory education (Johns, 2003). Coming to college level, these students are no longer bound by compulsory physical education. Therefore, a regular voluntary PA habit becomes essential to attain global health benefits. Along this track, instilling health promotion components into physical education settings might enhance PA habits of college students. Contrary to our conventional mind-set, recent research evidence showed that education, adopting traditional sports activity approach, might be obsolete was not enough to help people acknowledge the pros and cons of health choices, food, stress management and medical care. Worst of all, education was criticized as inadequate and unimportant (O' Donnell, M. P., 2012). A paradigm shift from sports education approach to health education approach is appreciable.

This research means to changes in many ways. At policy level, the study could inform reformation of goals of physical education thus gearing the curriculum toward a more conducive approach. At pedagogical level, upon the outcome sought from this study, we might have better ideas hence deeper thoughts in integrating health promoting intervention strategies into our physical education programs. This attempt hoped to create another channel of interdisciplinary collaboration between physical education and allied health professions concerning health and physical activity promotion. Overall, the study introduces social-cognitive theoretical approaches, such as TTM and MI, into our health promotion programs which are hoped to improve people's mind, behavior and hence the quality of lives.

The delivery of PA counselling using TTM model with MI approach among Hong Kong college students is conjured as an innovative attempt for an appreciable chemistry. Such practice aims to result in a better and more explicable treatment effect in terms of clearer and more concise identification of PA engagement stages with more specific stage matching of mediators. Along with the clearer identification of psychosocial mediators, physiological benefits are expected to emerge more clearly as well.

In practice, the study attempts to customize interventions for adoption and maintenance of PA among

college students of transiting from four base stages (namely Pre-Contemplation, Contemplation, Preparation, Action and Maintenance) to one or more of the next stages. Therefore, five specialized intervention programs were formulated with reference to theory-based PA intervention framework of TTM to be delivered with MI approach. With supportive overall findings (Martins, & McNeil, 2009), MI has been proven to be effective in conjunction with TTM framework in promoting PA engagement. With much to be found, the effectiveness of TTM delivered in MI approach in local context is highly valuable for investigation.

This study strived to be significant in a) understanding the changes of mental and physical outcomes of college students in view of their diverse PA engagement levels; b) examining the feasibility of applying Transtheoretical Model (TTM) through Motivational Interview (MI) counselling approach on PA engagement among Hong Kong college students; and c) enhancing college students' motivation in PA engagement.

The potential impact of the study includes a) MI can be adopted as a prudent PA promotion approach, b) the PA program designer can be informed by this study to devise effective PA enhancement programs, and c) the application of TTM in MI approach can be compiled into a program manual which will be used to boost college students' lifestyle hence their health.

The methodological quality of local studies concerns scholars of various fields. In response to concerns raised about local research in previous chapter, research in larger scale using more rigorous randomization, concealing blinding and other quality ensuring methods would shed more light on these recently null findings and the variability observed.

Purposes and hypothesis

This study aimed to evaluate the efficacy of a MI counselling approach on PA engagement and on health outcomes among Hong Kong college students. Moreover, the study adopted TTM as the theoretical framework to guide the intervention. The objective of this study was to assess the efficacy of using the approach of MI to foster enhancement in PA behavior. The primary outcome measure of this study included the behavioral outcomes shown by accelerometry readings and physical outcomes demonstrated by body composition and the psychological outcomes concerning TTM domains, grit

and health-related quality of life.

The primary hypothesis of this study was that MI recipients (treatment arm) would, relative to the controls (control arm), report greater improvement in PA engagement. The study also hypothesized that MI recipients would demonstrate greater improvement in a) psychological outcomes concerning TTM domains, grit and health-related quality of life and b) direct-measured health fitness outcomes, including body fat percentage, body mass index and waist-hip ratio than non-recipients, from pretest to posttest and then to follow-up.

Chapter 3: Methodology

Participants

The scope of this study concerns Vocational Training Council (VTC), a post-secondary vocational education training (VET) organization in Hong Kong. With 13 member institutes spanning across Hong Kong Island, Kowloon and the New Territories, VTC offers vocation-oriented tertiary education to approximately 250,000 students (VTC, 2013).

All full-time year-one students, around 3000 in total, from two member institutes of VTC, both housed in a mega-campus in eastern New Territories, were invited to join this study through posters and e-flyers. Therefore, all participants were required to be at least 18 year old and were currently on-roll in one of these two designated institutes. The inclusion criteria adhered that the participants were a) consented to participate in written form, b) having at least 12 months to complete their study program, c) ignorant from any prior PA counselling and d) being physically capable to undergo PA for health benefits. The exclusion criteria were a) having known mental or physical inability or b) taking regular medication. After clearly briefed on the importance of their voluntary agreement and sustained commitment, all participants submitted their consent form of participation at least a week before attending a baseline test. To respect participants' free will, they were encouraged to make their comments and suggestions known to the researcher, the researcher's supervisors or the human research and ethics committee of the host institute of this research at any time.

Based on a pilot study published recently (Cheung, et al., 2015) and the historical data from a study (Martens et al., 2012), a minimal sample of 35 for each group were required (n=70). To protect against the impact of student attrition, the sample size was inflated by 14% so that 80 participants was anticipated.

An initial sample of 79 participants (males = 50, females = 29) completed the baseline assessment ($t0$) (Figure 1). The intermediate sample of 70 participants (88.6%; males = 44, females = 26) completed the post-intervention assessment ($t1$). The final sample of 51 participants (64.6%; males = 32, females = 19) the follow-up assessment as well.

Procedures

Upon obtaining ethical approval from the human research and ethic committee at the author's institute, online and face-to-face recruitment commenced in the two designated VET institutes. Three thousand VET students were screened for eligibility between December 2015 and January 2016 (see Fig. 3). The ineligible students were excluded for the following reasons: (i) with identified mental or physical inability, (ii) on regular medication, (iii) lack of interest or (iv) other reasons of rejection.

Willing students first joined one of the briefing sessions. They were briefed with the project outlines, the procedures of the study, the requirement of their total and willful commitment total respect of their free wills and all comments only to be in written form at any time of the project period. Upon being briefed in details of the aim of the study, interested and eligible students joined the project by signing the written consent on a voluntary basis.

Both targeting institutes are a setting for both intervention and social interaction, participants from the same class might exchange matters about the study, possibly about the intervention, with other members in a natural manner. Diffusion of treatment across different groups of participants could impose a major risk of contamination hazard for a randomized design (Pradeep, Isaacs, Shanbag, Selvan, & Srinivasan, 2014). For treatment integrity and prevention of contamination, the researcher found it more appropriate for participants from the same class to join in the same group. Hence, a randomization using a block random allocation technique with a block size of 1 to 4 persons was carried out (Bender, Choi, Won, & Fukuoka, 2014). (Figure 1). Nearly equal number of participants emerged after a couple of trials.

Eighty students enrolled in the study in February 2016. One student withdrew from the study prior to baseline assessment in the same month. All 79 baseline assessed participants were randomly assigned with the adoption of block randomization by class. Forty students (in which 30 were males) were randomized to Treatment Group (Rx) while another 39 students (in which 20 were girls) were assigned to the Control Group (Ctrl).

Rx (n=40) were assigned to 4-month counselling intervention series using MI approach and were each provided with self-study manual, whilst Ctrl (n=39) were provided with the same self-study manual only. For the integrity and fidelity purpose, consents of confidentiality were sought at the baseline assessment. Immediately after the last counselling session, the post-intervention assessment ($t1$) was performed in May. The follow-up assessment ($t2$) was conducted after 2 months of follow-up period

(see Figure 1).

The researcher conducted the counselling program for each participant of the Rx (n=40) once a fortnight for 4 months at a designated classroom of this campus. This study assessed participants' PA engagement, psychological outcomes and physical outcomes with same set of instruments administered at three time-points, i.e. immediately before (*t*0), immediately after (*t*1) and two months after (*t*2) the counselling program. In this single-blinded RCT, all assessments were conducted anonymously at the absence of the instructor at a designated campus sports facility, while the outcome assessors were blinded to participants' allocation status throughout.

Intervention

This study aimed to help Rx participants progress from covert motivation enhancement to overt behavioral commitment across the 4-month intervention period and beyond. Guided by a randomized controlled trial (RCT) design, assigned conditions remained irreplaceable throughout the entire data collection period. The two conditions were a) motivational PA intervention and an interactive practicum booklet as treatment; and b) only the interactive practicum booklet as control.

All Rx participants attended one-to-one MI intervention for 6 sessions in total, each lasting 45 minutes. The tenets of each PA counselling session was guided by the theoretical framework while conducted in MI approach. Exercise Stage of Change (List) was given to every Rx interviewee as an ice-breaker of each session.

To start the session, the interviewer used open-ended questions, affirmations, reflective questioning and summary statements based on the current SoC and other situations of the participant.

Intrinsic Motivation Phase (Pre-contemplation and Contemplation)

Goals for this phase were to create a rapport, to increase awareness, to think more seriously about changing, to exaggerate importance of change. Focuses of this phase fall on establishing connections between PA and one' own life, expressing feeling of discrepancy between behavior and goal or value and affirming explorations of actions and commitments. Strategies for this phase include debating between "me" and "myself", expressing pros and cons of PA, setting goals from short term to long term and exploring solutions for current obstacles.

Commitment-to-Change Phase (Preparation, Action and Maintenance)

Goals of intervention sessions ranges from to get ready for it, to keep it going and then to make it a habit. At this phase, focuses fall on boosting confidence, checking and affirming action-belief congruence, planning for alternatives, monitoring and affirming actions taken and success, exploring future steps, affirming self-efficacy, building allies for sustainability. Strategies for this phase include reviewing goals, checking goal-action congruence, detecting or foreseeing obstacles, modifying plan A or drafting of plan B, affirming gains, goal attainment and feeling.

At the end of each session, the interviewer made appointment for the next session. For follow-up in subsequent sessions, notes were taken for each session.

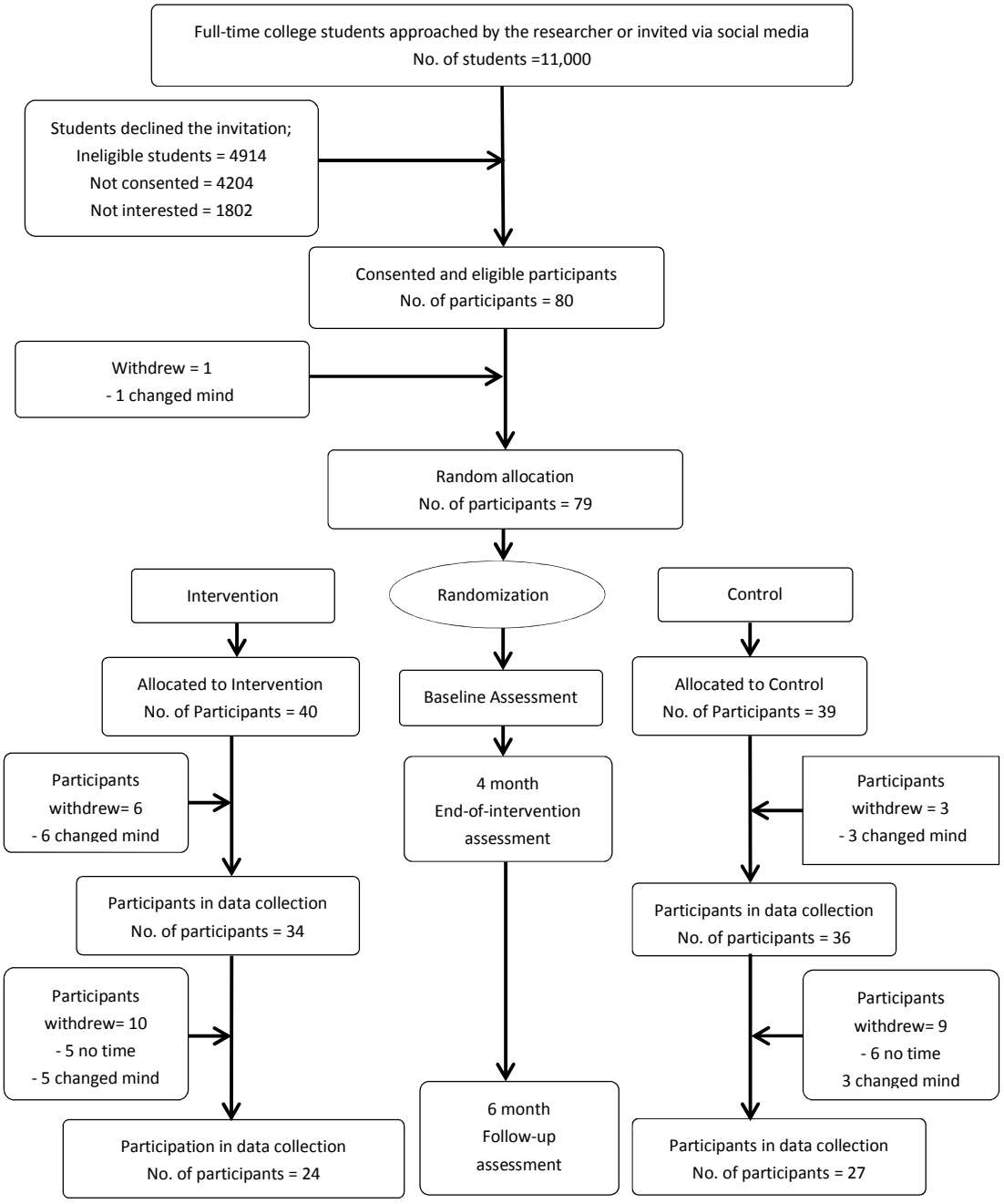


Figure 1. Study flow diagram

Measures

The present longitudinal study measured PA engagement as primary outcome, self-reported psychological health aspects including four dimensions of TTM, Grit and Health Quality of Life and direct-measured fitness levels as secondary outcomes. All participants were assessed at all three

designated time points of assessment. At each point of assessment, same sets of instruments were administered.

In specifics, the researcher strategized a) to measure of day-to-day PA execution time with accelerometer recordings and self-reported PA log, b) to measure psychological and PA habits aspects with four TTM constructs, c) to assess PA related perseverance with a Grit Scale, d) to assess their health related quality of life (HQoL) with the HQoL Scale, and e) to record physical health levels with direct-measured somatic measurements, i.e. BIA and Waist Hip Ratio.

The set of instrumentation was formulated in the pilot study in 2015 (Cheung, et al., 2015). In that pilot study, the TTM and Grit questionnaires were translated into Chinese. According to proper procedures of back translation, written approval sought for the use of from all authors concerned prior to translation. With the reliability and the validity examined, the set of instruments was administered in the main study, among volunteering college students from the same organization. Cronbach Alphas were reported in following sections.

PA engagement

Accelerometers, since regarded as an objective, valid and reliable instrument of direct-measurement, were originally strategized to measure primary outcomes. Yet, the data in this aspect failed to be collected sufficient enough to be reported for various reasons to be explained in latter chapters. According to the original plan, duration of PA was to be collected (Dollman et al., 2009; McClain & Tudor-Locke, 2009). Participants were asked to wear the designated accelerometers (brand: Xiaomi; model: Mi Band Pulse Black; make: Beijing Xiaomi Technology Co., Ltd., Beijing, China). They were to wear the device between time of getting out of bed and that of getting back into bed for at least 10 hours (600 minutes) each day (removed before showers/swimming), for 7 consecutive days every other week (Umstattd Meyer et al., 2013). Participants were requested to wear the accelerometers by the beginning of every wearing week during the four-month treatment period and follow-up period over the 16-week data collection period, and to update ***PA logs*** with valid and non-missing accelerometer recordings manually, in order to be entitled to the study (Maslow & Colabianchi). For better compliance, they were reminded to start wearing their accelerometers via a mutually agreed social

communication platform (Lubans et al., 2010; Okely et al., 2011). Therefore, mobile contact numbers were obtained upon seeking their written consent. Raw data of PA were stored and displayed on participant's smartphones via Bluetooth connections.

Psychological Outcomes

Self-reported psychological outcomes were assessed by Exercise Stages of Change, Exercise Self-Efficacy, Decisional Balance, Process of Change, Grit and Health-Related Quality of Life. Assessments were administered at the baseline, end-of-intervention and follow-up time-points by blinded assessors.

Exercise Stages of Change **(ESoC)** Algorithm version and List version were used to report participants' PA patterns throughout the project period. ESoC Algorithm version and List version were both used during the three assessment time points. ESoC List version which measured the single construct of PA engagement over the past weeks, was applied to all Rx participants, and was administered at the beginning of each interview session. ESoC Algorithm version has a format of 4-item dichotomous questionnaire scored with an algorithm (Fish et al., 2007). One-week test—retest reliability on the original version was excellent (r = 0.88) (Fish et al., 2007). Supported by Oka (2000), the List version has a two-week test-retest reliability (r = 0.75). In this study, the Cronbach's alpha for the 4-item Algorithm version and the 5-item List version were (α=.54) and (α=.71) respectively. So the latter version seemed to be more applicable to local VET students.

Exercise Self-Efficacy (ExSE) was assessed by Exercise Self-Efficacy Measures, which measured the single construct of SE. Marcus & Forsyth (2009) first developed the ExSE measure, a 5-item questionnaire to measure against a 5-point Likert scale The scale received excellent internal consistencies, ranged from Cronbach's α = 0.78 to 0.86 (Papandonatos et al., 2012). The ExSE inventory in this research was found to be acceptably reliable (5 items; α = .72).

Decisional Balance (DB) was assessed by the 16-item Decisional Balance instrument which is a 5-point Likert Scale developed by Marcus and colleagues (1992), This instrument measured the single construct of overall balance of perceived net gains of PA, the difference between perceived benefits of PA engagement and costs of PA engagement by convention. A high internal consistency, ranged from Cronbach's α =0.82 to 0.85 across time was shown (Papandonatos et al., 2011). Cronbach's alpha for

the DB questionnaire used in this research was marginally questionable (α = .65). Decisional Balance (DB_Diff) was meant to be the difference between Pros and Cons of each respondent, i.e. DB_Diff = Total Score of Pros – Total score of Cons. The larger the value of DB_Diff, the more positive the decisional balance tipped over to, vice versa.

Process of Change (PoC) *Scale* is a 29-item instrument (Nigg et al., 1999). The PoC Scale was used to measure two collated constructs of cognitive processes and behavioral processes. Measured against a 5-point Likert scale, the Scale received satisfactory internal consistency, ranged from Cronbach's α = 0.64 to 0.89 for the cognitive processes and from 0.74 to 0.92 for the behavioral processes (Bezyak et al., 2011; Kosma et al., 2006). The set of questionnaire however received a questionable Cronbach's alpha (α = .65).

Grit was assessed by the 8-item Short Grit Scale (Grit—S) on a 5-point Likert developed by Duckworth and Quinn (2009) who posited that grit delineated consistent interest and persevering effort in tasks lasting for months or longer. Highly satisfied average internal consistency estimates (α = .83) suggested that Grit - S ratings can be reliably assessed (Duckworth & Quinn, 2009). The Grit Scale for this research was found to be highly acceptable (8 items; α = .79).

Health-Related Quality of Life (HRQoL) was measured by The Chinese SF-12v2 Scale. HRQoL measured satisfaction levels in both mental health and physical health. Internal consistency of HRQoL is satisfactory (Cronbach's α= 0.80) (Fong et al., 2010). However, with the population of current study, the internal consistency was rather low (12 items, α = .54).

Direct-measured fitness outcomes

Second part of the secondary outcomes constituted Waist-to-Hip ratio and Body Fat Percentage, both direct-measured to indicate body composition.

Waist-to-Hip ratio was adopted to indicate body composition. Circumferences of hip and waist was measured with tape measures (correct to 0.1 cm). To standardize the measurement, the tape measure was taken over the navel for waist measurements and over the maximum girth of the buttock for hip measurements. Waist to hip ratio was calculated and matched against the norm (Central Health Education Unit, 2012; Bener et al., 2013; WHO, 2013).

Body fat percentage was obtained to indicate body composition by using the Bioelectrical Impedance

Analysis (BIA) approach. PA measures were found to be negatively associated with body fat percentage (r = -.20 to -.30) with stronger correlations observed for vigorous energy expenditure scores (van Poppel et al., 2010). The Tanita BC-601F FitScan Segmental Body Composition Monitor (Tanita Corporation of America, Inc., Arlington Heights, IL) measured body fat percentage (correct to 0.1 %).

Subject to verification from independent researchers, the product manufacturer claimed that their BIA method produced highly correlated results with both DEXA and Hydrostatic Weighing (within +1- 4 percentage points). Under consistent conditions, the test-retest reliability seemed quite high (less than 1% variation). The BIA approach seemed inexpensive, easy to operate and in no need for technician's training. Kyle, et al. (2004) have suggested that BIA worked well in healthy subjects with stable water and electrolytes balance. This device adopted a BIA equation appropriate to age, sex and race.

Two assessors collected assessment data of PA engagement, psychological outcomes and fitness outcomes in the absence of the instructor and counsellor at the baseline test, post-intervention test and follow-up test anonymously. Both of them were blinded against the randomization and grouping conditions of each participant. All collected data were reported quantitatively.

All participants were scheduled for an on-site assessment in each assessment week according to their timeslot preference. Conditions of treatment, assessment period, age, gender, socio-economic status, year of study and major of study were encoded following the coding criteria. A participant identity number was assigned at Baseline (*t*0) for matching of data collected at subsequent time points. Reliability tests done though a pilot study in 2015 indicated that the questionnaire set was providing best goodness of fit for this study (Cronbach's α from .54 to .79). The pilot study demonstrated that the questionnaire set deemed to be a valid and reliable self-report measure for the assessment of changing motivation of VET students in general.

In summary, the questionnaire set demonstrated adequate reliability and showed sufficient evidence of validity in assessing psychological dispositions and behavioral patterns of Chinese VET students in Hong Kong. Therefore, the questionnaire set was confirmed for adoption in the main study.

Chapter 4: Data Analyses and Results

A. Data Analysis

Data screening and missing values

First, the data of all randomized participants were screened for missing values with the application of ITT principles (Gupta, S., 2011). Then, the test of Little's Missing Completely At Random (MCAR) was adopted to diagnose the randomness of missing values (Little, 1988), i.e. to assess whether the missing data are missed in complete randomness, as a measure to avoid the overestimate (unbiased) of subsequent imputation. Little's MCAR test from SPSS v.22 Missing Value Analysis (MVA) module was used to compare patterns of missing data on all variables with the pattern expected for random missing data. If the missing data were classified as MCAR, Last Observation Carried Forward (LOCF) was used to handle missing values by carrying out data imputation. Otherwise, the non-random missing data processes was to be employed.

With the affirmation of MCAR assumption and a repeated measure data structure, Last Observation Carried Forward (LOCF) was adopted as an acceptable and a common approach for missing data imputation supports (Gupta, S., 2011). In LOCF the researcher carried the last available value forward by imputing the value obtained from the last time point for the missing values (Debray, T., Schuit, E., Efthimiou, O., Reitsma, J., Ioannidis, J., Salanti, G., & Moons, K., 2016).

Descriptive statistics (M ± SD) for all demographics and baseline PA variables were calculated for the treatment and control groups (Table 1). To uncover covariates at baseline, the treatment and control groups were compared with either student t-test (continuous variables) or Chi-square test (categorical variables). Then, statistical analyses were employed to test the hypotheses in accordance to the RCT design, based on the intention-to-treat principle. All covariates were included in the adjusted primary analysis (Europeans Medicines Agency, 2015). Data analysis included between-group and within-group comparisons of repeated measures and temporal variations in intervention effects.

Primary Analyses

This study applies the method of General Linear Modelling (GLM) repeated measures to analyze the longitudinal data, including PA engagement, psychological outcomes and physical outcome variables. First, between group differences in any dependent variables are to be located with the adoption of

univariate repeated analysis with the assumption of independence. GLM repeated measures univariate analysis for between group comparisons on main outcome measures (p-value) was carried out to indicate the treatment effect on psychological and physical outcomes at each time point (Time), i.e. baseline assessment ($t0$), end-of-intervention treatment ($t1$) and follow-up assessment ($t2$) for Rx group and Ctrl group separately and collectively. Main effect of treatment indicates the between-group difference independently with all three time points collapsed. Main effect of time indicates the within-subject difference independently among all participants with both groups collapsed. Interaction effect of Treatment and Time indicates the between group difference in three separated time-points.

In this univariate analysis, the assumption of independence is applied, i.e. all dependent variables are assumed making a contribution to the main effect independently from each other. That said, since significant between-group difference has been located in age and gender at baseline (t0), these two independent variables acted as covariates in subsequent analyses (Table 2).

Secondary Analysis:

Once potential individual main effects were located, further investigation on the extent of contribution of each potential dependent variable to the overall between-group differences followed up with the adoption GLM Repeated Measures Multivariate Analysis. All potential dependent variables are grouped together as an integral. Interaction effects and main effects were examined. With an imbalance in Sex and Age between Rx and Ctrl, the multivariate analyses were again controlled for these two covariates.

B. Results

Primary outcome for this study was planned to involve PA engagement which was supposed to be represented by the direct observed accelerometer counts. Within group differences delineated whether there was any improvement of each group across time points. Between-group comparisons should present the difference in extent of PA engagement between the Rx group and Ctrl group at each time point. Subsequently interaction by group and time points should demonstrate the between-group difference in PA engagement across three time points. Tukey's Post-Hoc tests were to provide clear details for the significant difference located. However, due to unforeseeable technical issues, direct-measured PA engagement record from accelerometers fail to contribute to the study result part as planned.

Originally, each participant was provided with a wrist-mounted Mi-Watch, and were required to wear 7 consecutive days during alternative measuring week, at least 10 hours each day during awake hours. All were also requested and reminded to send back the filled out online record form. Only 3 students (3.8%) managed to return record in full. Thirty-two participants (40.5%) had completely missed reporting their data. The rest 44 four participants (55.7%) returned only one to three weeks of data to blinded assessor. Though no further reports in this chapter, more information was further reported and explored in the following chapter.

Secondary outcomes for this study involved self-reported psychological outcomes and direct measured physical outcomes which were represented by the direct observed accelerometry data. Within group differences delineated whether there was any improvement in psychological outcomes and direct measured physical outcomes of each group across three time points. Between group comparisons presented the difference in extent of PA engagement between the Rx group and Ctrl group at each time point. Interaction evidenced the between group difference in PA engagement across three time points.

Missing Values

The Little's MCAR diagnostic test utilized the SPSS program Missing Value Analysis 7.5, an Expectation Maximum (EM) technique (Hill, 1997). The MCAR test result (Table 10) shows no statistically significant differences χ^2 (51) = 46.281, p<.662 at 5% significance level, supporting data missing at random (i.e., data missing with no identifiable pattern). There exist obviously no significant

differences between missing data and the expected missing data at random, in patterns on all variables. Therefore, test result affirms the missing data as MCAR, hence the assumption of no change from one visit to the next for those who dropped out is reasonable and relatively unbiased (Lachin, J., 2016). And, the imputation approach of LOCF is acceptable to be carried out before main analyses.

resulted in a chi-square = 46.281 (df = 51; p<.921), which indicates that the data is indeed missing at random (i.e., no identifiable pattern exists to the missing data). The

Table 1: Little's MCAR test Results

EM Means[a]															
Soc_Alg_t1W missing	SE_t1_Wmissing	DB_DIFF_t1_Wmissing	PoC_Total_t1_Wmissing	GRIT_Total_t1_Wmissing	QoL_total_t1_Wmissing	WHratio_total_t1_Wmissing	SoClist_total_t1_Wmissing	SoC_Alg_t2_Wmissing	SE_t2_Wmissing	DB_DIFF_t2_Wmissing	PoC_Total_t2_Wmissing	GRIT_Total_t2_Wmissing	QoL_total_t2_Wmissing	WHratio_total_t2_Wmissing	SoClist_total_t2_Wmissing
3.598	2.431	.718	119.6085	42.154	21.627	.842	3.466	3.534	2.298	.479	118.4020	42.355	20.922	.816	3.505

a. Little's MCAR test: Chi-Square = 46.281, DF = 51, Sig. = .661

Characteristics of Participants:

The baseline characteristics of Rx and Ctrl in terms of demographics, PA engagement, psychological characteristics and direct-measured fitness outcomes were shown (Table 1). Comparing between two groups, Rx had more males (30) than Ctrl (20), χ^2 (2, N=79) = 4.78, p< .05; were taller (169.3cm ± 6.4) than Ctrl (165.7cm ± 9.4), *t*(79) = 1.98, p< .05; and older in age (20.3 yrs ± 2.31) than Ctrl (19.4 ± 1.27), *t*(79) = 2.06, p< .05. Apart from the aforementioned three aspects, no other significant statistical differences existed between two groups (all ps> .05) (Table 1).

Four months later, a total of 70 participants, thirty-four and 36 in Rx and Ctrl respectively, completed the End-of-Intervention Assessment 4 months later. After another 2 moths, fifty-one participants, twenty-four and 27 in Rx and Ctrl respectively, completed the Follow up assessment.

Table 2 Participant Characteristics of the Two Groups (*M*± *SD*)

Variables	**Treatment Group**	**Control Group**	***p*- value**
N	*40*	*39*	
A. Characteristics of Participants			
Female, No. (%)	10 (25.00%)	19 (48.72%)	.03^*
Age (years)	20.25 ± 2.31	19.38 ± 1.27	.04*
Family Income in 3 levels (HK$)*, No. (%)			.64^
<10,000	12 (30.00%)	11 (28.21%)	
10,000-29,999	22 (55.00%)	20 (51.28%)	
≥30,000	6 (15.00%)	8 (20.51%)	
Program of Studies, No. (%)			.71^
Higher Diploma	24 (60.00%)	25 (64.10%)	
Foundation Diploma	16 (40.00%)	14 (35.90%)	
Department of Studies, No. (%)			.46^
Engineering	12 (30.00%)	8 (20.51%)	
Fashion and Image Design	7 (17.40%)	17 (43.59%)	
Information Technology	18 (45.00%)	14 (35.90%)	
Product and Interior Design	3 (7.50%)	0 (0.00%)	
B. Transtheoretical Model Constructs			
ExSoC (Algorithm Version)	2.98 ± 1.21	2.97 ± 1.25	.43
ExSoC (List Version)	3.18 ± 1.03	3.33 ± 1.06	.34
ExSE	2.47 ± 0.79	2.38 ± 0.62	.57
Decisional Balance (Pros)	3.59 ± 0.67	3.36 ± 0.59	.11
Decisional Balance (Cons)	2.80 ± 0.72	2.79 ± 0.55	.93

Decisional Balance (Pros – Cons)	0.78 ± 0.97	0.57 ± 0.78	.28
Process of Change (Cognitive)	58.43 ± 13.92	56.90 ± 9.67	.57
Process of Change (Behavioral)	58.95 ± 13.14	58.56 ± 8.88	.88
Process of Change (Cognitive + Behavioral)	117.38 ± 25.43	115.46 ± 17.07	.70
C. Grit			
Internal Consistency (Int_Con)	22.13 ± 4.11	21.82 ± 4.55	.76
Effort Perseverance (Eff_Pers)	18.60 ± 4.19	18.10 ± 4.65	.62
Grit Score (Int_Con + Eff_Pers)	40.73 ± 6.45	39.92 ± 7.37	.61
D. Health Quality of Life (HQoL)			
Physical Component Summary (PCS) Score	6.58 ± 1.58	6.64 ± 1.78	.86
Mental Component Summary (MCS) Score	15.20 ± 3.25	14.67 ± 2.75	.43
HQoL Score (PCS + MCS)	21.78 ± 3.89	21.31 ± 3.47	.58
E. ***Direct-measured Fitness Outcomes***			
Body Height (cm)	169.28 ± 6.36	165.71 ± 9.43	.05
Body Weight (kg)	66.78 ± 12.42	64.06 ± 14.44	.37
Body Fat Percentage (%)	20.74 ± 10.28	23.82 ± 10.42	.19
Waist Circumference (cm)	82.93 ± 10.31	82.90 ± 12.54	.99
Hip Circumference (cm)	98.35 ± 9.09	97.84 ± 10.69	.82
Waist/Hip Ratio	0.82 ± 0.13	0.85 ± 0.07	.32

- Results obtained from Student t-test or Chi-Square tests for Continuous data and Categorical Data respectively as stated in the Statistical Analysis Section in the chapter of Methodology.
- *p*-value* indicates between group difference statistically significant ($p < 0.05$).
- ^: Categorical data analyzed with Chi-square tests

SoC (alg)=Stage of Change (Algorithm version); SoC (list)=Stage of Change (list version); DB=Decisional Balance; PoC=Process of Change; EXP= Experiential Component; BEH=Behavioral Component Score; EXP=Experiential Component Score; Int_Con=Internal Consistency Score; Eff_Pers= Effort Perseverance Score

Psychological Outcomes

As part of the secondary outcomes, self-reported psychological outcomes were assessed by Exercise Self-Efficacy, Decisional Balance, Process of Change, Grit and Health-Related Quality of Life. There was a nearly significant main within-subject effect of Time for Grit across Rx and Ctrl grouping. Interaction effect was observed for Stage of Change (List) and Decisional Balance. Other outcomes failed to demonstrate significant difference in any aspects.

Stage of Change

As shown in Table 3 below, the descriptive result showed that 31.3 % (n=25) of the Rx participants had progressed at least 1 stage (*t*1: 50%; *t*2: 12.5%). Participants in Ctrl arm also showed 26.9% (n=21) progression (*t*1: 28.2%; *t*2: 25.6%). With that being said, an average of 51.3% (n=41) of Rx participants remained unchanged in either between any two time points or throughout all three of

them. Likewise, there were 42.3% (n= 33) of the Ctrl participants remained unchanged in the similar ways.

On the other hand, there were 17.5% (n=14) demotion among the Rx participants (*t*1: 17.5%; *t*2: 17.5%). Comparatively, a demotion of 30.8% (n=24) was observed among the Ctrl participants (*t*1: 38.5%; *t*2: 23.1%).

Table 3. Comparison of Within-Subject Changes across three time-points on Stages of Change

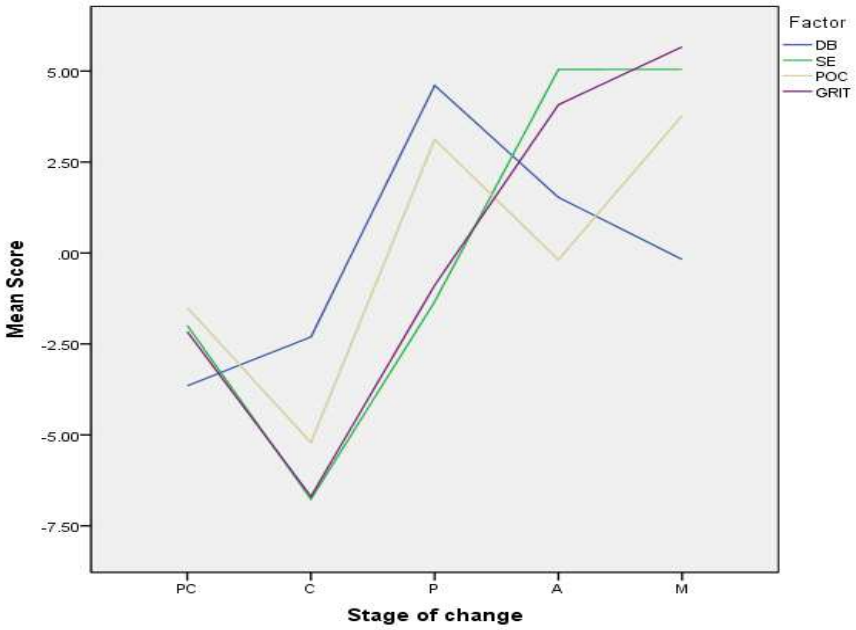
		No. of Participants					
		Rx			Ctrl		
		*t*0	*t*1	*t*2	*t*0	*t*1	*t*2
PC	demoted	**1**	0	0	**3**	0	1
	unchanged		0	1		1	2
	promoted		1	0		2	0
C	demoted	**11**	1	2	**4**	3	1
	unchanged		3	6		0	2
	promoted		7	3		1	1
P	demoted	**12**	1	2	**13**	3	4
	unchanged		1	10		4	7
	promoted		10	0		6	2
A	demoted	**12**	3	3	**15**	5	3
	unchanged		7	8		8	8
	promoted		2	1		2	4
M	demoted	**4**	2	0	**4**	4	0
	unchanged		2	3		0	1
	promoted		0	1		0	3
Total	**demoted**	**40**	**7**	**7**	**39**	**15**	**9**
	unchanged		**13**	**28**		**13**	**20**
	promoted		**20**	**5**		**11**	**10**

The results of the MANOVA indicated significant effect for Stage of Change (List), $F(1, 79) = 4.15$, $p < .05$. Figure 2 also indicates the standardized score of Self-Efficacy, Decisional Balance, Process of Change and Grit across five stage of change and across time points with both Rx and Ctrl groups

combined, the figure indicates a rather curvilinear fashion of all four parameters across the five stages. All variables, except Decisional balance reached their lowest among participants at Contemplation stage. Preparation level participants received a higher score in all constructs than Contemplators, in agreement with Horiuchi et al., (2013). A slight drop in Decisional balance and Process of Change was observed for Action stage participants. Yet Maintenance participants excelled in all, but Decisional Balance, constructs, also in agreement with Horiuchi, et al. (2013).

Further analysis showed that the Control Group remained much in cognitive categories (PC/C/P) in Stage of Change (List) levels from Baseline to Post-Intervention and then Follow-up, whereas the Treatment Group showed significant advancement in Stage of Change (List) categories from Baseline to Follow-up (Table 5b). Other PA engagement measure, i.e. ExSoC (Algorithm), displayed no significant difference in all aspects. Between-group difference widens across time (Figure 4, Table 5a). The Chi-square Test also showed a statistically significant between-group difference in SoClist at *t*1 (*p*=.016) and *t*2 (*p*=.025).

Figure 2: Means and Standard Deviations of Self-efficacy, Decisional Balance, Process for Change and Grit across stages and in combined grouping



DB=Decisional Balance; SE=Self-Efficacy; POC=Process of Change; GRIT= Grit
PC=Pre-Contemplation; C= Contemplation; P=Preparation; A=Action; M=Maintenance

Figure 3: Stage of Change Profile (Stage Size) by Grouping and by Time Points

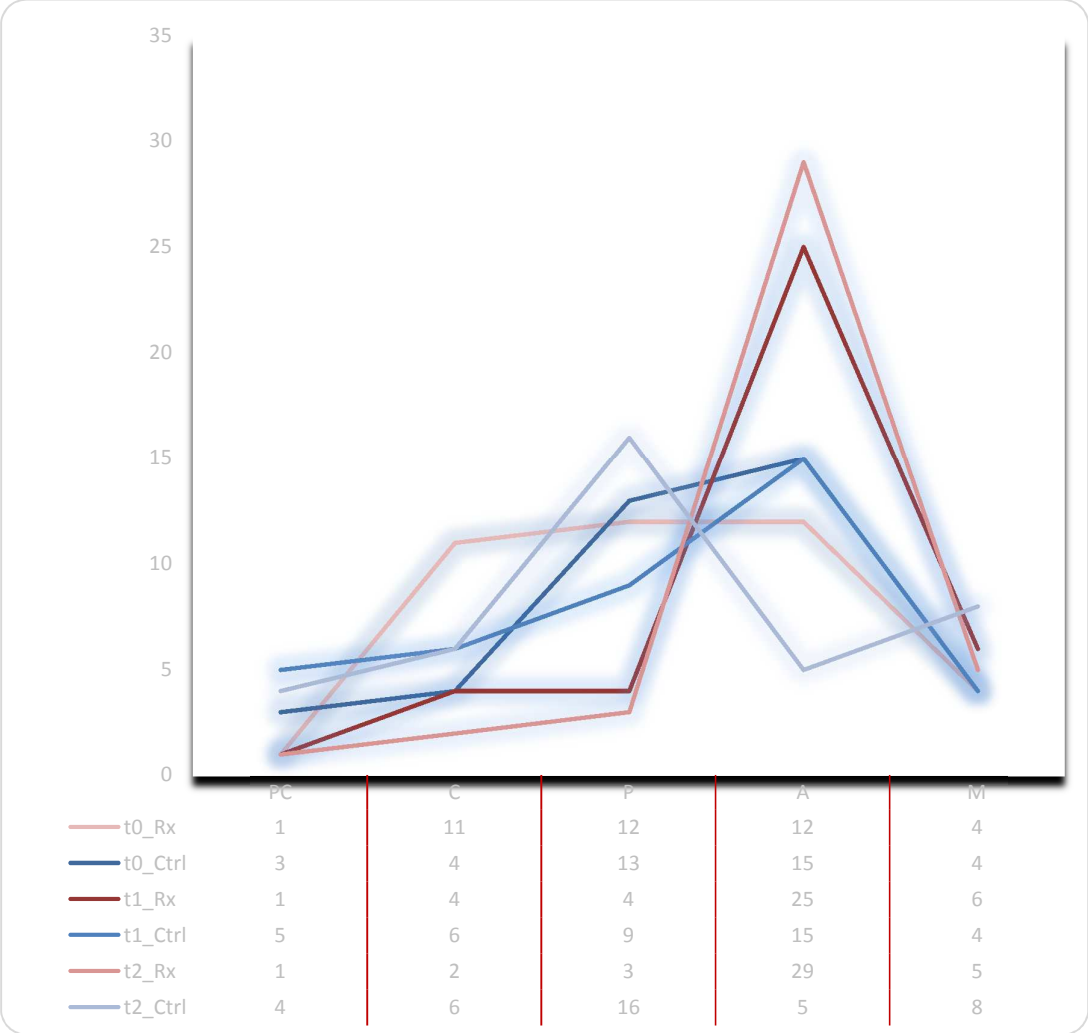


Table 4 Stage of Change Profile (Stage Size and Percentage) by Grouping and by Time Points

	Baseline		Post-intervention		Follow-up	
Stage of Change Classification	Rx (n=40) n (%)	Ctrl (n=39) n (%)	Rx (n=40) n (%)	Ctrl (n=39) n (%)	Rx (n=40) n (%)	Ctrl (n=39) n (%)
Pre-contemplation	1(3%)	3 (8%)	1 (3%)	5 (13%)	1 (3%)	4 (10%)
Contemplation	11(28%)	4 (10%)	4 (10%)	6 (15%)	2 (5%)	6 (15%)
Preparation	12 (30%)	13 (33%)	4 (10%)	9 (23%)	3 (8%)	16 (41%)
Action	12 (30%)	15 (38%)	25 (63%)	15 (38%)	29 (73%)	5 (13%)
Maintenance	4 (10%)	4 (10%)	6 (15%)	4 (10%)	5 (13%)	8 (20%)

Figure 4. Grit and Decisional Balance as a function of Group and Time:

Figure 4a. Grit

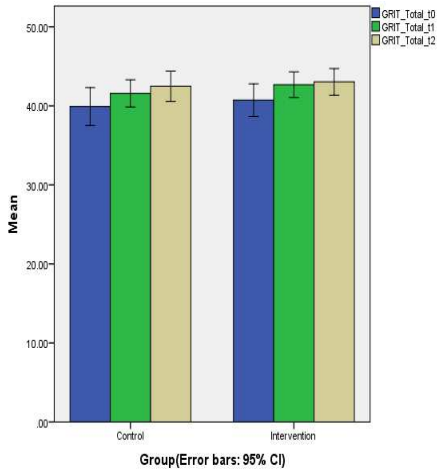
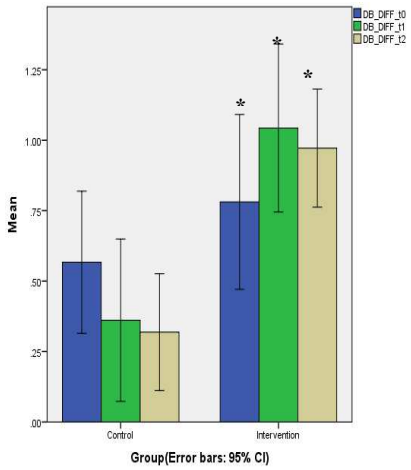


Figure 4b) Decisional Balance



* Denotes significant difference between Treatment Group and Control Group

Decisional Balance (DB_Diff):

For the outcome of Decisional Balance (DB_Diff) scores, the main effect of Treatment was highly significant, F (1, 79)=7.56, p<.007) . Also, the interaction of Time (t0 vs t1 & t0 vs t2) and Treatment (Rx vs Ctrl) was significant which means that the two groups were splitting up over time in opposite directions (Table 5a). In details, the estimated marginal means of DB_Diff from two groups at Baseline (t0) were Rx: 0.78 ± 0.97 vs. Ctrl: 0.57 ± 0.78, p > .28 at 5% significance level (Table 5a-b). At end-of-intervention (t1), the difference between marginal means of DB_Diff from two groups became highly significant (Rx: 1.04 ± 0.93 vs. Ctrl: 0. 36 ± 0.89), much improved Rx when comparing with the much lowered Ctrl, p <.001 at 5% significance level (Table 5a-b). Finally, two months after intervention, the average scores of DB_Diff from Treatment Group were still significantly higher than that of the Control Group at follow up (t2) (Rx: 0.97 ± 0.66 vs. Ctrl: 0.32 ± 0.64) at 5% significance level (p <.001) (Table 5a-b). Across time, Treatment Group tipped their decisions much more toward Pros in PA engagement at End-of–Intervention (t1) and Follow-up (t2) assessments than their Control Group counterparts did.

The result also showed that the Rx group improved much more in their Decisional Balance upon intervention, and then tapered off slightly at follow-up. The Ctrl group, though began at similar level

with the Rx group, dropped drastically at *t*1, and further at *t*2 (Table 5a, Figure 4b).

Table 5a. GLM Univariate F-Tests Statistics for DB_Diff

Measure		Sum of Squares	df	Mean squares	F	Sig.
DB_Diff	Contrast	2.89	1	2.89	7.56	.007
	Error	28.26	74	.38		

The F tests the effects of Group. The test is based on the linearly independent pairwise comparisons among the estimated marginal means.

Table 5b. Group Statistics for Decisional Balance (DB_diff) at each time point Table

Measure	Group	N	Mean	Std. Deviation
DB_DIFF_t0	0	39	.57	.78
	1	40	.78	.97
DB_DIFF_t1	0	39	.36	.89
	1	40	1.04	.93
DB_DIFF_t2	0	39	.32	.64
	1	40	.97	.66

Group 0: Ctrl group; Group 1: Rx group

Table 5c. GLM Univariate Tests Statistics for DB_Diff

Source	Measure	Time	Type III Sum of Squares	df	Mean squares	F	Sig.
Time * Group	DB_Diff	Level 2 vs. Level 1	3.18	1	3.18	3.50	.07
		Level 3 vs. Level 1	6.08	1	6.08	6.93	.01

Table 5d. Independent Samples Test for Decisional Balance (DB_diff) at each time point (p-value)

	Levene's Test for Equality of Variances	t-test for Equality of Means					
						95% Confidence Interval of the Difference	
Measure	F	t	df	Mean Difference	Std. Error Difference	Lower	Upper
DB_DIFF_t0	1.098 (***.298***)	-1.080 (*.283*)	77	-.214	.198	-.609	.180
DB_DIFF_t1	.654 (***.421***)	-3.327 (***.001***)	77	-.682	.205	-1.090	-.274
DB_DIFF_t2	1.195 (***.278***)	-4.482 (***.000***)	77	-.653	.146	-.943	-.363

Equal variances assumed for all three time points

Grit

No statistically significant intervention effects over time were observed in the Grit outcome measures (Table 4b). However, both groups exhibited an overall increase in Grit measure from baseline through the 2-month follow-up (Figure 4). This increase was statistically significant for both Rx (mean increase: 61.6; 95% confidence interval [CI]=7.5, 115.6) and Ctrl (mean increase: 61.8; 95% CI=24.5, 99.1). The Grit Scores of both Rx and Ctrl rose for quite a range throughout the entire six-month period of study The Mean GRIT score of rose from 40.33 ± 6.89 at Baseline (t0), to 42.14 ± 5.21 ($p<.05$) at

End-of-Intervention (t1), and tapered off to 42.76 ± 5.58 at Follow-Up (t2), whereas the Control Group rose from 39.92 ± 7.37 at Baseline (t0), to 41.58 ± 5.32 at End-of-Intervention (t1), and also tapered off to 42.48 ± 5.94 at Follow-Up (t2), (Table 6a). However, no significant difference was found between Rx and Ctrl groups at any time point (p>.05, Figure 7b).

Table 6a. Descriptive Statistics and Pairwise Comparisons by Time for Grit

	Descriptive Statistics			Pairwise Comparisons ($Mean_a$ - $Mean_b$) (p-value)		
Measure	N	Mean	Std. Deviation	t0	t1	t2
Grit_total_t0	79	40.33	6.89	-	t0 – t1* **(.04)**	t0 – t2* **(.01)**
Grit_total_t1	79	42.14	5.21	t1 – t0* **(.04)**	-	t1 – t2 (.57)
Grit_total_t2	79	42.76	5.58	t2 – t0* **(.04)**	t2 – t1 (.57)	-

Based on estimated marginal means

*. The mean difference is significant at the .05 level

Table 6b. GLM Univariate Tests Statistics for Grit

Source	Measure	Time	Type III Sum of Squares	df	Mean squares	F	Sig.
Time * Group	Grit	Level 2 vs. Level 1	1.16	1	1.16	.039	.84
		Level 3 vs. Level 1	3.33	1	3.33	.082	.78

Direct-measured Fitness Outcomes

Among all direct-measured fitness outcomes, no statistically significant intervention effects were observed for BIA or Waist-Hip Ratio across the three time points (Table 2). body height is the only parameter that was significantly difference since baseline. All other direct-measured Fitness Outcomes began with no significant difference, and showed no significant change across time, *ps* > .05 (Table 1).

Chapter 5: Discussion and Conclusions

Discussion

Results of this experimental research were affirmative regarding efficacy of the one-to-one motivational intervention tested in a RCT trial. Improvements were reported in self-reported moderate and total weekly PA as well as decisional dispositions following participation in the MI–based intervention. Improvement in self-reported PA engagement was encouraging based on significant increases from baseline (t0) to post-intervention (t1) then follow-up (t2) among the treatment group and significant increases in decisional balance is notable. One plausible explanation for the noteworthy enhanced PA engagement might be associated with the contribution of the improved decisional balance. A change in Decisional Balance may become possible through MI intervention. Decisional Balance, similar to Ambivalence in MI, though still unable to be completely asserted without further investigations, is more than likely to be seen the key precursor to the resolution between the wishful belief and avoidance behavior. All in all, preliminary findings in this study shed light to the development of PA counselling, at least in local settings.

Sample Size

Though the personal resource only allowed a small participant size, the author did stretched his capability to cater the most he could beyond the required group size to ensure the power and external validity. Though the sample is relatively small, the sample is however diverse enough to cover all majors and all different years and departments of the twin campus, hence the local vocational post-secondary sector. With the significant differences in sex, age and height, the sample was sufficiently diverse, yet similar between two arms, and rather close-to-likely to be regarded as a taster version of the tertiary population to which the intervention was intended to apply on. That is, the sample included a total of 79 young adult students who were from a tertiary design school were mostly not engaging in sufficient physical activity. Although most participants were generally healthy, some of them who might be overweight or obese were not explicitly targeted for recruitment, but were included as long as they fulfill the inclusion criteria.

Psychological attribute changes

In addition to assessing changes in physical activity engagement in a relevant sample, the study

examined changes in psychological attributes (which have not been included in prior research targeting local college students). That is, research on changes in psychological variables targeted during interventions that are physical activity oriented and in MI approach was not previously available in concerned setting. Acknowledging improvement in the targeted psychological variables, though only two of them, is encouraging and essential for comprehending the logics by which the intervention is likely to influence the cognition and hence the explicit PA behavior.

At baseline (*t*0), the two groups demonstrated no significant group differences, in terms of demographics, Transtheoretical Model Constructs, Grit, Health Quality of Life (HQoL) and Direct-measured fitness outcomes (Table 2), except that the Rx were more in males (X_{Rx} = 30 vs. X_{ctrl} = 20), older in age and taller in height. Number of male participants and mean body height were moderately positively correlated, r (79) = .70, p< .05. , indicating large overlapping in their patterns and affects, height was therefore excluded from further analysis.

The study reported significant improvement in Stage of Change and Decision Balance than Control Group (Figure 4a, 2c, Table 4a,3c, Table 5a, 5c, 5d). Results regarding self-reported PA and two psychological variables, namely decisional balance and grit, are exceptionally powerful given the strength of this piece of work. Though starting at about same level, Treatment Group demonstrated more increase in self-reported PA engagement at End-of–Intervention assessment (*t*1) and Follow-up (*t*2) than the Ctrl group. Ctrl, however, reported an overall decline in PA engagement.

Caution was warranted in interpretation of self-reported data, only with subjective measures, participants' response of this study was based on their memory precision, social desirability and own emotion status (Hellsten, Nigg, Norman, Burbank, Braun, Breger, & ... Wang,

With regard to measurement of PA, the use of both objectively measured accelerometers and self-reported surveys receive credit, as PA Stage of Change questionnaire was affirmed to be behaviorally valid as evidenced by self-reported PA and pedometers (Hellsten, et. al., 2008). That has been said, current academics still expect to further cross validate the objective measured PA and self-reported counterparts.

However, since the Ex SoC questionnaire (List version) received a much higher validity (Cronbach Alpha = .71). Among the 31.3% (n=25) promoted for at least 1 level, more than half were originally

from Contemplation and Preparation categories (C: n=7; P: n=10). In the Ctrl Group, participants from the Preparation category dominated the promotion cohort of 11 in total (P: n=6). The finding is in agreement with Huriuchi et al., (2012).

Note that at Post-Intervention (t1) four months after baseline (t0), a few students reported, advancing from Pre-contemplation or Contemplation. Maintenance requires at least 6 months of regular weekly PA engagement whereby one engages in PA during most days of a week.

Interpretation of PA engagement based on stage classification outcomes is complicated by internal validity issues in the instrumentation. Specific validity issue concerns questionable accuracy of participants' response to Stage of Change Questionnaires given that two instruments failed to generate similar results (Table 2). Whether participants have a different concept of Stage of Change or confused by the wordings of the questions at either or both of the assessment instruments warrants further investigation. Because of questionable internal validity of the stage of change outcomes, triangulation with other means of PA data collection is recommended for PA studies in the future.

Meanwhile, the result also showed that the Treatment Group (Rx) improved much more in their Decisional Balance upon intervention than the Control Group (Ctrl). Rx tipped their balance toward the pros of PA for a greater extent than the Ctrl. These two differences remained significant over to the follow up period (*t*2) when compared against the baseline (Table 2). That said, other variables seem to be of no difference, hence suggesting no other effects in this intervention attempt.

Overall, changes in self-reported PA engagement and psychological variables at post-intervention and follow-up confirmed the direction expectation and are in agreement with the conclusion ad recommendations in the pilot study. Whether a casual effect could be drawn between the improvement in Decisional Balance and more PA engagement needs further investigation and more sophisticated experiment design and causal relational statistics tools

Limitations

Accelerometer:

Originally, the research design required all participants to wear an accelerometer, hence reporting the PA record regularly. However, similar to some other research, various issues undermine collection of such data.

Reported by participants, greatest burden of mi-band wearing was the Bluetooth connection. Second, recharging contributed to another technical issue. Only those highly complying participants managed to contact the customer service for help. Comparing with other popular brands in the market, participants reported that these devices were as less stylish, not as versatile and low inaccuracy, seemingly overestimating more than often. At that affordable budget, this model seemed to be the only device appropriate for the study with all its promised features, i.e. tracks steps, sleep and heart rate, with acceptable track record from its predecessor.

Most students at college age would not want to embarrass others by wearing additional gadgets around, let alone the outlook and quality of that device. Even they agree to wear that gadget, their compliance would plunge once they found the device was low in user friendliness. Should future research on direct observed PA be indispensable, reducing physical and psychological burdens and ensuring agreement with study aims and importance should help reduce burden, attrition rate with an improvement in wearing compliance (O'brien, W., Shultz, S., Firestone, R., George, L., Breier, B., & Kruger, R., 2017). Data quality could be enhanced when data synchronization scheduled to be daily, either online or physically present at spots convenient to the participant. And, deployment of at least one designated and blinded assessor or assistant would be an asset to attends to daily data collection throughout the period of project.

Sample Size

The limitations discussed should be taken into consideration when interpreting the results of this study and when planning future research. With limited resource, a rather small sample size could only allow an exploratory efficacy investigation. Therefore, causal effect of the MI intervention is beyond the scope of current study. This small-in-size study is valuable and significant in serving as a solid basis to support further research. To address this limitation, future research efforts could consider a larger sample size in order to have a sufficient power to explore further the mechanism of how counselling intervention could impact on PA behavior.

Trials with broader sample have greater external validity that could be helpful in generalizing the conclusion onto a wider scope of local college population (Bench, Day, & Metcalfe, 2013). Yet,

resource constraints and cost effectiveness always concern research studies. To strike for an optimal balance between current limitation and research outcomes.

Attrition rate

There were 28 dropouts (35.4%), 9 in first four months. The dropout rate fell into the high category (25-50%) among PA intervention studies (Linke, Gallo, & Norman, 2011). Similar to other prolonged studies (Schmidt, Gruman, King, & Wolfson., 2000), participants dropped out for following reasons: (a) lack of time due to busy study and work schedule, (b) decrease of interest, and (c) drop out of main supporter (see Fig. 3). Of note, those failing to complete the intervention phase and follow up engendered no particular data patterns, confirming that all missing data at complete randomness (Table 1). That said, with a more vigilant preparation and management of trials, missing data can be deterred. In particular endeavoring personnel to follow up on all recruited clients regardless of their allocation (White, I. R., Horton, N. J., Carpenter, J….Pocock, S. J., 2011).

Recruitment of a larger sample is necessary to allow sufficient statistical power for a RCT study. Sample characteristics in the current study also reveal that the attrition rate in college setting is considerably high. This study is also valuable in the preparation for participant attrition or data missing handling mechanisms, from ITT principles, to MCAR checking and data imputation. Though the LOCF imputation seems very common and handy, considerable issues do arise. In order to minimize the impact of missing values, attrition prevention and subject retention needs to be addressed at the first hand. Should data missing still occur, which is normal, more stringent statistics tools could be employed to prevent occurrence of similar issues.

Similar to reasons summarized from most studies on youth populations, this population might retain in PA intervention studies for longer periods when following strategies are devised, including experience from previous program participation, perceived condition and benefits on health or fitness, support from partner or spouse, accessibility and convenience of program facility, setting of contracts, agreements and contingency measures, and stimulus and reinforcement control (Schmidt, et al., 2000).

Conclusions

Results are consistent with previous research (Miller & Rollnick, 2012; Passmore, 2011; Sorensen et.

al., 2007). These results help further support TTM based counselling, applied in MI approach, for increasing PA participation. In this study, the MI approach demonstrates preliminary evidence of effectiveness for enhancing self-reported physical activity in vocational tertiary education setting. The TTM-based counselling in MI approach might be effective in enhancing college students PA engagement through changes in certain targeted psychological variables, such as Decisional Balance or Grit.

Should the pathway of mediation become realizable, more efforts would be worthwhile to investigate or to explore on what mediators are essential to enhance PA engagement. And, what approaches are hence most effective to boost changes in these mediators from studies for settings within PA field or beyond. With that effort, researchers might be interested to determine a) whether the intervention directly influences targeted mediators, and b) what doses of changes in these mediators could contribute toward increase in PA most effectively.

The intervention was designed to match the popular time limits for interviewing or counselling type of intervention in primary care and allied professional health settings, as well as education settings. The findings suggests that counselling type of intervention may in fact be effective for promotion of physical activity among non-athlete college students in an education setting. Advantages of this intervention seem to be less time consuming with a very affordable involvement of health care professionals a) required approximately 50 minutes of participation per week for a total of six weeks, b) the physical resource for delivery required only an interview room, c) a MI trained professional, d) delivery of weekly instant messaging reminder to treatment group participants. That said, web-based MI has become available at pilot stage (Karnes, et al. 2015). Web-based counselling provides not only flexibility in exchange of physical accessibility limitation but also convenience of replicability when the system becomes sophisticatedly mature.

Motivational interviewing, delivered in vocational educational training settings, offers a viable venue for reaching college students campus-wide and have the potential to empower behavioral shifts that align well with efforts to improve PA engagement.

College students should be a viable population for active lifestyle interventions. They are served with resourceful health specialists, well-trained researchers and sufficient facilities, thus making campus

setting an ideal place with perfect ecological ambiance for PA promoting. Moreover, students are in a learning environment are still at an age where impact of lifestyle behavioral patterns toward one's future life can be improved (Plotnikoff et al, 2015).

Finally, this study met the original expectation by having successfully investigated the effect of motivational interviewing intervention on PA engagement of college students in Hong Kong. The 4-month counselling intervention sufficed to generate a significant improvement in self-reported PA engagement, motivational attributes, such as Decisional Balance and Grit. This study did not show significant change in other motivation attributes, health quality of life and other fitness parameters of college students. The improvement in PA engagement, Decisional balance and Grit, after showing significant improvement in the four-month intervention period, managed to sustain for at least two months of follow-up period when all participants were free from any intervention. Utilization of most viable instrument to direct measure PA engagement seems rather essential. Further investigation in interventional approaches on local college students are recommended.

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