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Standing balance – static and dynamic – in older women who practice the Feldenkrais Method

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Abstract

The Feldenkrais Method is an intervention method proven by research to improve balance in older women. This study examined the static and dynamic balance of older women who participated in Feldenkrais classes for more than three years, without a dedicated balance improvement program. Ninety-two independent women over 65 years of age were examined: 34 had participated in Feldenkrais classes for more than three years, 36 had participated in general exercise classes for more than three years, and 22 did not exercise at all. Their static standing balance was measured in six different positions on a Tetrax® device. Their dynamic standing balance was measured when reaching as far forward as they could. The results show no difference in static ($P>0.1$) and dynamic ($P>0.1$) balance between women who participated in Feldenkrais classes and the other participants. The study's conclusion is that due to the importance of this issue, further research is needed. To this end, an interventional study should be conducted in which balance is examined at different time points, as well as daily functions requiring static and dynamic balance.

Keywords: Older women, Feldenkrais Method, static balance, dynamic balance

Introduction

Balance, the body's ability to maintain stability by organizing its center of gravity over its base of support (Bellew, Yates and Gater 2003), both when static (e.g., standing) or dynamic (e.g., walking), is achieved by means of three systems that provide information on the body's balance, and coordinates between them: the visual system, the vestibular system (responsible for balance, located in the inner ear), and the somatosensory system, which provides information from the muscles and joints, especially the lower limbs and cervical vertebrae. These three systems transmit information to the brain, which processes the information and "translates" it into motor information that constantly creates postural corrections by means of the muscles, and thus maintains balance (Rivkes-Spectorman 2011; Shoja et al. 2023). Impaired balance can occur as a result of damage to one or more of the components comprising this neurological mechanism.

As people get older, there is a general decline in their physical and mental health, and even a slight impairment in the vestibular system can cause a fall (Mahoney, Cotton and Verghese 2019; Osoba et al. 2019). Impaired balance can increase the risk of falls, fractures, and even death (Palmer et al. 2023; Tapanya et al. 2023; Yamamoto et al. 2023).

The issue of falls poses a significant problem for healthcare services worldwide. In Israel, approximately 1,000 men and women aged 65 and over fall every day, and one out of four people in this age group reported at least one fall within a single year (Israel Ministry of Health 2024). According to US data on falls among adults over 65 (CDC 2025), about three million adults visit emergency rooms every year due to falls; about one million adults are hospitalized every year due to fall-related injuries; and nearly 319,000 adults are hospitalized every year due to hip fractures. 41,400 people in the US died in 2023 as a result of falls, accounting for 56.1% of fatal injuries in this age group.

The risk of falls and consequent fractures is higher in women than in men (Gale, Cooper and Sayer 2016; Tapanya et al. 2023). This is due to significant loss of minerals in the bones, urinary incontinence, and frailty (weak muscles and

weakness, especially in the lower limbs) in women (Gale, Cooper and Sayer 2016).

People who participate in physical activity have been found to significantly improve their balance (Hauer et al. 2003; Kim et al. 2021; Lofshult 2003; McCrum et al. 2022; Sihvonen, Sipilä and Era 2004). Effective programs are those held under supervision in a variety of forms of physical activity, including tai chi, strength and endurance, personal training, balance pad exercises, virtual reality, and home exercises prescribed by a physiotherapist (Barnett et al. 2003; McCrum et al. 2022).

A physical activity that has been tested in connection with balance is the Feldenkrais Method (FM). This method, which is based on relatively gentle movement routines to stimulate the neutral mobility of the body's joints, has been found to significantly improve awareness and the ability to recognize new information. Once they have recognized new information, FM practitioners integrate the skills they have acquired while practicing the method (e.g., balance) into their everyday activities (Chiang 2023; Molders and Araujo 2023; Smith et al. 2016).

In 2023, Hillier and Worley (2023) reviewed numerous studies that examined a variety of parameters and populations, seeking evidence for the benefits of FM and for which populations. They concluded that FM indeed has benefits. With regard to balance, they concluded that some of the parameters that can contribute to preventing falls, e.g., the Functional Reach Test (FRT) (which has been significantly proved), and the Timed Up and Go Test (which has been proved, but not significantly), can indeed improve as a result of practicing FM in adults who are prone to falls as well as adults who are not. Additionally, FM is beneficial in improving movement, reducing effort in movement, and reducing pain or discomfort.

Since improving balance by practicing FM has been proved but not definitively, and since most of the studies engaged with balance following and immediately after a specific intervention program, the author of the present article thought it

appropriate to publish the results of another study on this subject. The aim of the study was to examine the association between older women who practice FM and their long-term static and dynamic balance (as a matter of routine, not only immediately after a class).

Research Hypotheses

1. Older women who have been practicing FM for at least three years will have better static balance in their everyday life than older women who perform general exercise routines, and older women who do not exercise regularly.
2. Older women who have been practicing FM for at least three years will have better dynamic balance in their everyday life than older women who perform general exercise routines, and older women who do not exercise regularly.

Materials and Methods

Study Participants

The participants in the present study were 92 independent women over 65 years of age with no particular medical history.

The participants were divided into three groups: (1) Experimental Group. 34 Women who have participated in at least two FM classes a week for the past three years (mean age 74); (2) Control Group A. 36 Women who have participated in at least two general physical activity classes a week for the past three years (mean age 70); and (3) Control Group B. 22 Women who have not participated in any regular physical activity for the past three years (mean age 74). The participants completed a demographic questionnaire, which also showed that they were similarly distributed in each of the three groups (Experimental, Control A, Control B) in terms of age and general health. The participants were divided into three five-year age groups: 65-70, 71-75, 76 and older. Their health condition was divided into three levels based on the participants' subjective assessment –

healthy, healthy for her age, unhealthy – and on reported medical conditions, e.g., osteoporosis and hypertension.

The study was examined and approved by the Helsinki Committee, Israel.

Research Tools and Test Protocols

a) Clinical Test of Sensory Interaction and Balance (CTSIB) (static balance)

b) Functional Reach Test (FRT) (dynamic balance)

a) The static balance test, CTSIB (Shumway-Cook and Horak 1986; Werber and Cass 1993), was performed standing in six different positions on a Tetrax® computerized posturography device to measure balance (Sunlight Medical Ltd., Tel Aviv, Israel): (1) with eyes open; (2) with eyes closed; (3) with a dome (approx. circumference: 40 cm) over the face, obscuring field of vision; (4) on foam-rubber pads (approx. length: 315 mm; width: 125 mm; thickness: 60 mm); (5) on foam-rubber pads with eyes closed; and (6) on foam-rubber pads with a dome over the face, obscuring field of vision.

   The six standing positions were designed to shed light on the correctness of the information, and the integration of sensory signals transmitted by the somatosensory, visual, and vestibular systems in the context of balance. In an attempt to assess the contribution of each of the three sensory components, some of the positions neutralized other components. For example, in the second position, closing the eyes neutralized the visual system.

   The CTSIB was carried out with the participant standing on the base platform of the Tetrax® system, which is a convenient, commonly used, and reliable system for testing balance in adults (Laufer 2000; Laufer et al. 2003; Schwartz et al. 2005). The system consists of a metal platform equipped with four pads: one for the left heel, one for the left toes, one for the right heel, and one for the right toes. Each pad has a sensor that measures vertical force 32 times per second. The measured signals are transferred to a computer where they are

processed using dedicated software. The software provides a set of parameters by means of which the intensity of the body's movements during the test can be measured, and thus the posture of the examinee to be "diagnosed" (Schwartz et al. 2005).

In the present study, the participants stood barefoot with feet close together, and arms at the side of the body. Each of the six positions were maintained for 30 seconds. The data recorded was at a sample frequency of 32 Hz. In other words, 32 results per second for each of the six tests, multiplied by 30 seconds for each test, a total of 960 measurement data per test. Two variables were calculated and extracted from these data:

1) Postural Sway (PS) – a variable expressing the body's movements when standing, and calculated in accordance with the following formula:

$$PS = \frac{10000 \cdot \sum_{i=1}^{1023} \sqrt{\left[(A'_{i+1} - A'_i)^2 + (B'_{i+1} - B'_i)^2 + (C'_{i+1} - C'_i)^2 + (D'_{i+1} - D'_i)^2\right]}}{1024 \cdot (\text{Weight})}$$

2) Weight Distribution Index (WDI) – a variable expressing how weight is distributed between the four pads:

$$WDI = \sqrt{\frac{(A\%-25)^2 + (B\%-25)^2 + (C\%-25)^2 + (D\%-25)^2 +}{4}}$$

The formula provides an index relating to the distribution of weight between the four pads, with reference to 25% on each pad as a base value.

b) The dynamic balance test, FRT (Browne and O'Hare 2001; Duncan et al. 1990; Whitney, Poole and Cass 1998), provided information about the participants' ability to keep their balance when shifting center of gravity. In the first stage, they were instructed to make a fist and extend their arm to 90° (parallel to the floor), and the examiner recorded the location of the distal end of their fist (third proximal phalangeal joint). In the second stage, the participants were instructed to reach as far forward as they could without

losing their balance or moving their feet, and the examiner recorded the location of the distal end of their fist. The difference (in cm) between the measurements in the first and second stages is the reach distance (Duncan et al. 1990; Whitney, Poole and Cass 1998). FRT, which is an accepted method for the assessment of adults experiencing age-related balance problems, was found to have high reliability (Browne and O'Hare 2001).

Data Collection: Place and Procedure

The study was conducted in the course of 2006 at the Zinman Academy for Physical Education, The Wingate Institute, Israel. The participants came in buses from Haifa after receiving an explanation that the aim of trip was to participate in a study on balance, and after they signed an informed consent form.

After completing a demographic questionnaire, the participants were divided into two groups. The first group performed the FRT and then the CTSIB, and the second group performed the CTSIB and then the FRT. All the participants (92) performed the FRT, and 66 performed the CTSIB. The difference between the number of participants who came to participate in the study and the number of those who actually performed the CTSIB stemmed from a technical problem.

Statistical Analysis

Descriptive statistics were used to examine the characteristics of the study population (means, standard deviations (SD), standard errors (SE), confidence interval (CI), minimum and maximum). ANOVA tests were used to examine the effects on balance of practicing FM, which provided various one-way analysis tables with one independent variable (group belonging) and one dependent variable (test score).

Results

The first four tables below present the association between the independent variable – group belonging – and each of the dependent static balance variables according to the CTSIB scores. The two additional tables present the association between the independent variable – group belonging – and dynamic balance scores according to the FRT.

Table 1 Means, standard deviations, standard errors, confidence interval, minimum and maximum of PS variables in the experimental group and the control groups in a computerized balance test

Test	Group	No.	Mean	SD	SE	CI		Min.	Max.
						Lower limit	Upper limit		
Standing with eyes open	FM	22	19.25	6.47	1.38	16.38	22.12	10.32	31.01
	General exercises	25	17.77	4.82	0.96	15.78	19.76	11.05	29.53
	No physical activity	19	20.68	9.04	2.07	16.32	25.04	10.26	47.00
	Total	**66**	**19.10**	**6.80**	**0.84**	**17.43**	**20.77**	**10.26**	**47.00**
Standing with eyes closed	FM	22	22.57	8.33	1.78	18.88	26.26	10.78	42.84
	General exercises	25	22.41	6.75	1.35	19.63	25.20	12.15	38.53
	No physical activity	19	24.22	9.16	2.10	19.80	28.63	11.29	46.02
	Total	**66**	**22.98**	**7.94**	**0.98**	**21.03**	**24.94**	**10.78**	**46.02**
Standing with dome over face	FM	22	19.78	6.62	1.41	16.85	22.72	10.76	31.01
	General exercises	25	18.58	5.44	1.09	16.33	20.83	9.45	32.72
	No physical activity	19	20.30	7.94	1.82	16.48	24.13	8.77	39.50
	Total	**66**	**19.48**	**6.57**	**0.81**	**17.86**	**21.09**	**8.77**	**39.50**
Standing on foam-rubber pads with eyes open	FM	22	24.05	8.76	1.87	20.17	27.93	12.07	40.49
	General exercises	25	23.17	6.27	1.25	20.59	25.76	14.50	36.75
	No physical activity	19	22.76	6.18	1.42	19.78	25.74	13.99	34.58
	Total	**66**	**23.35**	**7.08**	**0.87**	**21.61**	**25.09**	**12.07**	**40.49**
Standing on foam-rubber pads with eyes closed	FM	22	30.82	9.69	2.07	26.53	35.12	14.39	49.96
	General exercises	25	31.67	8.90	1.78	28.00	35.35	17.28	55.80
	No physical activity	19	27.57	8.76	2.01	23.35	31.80	16.65	46.27
	Total	**66**	**30.21**	**9.16**	**1.13**	**27.96**	**32.46**	**14.39**	**55.80**
Standing on foam-rubber pads with dome over face	FM	22	26.62	7.85	1.67	23.14	30.10	12.28	42.30
	General exercises	25	25.27	7.78	1.56	22.06	28.48	14.58	49.25
	No physical activity	19	26.06	7.52	1.72	22.44	29.69	14.59	44.21
	Total	**66**	**25.95**	**7.63**	**0.94**	**24.07**	**27.82**	**12.28**	**49.25**

Table 1. The means, standard deviations, and maximal measures obtained in the CTSIB by the participants in all three groups. It is evident that although the mean PS score representing standing balance increased as the postural task became more difficult, its values were similar across the three groups.

Table 2 Variable analysis of computerized balance test results (PS)

ANOVA

Test	Variance	Sum of squares	Degrees of freedom (df)	Mean	Statistical value (F test)	Significance
Standing with eyes open	Variance between groups	92.197	2	46.099	0.998	0.374
	Variance within groups	2,909.271	63	46.179		
	Total variance	**3,001.468**	**65**			
Standing with eyes closed	Variance between groups	40.726	2	20.363	0.316	0.730
	Variance within groups	4,060.538	63	64.453		
	Total variance	**4,101.264**	**65**			
Standing with dome over face	Variance between groups	35.215	2	17.608	0.401	0.671
	Variance within groups	2,766.405	63	43.911		
	Total variance	**2,801.620**	**65**			
Standing on foam-rubber pads with eyes open	Variance between groups	18.137	2	9.068	0.176	0.839
	Variance within groups	3,240.223	63	51.432		
	Total variance	**3,258.359**	**65**			
Standing on foam-rubber pads with eyes closed	Variance between groups	194.049	2	97.024	1.163	0.319
	Variance within groups	5,255.682	63	83.424		
	Total variance	**5,449.730**	**65**			
Standing on foam-rubber pads with dome over face	Variance between groups	21.597	2	10.799	0.181	0.835
	Variance within groups	3,765.258	63	59.766		
	Total variance	**3,786.856**	**65**			

Table 2. In this table, there are two degrees of freedom (df) between the groups, and 63 within the groups. The statistical value of the F-test ranges from 0.176 (standing on foam-rubber pads with eyes open) to 1.163 (standing on foam-rubber pads with eyes closed). In all six tests, no statistical significance was found ($P>0.1$). In other words, no significant difference was found between the three groups.

Table 3 Means, standard deviations, standard errors, confidence interval, minimum and maximum of the WDI variable in the experimental group and the control groups in a computerized balance test

Test	Group	No.	Mean	SD	SE	CI		Min.	Max.
						Lower limit	Upper limit		
Standing with eyes open	FM	22	5.59	2.34	0.50	4.56	6.63	1.70	10.78
	General exercises	25	5.29	2.76	0.55	4.15	6.43	1.34	13.56
	No physical activity	19	5.28	2.42	0.56	4.11	6.45	1.66	11.02
	Total	**66**	**5.39**	**2.50**	**0.31**	**4.77**	**6.00**	**1.34**	**13.56**
Standing with eyes closed	FM	22	5.02	2.07	0.44	4.10	5.94	1.57	8.64
	General exercises	25	5.15	1.78	0.36	4.41	5.88	2.01	8.48
	No physical activity	19	4.52	2.38	0.55	3.37	5.67	1.34	9.79
	Total	**66**	**4.92**	**2.05**	**0.25**	**4.42**	**5.43**	**1.34**	**9.79**
Standing with dome over face	FM	22	5.32	2.97	0.63	4.00	6.63	1.60	12.06
	General exercises	25	4.91	1.71	0.34	4.20	5.62	1.60	8.88
	No physical activity	19	4.29	2.02	0.46	3.32	5.26	1.86	8.74
	Total	**66**	**4.87**	**2.29**	**0.28**	**4.30**	**5.43**	**1.60**	**12.06**
Standing on foam-rubber pads with eyes open	FM	22	6.00	3.11	0.66	4.63	7.38	2.24	14.88
	General exercises	25	7.21	3.44	0.69	5.80	8.63	1.71	15.55
	No physical activity	19	6.86	2.97	0.68	5.43	8.29	1.86	12.82
	Total	**66**	**6.71**	**3.19**	**0.39**	**5.92**	**7.49**	**1.71**	**15.55**
Standing on foam-rubber pads with eyes closed	FM	22	5.75	3.01	0.64	4.42	7.09	1.55	11.55
	General exercises	25	6.35	3.35	0.67	4.97	7.73	1.78	13.51
	No physical activity	19	6.51	3.86	0.89	4.65	8.73	0.66	14.98
	Total	**66**	**6.20**	**3.36**	**0.41**	**5.37**	**7.02**	**0.66**	**14.98**
Standing on foam-rubber pads with dome over face	FM	22	5.82	3.30	0.70	4.35	7.28	2.00	15.56
	General exercises	25	6.24	3.14	0.63	4.94	7.54	1.07	12.24
	No physical activity	19	5.72	3.63	0.83	3.98	7.47	1.27	13.12
	Total	**66**	**5.95**	**3.29**	**0.41**	**5.14**	**6.76**	**1.07**	**15.56**

Table 3. The mean distances, standard deviations, and maximal measures obtained in the CTSIB by the participants in all three groups. It is evident that the mean WDI score representing the weight distribution between the four foam-rubber pads, varies in the different tests. Despite the differences in the tests, there are no differences in WDI scores between the three groups.

Table 4 Variable analysis of computerized balance test results (WDI)

ANOVA

Test	Variance	Sum of squares	Degrees of freedom (df)	Mean	Statistical value (F test)	Significance
Standing with eyes open	Variance between groups	1.410	2	0.705	0.110	0.896
	Variance within groups	404.425	63	6.419		
	Total variance	**405.835**	**65**			
Standing with eyes closed	Variance between groups	4.543	2	2.271	0.533	0.589
	Variance within groups	268.359	63	4.260		
	Total variance	**272.901**	**65**			
Standing with dome over face	Variance between groups	10.869	2	5.435	1.040	0.359
	Variance within groups	329.175	63	5.225		
	Total variance	**340.044**	**65**			
Standing on foam-rubber pads with eyes open	Variance between groups	17.735	2	8.867	0.866	0.426
	Variance within groups	645.448	63	10.245		
	Total variance	**663.183**	**65**			
Standing on foam-rubber pads with eyes closed	Variance between groups	6.820	2	3.410	0.296	0.745
	Variance within groups	726.570	63	11.533		
	Total variance	**733.390**	**65**			
Standing on foam-rubber pads with dome over face	Variance between groups	3.465	2	1.732	0.155	0.856
	Variance within groups	702.231	63	11.147		
	Total variance	**705.695**	**65**			

Table 4. The statistical value of the F-test ranges from 0.705 (standing with eyes open) to 1.040 (standing with dome over face). There are two degrees of freedom (df) between the groups, and 63 within the groups. In all six tests, no statistical significance was found (P>0.1). In other words, no significant difference was found between the three groups.

Table 5 Means, standard deviations, standard errors, confidence interval, minimum and maximum of the FRT in the experimental group and the control groups

Variable	Group	No.	Mean	SD	SE	CI		Min.	Max.
						Lower limit	Upper limit		
Mean	FM	29	30.21	6.33	1.18	27.28	32.62	19	44
	General exercises	41	28.39	5.12	0.80	26.77	30.01	15.5	39
	No physical activity	22	27.58	4.72	1.01	25.49	29.67	18.2	34.5
	Total	**92**	**28.77**	**5.48**	**0.57**	**27.63**	**29.91**	**15.5**	**44.1**

Table 5. The distance between reaching forward from a static standing position, and shifting the center of gravity. The mean scores of participants practicing FM are higher than those of participants who perform general exercises and those of participants who do not exercise at all. Additionally, of the two control groups, the physically active participants scored higher than the participants who do not exercise at all. However, as Table 6 shows, statistical significance cannot be inferred from these differences between the groups.

Table 6 Variable analysis of computerized balance test results in the FRT

ANOVA

Test	Variance	Sum of squares	Degrees of freedom (df)	Mean	Statistical value (F test)	Significance
FRT	Variance between groups	97.254	2	48.627	1.640	0.200
	Variance within groups	2,638.456	89	29.646		
	Total variance	**2,735.710**	**91**			

Table 6. The statistical value of the F-test is 1.640. There are two degrees of freedom (df) between the groups, and 89 within the groups. The degree of statistical significance is 0.200, (P>0.1), and the difference between the groups is not significant.

Discussion

FM is generally perceived as effective and beneficial, and is widely practiced in Israel and around the world. Studies examining the effects of FM on psychological aspects, e.g., improved mood, and physical aspects, e.g., balance (Chiang 2023; Hillier and Worley 2015, 2023; Molders and Araujo 2023; Smith et al. 2016), have indeed proved its effectiveness.

The present study expanded the extant body of knowledge concerning FM, and examined the association between older women who practice FM and their long-term static and dynamic balance (in their everyday life, not only immediately after a class).

Hypothesis 1

The mean results of the PS and WDI variables in the CTSIB in the present study fall within the norm (comparison of the results of the present study with the mean was performed using the Tetrax® software). PS ranging from 20 to 30, and WDI ranging from 4 to 6. The test results show a difference between the different test results. The more difficult the task (standing on foam-rubber pads compared to standing on a hard surface, or standing with eyes closed compared to eyes open), the bigger the fluctuation in the results obtained.

The results of the CTSIB showed slight differences in favor of the Experimental Group, but they were not statistically significant. A similar finding was obtained in the FRT as well, the results of which did not indicate any significant differences between the groups.

Despite the reliability of the CTSIB, which emerged from the data, and in spite of the relatively large number of participants, and the relatively high number of tests, the slight differences in favor of the Experimental Group are not significant. In other words, the study's first hypothesis was not supported.

What are the possible reasons that no differences were found in favor of the Experimental Group?

In reference to static balance, the reason may stem from the nature of the Tetrax® system. According to the literature (Laufer 2023; Laufer et al. 2000; Schwartz 2005), this system is mainly used to test people who have experienced health events that markedly affect balance, e.g., patients in rehabilitation following a stroke or hip fracture. It may be assumed that more pronounced differences in balance would be found in such populations compared to the participants in the present study, who were relatively healthy, independent women. In other words, a more sensitive system or device that collects data at a rate of 300 results per second (rather than the 32 measured by Tetrax®) might have shown variance between the groups.

Conversely, the reasons may stem from the population itself. The women selected for this study did not suffer from specific balance problems. We might have observed differences between the groups had we chosen women who suffer from balance problems, some of whom practice FM or participate in exercise classes, and others who do not participate in any physical activity.

The literature describes studies that examined the effect of physical exercise on balance in older people, and included a particular intervention (Barnett et al. 2003; Hauer et al. 2003; Kim et al. 2021; Lofshult 2003; Sihvonen, Sipilä and Era 2004). In other words, the participants' balance was tested before and after the exercise program. By contrast, the aim of the present study was to examine whether there is an association between practicing FM and the participants' long-term balance. The study sought to examine whether practicing FM can improve quality of everyday life in older women by being assimilated into their everyday life rather than at a particular time. Significant differences might have been found between the groups had we collected the data immediately after specific physical activity to improve balance.

Although the participants were divided into groups according to participation or non-participation in FM or general exercise classes, this is a retrospective test that has no control over the participants' way of life. The results may have been influenced by intervening factors that could not be controlled, e.g., living on the

fourth floor without an elevator, or regularly walking from one place to another, are factors that could have a positive effect on balance.

Additional uncontrolled data in a retrospective examination, associated with the test itself, which might affect the results of the study, are the exercises given in the classes, group size in the classes, and the group's composition. There are advantages to these data being uncontrolled, e.g., absolute unbiased objectivity, as well as disadvantages, e.g., lack of control, monitoring, and direction.

The FM classes given to the participants over the years did not include specific classes or exercises to improve balance. In other words, in accordance with FM, most of the classes were conducted lying down, and only a few in a sitting or standing position. It may be assumed that FM, or any other physical exercise routine to improve balance, should be examined after practicing positions that challenge balance (e.g., standing). These positions, which challenge the vestibular system vis-à-vis gravity, are likely to contribute more to improving balance. Additionally, some FM classes are held in groups, as in the case of the participants in the present study, and some individually. Practicing FM individually might yield different results.

Hypothesis 2

Regarding the dynamic balance test, the fact that no differences were found between the groups in FRT scores is possibly because various studies proving that different forms of physical exercise improve balance did not measure the effects of the exercises on everyday life (Kim et al. 2021; Tapanya et al. 2023). For example, Tapanya et al. (2023) examined static balance when standing on one foot. This is not a routine function like standing or extending an arm forward, which the present study measured.

There may also be other reasons: this is not a manual test, hence the accuracy of its results is limited in advance; when shifting the center of gravity forward from the body's support base, the body's degree of flexibility (in shoulder, back, and hip joints) is also important, and not only for balance; there was possibly also an

element of social pressure that affected the test results since the FRT was conducted in a waiting room, and there were several participants present at the same time.

Conclusions

Possible reasons for the absence of differences between the groups: while the participants were older, independent women, studies of older people generally focus on populations with health issues; a Tetrax® device is usually used to measure balance in people with balance problems, and may not be sufficiently sensitive to measure balance in a healthy population; the results may have been affected by interfering factors beyond the researchers' control. Lastly, since neither of the study's hypotheses was supported, the possibility that FM does not improve the participants' static and dynamic balance should not be discounted.

Future Research

First, the immediate effects of practicing FM on balance should be examined, i.e., examining balance before and immediately after a class. If there is improvement in balance, how long this improvement lasts should be examined (up to an hour, two hours, a day…), and only then whether the improvement can be assimilated into everyday life.

A comparison should be conducted between different groups (practicing FM, general exercise routines, no physical activity) of young, healthy people aged 20-30, and an older population. In older people, several natural processes lead to impaired balance (Mahoney, Cotton and Verghese 2019; Osoba et al. 2019). Consequently, in older people it is harder to isolate and examine whether there is an association between physical activity – or inactivity – and balance than in younger people.

Balance can be tested before and after a specific FM intervention program to improve balance. An intervention study allows greater control of the studied population's physical and mental condition, the content of the classes, group size, and external confounding variables, e.g., physical activity outside classes.

Summary

The present study joins previous studies that engaged with the association between practicing FM and improved balance, and its uniqueness is that it examines the effect of FM on long-term balance. In other words, unlike most studies, it did not examine the immediate effect of practicing FM, or any other intervention program, but rather how and whether practicing FM over several years affects long-term static and dynamic balance in everyday life. Regrettably, no association was found between practicing FM and improved long-term static and dynamic balance. Nevertheless, and based on the diverse evidence of the considerable effectiveness of FM, it is important to continue examining its effects on routine, everyday skills in different parameters, e.g., balance, rather than being satisfied with relatively short-term effects immediately after an intervention program of one kind or another.

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Statements and Declarations

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Competing interests

The author has no relevant financial or non-financial interests to disclose.

Ethics approval

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Helsinki Committee, Israel.

Consent to participate

Informed consent was obtained from all individual participants included in the study.