ARCHIVES OF BUDO
Journal of Innovative Agonology

e-ISSN: 1643-8698

Section: ***PREVENTIVE MEDICINE FROM INNOAGON PERSPECTIVE*** *Original Paper*

Cognitive-behavioural effects of reducing the susceptibility to the body injuries during the fall by nursing home care patients under the influence of innovative interventions

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Authors' Contribution:

A Study Design
B Data Collection
C Statistical Analysis
D Manuscript Preparation
E Funds Collection

Received: date
Accepted: date 20.12.2024
Published: date 20.12.2024

Dictionary:

Kyu –noun a level of proficiency in some martial arts [49].

INNOAGON – (innovative agonology) is an applied science dedicated to promotion, prevention, and therapy related to all dimensions of health and the optimization of activities that increase the ability to survive (from micro to macro scales) [35, 36].

Abstract:

Background and Study Aim: The phenomenon of the susceptibility to the body injuries during the fall (SFI) is neither a disease nor a pandemic, but affects every person - without exception – throughout ontogeny. Therefore, the three most important tasks of prevention are: permanent monitoring of the SFI phenomenon; reducing errors during unintentional falls through professional interventions; achieving the ability to protect the distal parts of the body that are most exposed to damage during a fall (head, upper limbs, trunk, lower limbs). The aim of this pilot study is the cognitive and motor effects of the intervention program among nursing home care residents (volunteers).

Material and Methods: Of the seven volunteers, the most homogeneous group consisted of four men: aged 62 to 81 years, with a body height of 167 to 174 cm and a weight of 62 to 114 kg; two with primary and two secondary education; all were eligible for the study and had a history of neurological events; and all participated in both general training (GWS) and dedicated safe fall sessions (SFS). The group of patients whose results are analysed is completed by a man, 75 years old (168 cm, 66 kg; primary education; bladder cancer); and a woman, 78 years old (149 cm, 71 kg; primary education; chronic obstructive pulmonary disease; hypertension). Both participated in SFS only.

The STBIDF-M was applied, elevated version (rehabilitation bed), because none of the subjects performed a deep squat during the pre-test. The Timed Test Up and Go (TTUG); 30 seconds Chair Stand Test (30CST) and 6 Minute Walk Test (6'MWT) were used to measure basic functional movement capabilities, balance, lower limb muscle strength and physical performance. In addition: Fall Efficacy Scale – International; the author's Questionnaire 'Fall In My Life'.

Results: All patients reduced collision errors with the distal parts of the body during simulated backward falls under laboratory conditions. The leader reduced errors by 69%. The four patients who participated simultaneously in the GWS and SFS sessions reduced

errors during simulated test falls by between 60% and 27%. This result correlates very highly positively with the number of days of training sessions ($r = 0.725$, but is not statistically significant. The effect of reduced errors in this subgroup correlates positively (considering the directional test) almost fully with the number of SFS ($r = 0.932$, $p<0.05$) and with their duration ($r = 0.926$, $p<0.05$). There is a very high correlation ($r = 0.842$) of the effects of reduced SFI with the number of both categories of sessions, but it is no longer statistically significant.

Conclusions: The method of combining GWS-specific exercises with SFS-specific exercises, as well as explaining the causes of impact injuries with simple examples, has proven to be an effective prevention, mainly in the behavioural dimension. We expect to see increased cognitive effects in recording relevant measures more accurately, as well as in monitoring immediate physiological effects (especially HR at rest and during exercise, explaining simple self-interpretation criteria to people), exercise motivation and satisfaction with motor performance. This is essential information for the individualisation of preventive and therapeutic measures in accordance with the criteria of a complementary approach.

Key words: INNOAGON, Polish School of Safe Falling, possibility of action, Questionnaire 'Fall in My Life'

1. Introduction

The phenomenon of the susceptibility to the body injuries during the fall (SFI) is neither a disease nor a pandemic, but affects every person – without exception – throughout ontogeny. The scientific exploration of this phenomenon has a relatively short history. It was brought to the attention of RM Kalina in 2009 [1], and so far two tests have been developed: STBIDF [1, 2] and STBIDF-M, with verified reliability by independent teams – researchers who did not participate in their creation [3]. The tests, used both in studies of the population of people meeting health standards and various groups at increased risk of falling (including disabilities), provide empirical evidence of the high prognostic value of these unique medical diagnostic tools [4-15]. Diagnosing the SFI phenomenon among children aged 2 to 6 years is possible by using innovative fun forms of falling [16, 17].

The use of video technology during documentation of observations enabled a thorough analysis and innovative interpretations of the results [18, 19]. In this work, we rely on the latest recommendations not yet published by A. Kalina, A. Kruszewski and B. Gąsienica-Walczak. These innovations strengthen the three most important tasks of prevention are: permanent monitoring of the SFI phenomenon; reducing errors during unintentional falls through professional interventions; achieving the ability to protect the distal parts of the body that are most exposed to damage during a fall (head, upper limbs, trunk, lower limbs).

The aim of this pilot study is the cognitive and motor effects of the intervention program among nursing home care residents (volunteers).

2. Materials and Methods

Participants

Of the seven volunteers, the most homogeneous group consisted of four men: aged 62 to 81 years, with a body height of 167 to 174 cm and a weight of 62 to 114 kg; two with primary and two secondary education; all were eligible for the study and had a history of neurological events; and all participated in both general training (GWS) and dedicated safe fall sessions (SFS). The group of patients whose results are analysed is completed by a man, 75 years old (168 cm, 66 kg; primary education; bladder cancer); and a woman, 78 years old (149 cm, 71 kg; primary education; chronic obstructive pulmonary disease; hypertension). Both participated in SFS only.

A 75-year-old man (165 cm, 70 kg; primary education; type 2 diabetes mellitus; hypertension; post-stroke condition) was the only person whose final SFI score worsened, but observation coincided with a radical deterioration of his condition and the patient soon died.

All participants met the inclusion criteria for the study: individual consent; positive medical qualification; awareness of the possibility to withdraw from the project without giving a reason, as well as voluntary participation in the intervention sessions under the guidance of the participating physiotherapist.

Assessment of the susceptibility to body injuries during a fall

The STBIDF-M was applied, elevated version (rehabilitation bed), because none of the subjects performed a deep squat during the pre-test [3]. Each patient was recorded during test performance in such a way that the camcorder was recording the required motor activities in the sagittal plane. The participants waiting for the test were in another room, and they could not contact those who had already performed the test (first implementation). The structure of the STBIDF-M included six motoric tasks.

The manner of protecting body parts that were most exposed to injuries during a fall (legs, hips, right hand, left hand, head) was assessed. Any incorrect collision, as indicated by the fastest possible change of posture from vertical (standing) to horizontal (lying on the back), was recorded as a error (1 point), with no errors recorded as "0". The total score is used as general indicator of the susceptibility to body injuries during a fall (i.e., the SFI Index), with scores classified as very low (0), low (1–11), average (12–18), high (19–23), very high (24–27) and extreme (28–30). The scores obtained for individual body parts legs, hips, right hand, left hand, head: very low (0), low (1) average (2–3), high (4), very high (5), extreme (6).

Motor potential, physical capacity and quality of effort assessment

The Timed Test Up and Go (TTUG) [20, 21], 30 seconds Chair Stand Test (30CST) and 6 Minute Walk Test (6'MWT) [22, 21, 23, 24] were used to measure basic functional movement capabilities, balance, lower limb muscle strength and physical performance.

The assessment of the quality of effort was based on the 'working heart rate' (HR difference indicators} [25] and the effort intensity zone [26] during 6'MWT. The interpretation of the results is based on the works cited above and [27, 28]

Quality of life indicators assessment

The following were used: 1) Fall Efficacy Scale – International [29]; 2) the author's Questionnaire 'Fall In My Life'. The questionnaire contains questions about: frequency of falls, the impact of these events on possible modification of motor activity, anxiety and stress, as well as personal experiences regarding safe fall education.

Documentation of physical effort during the session

The number of days during which patients undertook exercise, the number and duration of GWS and/or SFS sessions were recorded.

Statistical analysis

Quantitative and qualitative indicators of documented empirical variables were used in the individual patient profiles. The ordinal variable of the results presented is the difference in raw scores between the SFI index 'before' and SFI index 'after' and it is the quantitative criterion that we believe facilitates the perception of the results in the simplest way. The qualitative criterion, the proportion of reduced errors (%), may or may not be correlated with the quantitative score. Correlation coefficients were calculated between some of the empirical variables of the individuals observed.

3. Results

An unequivocally positive effect applies to the SFI phenomenon. All patients reduced collision errors with the distal body parts during simulated backward falls under laboratory conditions (Figure 1, Tables 1 to 6). The leader reduced errors by 69%, with a STBIDF-M score of 26 points before the intervention programme and 8 points (Table 1). A patient (P3♂) with an identical SFI Index before the intervention (26 points) reduced errors by 27% (Table 3). Patient P4 with the lowest initial score (SFI Index 14 points), reduced errors by 43% (Table 4). Two patients with identical SFI Index before the experiment (15 points) reduced errors by respectively: P2♂ by 60%, (Table 2), P5♂ by 33% (Table 5). The smallest difference was less than 7%, however, the patient (P1♀) had the lowest error rate (SFI Index 16 points) before the intervention (Table 6).

During the tests at the end of the experiment, all patients did not clap their hands during Tasks 5 and 6, which means: on the one hand, that they may have coordination disorders in the upper limbs during falls under difficult circumstances; on the other hand, that the cessation of clapping did not result in the support of the hands (with the hand) against the ground either before the buttocks and trunk came into contact with it or simultaneously with these body parts.

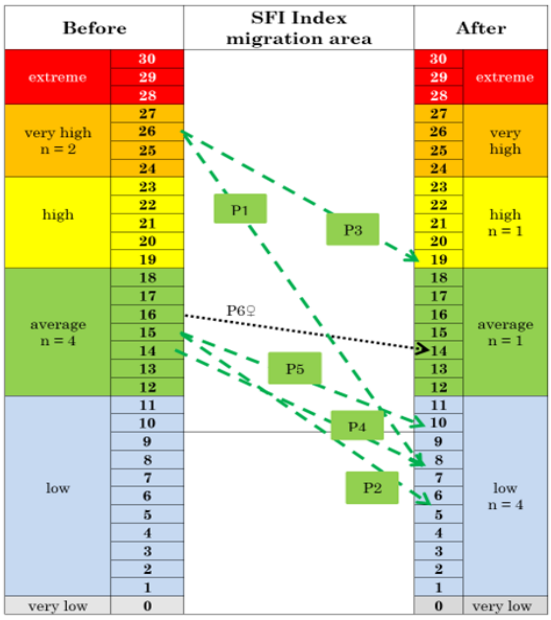

Figure 1. The effect of the intervention program documented by the SFIindex migration of 6 social welfare home patients between measurements before and after the experiment.

Table 1. Profile (before & after) of the effects of a seven-month preventive and therapeutic 'SFI intervention' among nursing home care patients – leader (code & gender: P1♂).

Generally about the patient						
age [years]	**somatic criteria**				**education**	**special motor experience**
	height [cm]	**weight [kg]**	**BMI**			
75	168	66	23.38	desired body weight	primary school	

Clinical characteristic			
case report	**MMSE**	**ADL**	**IADL**
bladder cancer	25 points cognitive impairment without dementia	6 points full efficiency	21points can do housework with a little help; unable to prepare and take medication independently

Motor potential					
Test Up & Go			**30 Seconds Sit To Stand Test**		**comments and remarks**
stage/ effect	seconds	norm*	number	norm**	
before	8.8	faster	16	average	*the 70–79–years–old population performs the test in an average of 9.2 seconds **age group of men 75–79 years: below average <11; Average 11–17; above average >17 slight deterioration of leg muscle strength with marked improvement in locomotor speed
after	7.01		15		
move	1.79 20.35%		0	0	
regress	0		1 6.25%		

Physical capacity and quality of effort							
The 6-Minute Walk Test						**intensity of effort**	
stage/ effect	**meters**	**reference group***	**$Sp0_2$ (%)**	**systolic/diastolic pressure**	**HR (HRmax 156)**	**HR difference**	**%HRmax**

			before test	**after test**	**before test**		**before test**	**after test**		**after test**	**zone (code)**
before	220	41.74%0	97	96	121/75	−4	114	110	−4	70.51	I$_{H}$
after	212	40.23%0	96	97	120/79	0	121	121	0	77.56	I$_{H}$
move	0	inferior to the popula-tion	0	1%	*community dwelling elderly people with independent function who were non-smokers with no history of dizziness and did not use assistive devices; 70-79 years, average test result male 527 meters; slightly higher energy cost of performing the test after the intervention programme with a 6% reduction in distance						
regress	8 5.64%		1%	0							

Quality of life indicators in relation to unintentional falls and prevention								
Fall Efficacy Scale			**Questionnaire 'Fall In My Life' (scale 1 to 10)**					
stage/ effect	**points**	evaluation criteria (points): 16 to 19: indicate low concern about falls 20 to 27: indicate moderate concern about falls 28 to 64 indicate concern about falls [29]	fall very rare (1), often (10)	negative for motor activity: none(1) very high (10)	mental effects: irrelevant (1); very negative (10)		prevention: none (1); special (10)	
					fear	stress	course	knowledge
before	16	indicate low concern about falls	1	10	10	10	1	1
after	16	indicate low concern about falls	1	10	1	1	1	1
move	0		0	0	100%	100%	0	0
regress	0		0	0	0	0	0	0

Susceptibility to the body injuries during the fall (STBIDF-M)											
stage/effect	**legs**	**hips**	**R hand**	**L hand**	**head**	**SFI index**	**level**	**fall at the same level**		**fall from a height with the feet down**	
before	6 (E)	6 (E)	4 (H)	4 (H)	6 (E)	26	VH	15	E	15	E
after	6 (E)	0	0	0	2(A)	8	A	4	L	4	L
move (progress) or no progress (0) of reducing of injuries											
points	0	6	4	4	4	**18**		11		11	
%	0	100	100	100	66.67	**69.23**		73.33		73.33	
comments and remarks	he reduced the probability of multiple body injuries from 86.67% (very high) to 26.67% (low), however, the probability of simultaneous injury to the lower limbs and head (regardless of the circumstances of the fall) is high (66.67%); the more difficult the circumstances of the fall, the greater the probability of impaired hand coordination (error of ceasing to clap during Tasks 5 and 6 of the STBIDF-M after the intervention program, and during Task 6 before)										

Table 2. Profile (before & after) of the effects of a seven-month preventive and therapeutic 'SFI intervention' among nursing home care patients (code & gender: P2♂).

Generally about the patient						
age [years]	**somatic criteria**				**education**	**special motor experience**
	height [cm]	**weight [kg]**	**BMI**			
62	174	91	30.06	obesity I degree	vocational education	karate 3 kyu

Clinical characteristic			
case report	**MMSE**	**ADL**	**IADL**
insulin-dependent diabetes mellitus; spontaneous hypertension; post-stroke condition with right-sided hemiparesis; focal epilepsy	22 points mild dementia	6 points full efficiency	14 points completely unable to travel unless special arrangements are made; completely unable to do any shopping;

			completely unable to do housework on his/her own; unable to do DIY and wash his/her own clothes; unable to prepare and take medication on his/her own

Motor potential

Test Up & Go			30 Seconds Sit To Stand Test		comments and remarks
stage/ effect	seconds	norm*	number	norm**	
before	19.35	more than twice as slow	9	below average	*the 60–69–years–old population performs the test in an average of 8.1 seconds **age group of men 60–64 years: below average <14; average 14–19; above average >19 increased leg muscle strength with a marked reduction in locomotor speed; both indicators differ significantly from the average results of the reference groups
after	21.75		10		
move	0		1 11.1%		
regress	2.4 12.4%		0		

Physical capacity and quality of effort

The 6-Minute Walk Test									intensity of effort		
stage/effect	**meters**	**reference group***	**Sp02 (%)**		**systolic/diastolic pressure**		**HR (HRmax 165)**		**HR difference**	**%HRmax**	
			before test	**after test**	**before test**	**after test**	**before test**	**after test**		**after test**	**zone code**
before	94	16.43%	98	99	156/77	191/82	58	67	9	40.61	I$_{L}$
after	106	18.53%	95	97	112/66	132/70	62	66	4	40	I$_{L}$
move	12 12.77 %	grossly inferior to the popula-tion	0	0	*community dwelling elderly people with independent function who were non-smokers with no history of dizziness and did not use assistive devices; 60-69 years, average test result male 572 meters; slight increase in distance after the intervention programme with a reduced HR difference during the 6'MWT may be related to low motivation for more intense exercise						
regress	0		3%	2%							

Quality of life indicators in relation to unintentional falls and prevention

Fall Efficacy Scale			Questionnaire 'Fall In My Life' (scale 1 to 10)					
stage/effect	**points**	evaluation criteria (points): 16 to 19: indicate low concern about falls 20 to 27: indicate moderate concern about falls 28 to 64 indicate concern about falls [29]	fall very rare (1), often (10)	negative for motor activity: none(1) very high (10)	mental effects: irrelevant (1); very negative (10)		prevention: none (1); special (10)	
					fear	stress	course	knowledge
before	24	indicate moderate concern about falls	1	10	1	1	10	6
after	19	indicate low concern about falls	1	10	5	7	7	1
move	5		0	0	0	0	0	0
regress	0		0	0	50%	70%	30%	100%

Susceptibility to the body injuries during the fall (STBIDF-M)

stage/effect	legs	hips	R hand	L hand	head	SFI index	level	fall at the same level		fall from a height with the feet down	
before	6 (E)	6 (E)	0(VL)	0(VL)	3 (A)	15	A	8	A	7	A
after	6 (E)	0(VL)	0(VL)	0(VL)	0(VL)	6	L	3	L	3	L
move (progress) or no progress (0) of reducing of injuries											
points	0	6	0	0	3	**9**		5		4	

%	0	100	0	0	100	**60**	37.5	42.86
comments and remarks	he reduced the probability of multiple body injuries from 50% (average) to 0% (very low), however, the probability of injury to the lower limbs is still extremely (100%); the more difficult the circumstances of the fall; the greater the probability of impaired hand coordination (error of ceasing to clap during Tasks 5 and 6 of the STBIDF-M, both before and after the intervention program)							

Table 3. Profile (before & after) of the effects of a seven-month preventive and therapeutic 'SFI intervention' among nursing home care patients (code & gender: P3♂).

Generally about the patient						
age [years]	**somatic criteria**				**education**	**special motor experience**
	height [cm]	**weight [kg]**	**BMI**			
65	167	62	22.23	correct weight	secondary education	

Clinical characteristic			
case report	**MMSE**	**ADL**	**IADL**
right hemiparesis after ischemic stroke; dementia syndrome of unknown aetiology	19 points mild dementia	6 points Full efficiency	23 points with a little help, prepares and administers medication

Motor potential					
Test Up & Go			**30 Seconds Sit To Stand Test**		**comments and remarks**
Stage /effect	seconds	norm*	number	norm**	
before	10.64	slower	11	below average	*the 60–69–years–old population performs the test in an average of 8.1 seconds **age group of men 65–69 years: below average <12; average 12–18; above average >18 improvement in below average levels of leg muscle strength to average (by 10.71%) and by 13.53% in locomotor speed
after	9.2	slower	15	average	
move	1.44 13.53%		4 10.71%		
regress	0		0		

Physical capacity and quality of effort											
The 6-Minute Walk Test									**intensity of effort**		
stage/ effect	**meters**	reference group*	**$Sp0_2$ (%)**		**systolic/diastolic pressure**		**HR (HRmax 163)**		**HR** difference	**%HRmax**	
			before test	**after test**	**before test**	**after test**	**before test**	**after test**		**after test**	**zone (code)**
before	272	47.55%	94	98	139/92	158/103	86	87	1	53.37	I_L
after	360	62.94%	99	95	145/90	136/90	72	86	14	52.76	I_L
move	88 24.44%	inferior to popula-tion	5%	0	*community dwelling elderly people with independent function who were non-smokers with no history of dizziness and did not use assistive devices; 60-69 years, average test female result 572 meters; locomotor capacity, despite improvement, is regressing in the population; a greater difference in HR during the 6'MWT after the intervention programme may indicate increased motivation to exercise						
regress	0		0	3%							

Quality of life indicators in relation to unintentional falls and prevention								
Fall Efficacy Scale			**Questionnaire 'Fall In My Life' (scale 1 to 10)**					
stage/ effect	**points**	evaluation criteria (points): 16 to 19: indicate low concern about falls 20 to 27: indicate moderate concern about falls 28 to 64 indicate concern about falls [29]	fall very rare (1), often (10)	negative for motor activity: none(1) very high (10)	**mental effects: irrelevant (1); very negative (10)**		**prevention: none (1); special (10)**	
					fear	stress	course	knowledge

before	28	reduced all fear: from 3 to 1 (when dressing and undressing; when bathing or showering; walking up and down steep terrain); from 2 to 1 (when cleaning the house/apartment; sitting down and getting up from a chair; walking up and down stairs; reaching for things overhead or on the ground; walking in a crowded place; walking on a slippery surface)	3	10	10	5	1	1
after	16		1	10	1	1	8	1
move	100%		2	0	100%	100%	80%	0
regress	0		0	0	0	0	0	0

Susceptibility to the body injuries during the fall (STBIDF-M)											
stage/ effect	**legs**	**hips**	**R hand**	**L hand**	**head**	**SFI index**	**level**	**fall at the same level**		**fall from a height with the feet down**	
before	6 (E)	6 (E)	6 (E)	6 (E)	2(A)	26	VH	13	VH	13	VH
after	6 (E)	6 (E)	4(H)	1(L)	2(A)	19	H	10	H	9	A
move (progress) or no progress (0) of reducing of injuries											
points	0	0	2	5	0	**7**		3		4	
%	0	0	33.33	83.33	0	**26.93**		23.01		30.77	
comments and remarks	reduced the probability of multiple body injuries from 86.67% (very high) to 63.33% (high) regardless of the circumstances of the fall; progress concerns the left hand (errors reduced by 83.33%%) and to a lesser extent the right hand (by 33.33%); the greater the probability of impaired hand coordination (error of ceasing to clap during Tasks 5 and 6 of the STBIDF-M, after the intervention program)										

Table 4. Profile (before & after) of the effects of a seven-month preventive and therapeutic 'SFI intervention' among nursing home care patients (code & gender: P4♂).

Generally about the patient						
age [years]	**somatic criteria**				**education**	**special motor experience**
	height [cm]	**weight [kg]**	**BMI**			
81	170	68	23.53	correct weight	secondary education	wrestling

Clinical characteristic			
case report	**MMSE**	**ADL**	**IADL**
arterial hypertension; damage to the left median nerve at the wrist; damage to the left ulnar nerve at the elbow joint; condition after ischemic stroke with right-sided hemiparesis and aphasia	20 points mild dementia	5 points full efficiency	23 points is completely unable to travel unless special arrangements are made; is completely unable to make any purchases; is unable to prepare and take medication independently; is unable to manage money independently

Motor potential					
Test Up & Go			**30 Seconds Sit To Stand Test**		**comments and remarks**
stage/ effect	**seconds**	**norm***	**number**	**norm**	
before	**34.73**	**over three times slower**	**4**	**below average**	*the population of people aged 80–99 years completes the test on average in 11.3 seconds ** age group of men 80–84 years: below average <9; average 9–14; above average >14 he maintains a very low level of leg muscle strength and has impaired locomotor speed
after	38.98		4		
move	0		0		
regress	4.25 12.24		0		

Physical capacity and quality of effort

The 6-Minute Walk Test									intensity of effort		
stage/ effect	**meters**	reference group*	**$Sp0_2$ (%)**		**systolic/diastolic pressure**		**HR (HRmax 151)**		**HR** difference	**%HRmax**	
			before test	**after test**	**before test**	**after test**	**before test**	**after test**		**after test**	**zone (code)**
before	64	15.35%	99	99	154/68	170/76	65	72	7	47.68	I_L
after	77	18.47%	95	99	134/68	146/68	62	58	4	38.41	I_L
move	13 20.31%	grossly inferior to the popula-tion	4%	0	*community dwelling elderly people with independent function who were nonsmokers with no history of dizziness and did not use assistive devices; 80-89 years, average test female result 417 meters; despite improvement, locomotor capabilities are inferior to those of the general population; good saturation after both 6'MWT but a small difference in HR during 6'MWT, especially after the intervention program, may indicate low motivation for cyclic physical exercise						
regress	0		0	0							

Quality of life indicators in relation to unintentional falls and prevention								
Fall Efficacy Scale			**Questionnaire 'Fall In My Life' (scale 1 to 10)**					
stage/ effect	**points**	evaluation criteria (points): 16 to 19: indicate low concern about falls 20 to 27: indicate moderate concern about falls 28 to 64 indicate concern about falls [29]	fall very rare (1), often (10)	negative for motor activity: none(1) very high (10)	mental effects: irrelevant (1); very negative (10)		prevention: none (1); special (10)	
					fear	stress	course	Knowledge
before	21	significantly increased concern about falls	5	1	2	1	1	1
after	29		3	1	1	1	8	1
move	0		2	0	50%	0	80%	0
regress	38.09%		0	0	0	0	0	0

Susceptibility to the body injuries during the fall (STBIDF-M)											
stage/ effect	**legs**	**hips**	**R hand**	**L hand**	**head**	**SFI Index**	**level**	**fall at the same level**		**fall from a height with the feet down**	
before	6 (E)	6 (E)	0 (VL)	0 (VL)	2(A)	14	A	7	A	7	A
after	6 (E)	0 (VL)	0(VL)	0(VL)	2(A)	8	L	4	L	4	L
move (progress) or no progress (0) of reducing of injuries											
points	0	6	0	0	0	**6**		3		3	
%	0	100%	0	0	0	**42.86%**		42.86%		42.86%	
comments and remarks		reduced the probability of multiple body injuries from 46.67% (average) to 26.67% (low) regardless of the circumstances of the fall; the greater the probability of impaired hand coordination (error of ceasing to clap during Tasks 5 and 6 of the STBIDF-M, both before and after the intervention program)									

Table 5. Profile (before & after) of the effects of a seven-month preventive and therapeutic 'SFI intervention' among nursing home care patients (code & gender: P5♂).

Generally about the patient						
age [years]	**somatic criteria**				**education**	**motor experience**
	height [cm]	**weight [kg]**	**BMI**			
63	170	114	39.45	obesity II degree	vocational school	
Clinical characteristic						

case report	MMSE	ADL	IADL
status post cerebellar ischemic stroke; hypertension; gout; vascular damage to the central nervous system; right hemiparesis; mixed aphasia	26 points cognitive impairment without dementia	5 points full efficiency	12 points is completely unable to travel unless special arrangements are made; goes out shopping for groceries with little help; is unable to prepare a meal for himself/herself; can do housework with little help; is unable to do his/her own DIY/wash his/her own laundry; is unable to prepare and take medication independently; is unable to manage money independently

Motor potential

Test Up & Go			30 Seconds Sit To Stand Test		comments and remarks
stage/ effect	seconds	norm*	number	norm**	
before	15.4	slower	9	below average	*the 60–69–years–old population performs the test in an average of 8.1 seconds **age group of men 60–64 years: below average <14; average 14–19; above average >19 an improvement in the level of leg muscle strength to below average level (by 22%) with a 28% deterioration in locomotor speed does not significantly change the motor potential in this dimension
after	19.74	slower	11		
move	0		2 22.22%		
regress	4.34 28.18%		0		

Physical capacity and quality of effort

The 6-Minute Walk Test									intensity of effort		
stage/ effect	meters	reference group*	$Sp0_2$ (%)		systolic/diastolic pressure		HR (HRmax 164)		HR difference	%HRmax	
			before test	after test	before test	after test	before test	after test		after test	zone (code)
before	130	22.73%	95	97	146/80	152/82	95	127	32	77.44	I_H
after	110	19.23%	95	98	138/83	155/78	109	125	16	76.22	I_H
move	0	grossly inferior to the population	0	0	*community dwelling elderly people with independent function who were non-smokers with no history of dizziness and did not use assistive devices; 60-69 years, average test male result 572 meters; deteriorated locomotor capacity significantly subsides in the population; a twofold difference in HR during the 6'MWT before the intervention programme may indicate a decrease in motivation to exercise intensively						
regress	20 15.38%		0	1%							

Quality of life indicators in relation to unintentional falls and prevention

Fall Efficacy Scale			Questionnaire 'Fall In My Life' (scale 1 to 10)					
stage/ effect	points	evaluation criteria (points): 16 to 19: indicate low concern about falls 20 to 27: indicate moderate concern about falls 28 to 64 indicate concern about falls [29]	fall very rare (1), often (10)	negative for motor activity: none(1) very high (10)	mental effects: irrelevant (1); very negative (10)		prevention: none (1); special (10)	
					fear	stress	course	knowledge
before	29	reduced all fear: from 4 to 1 (when walking around the home); from 4 to 2 (when walking on uneven surfaces); from 3 to 1 (when cleaning the house/apartment); from 3 to 2 (when walking on slippery surfaces); from 2 to 1 (when walking up and down stairs; deterioration of fear from 2 to 3 (when bathing or showering, reaching for things overhead or on the ground;); from 1 to 2 (walking up and down steep terrain)	3	1	7	5	1	1
after	21		1	1	3	3	10	1
move	27.6%		66.67%	0	42.86%	400%	100%	0
regress	0		0	0	0	0	0	0

Susceptibility to the body injuries during the fall (STBIDF-M)

stage/ effect	legs	hips	R hand	L hand	head	SFI index	level	fall at the same level		fall from a height with the feet down	
before	6 (E)	6 (E)	0	0	3(A)	15	A	7	A	8	A
after	6 (E)	2(A)	0	0	2(A)	10	L	5	A	5	A

move (progress) or no progress (0) of reducing of injuries

points	0	4	0	0	1	**5**	2	3
%	0	66.67	0	0	33.33	**33.33**	28.57	37.5
comments and remarks	he reduced the probability of multiple body injuries from 50% (average) to 33.33% (average) regardless of the circumstances of the fall; the greater the probability of impaired hand coordination (error of ceasing to clap during Tasks 5 and 6 of the STBIDF-M, after the intervention program)							

Table 6. Profile (before & after) of the effects of a seven-month preventive and therapeutic 'SFI intervention' among nursing home care patients (code & gender: P6♀).

Generally about the patient						
age [years]	**somatic criteria**				**education**	**special motor experience**
	height [cm]	**weight [kg]**	**BMI**			
78	149	71	31.98	obesity I degree	primary school	

Clinical characteristic			
case report	**MMSE**	**ADL**	**IADL**
chronic obstructive pulmonary disease; arterial hypertension	19 points mild dementia	6 points full efficiency	19 points will cover a distance beyond walking distance with little help; will purchase groceries with little help; with a little help will prepare and take medication; is unable to manage money independently

Motor potential					
Test Up & Go			**30 Seconds Sit To Stand Test**		**comments and remarks**
stage/ effect	seconds	norm*	number	norm**	
before	10.3	slower	10	average	*the 70–79–years–old population performs the test in an average of 9.2 seconds **age group of women 75–79 years: below average <10; average 10–15; above average >15 [….] maintaining average levels of leg muscle strength with a 20% deterioration in locomotor speed
after	12.33	slower	10	average	
move	0		0	0	
regress	2.03 19.71%		0		

Physical capacity and quality of effort											
The 6-Minute Walk Test									**intensity of effort**		
stage/ effect	**meters**	reference group*	**$Sp0_2$ (%)**		**systolic/diastolic pressure**		**HR (HRmax 153)**		**HR difference**	**%HRmax**	
			before test	**after test**	**before test**	**after test**	**before test**	**after test**		**after test**	**zone (code)**
before	172	36.52%	93	96	133/74	157/66	92	114	22	74.51	I_{MO} I_H
after	80	16.99%	97	96	152/76	176/80	86	97	11	63.4	I_{MO}
move	0	grossly inferior to the population	3%	0	*community dwelling elderly people with independent function who were non-smokers with no history of dizziness and did not use assistive devices; 70-79 years, average test female result 471 meters; 12% lower energy cost of performing the test after the intervention programme, but with a 53% reduction in distance						
regress	92 53.49%		0	0							

Quality of life indicators in relation to unintentional falls and prevention								
Fall Efficacy Scale			**Questionnaire 'Fall In My Life' (scale 1 to 10)**					
stage/ effect	**points**	evaluation criteria (points): 16 to 19: indicate low concern about falls 20 to 27: indicate moderate concern about falls 28 to 64 indicate concern about falls	fall very rare (1), often (10)	negative for motor activity: none(1) very high (10)	**mental effects: irrelevant (1); very negative (10)**		**prevention: none (1); special (10)**	
					fear	stress	course	knowledge

before	24	fear: reduced from 3 to 2 (walking up and down stairs); reduced from 2 to 1 (sitting down and getting up from a chair; reaching for things overhead or on the ground; walking in a crowded place; going out on different occasions); invariably 2 (walking around the area where you live; walking on slippery or uneven surfaces) increase from 1 to 2 (while bathing or showering; rushing to the phone; walking up and down steep terrain)	2	7	10	10	1	1
after	23		2	7	1	1	1	1
move	1 4.17%		0	0	100%	100%	0	0
regress	0		0	0	0	0	0	0

Susceptibility to the body injuries during the fall (STBIDF-M)											
stage/ effect	**legs**	**hips**	**R hand**	**L hand**	**head**	**SFI index**	**level**	**fall at the same level**		**fall from a height with the feet down**	
before	6 (E)	6 (E)	1 (L)	1 (L)	2 (A)	16	A	9	A	7	A
after	6 (E)	6 (E)	0(VL)	0(VL)	2(A)	14	A	4	A	4	A
move (progress) or no progress (0) of reducing of injuries											
points	0	0	1	1	0	**2**		5		3	
%	0	0	100	100	0	**6.66**		55.56		42.86	
comments and remarks		she reduced the probability of multiple body injuries from 53.33% (average) to 46.67% (average), however, the probability of simultaneous injury to the lower limbs, hips and head (regardless of the circumstances of the fall) is very high (77.78%); the greater the probability of impaired hand coordination (error of ceasing to clap during Tasks 5 and 6 of the STBIDF-M, both before and after the intervention program)									

Insufficiently effective was this intervention programme in sleepily strengthening the lower limbs sufficiently so that, during a fall, the person could compensate for loss of balance by a deepened squat before the body collided with the ground. However, it appeared that the number of repetitions by patients of the recommended specialised exercises (with the exception of one person) was sufficient to complete a simulated backward fall on an elevated (rehabilitation bed) to perform a 'cradle', i.e. to initiate cushioning rolling of the body upon impact with the ground. These exercises apparently resulted in a strengthening of the abdominal muscles (and this motor ability is not measured by the tests used and recommended).

Other motor and physical performance effects vary individually. Mental effects, including those related to quality of life, are more pronounced. With the exception of one patient (P4♂), the remainder either reduced completely or significantly the concern that the threat of falling limits their physical activity (Fall Efficacy Scale scores). These observations complement the results of the proprietary Questionnaire 'Fall In My Life'. Five patients reduced anxiety and four reduced stress that were related to thoughts of unintentional falling..

The four patients who participated simultaneously in GWS and SFS sessions reduced errors during simulated test falls from 60% to 27% (Table 7). This result correlates very highly positively with the number of training days ($r = 0.725$, but is not statistically significant. The leader with the highest number of training days (P4♂) and at the same time the sum of both categories of sessions, as well as the number of minutes he spent exercising, is third among the tested patients in terms of the qualitative effect of reduced errors (43%). The effect of reduced errors in this subgroup correlates positively (taking into account the directional test reasonably) almost fully with the number of SFS ($r = 0.932$, $p<0.05$) and with their duration ($r = 0.926$, $p<0.05$). There is a very high correlation ($r = 0.842$) of the effects of reduced SFI with the number of both categories of sessions, but it is no longer statistically significant.

Table 7. Number and duration of patient intervention sessions in relation to the reduced SFI phenomenon.

Patient	SFI reducing effect [%]	General workout sessions			Safe fall sessions			Total	
		number	minutes	total minutes	number	minutes	total minutes	sessions	minutes
P1♂	69	0	-	-	38	5 to 15	402	38	402
P2♂	60	38	10 to 65	1194	44	5 to 15	472	82	1666
P3♂	27	10	20 to 40	240	35	5 to 15	360	45	600
P4♂	43	47	20 to 70	1825	37	5 to 15	372	84	2197
P5♂	33	12	20 to 45	348	33	5 to 15	350	45	698
P6♀	7	0	-	-	42	5 to 15	410	42	410

Only the male subject achieved the most positive motor effects in a particular sense, despite a history of neurological incidents (P2♂). When performing the STBIDF-M at the end of the experiment, he made no errors hitting the ground with his hips (torso), hands or head during each of the six test tasks (Table 2).

The motor modifications used (clapping the hands and pressing the sponge with the chin against the torso) are very effective preventive measures. Of the half of the patients who supported themselves with their hands during the first Task before experiment, all eliminated these errors, with only P3♂ with the left hand reducing errors by 83% and with the right hand by 33% (Table 3).

4. Discussion

We attempt to base the analysis and discussion of the results on a complementary approach, as only residual knowledge of complementary research methodology is available [30, 31]. The interpretation of STBIDF-M results used in this analysis according to criteria not yet published by A. Kalina, A. Kruszewski, and B. Gąsienica-Walczak nevertheless shows extensive cognitive and application possibilities. These methodological innovations have their origins in the earlier work of the aforementioned research team [18, 15, 19]. In the original applications of STBIDF [1, 2] and STBIDF-M [3], the reliance on first- and second-order error ratings for the upper and lower limbs (legs in the case of STBIDF only in the last, third Task) deprived researchers of the possibility of precise diagnosis. This dilemma has only disappeared with the use of video technology during test observations. It is even possible to replay a specific sequence of a simulated fall multiple times and ascertain the specifics of the errors made.

Such knowledge and precisely this complementary approach, taking into account each profile individually, highlights the importance of diligence – starting with a thorough diagnosis, through the development of individual exercise programmes, step-by-step monitoring of effects and continuous motivation of patients. This observation is deeply substantiated by significant empirical findings. Despite a months-long intervention programme, none of the patients strengthened their lower limbs to such an extent that their natural function as 'shock absorbers' during loss of balance and falls was significantly improved. The results of the observations clearly indicate the patients' interest in the SFS session exercises. Since the observed effect of these specialised exercises is a marked improvement in the strength of the abdominal muscles, skilfully weaving exercises to improve

the shock-absorbing function of the lower limbs into this type of session is an opportunity to address what we believe to be the most significant problem of proper fall prevention. This point is important because it is impossible to eliminate falls from a person's physical activity (or even during sleep).

In addition, the empirical data presented in this paper confirm the earlier conclusions of the experts of the Polish School of Safe Falling that age, gender, physical ability and even a wide range of physical and intellectual disabilities are not obstacles to prevent the learning of safe fall [4, 9, 12, 13, 32-34]. Against the background of these observations, an important further implication is that of monitoring motivation during preventive and therapeutic exercise. This important diagnostic element is overlooked in recommendations based on the paradigm of, to say the least, fitness stimulation. It is the lack of this knowledge that prevents a meaningful interpretation of the results regarding the quality of patients‘ exercise during the 6'WMT. Meanwhile, the results of studies based on INNOAGON recommendations [35-38] favouring the measurement of 'possibility of action' (the strength, intellectual or manipulative prowess, knowledge/skill and willingness sufficient to perform a given action [39]), provide evidence of the cognitive relevance of such an approach [40-44]. However, most momentous, in our view, are the evidence-based recommendations that a radical breakthrough, in some sense, of traditional thinking about falls prevention [45], can be provided by modern, complementary preventive medicine [46-50].

5. Conclusions

The method of combining GWS-specific exercises with SFS-specific exercises (whether the sessions followed one after the other or were separated by breaks), as well as explaining the causes of collision damage with simple examples, proved to be an effective prevention, mainly in the behavioural dimension. We expect to see increased cognitive (and of course also behavioural) effects in recording relevant measures more accurately (repetition of exercise with cyclic and variation principles over longer periods, etc.), as well as in monitoring immediate physiological effects (especially HR at rest and during exercise, explaining simple self-interpretation criteria to people), motivation to exercise and the degree of satisfaction with motor performance. This is essential information for the individualisation of preventive and therapeutic measures in accordance with the criteria of a complementary approach.

Data Availability Statement: The data supporting this study's findings are available from the corresponding author upon reasonable request.

Institutional Review Board Statement: The study was approved by the Research Ethics Committee of University of Warminsko-Mazurski in Olsztyn nr 17/2022.

Conflicts of Interest: The authors declared no conflict of interest.

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Citation: Klimczak J, Dobosz D, Balewska-Juras K et al. Cognitive-behavioural effects of reducing the susceptibility to the body injuries during the fall by nursing home care patients under the influence of innovative interventions. Arch Budo J Inn Agon 2024, 20: 100-117