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Comparison of Fitness and Physical Activity Levels of Obese People with Hypertension

Jana Krzysztoszek [1,*], Janusz Maciaszek [2], Michał Bronikowski [1], Monika Karasiewicz [3] and Ida Laudańska-Krzemińska [2]

[1] Department of Didactics of Physical Activity, Poznan University of Physical Education, 61-871 Poznan, Poland; bronikowski@awf.poznan.pl
[2] Department of Physical Activity Science and Health Promotion, Poznan University of Physical Education, 61-871 Poznan, Poland; jmaciaszek@awf.poznan.pl (J.M.); idakrzeminska@awf.poznan.pl (I.L.-K.)
[3] Laboratory of International Health, Department of Preventive Medicine, Poznan University of Medical Sciences, 61-701 Poznan, Poland; mkarasiewicz@ump.edu.pl
* Correspondence: krzysztoszek@awf.poznan.pl; Tel.: +48-61-835-52-78

Abstract: This study assessed the relationships between the current level of physical activity (PA) and PA in childhood and the level of physical fitness (PF) of obese people aged 40+ with co-existing hypertension (HT). The study included 82 obese patients with co-existing HT in their history. In order to assess the level of PA, we used the IPAQ. PF was assessed by observing the performance of patients in a fitness test (a 30-s chair stand, a handgrip strength test, a sit-and-reach test, a one leg stand test, a plank test, a wall squat test, and a 2-min step-in-place test). According to the IPAQ category, 24.4% were classified as having a high level of PA, 45.1% a sufficient level of PA, and 30.5% an insufficient level of PA. We noted that the higher the level of PA, the higher the PF—even in obese participants with HT. On the other hand, co-existing diabetes lowered almost all analysed parameters, both biochemical and fitness. The current PA level, a deficiency in which seems to be related to low PF and/or HT, does seem to be related to the degree of PF.

Keywords: physical activity; physical fitness; obese people; hypertension; diabetes

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1. Introduction

The Survey of Health, Ageing, and Retirement in Europe (SHARE) has shown that 70.1% of the population aged 55–60 years suffers from one or more chronic diseases, while this percentage is higher than 80% for people aged 65+ [1]. The chronic diseases include conditions such as backache, osteoporosis, circulatory system diseases, obesity, type 2 diabetes, and stress, for the prevention and/or therapy of which physical activity is recommended [2]. However, the awareness of risks related to insufficient physical activity (PA) is very low, which indicates that there is an urgent need for more effective health education and health promotion [3] and that this may be a worldwide problem. For example, in Canada a significant decrease in PA levels in the last several decades was associated with an increase in obesity and other related co-morbidities, such as hypertension (HT), heart failures, and diabetes [4]. As the problem concerns over 20% of the adult population in Canada, guidelines and recommendations for HT education have been immediately updated with new research evidence. In Europe, Bennie et al. [5], in their comparative study on PA and sedentary behaviours (using the IPAQ questionnaire) in adults from 32 European countries, report about a 300 min average sitting time a week for the average European adult. Although geographical and cultural factors differentiating European nations prevented the generalisation of the scores, it is worth noting that high-sitting-time/low-activity individuals comprised 10% of the examined sample and these participants tended to self-report their general health state as "bad" or "very bad". In Poland, according to the MultiSport Index 2019, almost half of all Poles spend more than 5 h a day in a sitting position and 16% sit for more than 9 h per day [6].

The effects and benefits of PA on health have been widely described in the literature, both in the context of the prevention of non-communicable diseases (NCDs) and their therapy [7,8]. Physical activity at various stages of life plays a valuable role, from ensuring mobility, enabling recreation, and maintaining social interactions to the possibility of maintaining everyday activity and independence at an elderly age. Regular exercise and PA normalise glycaemia and positively affect the lipid profile [9], the body's composition, the functions of blood vessels, lung function, the immune system, and cardiac output [10]. On the contrary, I-Min Lee et al. [11] indicated that physical inactivity (which was defined as insufficient PA) causes 6–10% of several major non-communicable diseases, including coronary heart disease, type 2 diabetes, and breast and colon cancers. With the elimination of physical inactivity, the life expectancy of the world's population might be expected to increase by 0.68 years [12]. Physical inactivity seems to have an effect similar to that of obesity as a risk factor for poor health (0.5–0.7 years) [12].

It is known that PA habits are important predictors of weight history. Longer-term habitual PA in adolescents, particularly at a higher intensity, has been shown to minimise weight gain in adulthood, in both men and women, but particularly in women [13], and also to lower the odds of incident hypertension, especially in women with moderate to high levels of cardiorespiratory fitness [14]. A study by Lee et al. [15] found that, when considered simultaneously, fitness attenuated, but did not eliminate, the risk of impaired fasting glucose and type 2 diabetes when associated with obesity, and the highest risk was found in obese and unfit men. In the study by Chase et al. [16], individuals with previously known diabetes (DM) had the lowest fitness in the fully adjusted model. It was observed that the functional fitness decreased gradually with an increased impairment in glucose regulation. Both patients with newly diagnosed DM and the ones with impaired glucose tolerance had a significantly poorer physical performance compared with those with normal glycaemia. Michaliszyn et al. [17] indicated that greater fitness levels predicted better glycaemic control even among adolescents. Additionally, the strength of these relations may grow with age.

It has been reported that regular PA, depending on its type, lowers arterial blood pressure by 2–11 mm Hg [2]. According to Knieć et al. [18], it can lower systolic blood pressure (SBP) by 8 mm Hg and diastolic (DBP) blood pressure by 2.5 mm Hg. Indirectly, it also contributes to a reduction in body mass [19], thus limiting dyslipidemia and insulin resistance [20]. It should be noted that a reduction in body mass results in the lowering of SBP by 4.4 mm Hg and DBP by 3.6 mm Hg [21]. This was also confirmed by the Trials of Hypertension Prevention II carried out in people with high, but still within the normal range of, blood pressure and increased values of body mass index (BMI), where a decrease in SBP by 3.7 and DBP by 2.7 mm Hg was seen with a loss of 4.5 kg of body mass [20]. However, there are reports that only 18% of women and 50% of men in the 30–49 age group and 31% of women and 36% of men in the 50–70 age group increase their PA after being diagnosed with HT [22], which is an issue.

Walther et al. [23] noted that even the diagnosis of HT did not produce a positive lifestyle change. Similarly, Rosenzweig et al. [24] indicated that unhealthy lifestyles were more often observed in those with disease, as their presence increases the risk of developing HT and diabetes (DM). This should not be surprising, since compliance with the medical recommendations concerning PA is assessed negatively by as much as 48.5% of patients with type 2 diabetes [25], despite the research evidence that shows that regular PA has a statistically and clinically significant effect on VO_2 max (maximal oxygen consumption) in type 2 diabetic individuals [26]. Additionally, a 20-year longitudinal study by Carnethon et al. [27] showed that adult men and women who developed diabetes over 20 years experienced significantly larger declines in relative fitness versus those who did not. The study clearly indicated that poor fitness was significantly associated with diabetes incidence and was explained largely by the relationship between fitness and BMI. Obesity and HT, the most severe NCDs, generate serious health damage, including a drop in the patient's physical fitness (PF). Addition of any new disease has consequences not only for individual health, but also for public health (for instance because of the costs of care for disabled individuals).

The core interests and main subject of this study were obese patients with HT and their levels of physical fitness as well as associations with levels of physical activity (both in the past and present). The research question was: how and to what extent does concomitant disease, in combination with obesity and HT, differentiate levels of physical fitness and physical activity in patients 40+? We wished to show the importance of PA and the relationship between PA and PF, and we conclude that more attention must be paid to the importance of both PA and PF in the prevention and therapy of NCDs. It is important especially in the light of the trend in non-pharmacological therapy of NCDs seen among both patients and physicians that they are more willing to accept diet changes [28,29] than to initiate and increase their PA.

The current study assessed the relationships between obesity and the presence of DM with the levels of PA determining the level of PF in obese patients aged 40+ with co-existing HT. Moreover, the study looked for differences in the relationships by sex, age, and co-existing diabetes. Selected biochemical indicators were considered.

2. Materials and Methods

2.1. Study Design and Participants

The study was conducted in 2017/2018 at the Clinic of Internal Medicine, Metabolic Disorders, and Hypertension in Poznan. The study included 82 patients aged 40 to 75 years of which 48 were women and 34 were men. The criteria to qualify for participation in the study were a clinical diagnosis of obesity with co-existing HT in the patient's history, the patient's age being 40+ years, the patient being under constant specialist care, and access to medical records with basic health parameters, including information on comorbidities. The diagnostic survey method was used along with a questionnaire. The questionnaires (the IPAQ with additional questions) were filled in individually in quiet surroundings in a separate room, and completing it took approximately 10 min. Body mass, height, and waist data were collected by trained personnel with the use of anthropological instruments. Body height was measured to the nearest 0.5 cm using a portable stadiometer and body mass was measured to the nearest 0.1 kg using mechanical personal scales (Seco, CE). Waist circumference was measured to the nearest 0.5 cm using an anthropometric measuring tape (Baseline, CE). Body mass index, as a measure of body composition, was calculated as body weight/height^2 (kg/m^2). The data concerning diagnosed diseases (such as DM, lipid metabolism disorders, and atrial fibrillation), values of systolic and diastolic blood pressure, heart rate, and body weight at earlier visits, and the current results of laboratory tests (total cholesterol, HDL, LDL, triglycerides, glucose, sodium) were taken from the medical documentation of the patients.

2.2. Physical Activity

In order to assess the level of PA of the participating patients, we used the International Physical Activity Questionnaire (IPAQ)—Last 7 Days Physical Activity Recall—which has been validated in multiple international settings and population groups [30]. The intensity of various types of physical activity associated with daily life, work, and leisure is evaluated in the IPAQ using the metabolic equivalent of work—minutes per week (MET-min/week) coefficient. MET values were calculated using the methodological procedure [31] for the 4 PA levels identified: total, vigorous, moderate, and walking. Based on these results, three PA levels were distinguished in accordance with the study methodology [31], namely: high, sufficient, and insufficient.

Additionally, in order to collect information on the PA of the patients in childhood and adolescence, a short original survey was used that consisted of three parts. In the first part, similar to the screening question of Prochaska et al. [32] concerning the PA of children and adolescents, the participants were asked how many days a week they spent in the past on PA in three respective age categories: 6–14, 15–17, and 17–19 years. The second part concerned information on sport disciplines in which they engaged in the past, and in the third part the respondents made a self-assessment of their attitude towards PA. Employing the results of this survey together with the results of the IPAQ made it possible to compare the levels of current and past PA.

2.3. Physical Fitness

Functional fitness was assessed using seven selected trials (the fitness test). No standardised tool for the measurement of functional fitness of persons with obesity was found in the literature. In order to ensure the health and safety of participants, the authors of the test decided to perform two trials from the Senior Fitness Test (30-s chair stand test and 2-min step-in-place test) [33], two trials from the EUROFIT test battery (handgrip strength test and sit-and-reach test) [34], and three complementary trials (one leg stand test, wall squat test, plank test). The suggested battery of tests measures basic physical parameters related to the ability to function and perform everyday activities. By performing tasks relating to walking, climbing the stairs, or getting up, it specifies the resources of strength, endurance, balance, and flexibility. The selection of the most suitable, reliable, and accurate tests was preceded by an analysis of various scientific research papers that allowed us to examine what was considered the most important in assessing the fitness of obese people considering their health constraints and restrictions. The selected ones were chosen as the most accurate and reliable for this specific group of subjects. Additionally, in all tests the safety of participants was our priority and all tests were conducted in the presence of medical staff and assistants.

The fitness test:

1. 30-s chair stand test—tested lower body strength [33];
2. handgrip strength test—measured the maximum isometric strength of the hand and forearm muscles with a Lafayette Hand Dynamometer (Lafayette Instrument Company, Lafayette, Indiana) [34];
3. sit-and-reach test—measured the flexibility of the lower back and hamstring muscles with a box. The starting position was sitting with the lower extremities straight and the knee joints not bent. The task was to perform a maximum bend and reach as far towards the feet as possible. The participant was to reach and maintain this position for 1–2 s while the distance was recorded [34];
4. one leg stand test—a balance test—the participant was standing with their legs together, their toes forward, and their arms alongside, but not touching, the body. Then, the participant lifted one leg until the thigh and lower leg were at a 90-degree angle. The participant tried to maintain this position for 30 s. This was followed by a test of the other lower extremity [35];
5. plank test (prone bridge test)—a test of core muscle strength and stability. The test involves maintaining a position on forearms and toes, with the whole body lifted above the floor in one line. The result of the test was the number of seconds for which the correct position was maintained [36];
6. wall squat test—tested lower body muscular strength and endurance. The participant leaned on the wall with their feet placed at shoulder width, bent the knees at a 90-degree angle, and attempted to maintain this position for 30 s. The results of the test were the number of seconds for which the correct position was maintained [37];
7. 2-min step-in-place test (an alternative to the 6-min march test) [33]—an exercise tolerance assessment. The patient starts marching in place with their right leg, raising their legs alternately to an individually set height (mid-thigh) as fast as possible. To help keep balance, leaning against a wall, a chair, or a table is allowed. The final result is the number of right leg raises completed in 2 min [38].

The fitness test was performed with each patient individually by trained personnel in a specially prepared room for physiotherapeutic care. For the test, a hand dynamometer (Lafayette Digital Hand Dynamometer) was used, and a sit-and-reach box was used to measure flexibility when sitting. Flexibility was measured to the nearest 0.5 cm.

2.4. Ethics

The research protocol was approved by the Local Bioethics Committee of the Karol Marcinkowski University of Medical Sciences in Poznan (decision no. 537/17). The authors declare that all methods have been applied in accordance with the relevant guidelines and regulations and that certified consent was obtained from all participants. Participation in the study was free, voluntary, and anonymous. Participants could withdraw from the study at any time without explanation.

2.5. Data Analysis

Basic and advanced statistical procedures of the STATISTICA 13.3 (Stat.Soft, Krakow, Poland) software package were used to conduct data analysis. Statistical significance was set at $p < 0.05$. Because the distribution of quantitative variables was not normal, the following non-parametric tests were used for statistical calculations: the Mann–Whitney U test, the Kruskal–Wallis ANOVA test, the repeated measures ANOVA test, the two-way ANOVA test, and Spearman's rank correlation significance test with bootstrap confidence intervals.

3. Results

The mean age of the participants was 54.1 ± 13.0 years. The minimum BMI value, both for men and for women, was 30 kg/m^2. The mean BMI value in women was 39.06 kg/m^2 and was higher than in men (37.54 kg/m^2), whereas for the whole studied group it was 38.43 kg/m^2. In addition, the waist circumference values were similar: 150 cm in women and 157 cm in men. Taking into account the degree of obesity, the largest number of patients (39%) had third-degree obesity and the smallest number of patients in the studied group (28%) had second-degree obesity. First-degree obesity characterised 33% of the participants. There were 49 patients (57% women) with diagnosed insulin-dependent diabetes. Anthropometric data are presented in Table 1.

Table 1. Descriptive statistics of BMI, waist circumference, mean annual decrease/increase in body weight, blood pressure and HR values, and the results of laboratory blood tests and their differentiation by gender, age, and the presence of DM (with a Mann–Whitney U test).

Parameter	Mean (SD)			*p* (F/M)	*p* (Age < 60/> 59)	*p* (DM)
	Female *n* = 48	Male *n* = 34	Total *n* = 82			
BMI (kg/m^2)	39.06 (6.78)	37.54 (6.73)	38.43 (6.76)	0.325	0.103	0.366
Waist circumference (cm)	116.90 (15.62)	121.79 (16.84)	118.93 (16.22)	0.190	0.559	0.049
Mean annual decrease/increase in body weight (kg/year)	0.01 (4.78)	0.64 (3.13)	0.27 (4.16)	0.728	0.475	0.296
Systolic blood pressure (mm Hg)	143.30 (12.88)	148.94 (17.74)	145.63 (15.25)	0.205	0.153	0.113
HR (L/min)	76.65 (7.19)	77.50 (6.78)	77.00 (6.99)	0.399	0.002	0.121
Total cholesterol (mmol/L)	5.80 (2.34)	5.33 (2.19)	5.63 (2.28)	0.318	0.151	0.347
HDL (mmol/L)	1.27 (0.30)	3.28 (10.12)	2.01 (6.16)	0.351	0.899	0.571
LDL (mmol/L)	3.42 (1.14)	3.22 (1.19)	3.35 (1.15)	0.540	0.102	0.162
Triglycerides (mmol/L)	2.09 (0.99)	1.91 (0.99)	2.03 (0.98)	0.339	0.757	0.880
Sodium (mmol/L)	140.77 (2.57)	141.26 (2.88)	140.95 (2.68)	0.723	0.004	≤0.001
Glucose (mmol/L)	6.98 (2.67)	7.01 (2.21)	6.99 (2.49)	0.444	0.025	0.086

Note: BMI, body mass index; HR, heart rate; HDL, high density lipoprotein; LDL, low density lipoprotein; SD, standard deviation. Statistical significance was set at $p < 0.05$.

In the above parameters, sex did not differentiate the participants; however, age did in terms of resting HR and levels of glucose and sodium (lower parameters for younger participants, with the exception of the heart rate) and the presence of DM in terms of waist circumference and glucose level (all parameters were lower for participants without diagnosed DM).

Additionally, the results of blood biochemical tests of 62 patients were analysed. The mean value of total cholesterol in the participants was 5.63 mmol/L (slightly higher in women than in men, 5.80 mmol/L and 5.33 mmol/L, respectively), and in almost half of the participants (45.1%) blood cholesterol levels exceeded the normal level. The levels of LDL cholesterol, triglycerides, and glucose (3.34 mmol/L, 2.02 mmol/L, and 6.99 mmol/L, respectively) were also above normal in a large group of participants. Only the levels of sodium were normal with a minimum value of 135.00 mmol/L. Normal values were also noted for HDL cholesterol in the vast majority of participants, with the mean value of 2.01 mmol/L (see Figure 1).

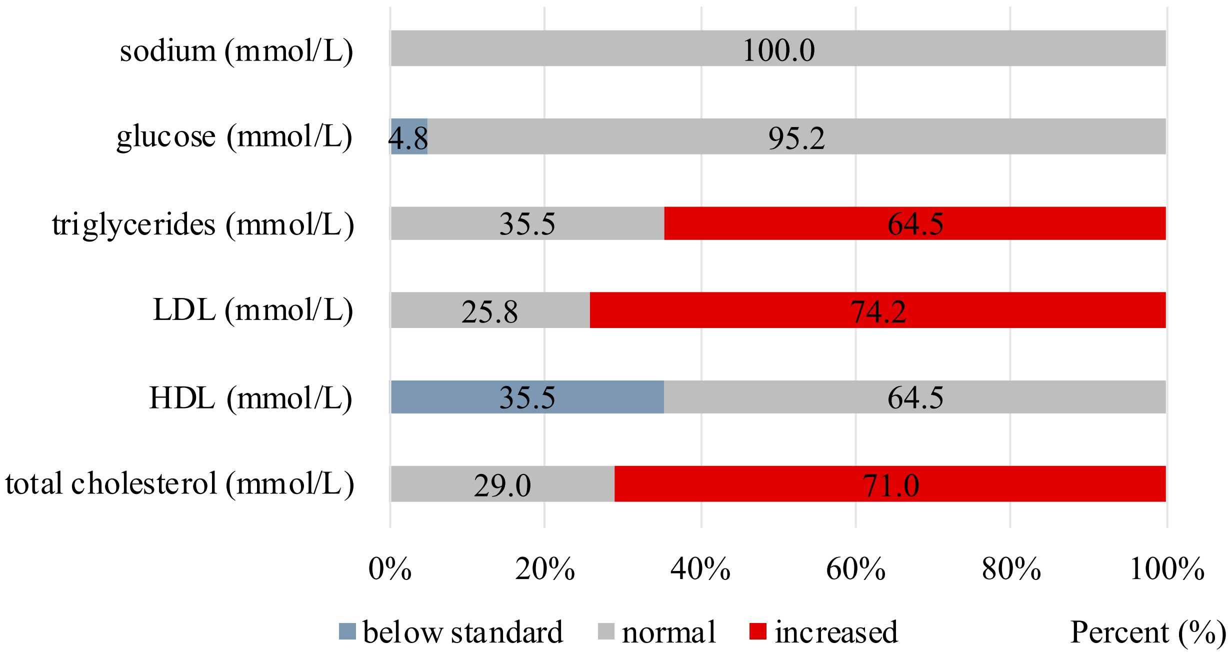

Figure 1. Analysis of results of blood biochemical tests in reference to normal levels of the parameters. Note: HDL, high density lipoprotein; LDL, low density lipoprotein.

3.1. Physical Activity

The results clearly show that few participants undertake intensive physical exercise (28%), which allows for a more effective reduction in weight. Walking, defined as walking without a break for at least 10 min, has been shown to be a significant preventative factor but definitely less effective in the context of body weight reduction. However, it was preferred by a large majority of participants (88%). Detailed data on the level of actual PA declared by the respondents are presented in Table 2. Men declared a significantly higher level of total activity and intensive activity. The current age of the participants and the presence of insulin-dependent DM did not differentiate the frequency of undertaking PA of various intensities.

Table 2. Various levels of PA of the participants by gender, age, and diagnosed DM (with the Mann–Whitney U test).

Physical Activity	MET-min/week	Female $n = 48$	Male $n = 34$	Total $n = 82$	p (F/M)	p (Age < 60/> 59)	p (DM)
TOTAL, MET-min/week	Mean (SD)	1961.25 (2862.99)	3194.25 (3403.80)	2472.49 (3138.44)	0.048	0.781	0.677
	Median	371.25	1749.0	1287.0			
VIGOROUS, MET-min/week	Mean (SD)	611.67 (2023.29)	1625.88 (2676.57)	1032.19 (2355.16)	0.006	0.172	0.254
	Median	0.0001	0.0001	0.0001			
MODERATE, MET-min/week	Mean (SD)	730.83 (1116.67)	523.53 (806.06)	644.88 (999.40)	0.381	0.481	0.172
	Median	400.00	0.0001	300.00			
WALKING, MET-min/week	Mean (SD)	618.75 (841.46)	1044.84 (1311.87)	795.42 (1075.45)	0.223	0.391	0.853
	Median	371.25	511.50	371.25			

Note: MET-min/week, metabolic equivalent of work—minutes for the week. One MET corresponds to the amount of oxygen consumed at rest and is equal to 3.5 mL of oxygen per kg of body weight per minute; SD, standard deviation. Statistical significance was set at $p < 0.05$.

Repeated measures ANOVA showed a significant differentiation in the amount of MET-min/week obtained for particular activities (vigorous, moderate, and walking) by men (with Greenhouse–Geisser correction, F = 3.645, df = 1.41/46.66, $p = 0.048$) with a significantly greater amount of vigorous activity than moderate activity (Tukey's HSD post-hoc comparisons, $p = 0.024$). There were no such results among women.

The participants were also divided into three groups based on the levels of activity measured with the IPAQ (insufficient, sufficient, high level), and relationships with PA in the past, the level of current PA, the level of obesity, and biochemical parameters were determined. A high level of PA was noted for 24.4% of the participants (18.8% of women and 32.4% of men), a sufficient level was noted for 45.1% of the participants (43.7% of women and 47.0% of men), and an insufficient level was noted for 30.5% of the participants (37.5% of women and 20.6% of men).

Looking at PA undertaken in childhood and adolescence, it can be stated that men were generally more active than women (in particular in childhood) and that the current age of the participants does not differentiate them in this respect, similarly to the co-existence of DM or the current level of PA (see Table 3). However, a weak correlation was found between the level of activity in the past (for the youngest and the oldest age groups) and the current expenditure carried out in an intensive manner (for 6–14 yo: r = 0.220, $p = 0.047$, and 95%Cl = [0.002, 0.410]; for 15–17 yo: r = 0.193, $p = 0.083$, and 95%Cl = [−0.025, 0.387]; and for 17–18 yo: r = 0.240, $p = 0.030$, and 95%CI = [0.023, 0.428]). This indicates a larger tendency to undertake intensive activity by persons who were active in childhood. However, the decline in daily activity with age is clear (Chi^2 Friedman's ANOVA (N = 82, df = 2) = 57.922, $p < 0.001$). The recommended daily dose of 60 min of PA per week was undertaken by only 12.2% of the participants at the age of 6–14 years (33% at least six times a week) and in the later years of adolescence: at the age of 15–17 years—9.8% and 28.1%, respectively, and at the age of 17–19 years—8.5% and 18.3%, respectively.

In the other analysed parameters (BMI, obesity level, waist circumference, blood pressure, HR values, and the results of laboratory blood tests) the current PA level did not differentiate the studied participants (for all, $p > 0.05$).

Table 3. Characteristics of the level of PA (the mean number of days in the week with a minimum of 60 min of activity per day) of the participants in childhood and adolescence and the differentiation by age, sex, the presence of DM, and the current level of PA (with the Mann–Whitney U test and the Kruskal–Wallis test for levels for PA differentiation).

Age	PA in Childhood	Female $n = 48$	Male $n = 34$	Total $n = 82$	p (F/M)	p (Age < 60/> 59)	p (DM)	p (Levels of PA)
6–14 years	Mean (SD) Median	4.15 (1.81) 5.000	4.97 (1.61) 5.500	4.49 (1.77) 5.000	0.029	0.539	0.881	0.115
15–17 years	Mean (SD) Median	4.00 (1.69) 4.000	4.62 (1.72) 5.000	4.26 (1.72) 4.500	0.108	0.654	0.996	0.477
17–19 years	Mean (SD) Median	3.00 (2.19) 3.000	3.82 (1.95) 3.000	3.34 (2.12) 3.000	0.067	0.128	0.569	0.407

3.2. Physical Fitness

The participants performed seven tests assessing selected fitness parameters. The differences between sexes related to age, DM, and the level of current PA for the tests are presented in Table 4. Generally, sex differentiates only the results of the hand grip strength test (men are stronger than women) and age differentiates most of the tests. The fitness of the participants declines with age. Similarly, DM is linked with a decline in the fitness of the studied patients. The level of current PA differentiated the level of results of the participants in all fitness tests. Higher activity was related to better results in fitness tests (see Table 4).

Table 4. Differentiation in the results of fitness tests by gender, age, the presence of DM, and the current level of PA of the participants (with the Mann–Whitney U test and the Kruskal–Wallis test for levels for PA differentiation).

Fitness Test	Mean (SD)			p (F/M)	p (Age < 60/> 59)	p (DM)	p (Levels of PA)
	Female $n = 48$	Male $n = 34$	Total $n = 82$				
1. Chair stand test, number of repetitions	11.7 (9.31)	14.47 (9.49)	12.87 (9.42)	0.078	0.003	0.015	<0.0001
2. Handgrip strength test, kg	10.44 (6.24)	19.12 (10.65)	14.04 (9.34)	<0.0001	0.205	0.628	0.015
3. Sit-and-reach test, cm	11.42 (9.87)	11.22 (9.49)	11.34 (9.65)	0.996	0.0004	0.108	0.007
4L. One leg stand test—left leg, seconds	11.31 (11.37)	15.21 (12.26)	12.93 (11.83)	0.241	0.012	0.024	0.002
4R. One leg stand test—right leg, seconds	10.09 (11.31)	13.06 (12.25)	11.32 (11.73)	0.155	0.007	0.054	0.002
5. Plank test, seconds	5.02 (7.33)	6.32 (8.93)	5.56 (8.01)	0.854	0.0001	0.004	0.029
6. Wall squat test, seconds	8.69 (10.01)	10.00 (9.58)	9.22 (9.79)	0.506	0.0001	0.015	0.004
7. 2-min step-in-place test, number of repetitions	9.77 (11.23)	14.56 (16.47)	11.76 (13.76)	0.230	<0.0001	0.030	0.024

Hence, in the subsequent stage the relations between DM and the level of PA and the level of fitness were determined. The two-way ANOVA model was used. In the analysis of relations with reference to individual fitness tests, no interactive relations were noted, only the main effect for individual qualitative factors. This may mean that each of them makes an independent contribution to an improvement or a decline in the fitness of the studied patients (see Table 5).

Table 5. Main effects and interaction effect of DM and PA on fitness tests—results of two-way ANOVA.

Fitness Test	Variables	df	F	p	η_p^2
1. Chair stand test, number of repetitions	PA	2	15.82	<0.0001	0.294
	DM	1	6.34	0.014	0.077
	PA × DM	2	0.37	0.689	0.010
2. Handgrip strength test, kg	PA	2	2.75	0.070	0.068
	DM	1	0.03	0.867	<0.001
	PA × DM	2	0.19	0.828	0.005
3. Sit-and-reach test, cm	PA	2	4.17	0.019	0.099
	DM	1	1.09	0.300	0.014
	PA × DM	2	0.31	0.736	0.008
4L. One leg stand test—left leg, seconds	PA	2	6.44	0.003	0.145
	DM	1	4.75	0.032	0.059
	PA × DM	2	1.52	0.226	0.038
4R. One leg stand test—right leg, seconds	PA	2	7.35	0.001	0.162
	DM	1	3.12	0.081	0.039
	PA × DM	2	2.24	0.113	0.056
5. Plank test, seconds	PA	2	2.37	0.101	0.059
	DM	1	7.57	0.007	0.091
	PA × DM	2	0.73	0.485	0.019
6. Wall squat test, seconds	PA	2	6.36	0.003	0.145
	DM	1	7.38	0.008	0.090
	PA × DM	2	0.29	0.751	0.008
7. 2-min step-in-place test, number of repetitions	PA	2	4.54	0.015	0.154
	DM	1	0.08732	0.769	0.002
	PA × DM	2	0.85751	0.430	0.033

Note: DM, diabetes; PA, physical activity level; η_p^2, partial eta squared.

4. Discussion

We believe that the current work is the first study to present differences in the level of PF depending on the level of PA of obese people with co-existing HT. Our studies indicate that PF is probably not related directly to the obesity of the participants or the coexisting HT. Rather, the current PA, a deficiency in which determines a low level of PF and/or HT, may be the critical factor. We noted that the higher the level of PA, the higher the PF—even in obese participants with HT. On the other hand, the co-existence of DM lowers almost all of the analysed parameters, both biochemical and fitness.

It should be noted that slightly higher values than ours (33.4% vs. 28%) in terms of vigorous physical effort were obtained by Biernat [39] in a study of 373 administrative, technical, and manual workers, only 10.5% of whom were obese. Almost half of the subjects had a normal weight (46.4%), and 33.5% were overweight. This comparison shows that the feature that characterises the population studied by us (diagnosed diseases in patients and obesity, HT, and DM in some of the participants) and often the accompanying decrease in the quality of life and health do not motivate patients to undertake intensive physical exercise more often.

On the other hand, in the comparison of the total energy expenditure with the results obtained by Biernat [39], slight differences should be noted for high levels of PA (24.4% vs. 20.3%) and moderate levels of PA (45.1% vs. 49%), respectively, whereas for lower levels of PA the results are almost identical (30.5% vs. 30.8%). It could be suggested that the fixed model of lifestyle in terms of PA is a highly stable variable and a factor such as disease does not modify it. The results are also consistent with the findings of a comprehensive study of the health of the Polish population in 2009, conducted by the Central Statistical Office [40]. We have to note, similarly to the authors of [40] and Biernat [39], that the level of PA of Poles is low. For at least one-third of obese patients with HT, the level of PA is insufficient to maintain health at an unchanged level, and for the other half it is insufficient to satisfy the criterion for effective non-pharmacological therapy. Moreover, we noted that those participants who are currently physically inactive obese adults with HT were also children with a low level of PA in the past. The recommended daily dose of PA was undertaken by a small percentage of children.

In terms of the PF of the studied obese patients with HT, the highest level of fitness occurred in persons in the group with a high level of PA. All participants in the studied group were under constant medical supervision and their blood pressure level was maintained pharmacologically; therefore, we could not identify any relationship between PA and fitness and the level of blood pressure of the respondents. We observed, however, that in obese people treated for HT, appropriate PA co-existed with high PF. These are two basic factors that offer a chance for therapeutic success in such patients. A recently published review updated previous reports of an association between higher levels of PA and a lower risk of incidental obesity, coronary heart disease, and diabetes and a reduced risk of developing new diseases [41]. At the same time, this review showed that we need more research to draw a conclusion on the relationship between PA and hypertension [41]. At present, the therapeutic mechanisms by which physical exercise decreases blood pressure in hypertensive patients are unclear. There are many important, different factors and mechanisms [42]. Diaz and Shimbo [43] list several probable mechanisms of the effect of PA on blood pressure, but we can add that the concurring factor may be the fitness of the locomotor apparatus (motor fitness).

This study showed that there is no single causative factor that directly characterises patients with high blood pressure. We demonstrated, however that PF, the appropriate level of which is a necessary pre-condition of successful HT therapy, is probably a consequence of current PA. The activity undertaken in childhood is not directly associated with health (including the level of blood pressure) or with PF in adult life. However, an appropriate lifestyle in adulthood may be the effect of patterns of behaviour developed in childhood and adolescence. However, studies on obese people with HT showed that the relation between PA in childhood and PA in adult life is not necessarily a rule.

In our study, we noted that the PF of obese patients with HT is significantly related to the co-existence of DM. Of course, it is difficult to indicate a primary factor—DM or PF—within this study but it opens interesting avenues for further research. In addition, patients with two or three chronic diseases (obesity, HT, and/or DM) have a greater illness/disease burden and are more disabled as they experience greater barriers to overcome in order to be physically active compared with populations with one or two diagnosed conditions. Patients with multiple chronic diseases experience greater barriers to be overcome in order to be physically active because they are more depressed and likely to have less vitality, probably because of the burdens of multiple treatment regimens, concerns about complications, poorer perceptions of health, and the need to take more medication. Thus, they may perceive lower levels of autonomy and competence in dealing with it all [44]. Our study shows that the level of PA of obese people with HT is low and particular deficiencies in this respect were noted in people with diagnosed DM. Patients with DM in the first years of their illness are often recommended to make lifestyle changes in the absence of noticeable diabetes-related symptoms or complaints. Van Puffelen et al. [45] observed that many patients do not seem to perceive their condition to be serious and postpone lifestyle changes until DM-related complications appear. The fitness levels of youth with DM seem to be in the low range, with youth with type 2 diabetes having poorer fitness levels than youth with type 1 diabetes [46]. Our findings indicate the need to develop and implement better education programmes than those available at present for people with diagnosed DM. Our patients already had obesity and HT; however, those who had another diagnosed disease—DM—were still characterised by the lowest PF. Of course, it cannot be conclusively shown that low PF is a causative factor of DM, but we have demonstrated the relations between these two variables.

Moreover, we noted that the level of fitness of our patients was relatively low. For example, patients studied by us performed on average 12 repetitions in the chair stand test, whereas 64 older adults (≥60 years) studied by Shahtahmassebi et al. [47] performed approximately 16 repetitions before undertaking exercise, and even 20 repetitions after 18 weeks of training. Roongbenjawan and Siriphorn [48] indicated that a low number of repetitions in this test may significantly increase the risk of falls, because people who reported falls were able to perform only approximately nine repetitions. People in the age group studied by us should perform more than 13 repetitions on average [49].

The low fitness of our patients was also demonstrated in the co-ordination tests. In the one leg stand test, their time was only approximately 12 s, which shows a weak functioning of the body's balance system. Da Silva et al. [50] noted that subjects aged over 60 years, living independently, with no falls in the past, can stand for 25 s (ranging from 6 to 74 s). The subjects also had very significant difficulties with the correct execution of the 2-min step-in-place test.

Based on the previous studies [51,52], we expected that handgrip strength would correlate to PA or other health-related components. Akbar and Setiati [53] observed that handgrip strength correlated to nutritional status. In our study, the level of handgrip strength was independent of the other tested variables. The low level of handgrip strength in our patients can explain this rare and dangerous situation. Poor grip strength has been found to be a common factor in the elderly who have suffered a fall [54]. Maximal hand grip strength is associated with self-efficacy as related to the fear of falling [55]. Interestingly, Semba et al. [56] observed that grip strength correlates strongly to overall body strength and the ability to perform functional tasks. For this reason, the low level of hand grip strength in our patients could be worrying. On the other hand, the lack of statistically significant relationships with other components of functional efficiency is difficult to explain. In addition, Awoitidebe et al. [57] observed that people with diabetes mellitus likewise demonstrated poor handgrip strength and that selected upper limb anthropometric characteristics significantly correlate to handgrip strength. Our subjects presented a low level of handgrip strength, which correlated only to gender. This is worth further investigation with a more in-depth study.

The functional fitness factors studied by us are listed as some of those that contribute to successful ageing [58].

Among the limitations of the study, we can list a possible recall bias for the PA in the past and a small sample size; however, considering the specificity of the analysed factors (DM, HT, and obesity), the sample size was still reasonable. Adding PF with group-specific tailoring of the tests, which is rare in this kind of research, should be considered a strength.

The analysis shows that a deeper understanding of the causes of the lower PF of obese people with HT and additionally DM is needed in order to recognise the motivation, or the lack of motivation, to participate in the therapeutic process. Without the patient's cooperation, a doctor involved in the patient's care may be ineffective. Obese patients, particularly those with concomitant HT and DM, should be provided with interdisciplinary care by not only physicians and dieticians, but also by physical activity specialists: physiotherapists, occupational therapists, or personal coaches. The presence of several concomitant diseases depletes patients' health resources and generates a greater anxiety against and an unwillingness to make changes in terms of PA with its underestimated protective role. PA, meanwhile, should be intensely included both in the prevention and non-pharmacological treatment of NCDs. Mere recommendations to increase the daily amount of PA may be insufficient. Muscle tissue volume, a prerequisite for adequate fitness and, hence, self-dependency, and the lack of difficulties with self-care and the activities of daily living decrease with age. The consequences of the lack of adequate support in this area for the health care system and social services are vast, both in terms of financing (e.g., costs of therapeutic and corrective actions) and social costs (e.g., the costs of caring for a disabled person). Educational messages addressed to people suffering from NCDs should also be significantly modified to emphasise the importance of daily, well-designed PA to improve PF. This is the purpose, among other things, of the health-related fitness concept.

5. Conclusions

Our study clearly shows that the presence of an additional concomitant disease, namely DM, in obesity with HT significantly reduces PF rates. Reliable PF tests dedicated to obese patients should be developed, which should be included in the assessment of patients' health resources.

Author Contributions: J.K. and I.L.-K. conceived the study design. J.K. and M.K. were involved in data collection. I.L.-K. and J.M. performed the statistical analysis. J.K., M.B., I.L.-K., and J.M. interpreted data and prepared a draft of the manuscript. All authors edited, critically reviewed, and approved the final version of the manuscript. All authors have read and agreed to the published version of the manuscript.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Please contact the corresponding author for data requests.

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