Physical Medicine and Rehabilitation – International

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Austin Publishing Group

Research Article

Physical Strain During Realization of Certain Physiotherapeutical Procedures – Research Report

Andrzej Lewandowski*; Marcin Siedlaczek; Zuzanna Piekorz

Chair Department of Physiotherapy Faculty of Health Sciences Ludwik Rydygier Collegium Medicum in Bydgoszcz Nicolaus Copernicus University

***Corresponding author: Andrzej Lewandowski**

Chair Department of Physiotherapy, Faculty of Health Sciences, Ludwik Rydygier Collegium Medicum in Bydgoszcz, Nicolaus Copernicus University, Toruń, ul. Świetojańska 20, 85-094 Bydgoszcz, Poland.

Tel/fax: +48 52 585-54-16, fax: ext. 119

Email: andrzej.lewandowski@cm.umk.pl

Received: December 12, 2023

Accepted: January 25, 2024

Published: February 01, 2024

Abstract

Introduction and Purpose: The aim of the study was determining the intensity of physical strain connected with performing certain rehabilitation procedures in relation to individual aerobic capacity of men and women realizing such procedures.

Material and Method: Heart Rate (HR) was measured and maximum aerobic capacity (VO_2max) was evaluated in the subjects performing PWC_{170} test. Then, the subjects applied three therapeutic standards: passive exercise, individual fitness exercises and verticalization with gait training during which, the relative intensity of work (% HR and % VO_2max) and resting Metabolic Equivalent (MET) were evaluated.

Results: VO_2max in men was significantly greater (3.4±0.3 l/min) than in women (2.7±0.5 l/min) ($p<0.05$). Therapeutic standards imposed a moderate physical load for men at the level of 51.2% HRmax and 29.0% VO_2max, with MET equal to 3.4. In women physical strain was similar to that of men (52.2% HRmax, 30.5% VO_2max and 4.0 MET). In the subjective evaluation of the work the physiotherapists described it as hard.

Conclusions: The results indicate that the subjective evaluations of physical load in physiotherapists were not directly related to their aerobic capacity and might be external or psychological in origin. It seems that physiotherapy students-to-be should represent a prepared mental profile and, at least, a moderate level of physical fitness.

Keywords: Physiotherapy; Aerobic capacity; Therapeutic standards

Abbreviations: BMI: Body Mass Index; HR: Heart Rate; MET: Multiple Resting Metabolic Equivalent; VO_2max: Maximal Oxygen Uptake; PWC_{170}: Physical Work Capacity; WHO: World Health Organization

Introduction

The profession of a physiotherapist frequently requires realizing some therapeutic procedures, which may constitute a serious strain for the organism [6,10,13,14,15,28]. Due to this fact, it is believed that physical effort in performing physiotherapy is a common phenomenon [2,4,7,8,24] for both men and women [13]. Modern day physiotherapy holds high expectations towards the staff performing the therapeutic procedures including mental and physical features [4,19,25,28]. Performing of the therapeutic standards is commonly considered by physiotherapists as an intense work load although, objectively it constitutes rather moderate strain on the organism [13-15,30]. Only the dynamic professional activities performed on neurosurgery wards classify physiotherapist's job as a moderate – hard [11,17,22,28]. Thus, a discrepancy is observed between objective, measureable, work load and subjective work load sensed by physiotherapists performing their profession [13,22]. However, literature data indicate that there are threats to the health of physiotherapists despite the moderate intensity of their work [10,20,30]. Hence, another attempt to analyze the previously identified problem, but from a slightly different perspective. The aim of the study was, therefore, to determine the intensity of physiological strain during execution of some rehabilitation procedures in male and female physiotherapist. It was assumed that therapist's individual aerobic capacity, motor predisposition and mental preparation have direct influence on the perception of comfort or discomfort of the work.

Citation: Lewandowski A, Siedlaczek M, Piekorz Z. Physical Strain During Realization of Certain Physiotherapeutical Procedures – Research Report. Phys Med Rehabil Int. 2024; 11(1): 1223.

Methods

Eight men and twelve women, aged between 22 and 56 years, participated in the study. The subjects work on hospital wards with rehabilitation sections in public and private health care institutions. In these institutions most therapeutic standards are performed including some strenuous procedures due to complicated health condition of patients with neurological or orthopedic problems.

Anthropometrics

Body height was measured using an electronic scale with height meter WPT/o 150C (from RADWAG) in a standing position to the nearest 0.1cm, and body weight was measured to the nearest 0.1 kg.

Procedures

Physical strain was measured in the subjects performing passive exercise (applied in the case of lack of voluntary muscle activity), individual general fitness exercise (a combination of actions directed at improving general psycho-physical fitness and neuro- muscular coordination) and verticalization together with gait training (a connection of two closely related standards – verticalization precedes proper gait training in case when a patient for various reasons had spent a significant amount of time bed bound).

According to Lovett's scale of the muscle strength, passive exercise is applied in patients evaluated at the level of 0-1. They rely completely on passive exercise of joint movement in maximal range, retaining at the same time length and flexibility of certain structures of motoric system such as muscles, tendons and ligaments. Therapist performs about 30 repeats of such exercise in selected joint axis. In the group included in the study, therapists performed exercises of flexion – extension motion, pronation and supination for talocrural joint and radiocarpal ligament; flexion – extension for knee joint and elbow joint; as well as flexion extension, adduction – abduction, rotation for humeral joint and hip joint.

Active resistance exercises are recommended in patients, whose muscle strength exceeds 3 on Lovett's scale. The movement performed by patient is against gravitation with additional external resistance (eg. therapists arms). In the studied group, therapists performed both upper and lower limb exercise in optimal motion range, while in final stages resistance was respectively reduced, but at the same time fluency of performance was retained. For talocrural joint and carpal joint a resistance flexion – extension and adduction – abduction was performed, for knee and elbow joints: flexion – extension; moreover, for hip joint resistance flexion – extension, adduction – abduction and both rotations were performed.

Active orthostasis and gait training is the process of helping to secure the patient during transfer from supine to orthostatic position and during gait training itself. In the phase of supporting and transferring therapist focuses on possibly best performance of single elements of gait by supporting body stability, movement and secure the balance loss. Training of particular gait phases is possible with the help of therapist applying resistance or alleviation for selected part of the body as well as influencing the balance of patient. In the studied group, therapists led patients through full orthostasis, starting with transferring from supine to sitting position, helped through rotation on bed and transfer to sitting with legs hanging down. Another stage was transfer to standing position and gait around the room. Physiotherapist controlled body orthostasis, stabilizing patient's coxal bone. After finalized exercise, patient sat down and next lied down on the bed.

The therapists recommended the selected procedures considering that they are most frequently executed and impose a relatively high strain on their body due to the intensity of the effort and relatively long time of realization of each standard [13,15].

Body height, mass and Heart Rate (HR) were measured in the subjects. To evaluate their aerobic capacity (VO_2max) the PWC_{170} test was performed on bicycle ergometer Monark 915 [1,13,21]. HR was monitored with Sport Tester Polar S 410. The rate of oxygen uptake (VO_2), for load not exceeding the value of HR≤170 beats /min, was calculated according to EUROFIT Test standard [1]. Based on the result of PWC_{170} test and calculated HRmax [27], VO_2max was calculated for each subject by means of Åstrand – Ryhming nomogram [3].

During performance of the therapeutic procedures HR was considered conclusive after reaching a steady-state [9,18]. The relative work load in the subjects was presented as percentage of VO_2max (%VO_2max) and the units of multiple resting Metabolic Equivalent (MET). These relative workloads for men and women were then compared with those reported for work physiology and ergonomics [4,9,18,23].

Statistical Analysis

The Student's t-test was used for intergroup and intragroup comparisons. For variables which did not meet criteria for parametric tests a Mann-Whitney test was applied for intragroup comparisons. Statistical significance of all the tests was set at $\alpha<0.05$. No statistically significant differences in the studied characteristics, with the exception of the physical effort of the male group and the female group expressed as VO_2max l/min allowed to present the results of the analysis as mean values, standard deviations and medians. The obtained results were also compared with the relevant classifications in the available literature.

Results

Table 1 presents basic characteristics of the tested physiotherapists.

Table 1: Characteristics of the subjects (mean ± SD).

Feature	Men	Women
Age (years)	30.0±7.9	32.3±11.6
Height (cm)	182.7±6.0	166.3±5.5
Body mass (kg)	83.7±13.9	60.5±9.0

Mean: average value of analyzed parameter; SD: Standard Deviation

Table 2: Heart Rate (HR), maximum oxygen uptake (VO_2max) and physical loads during PWC_{170} test in the subjects (mean±SD).

Feature	Men	Women
Resting HR (beats/min)	74.7±8.4	77.3±10.7
HRmax (beats/min)	197.1±4.2	192.5±5.9
PWC_{170} (W)	208.9±30.2	159.5±35.1
PWC_{170} (W/kg)	2.5±0.4	2.6±0.4
VO_2max (l/min)	3.4±0.3	2.7±0.5
VO_2max (ml/kg/min)	41.7±7.4	45.2±8.5

Mean: average value of analyzed parameter; SD: Standard Deviation; HR: Heart Rate; Hrmax: Maximum Heart Rate; PWC170: Physical Work Capacity; VO_2 max: Maximal Oxygen Consumption.

Table 3: Mean Heart Rate (HR) during realization of standard physiotherapy procedures.

Feature	Men		Women	
	mean ± SD	median	mean ± SD	median
Passive exercise	95.2±10.1	98.3	99.5±11.0	99.3
Resistance exercise	93.0±8.2	95.3	96.6±11.7	92.9
Gait training	100.8±10.5	103.1	100.7±13.4	99.5

No statistically significant differences were found
Mean: average value of analyzed parameter; SD: Standard Deviation; median: the median value of the set; p: value used to determine statistical significance

Aerobic capacity of tested subjects, denoted by the value of VO_2max was average, while VO_2max of men was significantly greater than that of women, which is consistent with the basic knowledge of the exercise physiology [9,18] (Table 2).

In both men and women mean heart rate, as a response to realization of physiotherapeutic standards, assumed similar values on the level of low effort (Table 3). In both tested groups the greatest strain appeared during verticalization and gait training, and the slightest strain appeared during exercise with resistance. However, the differences were not statistically significant.

Strain with work, expressed by means of relative pace of oxygen uptake % VO_2max, was low in both men and women (Table 4). The evaluation of work intensity described by relative increase in heart rate %HRmax and multiple resting Metabolic Equivalent (MET) presented a similar scenario.

The comparison of the level of work strain expressed in the volume of used oxygen VO_2 (ml/kg/min) in tested men and women during the realization of the therapeutic procedures selected for the study confirmed that both male and female physiotherapists work with similar intensity.

Table 4: Mean increase in Heart Rate (HR), maximum Oxygen uptake (VO_2) and multiple resting Metabolic Equivalent (MET) in men and women performing selected physiotherapy procedures.

Feature	Men			Women		
	%HRmax (beats/min)	%VO_2max (l/min)	MET (units)	%HRmax (beats/min)	%VO_2max (l/min)	MET (units)
Passive exercise	48.3±5.4	24.95±7.7	3.0±1.1	51.6±4.7	29.6±6.8	3.9±1.3
Resistance exercise	47.3±4.7	23.4±6.7	2.8±0.9	50.1±5.4	27.5±7.8	3.6±1.4
Gait training	51.2±5.4	29.0±7.7	3.4±0.9	52.2±6.1	30.5±8.8	4.0±1.5

Mean: average value of analyzed parameter; SD: Standard Deviation; %Hrmax: Percent of Maximal Heart Rate; %VO_2max: Percent of Maximal Oxygen consumption; MET: Multiple of resting Metabolic Equivalent

Table 5: Comparative characteristics of the volume of the Oxygen uptake (VO_2) in tested men and women during realization of standard physiotherapy procedures.

VO_2	Men		Women	
($ml \cdot kg^{-1}min^{-1}$)	mean±SD	median	mean ± SD	median
Passive exercise	10.5±3.9	11.5	13.6±4.6	13.8
Resistance exercise	9.8±3.2	10.9	12.6±4.7	11.9
Gait training	11.9±3.2	12.4	14.0±5.3	14.3

No statistically significant differences were found
mean: average value of analyzed parameter; SD: Standard Deviation; median: the median value of the set; VO_2 (ml.kg-1min-1): Volume of Oxygen consumption

Discussion

It has been reported that perception of the relative strain during realization of therapeutic standards by men comprises within the range of 60.6% - 78.3% [13] and much exceeds the physiological work load usually observed at the level of 30-35% VO_2max [4]. In this study objective work strain was close to 50% HRmax, 30% VO_2max and 3 MET in both men and women. In accordance with WHO guiding principles, such described intensity of measured therapeutic standards matches moderate physical activity occurring during a quick walk, dance, garden work or carrying loads up to 20 kilos [29].

These results confirm the finding of Ksykiewicz and Zając's [12], who qualified most of physiotherapist's professional activities as barely strenuous except the dynamic standards performed on neurosurgery wards described as a moderate-hard work. This work can also cause numerous overloads and injuries [17,24,30]. Similar results were obtained in the present study, which utilized different methods of evaluation of physical strain and included the specifics of the therapeutic procedures [11]. It seems, therefore that in order to evaluate the general work load of physical therapists the measurements of effects of short-term of physical effort as well as long-term effort related to specifics of physiotherapy standards should be considered [10,12,30].

Greater aerobic strain while participating in verticalization and gait training observed in this study can be explained by the character of this therapeutic standard requiring active securing of the patient. For certain physiotherapists this standard may constitute a greater psychological strain driving, additionally, the cardiovascular system [9,15,18]

Body structure and level of physical fitness of physical therapists influences their ability to perform physiotherapy standards [4,20]. VO_2max of men and women who underwent PWC_{170} test differed significantly. In men, it may be classified as a low or moderate whereas in women as a high. This finding leads to the conclusion that VO_2max greatly varies in physiotherapists with disadvantage to man. A similar figure of VO_2max dispersion was observed in previous studies [13-15]. It might be that men less care about importance while deciding on and then performing the physiotherapy profession. Study on physiotherapy students, with significant dispersion of physical fitness, revealed poor physical preparation of physiotherapists for the profession [26]. This statement is also confirmed by the results of our many years of research, which indicate a time-dependent deterioration in the endurance of adolescents undertaking physiotherapy studies [16]. It is probable that therapists with low level of physical fitness do not want to work in “difficult” hospital wards, where passive exercises, which significantly load the physiotherapist's organism, are the most frequently performed therapeutic standards [14]. The variety of patients' conditions and their anthropometric features can constitute an additional, unpredictable factor increasing physiotherapists' physiological strain [7,8].

In presented study the differences in the intensity of effort during the realization of rehabilitation procedures, calculated according to Jaskólski's [9] and Pollock's [23] methods, were insignificant. Expected differences do not exceed 8% of acceptable error resulting from conversions and their absolute values correspond to study results published by other authors [5,9]. It seems that applied methods can be of useful for evaluating intensity of work in physiotherapy.

Conclusions

It is concluded that the subjective evaluation of physiotherapist's work was not directly related to their aerobic capacity or physical strain during the realization of therapeutic procedures, which ought to be adapted to physical and psychological abilities of the staff. Subjective perception of task performed may be influenced by external conditions and personal characteristics of the physical therapist. Certain therapeutic procedures, i.e. commonly utilized passive exercise can constitute a significant strain for physiotherapist with low level of physical fitness. Physical therapists – to – be should represent at least minimum aerobic capacity and retain a proper level of psychological and physical fitness.

Author Statements

Conflicts of Interest

The authors have no conflicts of interest that are directly relevant to the contents of this manuscript.

Acknowledgements

The research was carried out as part of its statutory activities of the Department of Principles of Physical Culture, Faculty of Health Sciences, Ludwik Rydygier Collegium Medicum in Bydgoszcz, Nicolaus Copernicus University [WN381].

Data Availability

Data on individual measurements of anthropometric and endurance characteristics, used to support the findings of this study may be made available on the researcher's request submitted to the Bioethics Committee of the Nicolaus Copernicus University at the Collegium Medicum Ludwik Rydygier in Bydgoszcz, which you can contact, ul. M. Skłodowskiej- Curie 9,85-094 Bydgoszcz, Poland, tel. 48 52585-35-63, fax 52 585-38-11, e-mail: kom.bioetyczna@http://cm.umk.pl

Ethical Approval

A permission to conduct this study was obtained from the Bioethics Committee of the Ludwik Rydygier Collegium Medicum of Nicolaus Copernicus University in Toruń (no. KB 181/2008). All men and women were informed about the aim of the study, type and duration of the effort, and the possibility to withdraw from the study without giving any reason. Each potential participant granted a voluntary consent for participation in the study.

Consent

Each potential participant granted a voluntary consent for participation in the study.

References

1. Adam C, Klissouras V, Ravazzolo M, Renson R, Tuxworth W. Eurofit. Handbook for the Eurofit test of physical fitness. Committee for the development of sport. Rome: Imprimé en Italie. 1988.
2. Åhsberg E, Garnberale F, Kjellberg A. Perceived quality of fatigue during different occupational tasks Development of questionnaire. Int J Ind Ergon. 1997; 20: 121-35.
3. Astrand PO, Ryhming I. A nomogram for calculation of aerobic capacity (physical fitness) from pulse rate during submaximal work. J Appl Physiol. 1954; 7: 218-21.
4. Bilski B. Higiena pracy/Hygiene at work. AM, Poznań. 2005.
5. Brown SP, Miller WC, Eason J. Exercise physiology: basis of human movement in health and disease. MD: Lippincott. Baltimore: William and Wilkins. 2006.
6. Ezzatvar Y, Calatayud J, Andersen LL, Aiguadé R, Benítez J, Casaña J. Professional experience, work setting, work posture and workload infuence the risk for musculoskeletal pain among physical therapists: a cross sectional study. Inter Upational Environ Health. 2020; 93: 189-96.
7. Glover W, McGregor A, Sullivan C, Hague J. Work-related musculoskeletal disorders affecting members of the Chartered Society of Physiotherapy. Physiotherapy. 2005; 91: 138-47.
8. Glover W. Work-related Strain Injuries in Physiotherapists. Physiotherapy. 2002; 88: 364-72.
9. Jaskólski A, Jaskólska A. Podstawy fizjologii wysiłku fizycznego z zarysem fizjologii człowieka. Wrocław: The Atlanta women's foundation. 2005.
10. Kotejoshyer R, Punnett L, Dybel G, Buchholz B. Claim costs, musculoskeletal health, and work exposure in physical therapists, occupational therapists, physical therapist assistants, and occupational therapist assistants: A comparison among long-term care jobs. Phys Ther. 2019; 99: 183-93.
11. Ksykiewicz-Dorota A, Zając E. Selection of method of physical work load evaluation at the workplace of a physiotherapist. Ergon Opiece Zdrowotnej. 2003; 4: 83-9.
12. Ksykiewicz-Dorota A, Zając E. Physical work load at the workplace of a physiotherapist in a hospital. Ergon Opiece Zdrowotnej. 2003; 4: 91-6.
13. Lewandowski A, Gronowska I, Grucza R. Physiotherapist's occupation as defined by physiotherapists' evaluation of professional burdens. Med. Biol Sci. 2008; 2: 65-8.
14. Lewandowski A, Żółtowska J, Grucza R, Klawe JJ. Workloads of female personnel performing some physiotherapy procedures in hospital. Med. Biol Sci. 2009; 1: 57-61.
15. Lewandowski A, Wasielewska M, Grucza R, Klawe JJ, Zalewski P. Selected types of work load of male physiotherapists in hospital setting. Fizioter Pol. 2010; 10: 234-41.
16. Lewandowski A, Sarwińska J, Siedlaczek M, Piekorz Z. 10-year longitudinal changes in fitness parameters in physiotherapy students. BioMed Res Int. 2020; 2020.
17. Liao JC, Ho CH, Chiu HY, Wang YL, Kuo LC, Liu C, et al. Physiotherapists working in clinics have increased risk for new-onset spine disorders: a 12-year population-based study. Medicine. 2016; 95: e4405.
18. MacAuley D, editor by. Oxford handbook of sport and exercise medicine. rev ed. Oxford University Press. 2012; 2nd.
19. Marosz A, Lewandowski A. The model of a professional physiotherapist based on an opinion of patients – derived from the research carried out on patients of urban rehabilitation health centres in the kujawsko-pomorskie district. Med. Biol Sci. 2005; 3: 69-75.
20. Milhem M, Kalichman L, Ezra D, Alperovitch-Najenson D. Work-related musculoskeletal disorders among physical therapists: A comprehensive narrative review. Int J Occup Med Environ Health. 2016; 29: 735-47.
21. Oja P, Tuxworth B. Eurofit for adults: assessment of health-related fitness. Finland: Council of Europe; 1995; 37-84.

22. Piórko J. Profilaktyczne posiłki. Praca i zdrowie. 2009; 4: 42-6.

23. Pollock ML, Gaesser GA, Butcher JD, Després JP, Dishman RK, Franklin BA, et al. The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. Med Sci Sports Exer 1998. 1998; 30.

24. Rajkumar. JS, Sharan D. 637 Ergonomic risk factors, musculoskeletal symptoms, exertion and workload among physiotherapists in a single rehabilitation centre. Occup Environ Med. 2018; 75: A148-9.

25. Santos MC, Barros L, Carolino E. Occupational stress and coping resources in physiotherapists: a survey of physiotherapists in three general hospitals. Physiotherapy. 2010; 96: 303-10.

26. Sarwińska J, Zasada M, Lewandowski A. Components of physical adroitenss supporting health of physiotherapy men students at L. Rydygier's Med Univ Bydgoszcz Biol Sci. 2005; 1: 77-82.

27. Swaim D, Edwards S. High school healthy hearts in the zone: a heart rate monitoring program for lifelong fitness. J Hum Kinet. 2003; S928: RJ133.

28. Thornquist E. Profession and life: separate worlds. Soc Sci Med. 1994; 39: 701-13.

29. World Health Organization. Promoting Active Living in and through schools. A WHO statement.. Esbjerg. 2008; 1.

30. Yoopat P, Pitakwong P, Vanwonterghem K. Assessing the physiological strain of physical therapists according to work experience: A cross-sectional study. J Bodyw Mov Ther. 2020; 24: 253-62.