

A Cluster Randomized Controlled Trial of a Positive Physical Activity Intervention

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Abstract

Objective: Due to global urbanization, technological advancements, and increasing convenience in daily activities, reduced energy expenditure in all aspects of life has become a major public health concern. A positive physical activity (PPA) intervention was developed to promote physical activity and fitness among Hong Kong families. PPA utilizes positive affective attitudes to circumvent barriers to health behavior change by helping families associate feelings of enjoyment with physical activity. Zero Time Exercises (ZTE_x) were introduced and promoted as a foot-in-the-door approach. *Methods:* Using a community-based collaborative approach, the research team worked with social service organizations, a government department, and schools to implement a cluster randomized controlled crossover trial at a citywide scale. A total of 1,983 eligible participants from 1,467 families were recruited from all 18 districts in Hong Kong. Data were collected using structured questionnaires and physical fitness assessments at pre-intervention, and 1-month and 3-month follow-up. *Results:* PPA was effective in increasing ZTE_x and ZTE_x with family members at 1-month and 3-month follow-up, and in improving balance and endurance at 3-month follow-up. Semi-structured focus groups provided further support for the intervention effectiveness and added in-depth insights into the participants' motivational, interpersonal and affective experiences. *Conclusions:* The results not only shed light on the intervention effectiveness on physical activity and fitness, but also demonstrated that the community-based collaborative approach was successful in engaging relevant stakeholders in an active and fruitful partnership with effective capacity building for program development.

Keywords: randomized controlled trial, community-based intervention, positive psychology, physical activity, physical health

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Introduction

Physical activity (PA) is defined as the use of skeletal muscles to produce any form of bodily movement for everyday functioning, such as activities pertaining to work, transportation, household chores, and recreation (World Health Organization, 2018a). Since it has significant benefits for health and fitness, the World Health Organization (WHO) recommends that children and adults should engage in a minimum of 60 minutes and 150 minutes of moderate-intensity PA per week, respectively. However, due to global urbanization, technological advancements, and increasing convenience in daily activities, reduced energy expenditure in all aspects of life has become a major public health concern. Physical inactivity is a major cause of mortality and a primary risk factor for noncommunicable diseases. There are approximately 23% of adults and 81% of adolescents who did not meet the WHO recommendations worldwide and the prevalence is even more severe in developed countries (World Health Organization, 2018b). In Hong Kong, there is a staggering 71% of adults who did not meet WHO recommendations on PA, 67% were physically inactive, 53% spent 6 hours or more on sedentary behavior per day, and 91% did not engage in any PA with family members (School of Public Health, 2013). This persistent and growing health-related problem calls for an urgent need to develop an intervention program that can effectively promote PA not only at the individual level but also at the family, community and citywide level. In light of these concerns, a set of community-based family “holistic health” intervention programs were developed, implemented, and evaluated in the Happy Family Kitchen Movement (HFKM) project to promote well-being and health in Hong Kong. By integrating positive psychology concepts with health promotion activities (i.e., PA and healthy eating) in the programs, the results provided support for overall intervention effectiveness on well-being outcomes, including family harmony, subjective happiness, and mental quality of life (Ho, Mui, Wan, Yew, & Lam, 2019). To extend our

previous work, the present paper specifically reports findings on the physical health outcomes of the positive physical activity (PPA) intervention from HFKM in order to examine its effectiveness for promoting PA and fitness among families.

Various health behavior change models have been adopted in intervention programs that aim to increase PA. However, they have generally been criticized for inconsistent or lack of empirical support for theory assumptions (Marks, Murray, Evans, & Estacio, 2015).

Although intention to engage in health promotion behaviors is presumed to be the primary mechanism of behavior change, it is often difficult to increase PA even when people have the intention to be active and healthy (Rhodes & Dickau, 2012). Meta-analyses of PA intervention studies revealed that the current theory-based programs were no more effective than non-theory-based programs (McEwan et al., 2018; Prestwich et al., 2014). Furthermore, majority of the existing interventions were focused at the individual level, disregarded the social context of PA, reported high dropout rates and low intervention compliance, tailored to selective recipients (patients, unhealthy individuals), targeted multiple health promotion behaviors (PA, healthy diet, and smoking cessation), and required intensive engagement (an average of 18 contact hours) from program facilitators and recipients (Albarracin, Wilson, Chan, Durantini, & Sanchez, 2018; Marks et al., 2015; Prestwich et al., 2014). These barriers or deficiencies reduce the feasibility, acceptability, and scalability of the interventions for real-world implementation in community settings. Community-based programs should be simple for implementation by community stakeholders, oriented to behaviors that can easily be adopted, cost-effective with brief intervention sessions, and flexible for adaptation in social and health services.

Positive psychology, the scientific investigation of positive subjective experiences, individual strengths and virtues, and positive institutions that contribute to optimal human functioning (Seligman, 2002), can be adopted for the understanding, examination, and

promotion of PA and health. Increasing empirical evidence suggests that subjective well-being has a salutary impact on a wide range of health outcomes, such as longevity, general health, immune functioning, and cardiovascular health (Howell, Kern, & Lyubomirsky, 2007). Scholars speculate that participation in health promotion behaviors may be the underlying mechanism linking positive psychological states to physical health (DuBois et al., 2012). In particular, individuals with greater optimism and held positive attitudes about exercise were found to be more likely to participate in PA and adhere to a recommended exercise routine. The upward spiral theory of lifestyle change was recently proposed to explain the role of positive emotions in promoting health behavior change (Van Cappellen, Rice, Catalino, & Fredrickson, 2018). According to the theory, successful lifestyle change results from positive emotions experienced during a target health promotion behavior, such as PA, which increasingly motivate the individual to engage in that activity as personal resources are broadened by the positive emotions. The motivation to engage in PA is a nonconscious implicit process that helps to maintain the activity through a positive feedback loop. Since positive emotions also serve to build biological (e.g., cardiac vagal tone), cognitive (e.g., mindfulness), psychological (e.g., flourishing) and social resources (e.g., social integration), the positive feedback loop is further strengthened as these resources provide support for behavioral maintenance of PA (Fredrickson, 2013; Van Cappellen et al., 2018).

A series of community-based interventions based on a positive psychology framework and applied to family activities, such as cooking and dining together, have been conducted in Hong Kong to promote family communication and well-being (Ho et al., 2016a; Ho et al., 2016b). The results showed salutary intervention effects on family well-being. However, whether positive psychology concepts can be integrated with health promotion behaviors to enhance physical health among families is largely unknown. The intervention described in

the present paper, namely PPA, was developed with reference to positive psychology as a guiding framework and PA with family members as a platform. The intervention utilized positive affective attitudes to circumvent barriers to health behavior change by helping families associate feelings of enjoyment with PA. Through activating the incentive salience for PA, families would not only be motivated to change but actually engage in it. With reference from previous positive psychology interventions conducted in Hong Kong (Ho et al., 2016a; Ho et al., 2016b) and taking compatibility with PA into consideration, the positive psychology themes of joy, gratitude, and savoring were adopted in PPA. The joy theme emphasized on short-term pleasures and long-term gratifications from PA and PA with family members (Seligman, 2002). The gratitude theme involved the expression of thankfulness and appreciation to family members for doing and enjoying PA together (Peterson & Seligman, 2004). The savoring theme focused on enjoying and cherishing the present moment and the quality time spent doing PA with family members (Seligman, Rashid, & Parks, 2006). The intervention programs were brief and easy to implement so that people of all ages can engage in lifestyle change.

The target PA involved Zero Time Exercises (ZTE_x) which are simple, do not require extra time, and can be done while sitting, standing and walking by moving and stretching different parts of the body, such as head, neck, shoulders, waist, back, and upper and lower limbs (Lam, Ho, Lau, Wan, & Chan, 2017; Lam et al., 2016). It adopts a foot-in-the-door approach to start with a small amount of exercise during daily activities so as to match the busy working lives of Hong Kong people. It is adaptive to different contexts and situations and can be made into enjoyable activities for family members of different generations to engage in together. Examples of ZTE_x include stationary cycling while watching TV, stretching various parts of the body during a meeting, doing squats while waiting for the bus, and punching while walking¹. The duration, flexibility, distance, and intensity of ZTE_x can

be increased with practice to maximize health benefits. Research showed that even intermittent exercises can produce health benefits similar to continuous exercises of moderate-intensity (Gillen et al., 2014). ZTEEx is consistent with the PA guidelines for Americans which emphasize that increases in bodily movement and reductions in sedentary behavior will benefit almost everyone, especially individuals who are the least physically active (Piercy et al., 2018). It enables busy city dwellers to practice PA in small steps in order to cultivate a healthier lifestyle and engage in more intensive physical exercise regimens. Pilot studies conducted on small samples showed that ZTEEx training can increase PA, reduce sedentary behavior, and improve physical fitness (Lai et al., 2019; Yeung et al., 2018).

Using a mixed methods approach, this paper aims to examine the secondary outcome measures of HFKM by: (1) testing the hypothesis that PPA is effective for promoting PA and fitness (i.e., ZTEEx and ZTEEx with family members, and physical fitness assessments of balance and endurance); and (2) providing in-depth insights into the participants' motivational, interpersonal and affective experiences during health behavior change. The use of both quantitative and qualitative methods provides the opportunity to examine whether the intervention is effective as well as why it is effective in order to shed light on the psychosocial processes involved (Marks et al., 2015). To the best of our knowledge, no similar studies have been conducted to implement and evaluate a community-based family intervention that integrates positive psychology with health promotion behaviors to enhance PA and fitness.

Methods

Participants

HFKM (Ho et al., 2019) was a citywide project that involved participants from all 18 districts in Hong Kong. It was implemented from May 2015 to October 2016. To maximize

generalizability of the study results and increase public health impact, a more inclusive eligibility criteria was adopted (Spath, Kavanagh, & Dishion, 2002). The selection criteria of this study were: (1) Cantonese speaking; (2) intact verbal and hearing abilities for interpersonal communication; (3) reading and writing abilities for questionnaire completion; (4) aged 12 or older for participation in the intervention evaluation; and (5) attend the program sessions with one or more family members. Participants were recruited from local social service organizations, the Social Welfare Department of the Hong Kong government, kindergartens, and primary schools. Meta-analyses of over 200 studies with more than 110,000 participants revealed small effect sizes in intervention studies that aim to facilitate health promotion behaviors including PA and healthy eating (Albarracin et al., 2018; Dusseldorp, van Genugten, van Buuren, Verheijden, & van Empelen, 2014; Michie, Abraham, Whittington, McAteer, & Gupta, 2009). Prior research on community-based family interventions with similar intensity, duration, and time points showed a maximum dropout rate of about 50% at follow-up (Ho et al., 2016a; Ho et al., 2016b). With reference to prior experience, a sample size of at least 1,920 was required for this cluster randomized controlled crossover trial (cRCT) to detect small effect sizes of .20 with a statistical power of .80, an α of .05, and an attrition rate of 50% while accounting for clustering effects (Campbell, Thomson, Ramsay, MacLennan, & Grimshaw, 2004). A total of 4,198 individuals were invited and 1,983 eligible participants from 1,467 families participated in the study.

Participants were recruited from social service organizations, the government department, and schools through: (1) promotional materials such as posters, banners, leaflets, and publications; (2) phone invitations; (3) face-to-face invitations; (4) promotion through websites and e-mails; (5) home visits; and (6) referrals from social service workers and teachers. Written consent was obtained prior to the study. For children enrolled in the study, written consent was obtained from the adult next of kin, caretakers, or guardians on their

behalf. Participation was completely voluntary and participants had the right to withdraw at any time without consequences. As an incentive for completing the questionnaires and physical fitness assessments, two HK\$50 (about US\$13) supermarket gift vouchers were given to each participating family at the end of the study. Ethics approval was granted by the Institutional Review Board of the University of Hong Kong/Hospital Authority Hong Kong West Cluster (UW 15-083) and registered under ClinicalTrials.gov (NCT02563613).

Procedures

Social service workers and teachers of the participating social service organizations and schools were trained in a 2.5-day workshop to design and implement the community programs. It was implemented from May 2015 to April 2016. The training workshop was delivered by clinical psychologists, registered social workers, a registered nurse, and academic researchers to comprehensively cover the contents of positive psychology, PA, program design, and program evaluation. Experiential learning was used to help trainees design and deliver family-friendly activities that integrate positive psychology themes with PA. Since all of the trainees were exposed to the contents of the intervention in order to deliver the different program sessions in a crossover trial, it was inevitable for them to be knowledgeable about the study design. They were provided with a practice manual in addition to supervision and consultation from the research team during the planning and implementation stages of the community programs so as to ensure their quality and consistency.

cRCT was used to randomly allocate 54 clusters of social service units and schools (from 28 non-governmental organisations, 1 government department, and 7 schools) into three groups: Positive Physical Activity (PPA), Positive Healthy Diet (PHD), and Control (C). The randomization procedure was conducted using computer-generated random numbers (allocation ratio of 1:1:1). An independent statistician who was not in contact with the social

service units, schools, and participants performed the randomization and allocation. The participants were not informed about the other groups in the study. For Group PPA (intervention arm 1, consisting of 15 clusters, 528 participants), the participants received a core session of about 2 hours, followed by a booster session of about 1 hour 1 month later. For Group C (waitlist control arm, consisting of 20 clusters, 790 participants), the participants received a tea gathering session at the beginning and 1 month later. The core session in Group PPA was consisted of group activities and homework assignments on positive psychology and PA, the booster session in Group PPA involved consolidation of knowledge and skills obtained from the core session, and the tea gathering sessions included activities unrelated to the intervention, such as arts and crafts workshops (Ho et al., 2019). Group PHD (intervention arm 2, consisting of 19 clusters, 665 participants) is not described in detail here as it is outside the scope of the present paper. Crossover design was adopted in which the participants received a core session from another intervention arm after the outcomes had been assessed at 3 months (i.e., Group PPA subsequently received the PHD core session, Group PHD subsequently received the PPA core session, and Group C subsequently received the PPA/PHD core session). It ensured that all of the participants had an opportunity to take part in the intervention programs since the study was conducted in the community.

To examine PA and fitness on individual participant level, structured questionnaires and physical fitness assessments were administered at pre-intervention (baseline assessment, T₀), 1-month follow-up after the core session (before the booster session, T₁), and 3-month follow-up after the core session (T₂). These outcomes were not included at immediately after the core session (T₀) as it was irrelevant to assess behavior change at this time. The time points were chosen based on prior experience with community-based family interventions which modified behaviors for promoting well-being and health within 3 months (Ho et al., 2017). It is the typical assessment duration for other similar interventions that promote

health-related behavior change (Albarracin et al., 2018). Furthermore, 1-month and 3-month follow-ups aligned with the time frame of intervention implementation so that the effects of the core and booster sessions could be assessed. To minimize possible bias from the program facilitators and research team in handling the outcome assessments, the structured questionnaires were self-administered with standardized instructions and the physical fitness assessments followed a standardized protocol with a pre-recorded video to guide the procedure across all groups. As indicated by the Consolidated Standards of Reporting Trials (CONSORT) flow diagram in Figure 1 (Egger, Juni, & Bartlett, 2001), the retention rate for Group PPA was 87.3% at T₃ and 77.7% at T₄ while for Group C was 87.2% at T₃ and 75.4% at T₄.

Semi-structured focus groups were conducted on the participants after completing the community programs and follow-up sessions. Purposive sampling was used to recruit those who attended both the core and booster sessions in PPA. Two trained interviewers conducted 11 focus groups for a total of 92 participants. Semi-structured interview guidelines and prompts were developed according to a standardized focus group protocol (Krueger & Casey, 2000) to provide in-depth insights into the participants' experiences, underlying motivations, and thoughts and feelings associated with behavior changes, or lack of change, during and after participating in the intervention program. Flexibility was allowed during the group discussions to enable unanticipated themes to emerge. The focus groups were audio recorded and lasted for approximately 60 minutes in a quiet venue. A separate written consent was obtained prior to the interview and participation was completely voluntary. Another HK\$50 supermarket gift voucher was given to each participant as an incentive.

Intervention programs

After receiving the training workshop, social service workers and teachers designed and implemented the PPA programs by emphasizing on one of the three positive psychology

themes of their choice (i.e., joy, gratitude, and savoring). The flexibility for interventionists to tailor-make their own programs enabled the unique needs of families from different clusters to be accommodated. The overall objective of the intervention was the same for all programs regardless of the choice of themes, which was to promote ZTE_x and ZTE_x with family members. A total of 58 intervention programs were implemented within the period from July 2015 to October 2016.

ZTE_x and ZTE_x with family members were promoted in the programs through positive psychology themes. Each theme was consisted of three target behaviors for participants to engage in during group activities and homework assignments so that PA can be encouraged, reinforced, and sustained. The joy theme involved (1) sharing happy experiences in PA with family members, (2) discovering joy during PA, and (3) reminiscing a PA experience that makes one or one's family happy; the gratitude theme involved (1) appreciating the strengths of family members during PA, and (2) expressing one's gratitude to family members through words and (3) action for doing and enjoying PA together; and the savoring theme involved (1) paying attention to the process of PA, (2) savoring the moment of PA, and (3) treasuring quality time during PA with family members (Ho et al., 2019). These behaviors were practiced during the intervention through hands-on experiential learning so that positive emotions were elicited and character strengths were utilized within a positive environment. Homework assignments were used to reinforce these behaviors on a routine basis.

Onsite observation was conducted at each of the core, booster and tea gathering sessions to ensure the quality and consistency of the intervention programs. The degree of adherence in delivering the core messages of the intervention during the core (85.5%) and booster sessions (87.8%) was high. The degree of adherence to the fitness assessment protocol at T₁ (85%), T₃ (84.5%), and T₄ (85.1%) was also high. As rated on a scale of 1 to 5,

the activities designed by the program facilitators for the core ($M = 3.99$, $SD = .74$), booster ($M = 4.09$, $SD = .62$), and tea gathering sessions ($M = 4.00$, $SD = .58$) were of high quality. Furthermore, the intervention participants were actively engaged in practicing the target behaviors during the core ($M = 3.87$, $SD = .67$) and booster sessions ($M = 4.00$, $SD = .64$).

Measures

ZTE and *ZTE* with family members. Participants self-reported the frequency of ZTE and ZTE with family members in the past 4 weeks on an 11-point scale, ranging from 0 (*never*) to 10 (*very frequently*). The operational definition of ZTE was provided to the participants to improve the validity of the instrument (Iwai et al., 2001). This approach was commonly used to assess intervention-specific health behavior change (Hawkins et al., 2010; Park & Gaffey, 2007). Self-report single-item measures of PA have been evaluated for reliability and validity among adolescents (Ng et al., 2019), older adults (Gill, Jones, Zou, & Speechley, 2012), and healthy adult populations (Silsbury, Goldsmith, & Rushton, 2015), which provided empirical evidence for good to excellent test-retest reliability, moderate to good convergent, concurrent and discriminant validity against other self-report measures of PA and health, as well as moderate to good criterion validity against objective accelerometer data (Milton, Bull, & Bauman, 2011; Milton, Clemes, & Bull, 2013; Wanner et al., 2014).

Balance. Balance is a health indicator of physical fitness essential for preventing injuries and falls during daily activities and sports (Muehlbauer, Gollhofer, & Granacher, 2015). Participants were asked to perform single-leg stance by standing on one leg of their choice, with the other leg raised such that the raised foot was close to the ankle of the standing leg without touching (Springer, Marin, Cyhan, Roberts, & Gill, 2007). During the assessment, participants' eyes remained open looking forward and arms crossed over the chest. A stopwatch was used to measure the amount of time each participant was able to stand on one leg, with a maximum of 120 seconds. Time of assessment ended when the

participants either uncrossed their arms, touched the standing leg or floor with the raised foot, moved the standing foot to maintain balance, or the maximum time has been reached. The procedure was repeated 2 times and each time was reported on a record sheet. To ensure adherence to the single-leg stance protocol, a video prepared by the research team to demonstrate the procedure was shown on a large screen. Research assistants and volunteers provided assistance, monitored the procedure, and informed the participants that their assessment had ended when necessary.

Endurance. Muscular endurance is defined as the functional capacity of a muscle or group of muscles to perform repetitive motions over a period of time (Bemben, 1998). It is a health indicator for cardiovascular and respiratory fitness, mobility limitation, body composition, and mortality (Roshanravan et al., 2017; Vaara et al., 2014). Participants were asked to perform stationary cycling by sitting on a stable chair while leaning on its back, with hands holding onto both sides, hips flexed, knees slightly bent, and hamstrings off the chair (Lam et al., 2017; Lam et al., 2016). During the assessment, participants flexed the right hip with right knee up and then back to original position with right knee down, and successively flexed the left hip with left knee up and then back to original position with left knee down. This cycling movement was done at a pace of 1 cycle per second, with a maximum of 120 seconds. A stopwatch was used to measure the amount of time each participant was able to cycle and the assessment ended when the participants either rested their legs on the chair with hamstrings touching it, placed their feet on the floor, stopped the cycling movement, or the maximum time has been reached. The procedure was repeated 2 times and each time was reported on a record sheet. A video was used to demonstrate the procedure and research assistants and volunteers provided assistance during the assessment.

Data analysis

Quantitative data were analyzed using SPSS 25.0. Pearson's chi-square tests and multilevel linear mixed models were conducted to examine the comparability of demographic characteristics and baseline scores among the groups. Based on the principle of intention-to-treat analysis (Fisher et al., 1990), missing data were imputed using the expectation-maximization (EM) algorithm, which is an iterative procedure to identify maximum likelihood estimates (Schafer & Graham, 2002). Multilevel linear mixed models were conducted with the fixed effect of group allocation (i.e., PPA and C), and random effects of individuals (level 1) nested within families (level 2) nested within programs (level 3). Self-reported PA and objective physical fitness assessed at T₃ and T₄ were included as outcome variables. Age, sex, education level, and baseline values at T₁ were included as control variables. Between-group differences in the outcome changes (i.e., PPA vs. C) and within-group changes across time points were examined (i.e., T₁ vs. T₃, and T₁ vs. T₄). Intraclass correlation coefficient (ICC) was used to determine the relatedness of clustered data.

To ensure the reliability of the qualitative data, audio recordings were transcribed verbatim into Chinese. Thematic analysis was used to identify themes within the qualitative data (Braun & Clarke, 2006). Transcripts were read in detail and broad themes were recorded. An in-depth analysis was then conducted using a process of constant comparisons to identify main themes and sub-themes. To ensure objectivity during the analysis, a panel of researchers performed the coding analysis. Consensus was reached by reanalyzing the themes and checking the codes when necessary. The transcripts were reviewed to ensure that all meaningful interview data had been exhausted. Qualitative findings are reported in the online supplementary material.

Results

Demographic characteristics and baseline measures

Majority of the participants were aged 20 to 59 years, female, and received secondary education (Table 1). Group PPA had a higher proportion of males ($\chi^2(1) = 5.16, p = .02$) and lower education level than Group C ($\chi^2(4) = 15.68, p = .003$). No statistically significant differences were detected between the two groups on age. Group PPA scored lower on balance than Group C at baseline ($b = -5.21, SE = 2.17, p = .02$). Baseline scores of ZTE_x, ZTE_x with family members, and endurance were not significantly different between the two groups.

Intervention effectiveness

Table 2 shows that Group PPA's increase in ZTE_x at T₃ and T₄ was significantly greater than Group C ($b = .55, SE = .14, p < .001, d = .29$; and $b = .61, SE = .13, p < .001, d = .35$, respectively, Figure 2a). Furthermore, Group PPA's increase in ZTE_x with family members at T₃ and T₄ was significantly greater than Group C ($b = .85, SE = .15, p < .001, d = .42$; and $b = .55, SE = .14, p < .001, d = .29$, respectively, Figure 2b). For physical fitness assessments, Group PPA's improvement in balance at T₄ ($b = 4.46, SE = 1.56, p = .004, d = .18$, Figure 3a) and endurance at T₄ ($b = 3.49, SE = 1.65, p = .03, d = .14$, Figure 3b) were significantly greater than Group C. ICC were ranged from .11 to .35.

Within-group changes

Table 2 shows that there were significant within-group increases from baseline in Group PPA on ZTE_x at T₃ and T₄ ($p < .001, d = .34$; and $p < .001, d = .38$, respectively), ZTE_x with family members at T₃ and T₄ ($p < .001, d = .47$; and $p < .001, d = .43$, respectively), balance at T₄ ($p = .02, d = .09$), and endurance at T₄ ($p < .001, d = .16$). For Group C, there were significant within-group increases from baseline on ZTE_x with family members at T₃ and T₄ ($p = .01, d = .16$; $p < .001, d = .22$, respectively) and significant within-

group decreases from baseline on balance at T₃ and T₄ ($p = .02$, $d = .07$; $p = .003$, $d = .09$, respectively).

Discussion

The results showed that PPA was effective in increasing ZTE_x and ZTE_x with family members at 1-month and 3-month follow-up, with small effect size. Furthermore, PPA was effective in improving balance and endurance at 3-month follow-up, with small effect size. Within-group improvements were also observed in PPA for ZTE_x (T₃, T₄), ZTE_x with family members (T₃, T₄), balance (T₄), and endurance (T₄). The control group showed within-group improvements in ZTE_x with family members (T₃, T₄), decline in balance (T₃, T₄), and no changes in ZTE_x and endurance. The qualitative results provided further support for the intervention effectiveness and added in-depth insights into the participants' motivational, interpersonal and affective experiences associated with PA after participating in the program (online supplementary material). The results are consistent with those found in the literature on health behavior change interventions which typically produced small effect sizes of $d = .23$ (Albarracin et al., 2018), $d = .31$ (Michie et al., 2009), or $g = .31$ (Dusseldorp et al., 2014) for both self-reported and objective measures of health-related behaviors including PA and healthy eating. However, prior studies used multiple sessions to deliver the intervention which typically spanned over a period of 25 weeks (Michie et al., 2009) or lasted for approximately 18 hours on average (Albarracin et al., 2018). PPA is not only effective for promoting PA and fitness but it is also cost-beneficial, requiring only two sessions, approximately three hours in total, making it a more feasible and acceptable option for implementation in community settings. The present study should be considered for its merits in: 1) developing an innovative and practical health behavior change intervention; 2) implementing and evaluating the intervention in a territory-wide community context; 3)

increasing the public health impact by targeting universal samples; 4) accounting for accessibility by training non-health professionals to become the source of delivery; and 5) extending the intended benefits beyond the study participants via close collaboration with the social service and education sectors.

The study findings provide support for the major preposition of the upward spiral theory of lifestyle change in which health promotion behaviors are undertaken and maintained when positive emotions are experienced during these activities (Van Cappellen et al., 2018). Through the application of positive psychology themes, participants were able to associate feelings of enjoyment with ZTEEx, which nurtured nonconscious motives for that health promotion behavior and in turn led to successful lifestyle change. Physical fitness was ultimately improved. Nonconscious motives derived from the incentive salience of ZTEEx played a central mechanism that account for the maintenance of health promotion behavior (Van Cappellen et al., 2018), as supported by sustained engagement in ZTEEx and ZTEEx with family members up to 3 months. While traditional forms of PA, such as going to the gym, jogging, hiking, and swimming, require extensive efforts to plan the behavior by evaluating the pros and cons, assessing the potential barriers, and setting specific goals (Ajzen, 1985), ZTEEx utilizes the implicit motivational benefits of incentive salience since it can be done at anytime and anywhere. The participants did not have to go through great lengths to plan ZTEEx, as indicated by the qualitative interviews. As a foot-in-the-door approach, ZTEEx aims at getting inactive individuals to comply to a large request for more regular and greater amounts of moderate-to-vigorous PA by having them agree to a modest request first for intermittent lower-intensity PA that are more readily integrated into daily life (Lai et al., 2019; Yeung et al., 2018). Since positive affect experienced during ZTEEx broadens and builds biological, cognitive, psychological and social resources which in turn serve to amplify the effects of positive emotion on health behavior change and maintenance (Fredrickson,

2013), individuals who engage in ZTE_x would set a healthier lifestyle in motion with increasingly stronger motivation and more positive attitudes towards PA over time. Recent studies showed that induced feelings of joy can lead to increased activation and enhanced prioritization of PA goals, greater willingness to engage in various PA, and actual engagement in those activities (Cameron, Bertenshaw, & Sheeran, 2018). Further research is needed to examine whether PPA can promote engagement in more intensive forms of PA in the long run.

Although the study was conducted in Hong Kong, the findings should be generalizable to Western populations. The community-based intervention adopted a positive psychology framework which was originated from the United States (Seligman & Csikszentmihalyi, 2000). Positive psychology interventions were extensively examined in the West which have consistently showed beneficial effects on a wide range of psychosocial well-being and mental health outcomes, including increased happiness, positive affect, mental quality of life, and resilience, as well as reduced pessimism, negative affect, and depressive symptoms (Bolier et al., 2013; Odou & Vella-Brodrick, 2013; Pietrowsky & Mikutta, 2012; Seligman, Steen, Park, & Peterson, 2005; Sin & Lyubomirsky, 2009). Therefore, individuals from Western countries (e.g., North America, Western Europe, and Australia) should be similarly susceptible to the intervention activities that emphasize positive affect, positive behavior, and positive cognition (i.e., joy, gratitude, and savoring) adopted in the present study. In addition, while the intervention program is family-based, it is not only oriented for collectivistic cultures. Empirical evidence suggests that social support from family is an important determinant of PA across all age groups (Gill et al., 2018; Lindsay Smith, Banting, Eime, O'Sullivan, & van Uffelen, 2017; Wang, Pbert, & Lemon, 2014), especially if those family members can form a social norm for healthy lifestyle by also being physically active themselves (Scarapicchia, Sabiston, Pila, Arbour-Nicitopoulos, &

Faulkner, 2017). The increased levels of moderate-to-vigorous PA from family support was consistently found across Western countries (Van Dyck et al., 2014). Therefore, family-based interventions have been recommended internationally for promoting PA among male and female, young and old. Nevertheless, for populations that prefer PA to be enacted in individual and/or non-familial group contexts, many positive psychology themes proven to be effective in the literature (DuBois et al., 2012) can be adapted for integration with PA or specifically ZTEEx. For example, the “best possible self” is an optimism exercise in which participants can be asked to imagine their best possible physical health over the next several years and consider how to take steps towards a healthy lifestyle. Another example is “pleasurable and meaningful acts”, which is a purpose finding exercise in which participants are asked to complete the following three acts each day: 1) a pleasurable act done alone (e.g., working out at a fitness center); 2) a pleasurable act done with others (e.g., jogging with friends); and 3) a meaningful act (e.g., writing a physical activity diary). Future research can explore the various options in positive psychology for promoting PA among different populations and contexts.

The results of this study should be considered with the following limitations. First, as is the case with all intervention studies, the participants voluntarily chose to take part in the study so self-selection bias is inevitable. The participants might be more aware of the psychological and physical needs of their family members and were more motivated to engage in health behavior change than those who did not participate. Second, it was impractical and unethical to decline social service users and students of the social service centers and schools from joining the community programs on the basis of the study inclusion criteria or consent to provide research data. Therefore, there were more people enrolled in the community programs than the actual number of eligible participants who took part in the study. Third, ZTEEx was self-reported so the results might be susceptible to response bias.

However, it was not practicable to use pedometers, accelerometers, heart-rate monitors, or armbands in this study as they are too costly for a large-scale community-based program (Wanner et al., 2014). Furthermore, since ZTEx involves bodily movement during daily activities, motion monitor devices and sensors may not be able to distinguish the movements and workloads from other forms of PA (Silsbury et al., 2015). Nevertheless, positive results from the objective physical fitness assessments corroborated with self-reports on health behavior change. Fourth, performance on the fitness assessments of balance and endurance did not only depend on physical fitness but also the willpower to persist. This might explain the significant decline in balance for the control group because although the fitness assessments might have been novel and interesting to the participants at baseline, they likely lost interest by T4 without proper education and promotion. Increasing participants' motivation to engage in health behavior change for improving physical health was an important mechanism of PPA. Fifth, since assessments were administered at 1-month and 3-month follow-up, sustainability of the long-term intervention effects on PA and physical fitness is unknown. Nevertheless, this is one of the few rare community-based studies on health behavior change interventions that reported post-intervention follow-up data (Dzewaltowski, Estabrooks, Klesges, Bull, & Glasgow, 2004). Furthermore, it was meant to be a foot-in-the-door approach to engage inactive city dwellers to start with a small amount of exercise so as to facilitate subsequent compliance with more intensive physical exercise regimens. Future research is encouraged to integrate PPA into the initial stage of health behavior change intervention programs so that participants can practice ZTEx as small steps towards being physically active. Sixth, the results of this study showed small sized effects because low intensity brief intervention sessions were provided to the general population. However, it is in line with the public health approach in which effective and cost-beneficial interventions that reach and benefit large numbers of the general public can be valuable

(Spoth et al., 2002). It contributes by expanding knowledge of effective strategies for individual and family engagement, guiding utilization of empirically supported interventions in the community, and informing more ecologically sensitive intervention research. Finally, Bonferroni correction was not applied for testing multiple hypotheses in this study because: 1) PPA was at the initial stage of development in which it was more important to not miss a possible effect worthy of further study; 2) there would be an increased likelihood of type II errors due to the reduced statistical power to detect an effect; and 3) a priori hypotheses were determined before any data were collected and analyzed, as specified in the clinical trials registration (Armstrong, 2014; Perneger, 1998). More conservative tests can be performed in future studies to confirm and replicate the study results with different populations.

The HFKM project was a large scale citywide cRCT to examine the effectiveness of a community-based family intervention in Hong Kong. It was conducted in close collaboration with numerous community partners from different organizations in the social service and education sectors. The results not only shed light on the intervention effectiveness on PA and fitness for the general population, but also demonstrated that the community-based collaborative approach was successful in engaging relevant stakeholders in an active and fruitful partnership with effective capacity building for program development. HFKM laid a good foundation and served as a practical example for non-health professionals from similar urban areas to design and deliver cost-effective PA intervention programs for physically inactive city dwellers.

Footnote

¹ Demonstration videos of ZTEEx can be found at: <https://www.family.org.hk/en/health-communication/0-1-exercises/>

Practical information about ZTEEx with photos and text descriptions as well as fitness self-test for setting exercise goals and recording the results can be found in the Zero Time Exercise Mobile App: <https://www.family.org.hk/en/health-communication/zero-time-exercise-mobile-app/>

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