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A preparation cycle in strength training as a form of health training for adults

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
F Literature Search
G Funds Collection

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abstract

Background: The authors assume that 8-month systematic physical activity with individually selected resistance of progressively increasing volume and intensity will counteract the processes related to regress of motricity and the unfavourable change of body composition in people over 40 years old.

Material and methods: The research involved 178 persons (92 women and 86 men) aged 40–61 years old. The participants pursued training with small and medium weights, broken down into a younger (40–50 years) and an older (51–61 years) group. The workout plan was modelled on the adaptive strength training method (ASTM), which is used by weightlifters and bodybuilders. The change in overall physical fitness was assessed by means of the Pilicz test, body mobility and changes in selected parameters of body composition.

Results: In both groups (51–61 years old and 40–50 years old), a decrease in body weight and the adipose tissue and improved physical fitness and body mobility were noted. The most significant result was an increase by 18% of the lower limbs strength in women and men, while in the case of the upper limbs, the increase in strength in males was by 19% and in women by as much as 31%. Furthermore, levelling of overall fitness among the ASTM participants occurred.

Conclusions: Extensive mobilisation of the motor apparatus that is ensured by adaptive training offers highly beneficial effects in the fight against the symptoms of aging. After consultation with a doctor, this workout may be found useful in the prevention of injuries, the motor system dysfunctions, overweight and cardiovascular diseases in adults.

Key words: health training, strength training, adaptive strength training method, adults.

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INTRODUCTION

According to demographers' forecasts, by 2030 the population in the productive age in Poland will have decreased by 3.2 million, and simultaneously the population in the post-productive age will have increased by about 3 million [1]. A significant population growth will occur in the oldest age groups. It is estimated that the period after 2020 will be characterised by rapid ageing of the population, a low birth rate, increasing maternal age and a gradual rise in the number of deaths [2, p. 24]. The Polish population's extending age often involves a decline in the quality of life. Osiński [3] underlines that only 15–20% of adult Poles take up physical activity in a satisfactory amount, which is a weak result comparing to Europe. In addition, 42% of adult Poles spend more than 6h per day in a seated position, and the percentage of people leading a sedentary lifestyle is growing more dynamically than expected [4, 5]. In 2008, 55% of Poles admitted to inactivity, while 5 years later the population of physically inactive people increased by another 4% [6, p. 23]. The 2030 forecast expects an advance of this phenomenon up to 63% of adult Poles. It is presumed that future Polish society, dominated by people at the pre-retirement and retirement age, will be a serious burden to the state because of their weak physical condition. Therefore, there is a need for intensifying efforts to improve the health and the quality of life of ageing society because, as Szukalski emphasises, "the decline in labour resources resulting from an ageing population means a need to reduce its impact by means of an increase in labour productivity and an increase in the professional activity of elderly people" [1, p. 415]. However, the main problem in increasing the professional activity of mature and elderly people is the regress of their physical performance resulting from the involutional structural changes in internal organs, the respiratory system, the circulatory system and the passive and active motor system [7], which is larger and more dynamic than in peers from other European countries [8].

It has been found that appropriate physical training, taken up regardless of age, causes certain adaptive changes in the body, and the frequency of the undertaken effort is a vital factor in these changes [9–15]. It also follows from the mentioned publications that work of an endurance and strength character of effort is a legitimate direction of motor impact. Therefore, this study focuses on looking for a suitable method of strength training to inhibit involutional processes or to improve physical fitness of working people over 40 years of age. An attempt has also been made to determine the optimal external loads in the context of an effective dose of physical effort and to determine possible negative effects of resistance training.

MATERIAL AND METHODS

The original method by Tadeusz Stefaniak, defined as the Adaptive Strength Training Method (ASTM), in practice is generally used by athletes as an introductory method for resistance training of various special purposes [16]. The aim of the study was to determine the usefulness of a cycle of strength workouts based on the adaptive strength training method (ASTM) in training to delay a process of regression of physical fitness for men and women aged over 40. The evaluation of the training effects was based on a comparison of the initial and final values of selected parameters of the lipid profile and general fitness during an 8-month ASTM macrocycle. An original training cycle according to the methodological assumptions of strength training [16, p. 4; 17,p. 206; 18, p. 227] was planned with a view to developing exercise capacity and inhibiting involutional processes in women and men manifested in lowered physical fitness (an outline in Appendix 1).

Subjects

The study participants were volunteers, professionally active persons (N = 178;F = 92; M = 86), 40–61 years old, who after individual consultation with a doctor and performing control tests agreed to participate in the research program. Each experiment participant performed one 8-month workout cycle (Appendix 1). The following eligibility criteria for the study were adopted:

- absolute counter indications for moderate to medium intensity effort,
- absence of chronic diseases requiring medication: of the nervous system, cardiovascular and mental illnesses,
- at least 70% attendance during the 8-month workout cycle.

The participants of adaptive training were divided according to their age: Group I – older persons (51–61 years old) and Group II – younger persons (40–50 years old) (Fig. 1).

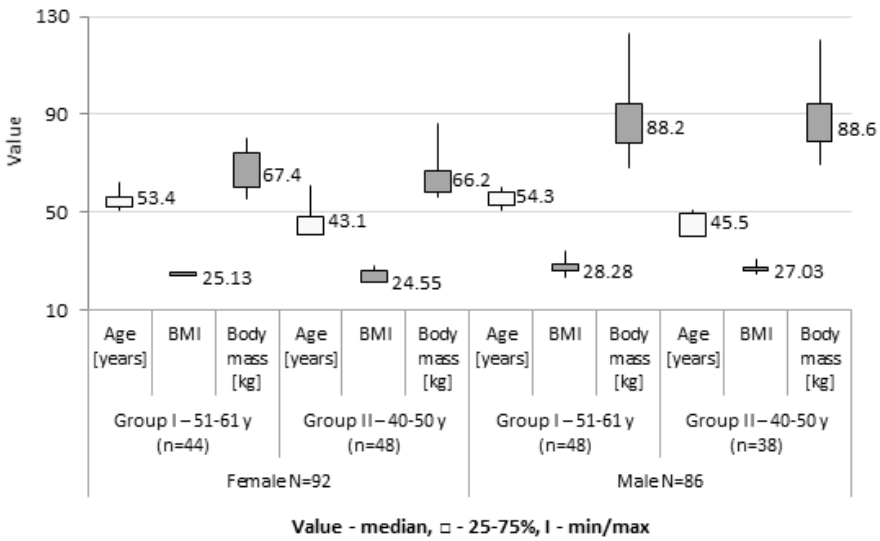

Fig. 1. Characteristics of the subjects

Description of the adaptive strength training method

The training plan involved an original method for introduction to strength training described by Tadeusz Stefaniak as the Adaptive Method (AM), or the Adaptive Strength Training Method (ASTM) [16, p. 4]. The author recommends using a specific cycle of exercises preparing the organism for increased work during the proper strength training. It is a program for people wishing – in the long run – to develop the strength potential and to build muscle mass. The main advantage of this method is a very large area of influence on the active motor system. ASTM is recommended for adults, mainly as introduction to strength exercises for different purposes, or as part of a sport pre-workout. It has not been applied on a large scale as health training or training compensating and inhibiting involutional processes, although there are publications proving its effectiveness [19].

ASTM is a circuit workout, and the regulation of training loads consists in increasing the volume of each exercise by one repetition at each subsequent training session, then multiplying the series of performed exercises, and only then in raising the intensity of work by increasing external resistance.

THE METHODOLOGICAL-ORGANIZATIONAL ASSUMPTIONS OF THE TRAINING FOR THE STUDY GROUPS

1. Research was conducted over a period of three years in which three editions of an 8-month ASTM macrocycle were implemented from October to late May. In each cycle 87 training units were planned (Appendix 1). Each subject participated in only one training macrocycle. All classes were held in one gym under the supervision of instructors. Each year, 2 series of tests were run, at the beginning (study 1) and at the end (study 2) of the 8-month study period of all participants who took up the training for the first time and completed their training plan in the last month of the experiment (in May).

2. The trainings for both groups were held 3 times a week in the afternoon: Group I – Mondays, Wednesdays, Fridays; Group II – Tuesdays, Thursdays, Saturdays. The participants decided themselves in which phase of the macrocycle they would implement the training plan two or three times a week. However, they were obliged to participate in at least 75% of the 8-month cycle (minimum 65 training units).

3. Two exercises were selected for each main body parts – for flexors and extensors. In the case of abdominal muscles, these were four exercises (due to abdominal oblique muscles). In one training session the participants performed 20 different exercises for all the body parts in the form of a circuit (Appendix 2).

4. In the first 2 weeks of the training, the focus was on learning techniques, and basic loads were used for the exercise.

5. In strength training individual loads are applied which depend on the capabilities of the exercising persons. The older (I) and younger (II) groups were both divided into subgroups A and B depending on the choice of the initial load, based on the strength training methodology [17, p. 206; 18, p. 227]. Sub-groups A performed strength training with medium weights (13–18 reps), and sub-groups B exercised with small weights but with more repetitionss (19–24 reps). The choice of the starting load was based on selecting such resistance that the exercising person performed in an unforced manner in the last repetition, but with increased agitation. Persons were assigned to particular subgroups on the basis of an interview about previous physical activity. Physically active persons were assigned to subgroup A, while beginners or those returning to an active lifestyle after a long break were assigned to subgroup B.

6. Breaks between exercises were not strictly defined; each participant could decide himself/herself when to approach the next exercise. During the break he/she was obliged to do flexibility exercises. A modified PIR method (post-isometric relaxation of muscles) was used in the alternate work which focused on maintaining a position forcing eccentric muscle work from 15 to 20 seconds with double progression of muscle elongation), stretching (alternately concentric and eccentric muscle work for up to 10 seconds) and swinging both straightened and flexed limbs in different directions as dynamic stretching.

7. Each workout started with a 15-minute warm-up of an aerobic character. The main part of strength training lasted between 60 and 80 minutes. In the 10-minute final part, the participants performed stretching exercises.

8. The main part of the training was started with 1 series of exercises with 13 (option A) or 19 (variant B) repetitions. In each next training session, the participant performed 1 repetition more until reaching the limit of 18 (for A) or 24 (for B) repetitions. Then the volume of training was increased by 1 series, returning to the original number of repetitions. When he/she performed all the exercises in 2 series in the successive training unit, they could increase the resistance by 5–10%. However, this change required a return to the volume of 1 series and 13 (for A) or 19 (for B) repetitions. To increase the resistance again by 5–10%, all previous phases of the training had to be completed.

9. The principles of strength training were applied: cycles of work, systematic activity, increasing loads and the principle of muscle confusion [16–18].

10. The current control was conducted by students of the instructing specialisation in bodybuilding.

Research method

1. Assessment of physical fitness was based on 5 trials of point test of general physical fitness according to Pilicz [20], which included the following tests: catching a falling sticks – [assessment of reaction time: 0–1]; lifting legs perpendicularly while lying on the back for 20 s [n]; broad jump or standing jump-and-reach (to choose) [cm]; burpees (squat thrusts) for 20 s [n]; forward bend measured by the distance between fingers and the ground [cm]. The Pilicz Test also includes a 12-min run [m], which was omitted from this study because the fitness assessment scale has been adjusted to both 5 and 6 trials.

2. Measurement of the muscular strength of the upper and lower limbs was taken with a patented force platform by Ewaryst Jaskólski et al. Patent no P. 186415 T of 08 Jan. 1976, cat. no. A61B [21, p. 11].

3. Assessment of triglyceride and cholesterol concentration of the blood serum taken on an empty stomach from the ulnar vein [mg/dl]. Parameters were determined by enzymatic methods using reagents for the quantitative determination of total cholesterol and triglycerides in human serum and plasma by the Biolabo company, cat.no. R87656 (CHOL), cat.-no. 87319 (TG) on the Olympus AU 560 Analyzer. The recommended values for CHOL are < 200 mg/dl and for TG 35–160 mg/dl.

4. To estimate the body fat content, expressed as percentage of the body weight, an infrared-based device (the NIR method) was used. The FUTREX 6100/ZL device works with a use of close infrared. The NIR method is based on using the biological properties of tissues and their ability to absorb and reflect light of different wavelengths. Assessment of the fat tissue content with the photooptical method is, therefore, based on the analysis of changes in the spectrum of reflected and absorbed light by the examined tissues [22]. The test involved the upper dominant limb in the middle part of the biceps brachii and held in a seated position. The extended limb, bent in the elbow joint and with the forearm in supination, rested freely on the table.

5. Assessment of the range of motion in the main joints of the upper and lower limbs and of the spine was made with a use of an orthopaedic goniometer Baseline and SECA 201 measuring tape.

The results were analysed in Excel 10.0 spreadsheet and Statistica 13.0 software. The assessment of the significance of differences between the mean values was made for dependent tests (t-Student test) after prior checking of the distribution of results (the Shapiro-Wilk test). The level of significance was adopted at $p \leq 0.05$. The Senate Committee for Research Ethics at the University School of Physical Education in Wrocław approved of the research on 1st Feb. 2013.

RESULTS

The results of the research indicate that the extensive mobilisation of the motor system which adaptive training ensures gives beneficial effects in the fight against the symptoms of aging. In both of the studied groups (the older and the younger one) both forms of adaptive training (with moderate and low external resistance) resulted in a beneficial training effect among both men and women. Observation of changes in selected parameters of the lipid profile in the 8-month ASTM cycle confirms the previous reports that the training with external resistance in adults induces relatively quick reduction effects, irrespective of the subjects' gender, age and load, although greater changes and variability of results are seen in groups training with higher resistance (Figures 2 and 3).

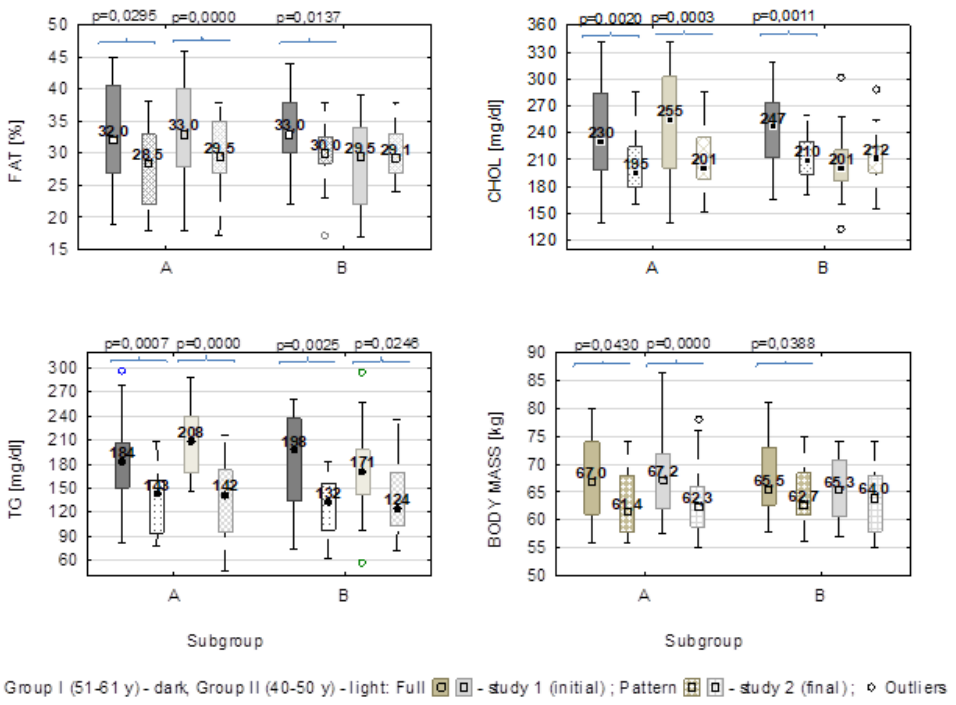

Fig. 2. Changes in the values of the tested parameters in women aged 40–61 after an 8-month ASTM training cycle with individual resistance: A – moderate weight – possible execution of 13–18 reps and B – small weight – possible execution of 19–24 reps [17, 18] (t-Student test for dependent trials)

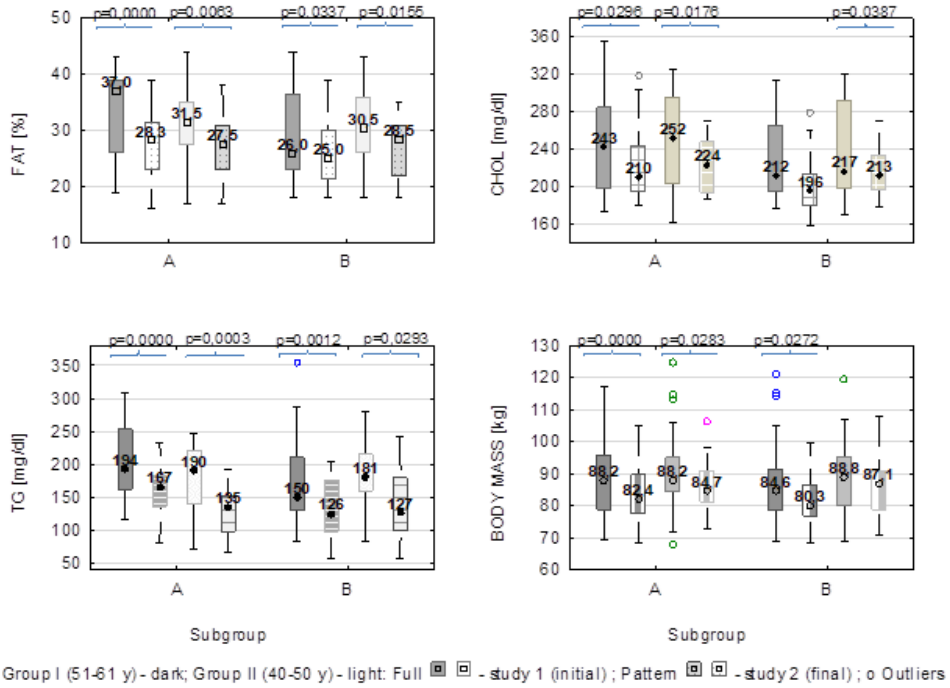

Fig. 3. Changes in the values of the tested parameters in men aged 40–61 after an 8-month ASTM training cycle with individual resistance: A – moderate weight – possible execution of 13–18 reps and B – small weight – possible execution of 19–24 reps [15, 16] (t-Student test for dependent trials)

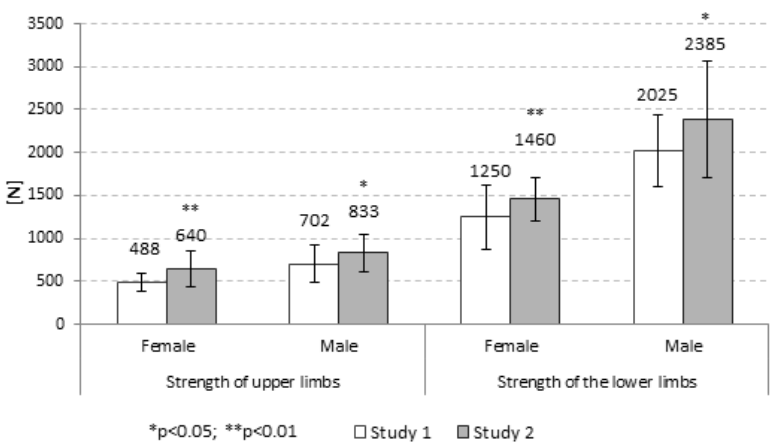

Fig. 4. Change in the level of maximum force [N] after an 8-month training cycle in men and women. Measurement of muscular strength on a force platform

An improvement in fitness was found in all male and female subjects during functional physical fitness tests in which the result of the efficiency was determined by the sum of points obtained in five test trials. In one of the subgroups, an increase in fitness of as much as 130% was observed. However, the most important result of the test was the levelling of fitness of the entire study population and achieving high mean general fitness of 22 points (±3 pts), which for both five and six trials in the Pilicz test means “good fitness” (Table 1, Fig. 5).

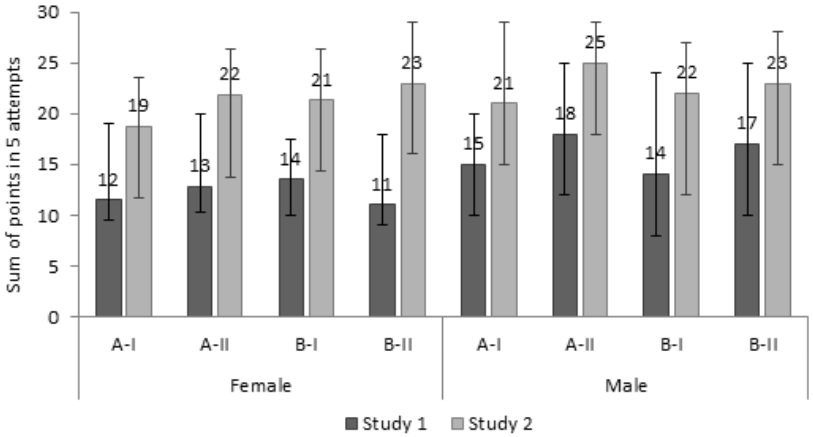

Fig. 5. Changes in physical fitness among both male and female subgroups in study 1 and 2 (median, minimum, maximum). All differences are statistically significant, $p < 0.01$

Table 1. Interpretation of the Pilicz point test results [20, p. 54]

Assessment of fitness	Based on 5 trials (without 12-min run) [pts]	Based on 6 trials
very good	24 and more	26 and more
good	20 – 23	22 – 25
sufficient	13 – 19	15 – 21
weak	9 – 12	11 – 14
very weak	8 and less	10 and less

The impact of ASTM on changing the range of motion in the examined group (Fig. 6 and 7) was also assessed. The efficiency improved, but mobility in the hip and shoulder joint after the 8-month training only neared to the lower limits of reference values and thus needs further improvement.

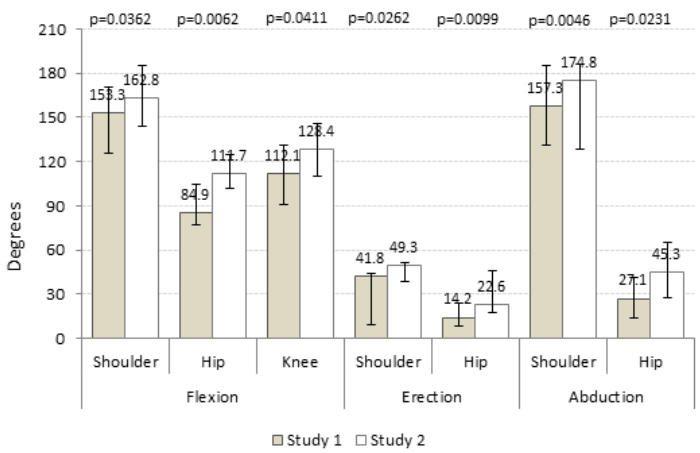

Fig. 6. Mobility in selected joints in study 1 and study 2. A comparison of medians between females (n = 83) and males (n = 67). The minimum and maximum values are marked.

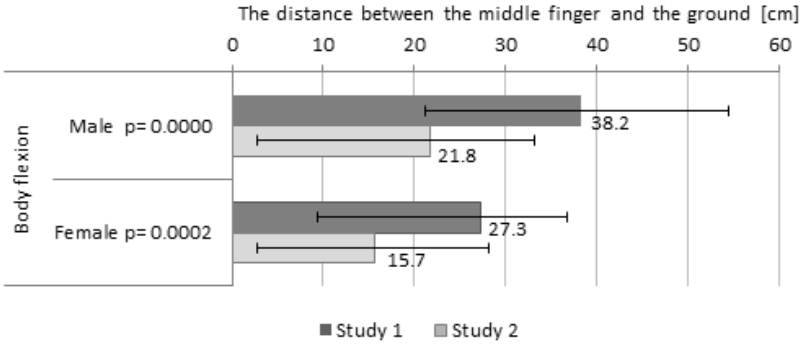

Fig. 7. Spine mobility measured by the depth of the forward bend in study 1 and study 2 in women (n = 83) and men (n = 67)

DISCUSSION

The order of Council of Ministers of 4 June 2016 on the National Health Programme for 2016–2020 reads that "the strategic objective is to extend life expectancy in health, to improve health and the associated quality of life of the population, and to reduce social inequalities in terms of health" [23, p. 2]. In this regulation, educational and preventive programmes do not form the backbone of the health policy, which translates into the number of health-care programs recommended by the Agency for the Evaluation of Medical Technology and Tarification (AOTMiT). Skóbel and Rudka report that since 2013 the number of preventive programmes filed by local and regional authorities has been systematically decreasing [24, p. 25]. Therefore, it is a political trend which is likely to involve cuts in public health expenditure or its transfer to other objectives. In 2015 there were only 20 prevention programmes related to physical activity (in two thematic blocks) filed by local authorities which received positive opinions. Most of them were designed for seniors and adolescents. In contrast, relatively little attention in government and non-governmental programmes has been paid to mature and professionally active persons. This is confirmed by the report of the European Commission of 2014, which shows that local authorities are insufficiently effective in encouraging citizens to physical activity [25, p. 78]. Currently, Polish citizens themselves must responsibly plan and monitor their physical activity, as systemic changes and their pace are inadequate to the needs and capabilities of working people. That is why, among others, the role of health promoters, the educational system and media is so important to educate society for safe and self-regulated health training. Encouraging people to have the longest working life should go together with projects to keep them on the job market in proper physical condition. These proposals should serve an individual, natural need for extending professional activity and the simultaneous reduction of state expenditure connected with work absenteeism. Research shows that inhabitants of Scandinavian countries and the Netherlands are in the best physical condition [5]. In these countries, from 55% to 70% of citizens admit to practising intensive exercises (in the sports or recreational form) at least once a week. Also the largest percentage of people working after 50 years of age and the lowest expenditure on treating older people is noted there. Polish forecasts of state expenditure on ageing society are staggering [1, 5, 6]. Projects supporting working people can be treated as long-term investment in healthy and active society. Therefore, this work seems to be an important contribution to the discussion on how to tackle demographic problems and public expenditure.

It should be remembered that physical activity of mature and elderly people carries the risk of mistakes. In strength training, there is a danger of sudden reactions of the body due to changes in blood pressure. These reactions may especially affect people with heart and the circulatory system dysfunctions. For this reason, doctors warn against resistance training, although practicing weight training does not have to be connected with high and maximum external loads. There are several types of strength training that require a separate methodology [16–18]. However, each type of strength training should be preceded by an appropriately modified cycle of adapting a participant to work with an increased load. The preparatory cycle may last from a few weeks to a few months and may constitute a separate training program that exclusively aims at implementing the adopted exercises based on the formulated assumptions. Such a program has a health and self-educational value, introducing a person to participate actively in physical culture.

It has been proven that resistance training of varying intensity, also at the age dominated by involutional processes, induces ultrastructural and biochemical changes in skeletal muscles thus improving the function of the whole body [9–13]. In addition, increased activity of collagen proteins is observed, which may indicate an increase in the circulation of muscle collagen [10]. Davis et al. [26] noted that a parallel use of aerobic and strength exercises in an 11-week training cycle improves both the endurance and the strength parameters. They also pointed out that the body composition changes to the benefit of the active tissue, and muscle elasticity is significantly improved in comparison to the group that was training less intensely. Although the experiment involved young women, it cannot be excluded that a similar mechanism of change in mobility (however less dynamic) will occur in both sexes of mature people. The literature of the subject provides extensive confirmation of the use of resistance exercises. Marques et al. observed positive changes in bone density (especially in women), improved balance, counteracting muscle atrophy and a reduction of body fat [27]. The influence of muscular strength stimulation on inhibiting osteoporotic change was confirmed by Borer [28], while Willis et al. [29] and Ormsbee et al. [30] positively evaluated the use of isometric exercises in the process of regulating resting metabolism. In turn, Kang et al. [31] demonstrated that resistance exercises performed prior to proper aerobic training affect increased metabolic activity during cardio exercises. Our research on finding the optimal health training program using strength exercises is a compilation of the above studies. The advantage of the proposed here ASTM program is its easy individualization and flexibility in changing the exercises depending on the capabilities and preferences of the practising person. This study shows that in the proposed ASTM exercise program, the choice of tasks and the adopted methodology of training loads is beneficial and safe for adults' health and effectively inhibits involutional processes both in women and men.

Despite the proven benefits of specific physical activity for mature people [32], there are relatively few published proposals in Poland for complex long-term programmes leading to increased functional performance of people after 40 years of age. Thus, for health reasons, the labour market is losing experienced workers [3]. It seems that Poles, especially in the working age, should intensify their efforts to improve the quality of life through systematic, planned movement. The method adopted in this study brings desirable training effects in the form of increased muscle strength, increased mobility and overall physical fitness. It intensifies fat metabolism, which is consistent

with the WHO expectations for physically active people of similar age [33]. However, a reasonable question arises: what should a participant in physical culture do on completion of the adopted ASTM health training program? From the methodological point of view, a break should be taken, similarly to a microcycle in sports training (a transition period). This period should not last longer than 8 weeks. We suppose that this training can be continued in the following years; however, we recommend that when choosing the starting resistance, the participant should go back to baseline loads. In continuing this research, it would be interesting to examine a relationship between improved physical fitness of professionally active persons and occupational fitness and performance depending on the job.

CONCLUSIONS

1. A modified cycle of introduction to strength and bodybuilding training, defined as an adaptive strength training method (ASTM), effectively implements the objectives of health training and may constitute a separate training program (a macrocycle).
2. The proposed methodological assumptions in both forms of training (with medium and small weights) inhibit the process of regression of mobility in both sexes.
3. The implementation of the training cycle by gradually increasing loads in strength training confirms its high effectiveness in the fight against overweight in mature people. The observed changes resulting from the proposed cycle of exercises prevent the active atrophy characteristic of involutional processes prevalent during this period of life.
4. The modified adaptive strength training method, as a form of health training for middle-aged and pre-retirement people, helps to increase the range of motion in joints and the flexibility of muscles and to improve work dynamics in functional trials.
5. The adaptive strength training method (ASTM) with appropriately selected tasks and loads may constitute a health training program, and its implementation may be treated as an objective for health activities.

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APPENDIX 1. FRAMEWORK PLAN FOR ASTM TRAINING

month	September				October				November				December		
week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
training session	1 2	3 4	5 6	7 8	9 10 11	12 13 14	15 16 17	18 19 20		21 22 23	24 25 26	27 28 29	30 31 32	33 34 35	36 37 38
resistance	baseline				I		II			III (I+5%)		IV (I+5%)		V (I+10%)	
n of ex. in a circuit	16				16					16					
n of series	1				2		3			2		3		2	
variant A	8		10	12	13 13 15	16 17 18	13 14 15	16 17 18		13 14 15	16 17 18	13 14 15	16 17 18	14 15 16	17 18
variant B	6		8	10	19 20 21	22 23 24	19 20 21	22 23 24		19 20 21	22 23 24	19 20 21	22 23 24	20 21 22	23 24

month	December		January				February				March			
week	16	17	18	19	20	21	22	23	24	25	26	27	28	29
training session	39 40		41 42 43	44 45 46	47 48 49	50 51	52 53 54	55 56 57	58 59 60	61 62 63		64 65 66	67 68 69	70 71
resistance			V (I+10%)	VI (I+10%)			VII (I+15% + 4 ex. with baseline resistance)					VII (I+ 10%)	VIII (I+15%)	
n of ex. in a circuit	16		16				20					20		
n of series	2		2	3			2	3				4	2	
variant A	18 28		13 14 15	13 14 15	16 17 18 19		13 14 15 16 17 18	13 14 15 16 17 18 19				13 14 15 16	13 14 15 16	
variant B	24 24		19 20 21	19 20 21	22 23 24 25		19 20 21 22 23 24	19 20 21 22 23 24 25				19 20 21 22	19 20 21 22	

month		April				May				June				July-August
week	29	30	31	32	33	34	35	36	37	38	39	40	41	42 43 44 45 46 .... 51 52
training session	72			73 74 75	76 77 78		79 80 81 82	83 84 85	86 87 88	89 90	91 92	93 94	95 96	
resistance				VIII (I+20%)			IX (I+20%)	X (I+20%)		IX (I+25%)			Aerobic exercises, stretching, PIR	
n of ex. in a circuit	20			20			20	20		16				
n of series	2			2			3	4		2				
variant A	17			13 14 15	16 17 18		14 15 16 17	13 14 15	16 17 18	13 14	15 16	17 18		
variant B	23			19 20 21	22 23 24		20 21 22 23	19 20 21	22 23 24	19 20	21 22	23 24		

Legend: baseline resistance – equipment weight being a carrier of external resistance; resistance I – individually determined load; I+5% - gradual increase in weights in reference to the baseline resistance

APPENDIX 2. PROPOSAL FOR THE ASTM TRAINING PROGRAM

Exercise plan based on [16] and [34].

Chest Exercises:

1. barbell flat bench press [16, p. 82]
2. flat bench dumbbell arm pullover [16, p. 83]

Exercises for the upper section of the back

3. seated front lat pulldown [34, p. 210]
4. seated cable row to chest [34, p. 205]

Exercises for muscle of shoulders and the upper section of the back:

5. seated barbell behind the head military press [16, p. 46]
6. dumbbell lateral raise [16, p. 50]

Exercises for muscles of the upper limbs:

- extensors:

7. cable rope triceps extensions [34, p. 136]
8. dumbbell triceps kickback [16, p. 33]

- flexors:

9. standing barbell curl [16, p. 18];
10. seated alternated dumbbell curl [16, p. 26]

Exercises for muscles of the lower section of the back:

11. “dead lift” with straight legs [16, p. 117]
12. barbell good mornings [16, p. 117]

Exercises for muscles of the lower limbs:

- extensors: (the front group of leg muscles):

13. narrow stance barbell half-squat [16, p. 113]
14. barbell lunge [16, p. 114]

- flexors (the back group of leg muscles):

15. lying leg curl [34, p. 380]
16. standing alternate leg machine curl [34, p. 380]

Exercises for abdominal muscles (note for points 17–20 – exercises for abdominal muscles are performed till the final repetition: 18 or 24):

- abdominal muscles:

17. hip raise on bars [16, p. 245]
18. leg raise [16, p. 241]

- oblique muscles:

19. cross body crunch [16, p. 255]
20. oblique crunch [16, p. 251].

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