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Effects of a judo training program on falling performance, fear of falling and exercise motivation in older novice judoka

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Abstract

Background. Multi-component group exercise programs are shown to prevent and reduce falls in older adults, with judo training producing positive effects on balance and bone health. Fear of falling (FoF) and negative feelings could lead to a decrease in physical activity, self-esteem, confidence, strength, and balance with advancing age. In contrast, enjoyment, motivation, and feelings of personal accomplishment support adherence to physical activity programs.

Aim. The study evaluated the effects of a 4-month judo program on fall skills and exercise motivation in older novice judoka (8 males, 8 females; age=69.3±3.9 years).

Methods. After each session, FoF and training enjoyment were assessed through Visual Analogue Scales (VAS). Before and after the program, Motives for Physical Activity Measure-Revised (MPAM-R) and Self-Regulation Questionnaire-Exercise (SRQ-E) were administered and two judo experts evaluated their breakfall-technique performance.

Results. Differences in fall skills, MPAM-R and SRQ-E, changes in FoF, enjoyment over sessions, and correlations of fall skills with MPAM-R and SRQ-E were ascertained. After the program, technical improvement in breakfall-technique performances ($p<0.001$) emerged, along with increased ($p<0.05$) enjoyment, competence, appearance, sociality (MPAM-R) and intrinsic motivation (SRQ-E). Fall skills and intrinsic motivation were correlated only after the intervention. VAS-FoF did not change and VAS-enjoyment remained steadily high.

Conclusions. Judo seems to be an enjoyable activity, suitable to improve both falling performance and motivation in older adults.

Introduction

Each year falls affect 28-35% of people aged 65 and older, representing the main cause of injury-related death and the third most frequent cause of poor health and frailty in older adults [World Health Organization 2008]. Multi-component group exercise programs are effective in reducing the rate and risk of falls in older adults [Gillespie *et al.* 2012]. Fear of falling (FoF) is usually associated with a decrease in physical activity, self-esteem, confidence, strength, and balance with advancing age [World Health Organization 2008]. Indeed, negative feelings can determine disengagement of active lifestyles [Biddle, Mutrie

2007], whereas enjoyment, motivation, and feelings of personal accomplishment support adherence to physical activity programs [Battistelli *et al.* 2016] and sport commitment [De Pero *et al.* 2009]. Therefore, it is crucial to evaluate the dynamic and subjective construct of FoF, enjoyment for exercise, and motivation of older individuals participating in sports activities [Hagberg *et al.* 2009; Richard *et al.* 1997; Ryan, Connell, 1989].

According to previous investigations [Ciaccioni *et al.* 2019b; Cromwell *et al.* 2007; Liu, Frank 2010], martial arts programs showed to be very useful for the prevention of fall-related injuries in older adults. In particular, the Olympic martial art judo (i.e., “gentle way”) aims at

physical and mental education [Kano 1994], and encompasses breakfall techniques (i.e., *ukemi*) to resist impacts efficiently and safely and to prevent fall-related injuries [Fujiwara *et al.* 2002; Hashimoto *et al.* 2015; Koshida *et al.* 2017a]. Correct *ukemi* require a large body area of contact with the floor, an elastic impact modality, and a time lag between the impacts of arms and legs [Toshikazu *et al.* 2011]. Actually, *ukemi* include backward, sideward, forward and the forward roll basic techniques, which require a progressive methodological learning approach [Gunther 2000] before judoka engage in training and sparring (e.g., *randori*) with an opponent [Kano 1994]. Therefore, severe injuries are rare consequences of body throws in judo training and competition [Pocecco *et al.* 2013]. Judo practitioners (i.e., judoka) present high levels of balance control [Perrin *et al.* 2002], cognitive functioning [Calmet, Miarka, Franchini 2010], and general health and wellbeing [DelCastillo-Andrés *et al.* 2018; Fukuda *et al.* 2011; Woodward 2009]. A judo adapted program for older novice practitioners showed positive effects on anthropometric, functional fitness variables and walking performance [Ciaccioni *et al.* 2019a; Ciaccioni *et al.* in press]. Furthermore, a positive association between judo and bone health in the life course was found, attributed to unusual and versatile load patterns and reduced bone impact force and velocity with respect to “natural” falls [Ciaccioni *et al.* 2019b]. Finally, training of lateral *ukemi* showed a reduction of the FoF of novice older individuals [Groen *et al.* 2010].

Despite the recommendation of exercise for fall prevention, the optimal typology, duration, frequency, and intensity of training programs for older individuals has not been determined yet [Gillespie *et al.* 2012; World Health Organization 2008]. Several aspects of a judo training program need to be monitored in order to match the individual fitness and skill levels of practitioners [Blumenstein, Lidor, Tenenbaum 2005]. It is important to monitor both external training load (e.g., type and number of techniques executed and total duration of a training session), assessed by means of time-motion and technical-tactical analysis [Calmet *et al.* 2010; Franchini, Takito, Bertuzzi 2005], and internal training load, evaluated via subjective ratings of perceived exertion (RPE) [Borg 1998; Bromley *et al.* 2018]. Based on the individual capability, several training sessions are required to perform specific martial arts techniques, with approximately 38 hours of training suggested allowing novice adult practitioners to acquire proficiency in defensive and offensive martial arts techniques [Burke *et al.* 2011].

Considering the lack of exhaustive information on the capability of novice older adults to practice judo with advancing years, the aim of the study was to evaluate the effects of an adapted judo program on 1) the performance of martial arts falling techniques and FoF of practitioners, and 2) the motivation for and enjoyment in physical activity. It has been hypothesized that

a 4-month adapted judo program (two 1h-training sessions per week) for novice older practitioners reduces FoF, increases enjoyment and motivation for physical activity, and enhances judo falling skills. This information is relevant to assess 1) the feasibility of a judo intervention for novice senior judoka to cope with the specific program demands and 2) its contribution to enhancing the motivation and therefore the probability of adherence to long-term physical exercise training.

Methods

A twofold approach was applied encompassing a video analysis for the evaluation of the novice practitioners' falling skills and specific questionnaires and scale to assess psychological variables. The adapted judo program [Ciaccioni *et al.* 2019a; Ciaccioni *et al.* in press; DelCastillo-Andrés *et al.* 2018] was based on the principles (i.e., maximum efficiency and promotion of the mutual health) and the techniques and training modalities of the Kodokan Judo [Kano 1994] and on the most recent recommendations for exercise [World Health Organization 2018]. The judo instructor was a 3rd Dan judoka with a master's degree in Sports Sciences. To evaluate the effects of the judo training, participation <75% was considered a cut-off for data analysis.

Participants

Nineteen older individuals (males=10, females=9; age=68.9±3.7 years) were recruited through community associations upon the local Ethics Committee approval (cod: 821/16), providing a written informed consent and a medical certification for non-competitive physical activity. The novice judoka were community dwellings, highly educated (≥ high school), 94% retired from work, with the majority presenting normal or above levels of upper limb flexibility (88%), upper limb strength (69%), lower limb flexibility (44%) and lower limb strength (100%) values in relation to co-aged individuals [Jones, Rikli 2002].

Procedures

Participants were free to opt-out at any time (i.e., not completing all the evaluations) without providing any reason. To familiarise themselves with the instruments, prior to the study, the participants were provided with written and oral instructions for the use of the RPE, Visual Analogue Scale (VAS)-enjoyment, VAS-FoF, MPAM-R, and SRQ-E. For the RPE, VAS-enjoyment, and VAS-FoF, participants were asked “How was your workout?” [Foster *et al.* 2001], “How do you experience your exercise?” [Hagberg *et al.* 2009] and “Are you afraid to fall?” [Scheffer *et al.* 2011; Scheffer *et al.*

al. 2010], respectively. The questionnaires were completed individually under the supervision of an investigator, who ensured confidentiality and informed that there were no right or wrong responses. To allow for anonymity, the personal information of the participants was coded prior to data collection.

Based on the international physical exercise recommendations for an old population [World Health Organization 2008, 2018], the judo program encompassed two 60-min sessions weekly. At the beginning of the judo program, the participants learned the *ukemi* techniques, which were included in every training session. In particular, the selected *ukemi* were *ushiro* (backward), *yoko* (right and left sides) *mae* (forward) and *mae-mawari* (forward roll) falling techniques [Kano 1994]. Each training session encompassed a 10-min judo-specific warm-up (e.g., walking at different speeds, light routines, and moving different body segments executing judo techniques), a 30-min judo central phase (e.g., *ne-waza*-ground techniques, *tachi-waza*-standing techniques, *kata*-sequences of specific movements, and *ukemi*-judo falling techniques), and a 20-min cool-down (e.g., stretching and relaxation as *kata* sequences). The beginning and end of each class comprised the initial and final ritual greetings. Considering that judo might be conceived as a threatening activity, older individuals might be timid, cautious and reluctant in attempting it. To overcome potential fears and to meet the participants' expectations, the judo instructor planned sessions with a low-moderate intensity and provided clear information about procedures and progress. Moreover, the activities were also organized in couples and/or groups to enhance sharing responsibility and to establish a positive relationship, promoting cooperation, mastery of adaptive tasks at hand, and preparing the participants for the next stage of psycho-physiological adjustments to learning challenges. After proper familiarisation, the RPE scale [Foster *et al.* 2001] was administered at 30-min of the recovery period of each session; to avoid that particularly high or low intensities applied toward the end of the training session would direct the subject's overall rating [Foster *et al.* 2001]. Characterized by verbal links (i.e., from 0 point-“rest” to 10 points-“maximal” practitioner's perception of efforts), the RPE scale [Foster *et al.* 2001] has been selected to monitor the internal load of the judo sessions, as a highly stable (ICC=0.94) and appropriate measure for workload evaluation in judo [Bromley *et al.* 2018].

To fulfil the first purpose of the present study, the fourth and last training sessions were recorded by a fixed camera (Sony HDR-CX410, Tokyo, Japan) positioned at a corner of the pitch, at a height of 2 m, which allowed full coverage of the training ground. To assess the falling techniques of practitioners, a specific rating scale for evaluating judo forward breakfall (i.e., *mae mawari ukemi*) with high interrater reliability (Kendall's tau coefficient range=0.63–0.92, $p=0.01$) was used [Reguli *et al.* 2008]. Two 5-Dan judokas with 20 years of teaching

experience were recruited to evaluate the *ukemi* techniques. According to the literature [Reguli *et al.* 2008], the judo experts used a slowdown frame rate to individually evaluate the five phases of a forward-roll *ukemi*. In particular, there were 10 items pertaining to five categories as follows. Item 1 pertains to the “Step forward” category (“Stepping forward, slight body turn”). Item 2 pertains to “Hand and elbow turning” (“Pronation of the hand-knife and the elbow in the direction of falling”). Items 3-5 pertain to “Arm rolling” (3: “Obtuse hand in the elbow, the arm should not be extended”; 4: “Neither palm nor backhand in contact with the floor”; 5: “Head is not in contact with the floor”). Items 6-9 pertain to “Breaking the fall” (6: “Hitting with extended arm before the trunk is touching the ground”; 7: “Whole arm is in contact with the floor (palm, forearm)”; 8: “Arm is in 45° angle with the body axis. The arm is in continuous contact with the floor”; 9: “Lying on half back, half side”). Finally, item 10 pertains to the “After impact position” category (“Right after impact position with prone head and hands in front of the body”). One pt was assigned to correct performances, whereas 0 pt was assigned to incorrect ones, with an overall 10-pt maximum. Then, scores ranging from 1 to 3 pt were considered “bad” breakfall performances, from 4 to 6 pts “fair” quality breakfall performances, and >7 pt “good” quality breakfall performances, respectively.

To achieve the second purpose of the study, the participants' enjoyment was assessed at the end of each training session, whereas the VAS-FoF was administered at the end of the second session of each week. According to the literature [Hagberg *et al.* 2009], the participants' enjoyment was defined as the emotional lift experienced during exercise and assessed on a 10-point scale (VAS-enjoyment) for how the judo sessions were experienced (1 = *entirely negative*, 10 = *entirely positive*). A specific VAS-FoF was used [Scheffer *et al.* 2011; Scheffer *et al.* 2010], which reported a significant ($p=0.01$) fair test-retest reliability ($r=0.56$). Finally, participant's motivation was evaluated via Motives for Physical Activity Measure-Revised (MPAM-R) [Battistelli *et al.* 2016] and the Exercise Self-Regulation Questionnaire (SRQ-E) [Ryan, Connell 1989], which showed reliability coefficients ranging from 0.78 to 0.88 and from 0.70 to 0.85, respectively.

These instruments were administered at the end of the first and last training session of the program. In particular, the SRQ-E investigates a multidimensional representation of motivation along a continuum encompassing external regulation (i.e., to obtain a reward or to avoid negative consequences), introjected regulation (i.e., to self-impose contingent rewards/punishments), identified regulation (i.e., to recognise core-values of a behavior with outcomes still extrinsically driven), and intrinsic motivation (i.e., to perform an activity for the pleasure derived from participation) [Ryan, Connell 1989]. The MPAM-R is a 30-item instrument [Battistelli *et al.*

2016], which measures five distinctive motives including appearance (i.e., to be attractive to others), health and fitness (i.e., to have more energy), social interaction (i.e., to be with others in activity) competence (i.e., to obtain new skills) and enjoyment (i.e., because it is fun).

Statistical Analysis

Data were analysed using the Statistical Package for the Social Science, version 24.0 (SPSS Inc., Chicago Illinois), with a level of statistical significance set at $p < 0.05$ for all computations. Before the analysis, the Shapiro-Wilk test was used to ascertain the normality of data distribution. For the analysis of the *ukemi* performance, Pearson's correlation coefficient was applied to ascertain the interrater reliability of the judo experts. Then, the scores were averaged and a paired-sample t test was used to determine pre- and post-intervention differences. Nonparametric Friedman's test for repeated measures analysis was applied to RPE, VAS-enjoyment, VAS-FoF, MPAM-R, and SRQ-E data. When significant differences emerged, Wilcoxon Signed Ranks was used for post-hoc comparisons. Finally, Spearman's rho correlation was applied to analyse the relationship of the *ukemi* performance with the MPAM-R and SRQ-E variables at pre- and post-intervention and for their pre-post delta values.

Results

Two women and one man attending the program did not meet the inclusion criteria for the analyses. Therefore, Table 1 reports the characteristics of the 16 included participants.

Significant inter-rater reliability emerged for the evaluations of the forward *ukemi* performances (pre-intervention: $r = 0.61$, $p = 0.012$; post-intervention: $r = 0.92$, $p < 0.001$, Table 2). Before the intervention, 5 participants (31%) presented “fair” breakfall performances and the remaining 11 participants (69%) presented “bad” breakfall performances, hence no participant presented good breakfall performances. After the intervention, an improvement ($p < 0.001$) emerged, with a mean increase of 2.0 pt (95% confidence interval 1.2–2.9) on the ten-point *ukemi* rating scale. In particular, 3 participants (19%) presented “good” breakfall performances, 12 participants (75%) presented “fair” breakfall performances and only 1 participant (6%) maintained a “bad” breakfall performance despite of a 1.5 pt improvement. Errors occurred most frequently in item 6 (100%), item 8 (94%), item 1 (75%) and item 10 (75%).

The intervention program showed no differences for VAS-FoF (1.2 ± 0.5 pt) and VAS-enjoyment, which showed always the highest score. Conversely, differences emerged for MPAM-R ($X^2_{(n=16, df=9)} = 78.70$, $p < 0.001$)

Table 1. Baseline age, anthropometric, fear of falling and functional fitness characteristics of the participants

	Participants		
	M (n=8)	F (n=8)	All (n=16)
Age (years)	71.0 (3.5)	67.6 (3.7)	69.3 (3.9)
Body mass (kg)	81.9 (9.1)	62.6 (8.3)	72.2 (13.0)
Stature (m)	1.7 (0.1)	1.6 (0.0)	1.7 (0.1)
BMI (kg m^{-2})	27.0 (2.0)	25.7 (3.3)	26.4 (2.7)
Fear of falling* (pt)	19.5 (4.2)	20.1 (2.0)	19.8 (3.2)
Lower limb flexibility' (n)			
below average	4	5	9
normal	3	3	6
above average	1	0	1
Upper limb flexibility'' (n)			
below average	1	1	2
normal	6	4	10
above average	1	3	4
Lower limb strength [§] (n)			
below average	0	0	0
normal	6	5	11
above average	2	3	5
Upper limb strength ^{§§} (n)			
below average	5	0	5
normal	3	6	9
above average	0	2	2

Note. BMI= body mass index; *According to the Falls Efficacy Scale-International (Ruggiero et al., 2009); n= number of participants lying below, within and above the normal range of scores (Jones & Rikli, 2002). 'Evaluated through the Chair Sit and Reach Test; ''Evaluated through the Back Scratch Test; §Evaluated through the 30-second Chair Stand Test; §§Evaluated through the Arm Curl Test.

Table 2. Sum of points in a ten-point rating scale for the evaluation of the forward fall-breaking technique (*ukemi*) performance before and after the judo programme

Participant	Expert 1		Expert 2	
	Pre	Post	Pre	Post
A	5	6	3	6
B	3	6	3	6
C	5	8	4	8
D	3	5	2	4
E	3	6	4	7
F	4	5	2	4
G	2	5	2	5
H	3	3	2	2
I	3	4	3	4
J	4	6	2	6
K	1	4	1	3
L	5	5	3	3
M	8	9	4	8
N	3	6	3	5
O	3	5	3	5
P	3	4	3	3

Table 3. Pre-post differences in participants' motivation

MPAM-R	pre mean (\pm sd)	post mean (\pm sd)	p	Cohen's d
Fitness	5.8(1.5)	6.5(1.0)	0.15	0.48
Enjoyment	4.9(1.5)	6.2(1.2)	0.02	0.84
Competence	4.8(1.7)	5.9(1.4)	0.03	0.66
Appearance	3.9(1.4)	5.1(1.5)	0.02	0.91
Sociality	3.6(1.5)	5.0(1.4)	0.03	0.94

SRQ-E	pre mean (\pm sd)	post mean (\pm sd)	p	Cohen's d
External regulation	5.9 (5.7)	4.1 (0.5)	0.14	-0.44
Introjected regulation	8.9 (5.1)	9.3 (4.7)	0.50	0.08
Identified regulation	21.3 (5.4)	24.4 (4.4)	0.02	0.6
Intrinsic motivation	19.6 (5.6)	22.5 (4.6)	0.02	0.55

Note. MPAM-R=Motives for Physical Activity Measure-Revised; SRQ-E= Exercise Self-Regulation Questionnaire.

and SRQ-E ($X^2_{(n=16,df=7)} = 88.98, p < 0.001$) (Table 3). For MPAM-R, post hoc analysis maintained differences for the enjoyment, appearance, competence, and sociality domains only. For SRQ-E, post-hoc analysis maintained differences only for identified regulation and intrinsic motivation. Whilst no correlations emerged for the *ukemi* performance in relation to MPAM-R and SRQ-E variables in the pre-intervention and for the pre-post delta values, the fall skills were moderately associated with introjected regulation ($r_s = 0.544, p = 0.030$) and intrinsic motivation ($r_s = 0.578, p = 0.019$) in the post-intervention.

Finally, the subjective ratings of efforts for the 30 judo sessions ranged between 1 pt (very light) and 6 pt (moderate activity). Differences ($X^2_{(n=16,df=29)} = 130.67, p < 0.001$) emerged between sessions, with the lowest values reported for the 1st, 2nd and 24th sessions (mean range: 1.1-1.3 pt) and the highest values for the 6th and 2nd sessions (mean range: 2.9-3.2 pt).

Discussion

The study aimed to assess the suitability of an adapted judo program for an older population of novice practitioners to improve falling performance, reduce their fear of falling and increase their enjoyment and motivation to physical activity and exercise that are relevant predictors of exercise adherence. The main findings of the present study were the significant technical progress in the *ukemi* performance, the positive changes in distinct subdomains of motivation (i.e., appearance, competence, enjoyment, and social motives of the MPAM-R, and identified regulation and intrinsic motivation of the SRQ-E) and the moderate positive post-intervention relationship of fall skills concerning introjected regulation and intrinsic motivation. The increased motivation and self-regulation from the beginning to the end of the intervention were paralleled by a consistently high adherence (84%). However, the low perception of effort and the steadily very high enjoyment prevent determine interaction between the training mental load and the per-

formance improvement, leaving large margins for future studies. More investigations are needed to understand how enhanced falling performance may translate into reduced fear of falling.

Judo is a physical and mental discipline suitable for older adults encompassing falling techniques applicable in sport-related activities as well as in daily-life situations [Ciaccioni *et al.* 2019a; Ciaccioni *et al.* in press; DelCastillo-Andrés *et al.* 2018; Kano 1994]. However, age-related motivation, attention, anxiety, and cautiousness might cause a variety of psychological and technical difficulties in teaching novel and complex motor tasks to older individuals [Spirduso, MacRae, Francis 2005]. Therefore, to monitor the intensity of the program and to add gradually more demanding activities, the subjective rating of perceived efforts collected at the end of each judo session were used. As expected, the lowest RPE values were found for the first sessions encompassing basic movements and for the 24th session, which included a technical evaluation of accuracy in performing judo skills. Furthermore, the participants perceived the exercise intensity of the remaining sessions as moderate. Finally, the high adherence of the participants confirmed the suitability of the judo program adapted for novice older individuals.

The literature on FoF in older adults reported significant improvements as a result of specific falling programs [Groen *et al.* 2010]. At baseline very low FoF values were found [Ruggiero *et al.* 2009], which remained stable during the experimental period. In considering that FoF is a multi-factorial construct affected by health problems and gait abnormalities of older individuals [Scheffer *et al.* 2010; World Health Organization 2008], it could be speculated that the lack of improvement in FoF was due to the starting health status and fitness level of the participants. Nonetheless, the acquisition of judo falling skills could be considered an effective resource to prevent fall-related injuries. Despite the individual differences in falling ability at baseline, the present study highlighted significant improvements also in the forward *ukemi* as a result of training, confirming the literature

on sideways *ukemi* in older adults [Groen *et al.* 2010; Groen, Weerdesteyn, Duysens 2007]. However, the evaluation of technical aspects at the end of intervention program showed the permanence of specific mistakes in stepping forward and breaking the fall. Actually, the risk for injury during a fall depends on the position and velocity of the body segments at the moment of impact, with protective responses deemed essential to decrease the velocity of the body segments during descent and the magnitude of loads applied to the body during the impact stage of the fall [Moon, Sosnoff 2017]. In particular, the stepping strategy is relevant to increase the fall duration with a consequent decrease in the impact velocity and allows adjustments that reduce the severity of injuries [Moon, Sosnoff 2017]. Furthermore, rolling and slapping the mat with the arm, the extension of arm before the landing phase and the pronation of the head are technical aspects relevant to the reduction of the risk of injuries [Gunther 2000; Koshida *et al.* 2017b]. Despite no participant reported any injury, at the end of the program the novice older judoka still presented difficulties in correctly preparing and executing the fall. However, it is noteworthy that looking at the fall performance of every participant individually, fall skill improved with two exceptions that maintained stable skill levels. Therefore, it is plausible that a judo program longer than 4 months is needed to develop correct sport-specific falling proficiency, which differentiate experienced and novice young adult judoka [Koshida *et al.* 2017a]. Moreover, since enhanced falling performance did not translate into reduced FoF, other risk factors could affect its development (e.g., age, previous falls, dizziness, health status, depression, gait, self-efficacy, and self-confidence) [World Health Organization 2008]. Of note, the judo program produced significant improvements in other relevant psychological aspects (e.g., enjoyment, motivation, self-regulation).

In the literature [World Health Organization 2008, 2018], >150 min.week-1 moderate-intensity activity programs are strongly encouraged to minimize the degenerative physical, psychological, social, and cognitive function that occurs with advancing years, whereas participation in vigorous physical activities may increase the risk of falls in older age [World Health Organization 2008]. To help older individuals reduce sedentary behaviors and engage in regular physical activity as individuals or groups, it is crucial to provide positive experiences from appropriately tailored sports programs delivered by qualified personnel [World Health Organization 2018]. Actually, led by a certified judo instructor, the present study focused on progressive and moderate-intensity activities.

In general, over the life course, the relevance of relationships, enjoyment, autonomy, security, and personal growth are considered key values [World Health Organization 2008, 2018]. In the present study, the novice

older judoka experienced the adapted judo program as an enjoyable, socially- and culturally-appropriate physical activity. Actually, the individual motivation follows an internalization process that encompasses active assimilation along a continuum ranging from external to intrinsic behavioral regulations [Ryan & Connell 1989]. The locus of causality is the perceived origins of motivated behaviors, which may be externally perceived (i.e., I have to do this) or internally and volitionally perceived (i.e., I want to do this). In particular, extrinsic motivation encompasses different forms of locus of causality [Biddle, Mutrie 2007]. Findings from the SRQ-E highlighted that the adapted judo program facilitated the intrinsic motivation of participants, substantiating that the improvement of judo technical skills enabled the process of internalization in older novice judoka in line with the principles of sports sciences supporting the autonomy of practitioners [Teixeira *et al.* 2012]. Moreover, the Spearman rho analysis indicated a moderate positive post-intervention relationship between the *ukemi* performance evaluated by the two judo experts and the introjected regulation (e.g., I try to exercise on a regular basis: because I would feel bad about myself if I did not; because people would think I'm a weak person if I did not) [Ryan, Connell 1989]. In addition, the analysis of the post-intervention values also revealed a moderate positive relationship between the *ukemi* performance and the intrinsic motivation (e.g., because it is fun; because it is interesting to see my own improvement) [Ryan, Connell 1989]. In brief, the results seem to suggest a connection between the technical fall skills acquired by the novel older judoka and the degree to which they felt autonomous with respect to exercising in the judo program. Specifically, whatever the size of the motivation and technical fall skill gains, the judo training seems to “align” specific aspects of introjected regulation and intrinsic motivation to specific technical judo skill competence. Considering the importance to prevent fall-related injuries especially later in life and the usefulness of the *ukemi* to resist impacts efficiently and safely [Fujiwara *et al.* 2002; Hashimoto *et al.* 2015; Koshida *et al.* 2017a], further research examining the relationship between the extrinsic and intrinsic motivation domains and the breakfall techniques acquired in judo programs should be considered.

Compared with co-aged participants in physical activity programs [Withall, Jago, Fox 2011], before and after the experimental period the novice judoka presented lower and higher values on MPAM-R health and fitness, enjoyment, social, appearance and competence motives, respectively. Only the health and fitness motive did not show a significant effect of the program, despite the improvement observed at the end of the experimental period approached the highest value (7 pt.) of the MPAM-R. These findings indicate that participants considered judo as a health-enhancing physical activ-

ity, relevant to maintain the quality of their life [Biddle, Mutrie 2007]. Conversely, the significant improvements observed for the remaining motives (enjoyment, social, appearance, and competence) support the efficacy of the judo program in developing self-determined forms of motivation, thus promoting stable and committed involvement in physical activity. Furthermore, the MPAM-R encompassed different aspects of enjoyment (i.e., because it is fun, because I like to do this activity, because it makes me happy, because I think it is interesting, because I enjoy this activity, because I find this activity stimulating, and because I like the excitement of participation). Of note, the MPAM-R presented a higher discriminatory power than the VAS-enjoyment, which always showed a ceiling effect. According to the judo principles of fairness and inclusion [Kano 1994], the program empowered the social integration of participants, as mirrored by the significant increases in the social motive emerging at the end of the experimental period. In particular, working in couples and groups helped them to interact with new people and to establish collaborative relationships with peers. In the literature [Biddle, Mutrie 2007], the physical appearance might represent an important barrier to exercise, particularly relevant for women. In this study, after the 4-month experimental period the appearance motive (i.e., to be physically active to become more physically attractive, to have defined muscles, to look better, and to achieve or maintain a desired weight). The assumption seems reasonable that coping in challenging activities and mastering novel skills support the self-esteem and self-perception of older individuals, also reinforced by the significant improvement in the competence motive. Indeed, mastering novel challenging falling skills determines psychological benefits in older individuals [Groen *et al.* 2010].

This study provided a stimulus for further advancement of knowledge on the effects of the learning of novel sport-related skills in older individuals. However, it presents some limitations mainly due to the potential self-selection bias of individuals particularly motivated to engage in novel activities and the relatively small sample size. Moreover, the lack of a control group does not allow for the comparison of the current judo program with other training schemes. However, the analysis of the correlations at pre- and post-intervention partially allows explaining our findings. Indeed, the post-intervention alignment of the *ukemi* performance and motivation gains seems to suggest that the exercise motivation improved thanks to the enhanced fall skills, even though the perceived FoF did not change. Therefore, further research is needed to ascertain the psychological adaptations to different training programs involving novel and challenging skills for older individuals. The reported relationship of activity level with education level and income [Biddle, Mutrie 2007] suggests future studies to include participants from various social-economic status.

Conclusions

Fall-related injuries in older adults are nowadays critical health and social problem. This work substantiated the feasibility of learning judo as an effective strategy to determine technical progress in the safe-falling performance in older adults. Specific preparation and competencies are required from instructors to adapt to the unique physiological and psychological needs and characteristics of the novel older judoka. In particular, new technical skills could be introduced through alternative approaches empowering self-determined forms of motivation. Furthermore, the results of this study encourage instructors to include complex coordination tasks in couples to support successful learning performance by means of collaborative training strategies. Finally, the proposed judo program has the potential to be integrated with other physical activities, which might support the maintenance of independent living in older individuals. Indeed, the integration of judo fall techniques in physical trainers and coaches' exercise plans are highly recommended as fall-related injuries prevention tools in sport-related and daily life situations.

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Wpływ programu treningowego judo na jakość upadków, lęk przed upadkiem i motywację do ćwiczeń u początkujących judoków w starszym wieku

Słowa kluczowe: judocy, osoby starsze, zdrowie, samoregulacja, zapobieganie upadkom

Streszczenie

Wprowadzenie. Wieloskładnikowe programy ćwiczeń grupowych wykazały, że zapobiegają one upadkom i zmniejszają ich liczbę u starszych dorosłych, a trening judo ma pozytywny wpływ na równowagę i zdrowie kości ćwiczących. Strach przed upadkiem (FoF) i negatywne uczucia mogą wpływać na spadek aktywności fizycznej, samooceny, pewności siebie, siły i równowagi wraz z wiekiem. Z kolei radość, motywacja i poczucie osobistego spełnienia sprzyjają przestrzeganiu programów aktywności fizycznej. Cel pracy. W pracy oceniano wpływ 4-miesięcznego programu judo na umiejętność upadania i motywację do ćwiczeń u początkujących judoków w starszym wieku (8 mężczyzn, 8 kobiet; wiek=69,3±3,9 lat).

Metody. Po każdej sesji, badano strach przed upadkiem (FoF) i przyjemność z treningu oraz oceniano za pomocą wizualnej skali analogowej (VAS). Przed i po programie przeprowadzono poprawione badanie Motywów pomiaru aktywności fizycznej (MPAM-R) i Kwestionariusza samoregulacji – ćwiczenia (SRQ-E), a dwóch ekspertów judo oceniało wykonanie techniki kontrolowanych upadków.

Wyniki. Stwierdzono różnice w umiejętnościach upadku (MPAM-R i SRQ-E), zmiany w strachu przed upadkiem (FoF), zadowolenie z sesji oraz korelacje umiejętności upadku z MPAM-R i SRQ-E. Po programie, techniczna poprawa w wykonaniu techniki upadku ($p<0.001$) pojawiła się wraz ze zwiększoną ($p<0.05$) radością, kompetencją, wyglądem, towarzyskością (MPAM-R) i wewnętrzną motywacją (SRQ-E). Umiejętność upadania i wewnętrzna motywacja były skorelowane tylko podziałaniu interwencyjnym. Skala VAS i FoF nie zmieniły się, a poziom zadowolenia z ćwiczeń utrzymywał się na stałym wysokim poziomie.

Wnioski. Judo wydaje się przyjemnym rodzajem aktywności, odpowiednim do wspólnego polepszania jakości upadków i motywacji u osób starszych.