Impact of Light Volleyball Intervention Programme on Improving Physical Attributes of Older Adults in Hong Kong: A Randomized Controlled Trial

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Abstract

Background: Physical inactivity, which increased older adults' likelihood of getting chronic diseases, is prevalent in Hong Kong older adults which the HKSAR government has been proactively promoting active ageing to mitigate the issue.

Objective: In accordance with the WHO's strategy to avert chronic diseases in older adults and to align with the global goal of active ageing, the study examined the impact of a 16-week light volleyball (LVB) intervention programme on the physical health amongst older adults in Hong Kong.

Methods: A randomized controlled trial was used to study the impact of 16-week LVB intervention on the physical health of participants. A total of 276 participants aged 60 years old or above were recruited and randomly assigned to three groups: LVB intervention, active control (Taichi), and control group. The intervention program took place from early 2020 to mid 2022, with data collected at pre-test, post-test, and follow-up tests. Both LVB and TC group participants attended a 16-week training class with two 90-minute sessions per week following the pretest. Physical attributes of older adults, including lower body strength, upper body strength, lower body flexibility, upper body flexibility, agility and balance, and aerobic endurance were measured using 7 distinct tests.

Results: Participants from LVB intervention demonstrated significant improvement in lower body strength h[F(2,272)?=?7.23, p =?.001, ?2?=?.05], agility [F(2,272)?=?6.05, p?=?.003, ?2?=?.043] and dynamic balance [F(2,272)?=?9.41, p?=?.001, ?2?= .065] when compared to TC active control group and control group.

Conclusions: To promote active ageing amongst older adults in Hong Kong, the results of this preliminary study together with the upcoming follow-up tests will provide insight for health specialists and practitioners to choosing LVB community programme given its positive health effect in older adults. Clinical Trial: ChiCTR, ChiCTR1900026657. Registered 17 October 2019, https://www.chictr.org.cn/showprojEN.html?proj=44350

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Competing interests

The author reports no conflicts of interest in this work.

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Abstract

Introduction: Physical inactivity, which increased older adults' likelihood of getting chronic

diseases, is prevalent in Hong Kong older adults which the HKSAR government has been proactively promoting active ageing to mitigate the issue. In accordance with the WHO's strategy to avert chronic diseases in older adults and to align with the global goal of active ageing, the study examined the impact of a 16-week light volleyball (LVB) intervention programme on the physical health amongst older adults in Hong Kong.

Study Design: A randomized controlled trial was used to study the impact of 16-week LVB intervention on the physical health of participants.

Setting/Participants: A total of 276 participants aged 60 years old or above were recruited and randomly assigned to three groups: LVB intervention, active control (Taichi), and control group.

Intervention: The intervention program took place from early 2020 to mid 2022, with data collected at pre-test, post-test, and follow-up tests. Both LVB and TC group participants attended a 16-week training class with two 90-minute sessions per week following the pretest.

Main Outcome Measures: Physical attributes of older adults, including lower body strength, upper body strength, lower body flexibility, upper body flexibility, agility and balance, and aerobic endurance were measured using 7 distinct tests.

Results: Participants from LVB intervention demonstrated significant improvement in lower body strength h[$F(2,272) = 7.23$, $p = .001$, $\eta 2 = .05$], agility [$F(2,272) = 6.05$, $p = .003$, $\eta 2 = .043$] and dynamic balance [$F(2,272) = 9.41$, $p = .001$, $\eta 2 = .065$] when compared to TC active control group and control group.

Conclusions: To promote active ageing amongst older adults in Hong Kong, the results of this preliminary study together with the upcoming follow-up tests will provide insight for health specialists and practitioners to choosing LVB community programme given its positive health effect in older adults.

Trial Registration: ChiCTR, ChiCTR1900026657. Registered 17 October 2019, https://www.chictr.org.cn/showprojEN.html?proj=44350

Keywords: Adapted physical activity; Older adults; Randomized controlled trial; Volleyball; Light volleyball; Intervention; Aging; Physical attributes

Introduction

Given the low birth rate and longer life expectancy, the ageing trend in Hong Kong (HK) will perpetuate in the subsequent decades. The number of people aged 65 years old or above will soar immensely to 1.89 million by 2019 and 30.5 million by 2069[1]. The continuous ageing population hints some social issues in the society such as decrease in working population; increase in burden to the social welfare and healthcare system in HK. With mainly rising share of older adults in the population, Hong Kong public health expenditure is projected to increase by 394% from $37.8 billion in 2004 to $186.6 billion in 2033; consuming 5.5% share of the total GDP in 2033[2]. The gradual decrease in working population and increase in social welfare expenditure for ageing population will give rise to severe financial hardships to the HK government within next decades.

While the advantageous aspects of physical activity have been well documented[3], there are approximately 40% of older adults aged 60 years old or above engaged in insufficient physical activity (PA) in HK[4]. Among the older adults in Hong Kong, over 50% were overweight or obese[5] while 75% of older adults in Hong Kong suffer one or more chronic illnesses[6]. Spiteri and colleagues[7] summarized the obstacles limiting older adults from engaging in physical activity in the literature. Their main PA barriers were perceived drawbacks (i.e., pain, risk of injury, fear of falling) and lack of knowledge and skills. Similar PA barriers were also found in Hong Kong older adults have an average daily sitting or lying time of 7.5 hours and 6.7 hours respectively[8]. Therefore, it is vital to promote active ageing[9]. That is in line with “Active ageing: A policy Framework” proclaimed by World Health Organization (WHO)[10], where if humanity continues to leave the issue of ageing population unresolved, eventually ageing population would drive humanity to the brink of health

care, social welfare bankruptcy. The HK government construed the term active ageing as a state of full physical, social and mental well-being[6]. Since 2001, HK government has conducted a report on heathy ageing which map out the strategies, including PA to promote active ageing in HK. For instance, the HK government has implemented 150 new sets of fitness equipment for older adults across Hong Kong to promote active ageing in 2017 – 2018[11].

Literature Review

For physical activity intervention in older adults, in balance, a systematic review and meta-analysis has well documented the positive effect of PA in alleviating issues of falling in older adults[12,13]. The study[12] also emphasized that the effect is more significant when the older adults were involved in PA programs that last at least three hours per week. For physical function, researchers[14] examined the effect of supervised PA intervention program that includes aerobic and resistance training on the physical health of older adults. The suggested future research agenda included a) increasing number PA intervention in Asia; b) intervention programs reviewed may align with the World Health Organization suggestion of 150 minutes (about two and a half hours) of PA every week[15]; c) more rigorous RCT study design is needed; and d) supervised PA intervention with larger sample size is needed. More recent reviews[16] further highlighted the research need to examine the impact of sports intervention on older adults' health. Specifically, among Chinese older adults, Wong and her colleagues reviewed 371 studies from the past 15 years that illustrated the effect of physical activity on older adults' physical health. The authors warranted future studies to identify and examine the impact of newly emerging exercise such as light volleyball to see if it could have a considerable influence and contribution to older adults' physical activity and health[17].

Qualitatively, Franco and colleagues studied the existing literature on how older adults view participation and suggested older adults enjoy participating in PA programs that are 1) professionally

instructed; 2) group-based where they can interact with peers; 3) easily accessed (i.e. affordability of the program) which was considered a major concern as to whether the older adults will be willing to participate in PA[18]. Similar themes about older adults' perspective on current existing PA programs/intervention were found in the study of Van Dyck et al.[18]. Older adults have a higher preference for new PA (e.g., aqua fitness or LVB in this study) than regular activities such as walking and cycling for intervention activities.

Light volleyball (LVB) is a newly-adapted PA derived from traditional volleyball. In comparison to traditional volleyball, LVB uses using balls that are bigger in size (LVB 80-83 cm circumference; volleyball 65 – 67 circumference) and lighter in weight (LVB 150 grams; volleyball 250 grams) which allows the LVB balls to travel through the air at a lower speed than traditional volleyball. These particular features make LVB more accessible compares to traditional volleyball, especially for population groups who are less physically capable of performing sports due to ageing-associated degradation (i.e., older adults). Also, the LVB sport court and the net height is lower (i.e., 1.8m) and smaller (i.e., badminton), respectively so these requires lower fitness requirements to the participants. While there were studies from China suggesting physical health benefits from regular practice in LVB, the studies were limited to the unclear standard of fitness measurement and lack of control group. In 2020, first author and her team examined the effect of LVB intervention in the physical and psychological health attributes of 78 older adults aged 60 years old or above via conducting a quasi-experimental intervention and the result suggested significant improvements in physical attributes (i.e. lower and upper body muscle strength, agility, balance, aerobic endurance) and psychological attribute (i.e PA enjoyment) were found in LVB group, when compared to the control in the study[19]. The improvement in upper body muscle strength, aerobic endurance and PA enjoyment were further found to be more prominent and significant in the LVB group then the active control group, Rouliqiu (RLQ) group. The study suggested effectiveness of LVB intervention

program in improving the physical and psychological health attributes of older adults. While this study showed the positive physical health impact of LVB on older adults, there are some limitations regarding the sampling size and the methodology. First, the sampling size of the study was small where 62 participants successfully passed the screening tests, partaken in the functional tests before and after the intervention and were included in the data analysis. Second, participants were not assigned into groups in a random manner.

Following up the positive results of the LVB pilot study and the priority of allocating resources to the prevention of age-related fitness degradation in HK, the first author and her team received a Research Impact fund (HK$7.4 million) to investigate the effectiveness of an LVB intervention on physical and psychological health attributes among older adults in HK by using both quantitative and qualitative methods with a larger sample (approximate 300 participants). In this study, we presented our preliminary results of this LVB intervention. Particularly, this study aimed to examine the effect of a 16-week LVB intervention group, with a TC group in regards of improvement a) in functional fitness and b) in balance in Chinese older adults aged 65 or above. It was hypothesized that both TC and LVB would bring about notable and commensurate improvement in the physical health attributes in comparison to the control group.

Material and methods

Study design

Randomized controlled trial (RCT) design was adopted to investigate the effect of LVB intervention in regard to the physical health outcomes of the participants. Details of the intervention can be found in our previously published protocol (Trial registration number: ChiCTR1900026657)[20]. The LVB group was compared to another active group (i.e. Taichi) and a control group. The Taichi (TC) was chosen specifically for the study given both LVB and Taichi involves movement of the entire body,

and they are both considered fitting for older adults[21,22].

Study intervention

In the study, the intervention programme was delivered from early 2020 to mid-2022. The research team collected data for two to three occasions (i.e., pretest which was right before the start of the intervention; posttest which was immediately after the intervention; follow-up test which were six months and twelve months after the intervention). In the preliminary study, only data collected in pretest and posttest was included. Both participants of LVB group and TC group were enrolled in a 16-week training class with two 90-min sessions per week after pretest. The length of the intervention aligning with the advice given by the Centers for Medicare and Medicaid Services of the U.S. Department of Health and Human Services indicates that the benefits of physical activity for older adults' health can be observed as early as one to three months after the start of a programme[23]. The duration of the LVB and TC training intervention commensurate with the current World Health Organization (WHO) global recommendation of 150 minutes (about two and a half hours) of PA every week[14]. The LVB and TC trainings were carried out by qualified and experienced coaches to ensure the safety of the participants. Meanwhile, the control group was instructed to maintain daily activities as usual and participate in a monthly social gathering (e.g., health workshops) to cancel out the psychosocial effect.

Participants

The participants were recruited with the requirements of 1) aged 60 years old or above, 2) living independently, 3) not having cognitive impairment, 4) not been participating in PA programs for two consecutive years prior to the program, 5) meeting passing score on Abbreviated Mental Test (AMT) and Time-up-and-go test (TUG test)[24,25]. The AMT was used to assess the cognitive capability of the participant and the participant would need to score at least 6 out of 10 and the participant would need

to finish the TUG test within 20 seconds to be qualified for the program. Also, participants who exhibited steady hypertension (160/90 mmHg or above), arthritis, and/or neurological disorders, were excluded from the study.

Recruitment and procedures

Participants were recruited via various local elderly centers. All participants were informed confidentiality of any personal data collected for the study and they are entitled to quitting the programme at any time. The research team would ask each participant for his/her consent before collecting data and immediately proceed to conduct the AMT and the TUG test for screening out unqualified participants. Once the participant has passed the screening test, they then proceed to complete the a) questionnaires, b) socio-demographic questions, c) measuring weight, and body fat percentage with the Tanita machine (TBF-410GS) and d) functional fitness test utilized in Leung et al[19,20]. The intervention programme started in the following week and lasted for 16 weeks (about three and a half months) before the research team arranged the posttest (within seven days after they finished the intervention program) for the participants. Two follow-up tests are planning to be carried out, after six months and twelve months respectively. All participants received a supermarket cash voucher of HK$100 as an incentive for their participation. The study was reviewed and approved by the university Research Ethics Committee (E2022-2023-0013).

Measures

Functional fitness

The research team utilized the Senior Fitness Test Manual for measuring the physical attributes of older adults[26]. The test encompassed 7 items: Chair stand test (lower body strength), Arm curl test (upper body strength), Chair sit and reach test (lower body flexibility), BS (upper body flexibility), 8-foot UG test (agility and balance), 2-minute step test (aerobic endurance). The Senior fitness tests

were found to be reliable with intra-class correlations ranging between .80 and .98 for participants in trials. Validity of the tests was corroborated and supported via content, criterion-related analyses and construct which includes comparison of the senior fitness test scores to other well-established and widely recognized measures such as treadmill VO2 testing[27].

In addition, it was selected for the extensiveness in physical attributes that can be measured includes upper and lower body strength, lower and upper body flexibility, agility and balance, and aerobic endurance.

Balance test

The Balance System SD (BBS-SD, 950-441 model) was used in measuring the older adults' dynamic balance in the study. It was measured by having a participant stand vertically at the center of the platform while observing the screen situated 30 centimeters (about 11.81 in) in front of the participant and completing three 20-second trials with 10-second break in between. The results of 3 trials were collected and its mean was recorded by the research team. Previous studies supported the reliability and the validity of the balance test[28,29]. The measurement index, overall stability index generated from this Biodex balance system was included in this study. This index measured the participant's dynamic balance, his or her balance fluctuation from different axis. Higher values indicated the participants had more deviations and poor balance control.

Data analysis

Data were analyzed with SPSS 27.0. Mean and standard deviation, frequency and percentage were used to descript the studied continuous variables and categorical variables, respectively. Preliminary checks were conducted to ensure there was no violation of the assumption of normality and homogeneity of variance. One-way ANOVA was used to evaluate baseline differences between the

groups. A series of three groups (LVB group, TC group and control group) by two (pretest, posttest) ANCOVA for the outcome physical attributes were used to examine the effect of the 16-week intervention program on physical attributes among the groups. The body mass of the participants was used as covariate as it was correlated to the measurement outcomes[30]. Partial Eta Squared, p-value and contrast *t* statistics were computed. Subsequently, the differences between the LVB and control groups, and between the LVB and TC groups were analyzed through planned contrasts. Cohen's d was calculated as a measure of effect size, and .1 was a "small effect"; .3 was a "medium effect" and .5 was a "large effect"[31]. Statistical significance was set at $p < 0.05$.

Results

At the beginning of the intervention, 338 older adults from seven elderly centers enrolled our intervention program and completed our pretest (LVB group, n = 122; TC group, n = 113; CG, n = 99). Three participants (two from LVB group and one from TC group) officially withdrew from our program due to their interest and seven others (two from LVB group, one from TC group, three from control group) withdrew from the program without reasons given. Among 318 participants, 42 of them attended no posttest for different personal reasons (e.g., sickness, lunar new year gathering, concerning social distancing measures during late COVID-19 pandemic). The retention rate (82.63%) was slightly higher than our expectation (80%). However, the retention rate could be higher (87.89%) since our enrollment was slightly higher than our proposed sample size (315 older adults). Finally, 276 participants (LVB group, n = 100; TC group, n = 86; CG, n = 90) who completed both pretest and posttest went into the final data analysis.

Table 1 presented the socio-demographic characteristics of participants. About 56% of participants aged 70 years old or below and only 8% of them aged 80 years or above. Majority of them were female (83%) and retired (78.6%). About 57.3% of them attained secondary education or above.

About half of them (58.3%) perceived their financial status as average. The average body mass index was 23.97 (SD = 3.56).

---- insert table 1 about here------

Improvement in physical fitness

Table 2 showed the means and SDs of physical measures of the groups at pretests and posttest, and the results of ANCOVA with repeated measures, controlling for BMI. After the intervention, the LVB group had statistically significant better performance in lower limb muscular endurance [Chairstand test, $F(2,272) = 7.23$, $p = .001$, $\eta 2 = .05$], agility [up and go test, $F(2,272) = 6.05$, $p = .003$, $\eta 2 = .043$], and dynamic balance [Biodex balance test, $F(2,272) = 9.41$, $p = .001$, $\eta 2 = .065$] compared with the other groups.

Results of pairwise comparison found that participants in LVB and TC groups had significantly higher adjusted lower limb muscular endurance [Chairstand test, LVB group, M = 17.62, TC group, M = 15.27, $p = .001$], better adjusted agility [up and go test, LVB group, M = 5.60, TC group, M = 6.16, $p = .001$], and better adjusted dynamic balance [Biodex balance test, LVB group, M = .53, TC group, M = .70, $p = .001$] compared with control group (Chairstand test, M = 15.30; up and go test, M = 6.32; Biodex balance test, M = .74). Importantly, participants in the LVB performed significantly better on the above three measures at posttest (Chairstand test, up and go test, and Biodex balance test) than participants in the TC group. At last, significant group differences were not found for the arm curl test ($F(2, 270) = 2.84$, $p = .06$, partial $\eta^2 = .021$), chair sit and reach test ($F(2, 270) = .06$, $p = .51$, partial $\eta^2 = .005$), and backscratch test ($F(2, 270) = 1.33$, $p = .27$, partial $\eta^2 = .01$), and 2-minute step test ($F(2, 270) = 1.13$, $p = .32$, partial $\eta^2 = .008$).

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Discussion

With the continuous growth of ageing population in Hong Kong and the limitations of our LVB pilot study, the study investigated the effect of a 16-week LVB intervention program on physical health outcome amongst older adults. Compared to our pilot study, this study adopted a randomized controlled trial intervention design and recruited 5.45 times more participants compared to that of the pilot study. The results show the LVB intervention has greater impact on improving older adults' lower body strength, agility, and dynamic balance relative to both TC and control groups. While improvement in lower body strength, agility and dynamic balance were found to be more prominent in LVB intervention, it was unexpected to have insignificant results for aerobic endurance and upper body strength.

Improvement in physical health

In the current study, it is within our anticipation that LVB intervention has greater improvement in lower body strength, agility and dynamic balance than control group as supported by the pilot study in 2018 where significant improvements were discovered in the corresponding physical attributes for LVB intervention when compared to control group[19].

It is also expected that the participants in the LVB intervention to have significant improvement in lower body strength, agility and dynamic balance when compared to TC. Firstly, LVB shares similar features with traditional volleyball such as having considerable amount of lower body movement which helped enhancing player's lower body strength immensely[32]. Secondly, LVB intervention is expected to have more significant improvement in agility and dynamic balance compared to TC given that LVB requires strong open skills in players which allows them to react and adapt to dynamic and perpetually changing surroundings whereas TC uses mainly closed skills that do not

requires players to react to the changes of surroundings[33]. While there might be disparity, Sheppard and Young have defined agility as a change in speed or direction in response to a stimulus such as a change in speed or direction in relation to the changes in environments[34]. A recent systematic review on comparing the effect between open skill PA and closed skill PA on cognitive function using intervention studies and observational studies has concluded that open skill PA are more effective in improving the cognitive function than that of closed skills exercise[35], in which Young and colleagues suggested agility is highly associated with cognitive function such as decision-making ability as well as perception[36].

Next, a strong correlation between lower body strength and ability in change of direction (COD) has been observed[37]. Recently it was discovered that a significant correlation exists between relative, absolute strength and agility (i.e. COD ability and linear speed)[38]. In addition, the current study also hinted the correlation between lower body strength and agility given they were the two major physical attributes amongst all fitness components measured that resulted in discernible improvement in LVB intervention when compared to TC group. Other than lower body strength, in maintain a good posture during acceleration and deceleration as well as sudden location and direction changes, balance is an important element for agility. Balance training was found to be beneficial in improving agility of the volleyball players[39].

While participants in the LVB intervention shows greater improvement in lower body strength, agility and dynamic balance, it was surprising to note that minimal difference was seen and found in upper body strength and aerobic endurance in which the two physical attributes was hypothesized initially to have significant difference when compared to TC. For upper body strength, LVB requires much frequent and vigorous arm, shoulder movements than TC such as spiking, blocking, which purportedly should result in stronger upper body strength[40]. In addition, assuming higher energy

usage in volleyball than Tai chi in hopes of participants achieving greater aerobic endurance in the LVB group[41], albeit difference in improvement in the two physical attributes of LVB intervention and TC were not significant. Still, this study showed that upper body strength and aerobic endurance in older adults were improved by both LVB and TC programme, despite the fact that LVB did not significantly outperform TC as hypothesized. There are studies showing that TC and LVB are beneficial to older adults' upper body muscle strength[42,19]. Regarding the aerobic capacity, even we assumed there was higher demand in aerobic endurance in playing volleyball, TC's breathing techniques were found to be beneficial to older adults' aerobic capacity[43] that are comparable to that gained from playing LVB.

Conclusion

This study examined the impact of a 16-week light volleyball (LVB) intervention programme on the physical health amongst older adults in Hong Kong. Results found that participants from LVB intervention demonstrated significant improvement in lower body strength, agility and dynamic balance when compared to TC active control group and control group. The study has furnished the previous pilot study by adopting RCT design; incorporating dynamic balance in the fitness component; having larger sampling size and the data were collected via seven local elderly centers instead of one elderly center. While the study has filled the limitations in the previous pilot study, the current study is also limited by the followings. Firstly, there were no follow-up test occasions to trace and monitor whether or how long the improved physical attributes can be maintained. Follow-up tests will be implemented as planned. Secondly, the gender representation was disproportional where there were more female participants in the study given they were recruited via local elderly centers and it was reflected by the elderly center that terms of participating in social gathering/ activities, female participants have always been more eager an active to join which well-explained the disproportion of gender representation in the study.

Further studies shall be conducted to resolve the limitation above. Firstly, studies should be conducted with equal gender representation and include follow-up test to record the maintenance of the physical attributes. While a plethora of studies have demonstrated the positive impact of PA on older adults in other aspects such cognition and psychology, the current study only included physical attributes; future studies shall incorporate cognitive and psychological attributes to have a deeper understanding of the impact of LVB on older adults. Furthermore, it is also imperative to understand how older adults view their participation in LVB intervention, future studies could adopt a mixed-method including qualitative and quantitative approach to comprehend the experience of the participants and the effect of LVB intervention on different health dimensions respectively.

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Table 1. Socio-demographic characteristics of participants

	LVB	TC	Control
Age			
60-64 yr	30	14	10
65-69 yr	35	34	33
70-74 yr	24	26	17

75-79 yr	8	8	15
80 yr or above	3	4	15
Gender			
Male	17	18	12
Female	83	68	78
Occupation			
Full time job	0	0	1
Housewife	16	11	21
Retired	79	72	66
Part time job or others	5	3	2
Education level			
No education	5	4	21
Primary education	35	23	30
Secondary education	40	41	29
Tertiary education	20	18	10
Perceived financial status			
Low	19	18	18
Below average	21	17	10
Average	53	50	58
Above average	3	1	3
Higher	4	0	1
House nature			
Bought	46	33	31
Rent	53	53	57
Body Mass Index, kg/m^2	24.11 (3.67)	23.54(3.65)	24.23 (3.37)

Notes:

Abbreviations: LVB, Light Volleyball group; TC group, Tai Chi Group; CG, Control group

Table 2. Means and Standard Deviations for Measures in Groups at Pretest and Posttest

Measures				*F*	Mean difference
	LVB	TC	CG		
	(N = 10)	(N = 86)	(N = 90)		

	pretest	posttest	pretest	posttest	pretest	posttest		LVB - TC	LVB - CG
Chair stand test (frequency)	16.40 (5.08)	17.62	15.01 (5.06)	15.27	14.97 (3.65)	15.30	7.23**	2.35**	-2.32**
Arm curl (frequency)	15.30 (4.94)	16.04	14.42 (5.10)	14.55	14.10 (5.25)	14.17	2.84	1.49	1.86*
Chair sit and reach test (cm)	7.29 (11.54)	7.84	4.97 (13.02)	5.16	5.07 (9.54)	4.81	.67	2.68	3.03
Back scratch (cm)	.61 (9.32)	.98	.86 (8.88)	.13	-2.01 (9.20)	-2.68	1.33	.86	3.66*
Up-and- go test (s)	6.00 (1.46)	5.60	6.23 (1.80)	6.16	6.54 (1.35)	6.14	6.05**	-.56*	-.72**
Step test (frequency)	92.10 (18.25)	94.62	89.43 (22.88)	90.04	85.26 (17.55)	85.92	1.31	4.58	8.70*
Overall stability index (Score)	.66 (.63)	.53	.68 (.60)	.70	.77 (.56)	.74	9.41**	-.17*	-.21**

Notes:

Abbreviations: * $p < .05$; ** $p < .01$ *** $p < .001$; LVB, Light Volleyball group; TC, Taichi group; CG, Control Group. The posttest scores were adjusted via ANCOVA for differences in BMI.

Supplementary Files

CONSORT (or other) checklists

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URL: http://asset.jmir.pub/assets/41d2d931cceda37ab7790ca39f597572.pdf

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