Anthropological Review • Vol. 75 (2), 107–116 (2012)
Available online at: https://doi.org/10.2478/v10044-012-0010-6

Evaluation of somatic and functional parameters of cardiovascular and respiratory systems in rural women in Poland

Tomasz Ignasiak[1], Zofia Ignasiak[2], Ewa Ziółkowska-Łajp[3], Krystyna Rożek[4], Teresa Sławińska[2] and Anna Skrzek[4]

[1]Natural and Technical Faculty, The Karkonosze Higher State School in Jelenia Góra
[2]Faculty of Physical Education, University School of Physical Education in Wrocław
[3]Faculty of Physical Education, Sport and Rehabilitation University School of Physical Education in Poznań
[4]Faculty of Physiotherapy, University School of Physical Education in Wrocław

Abstract: The aim of this study was the diagnosis of selected somatic parameters and functional parameters of cardiovascular and respiratory systems of rural women in Poland. The study involved a group of 95 rural women aged 35–60 years, staying in 3-week rehabilitation camps. The two groups of women were selected: younger ($\bar{x}$=43 years), which did not exceed 50 years of age (n=48) and older ($\bar{x}$=53 years) aged 50 years and older (n=47). The present study examines the measurement of the body height and weight, Body Mass Index (BMI) and functional parameters of cardiovascular and respiratory systems. For the evaluation of cardiovascular parameters, a 6 minute walk test was selected. Before the commencement of the test and in the first minute after it, the pulse and the blood pressure were measured. To assess the functional parameters of the respiratory system, the pattern of flow – volume curve was used. The test was performed with a Jaeger Flowscreen spirometer. The following parameters were determined: forced vital capacity (FVC), forced expiratory volume in one second (FEV1), peak expiratory flow (PEF) and Tiffeneau index (FEV1 in% VC). Examined rural women were likely to be similar to their urban counterparts. BMI of women was significantly higher than peers. Older rural women are particularly at risk of obesity. Heart rate and blood pressure, when at resting and after exercise, were normal and alike in both in young and older women. As expected, younger women had significantly higher levels of respiratory parameters. PEF values in younger women were slightly below the normal limit, and in their older peers, this value was significantly below the normal limit.

Key words: rural women, BMI, cardiorespiratory function

After World War II mass migration of the rural population to cities was observed. It was an opportunity to find lighter work at specific hours and a steady monthly income. In subsequent years, the migration was smaller and focused mainly on young people, resulting in the Polish village becoming clearly older (Gacek 2011;

Original Article: Received 11.09.2012; Accepted 05.12.2012
DOI: 10.2478/v10044-012-0010-6

Kaczmarek and Szwed 1997; Panek et al. 1988; Zając-Gawlak and Groffik 2010). Post-war migration was linked to certain biological characteristics such as secular trends in physical growth and earlier maturation (Bielicki et al. 1977). Currently, due to trends towards equalization of the socio-economic, communication and cultural conditions in both rural and urban areas, the migratory movement has considerably inhibited. You can even see the opposite phenomenon, especially around large cities and industrial centres. People migrate from the city and settle in small towns at some distance from the city.

Regardless of the recent migration trends, the long-term population outflow from rural to urban areas and the specific labour associated with running a farm have contributed to the formation of biological, social and cultural differences between rural and urban populations. Numerous studies indicate the impact of socio-economic and cultural status on development of the indicators of lifestyle and nutritional status, as determinants of health. Authors Gacek (2011), Zając-Gawlak and Groffik (2010) point out the significant differences in body build and health-related behaviours between the population of rural and urban women.

Bielicki et al. (1988) and also Kaczmarek and Szwed (1997) suggest that the positive measures of health, including somatic qualities, and efficiency of the musculoskeletal, respiratory and circulatory systems, are more favourable in the group of intellectuals in comparison with the workers and farmers. In these authors opinion the major determinant is a scale of social status, including higher material standard of living, a more rational management of the family budget, proper nutrition, type of work and a higher level of education, the latter, which is associated with attentiveness turned in own health, understanding the needs of recreation and systematic physical activity.

Intensive socioeconomic changes, observed in recent years has spread to all areas of life. These changes, however, mainly apply to the urban than rural communities. Despite considerable technical improvement, work on the farm is still hard, determined by the seasons of the year and specific work hours. The result is that the work associated with land cultivation and animal husbandry is not very attractive and is often associated with significant overloading on the musculoskeletal system. Research focused on the assessment of the biological condition of the rural adult population is scant and mainly concerns workers of the so-called socialized sector of agriculture – State Farms and Agricultural Cooperatives (Bielicki et al. 1988; Gacek 2011; Panek et al. 1988).

For obvious reasons, the biological condition survey is mainly carried out in urban areas and focused on analysis and assessment of changes in somatic parameters, body build, physical activity, quality of life and lifestyle. The socioeconomic factors are also taken into account. (Janiszewski 2003; Kabsch 2001; Lewis and Modelsky 2000; Nowak et al. 2005; Reece and Simpson 1996; Skrzek and Zagrobelny 2003). However, there is a lack of recent, comprehensive studies of the biological conditions of the rural adult population. This problem is mainly due to organizational difficulties in the performance of this type of research.

The aim of this study was to diagnose selected somatic parameters and functional parameters of cardiovascular and respiratory systems of rural women in Poland.

Materials and methods

The study was conducted at the Farmers Rehabilitation Centre in Szklarska Poręba. The study involved a group of 95 rural women aged 35–60 years residing in a 3-week rehabilitation camp. Due to the variety of age two groups of women were selected: younger who have not exceeded 50 years of age, (n=48), and the older, aged 50 years and older (n=47). The average age in the younger group was 43 ± 5.3 years; in the older group 53 ± 1.7 years. About half of the women in both groups of age had education at medium level (in younger women 54% and older 45%). The rest of women represented level of education below medium. In younger women 52% had 1 or 2 children and the rest had three or more. Within older women 42% had 1 or 2 children and the other 60% had 3 or more. All persons gave their written, voluntary consent to participate in the study. The research program was approved by the Commission for the Study of Ethical Problems in Scientific Research at the University School of Physical Education in Wroclaw.

The present study examines the measurement of body height and weight, Body Mass Index (BMI) and functional parameters of cardiovascular and respiratory systems. To assess the functional parameters of the circulatory system, a 6 minute walk test (6MWT) was selected (Rikli and Jones 1999), indicating cardio – respiratory efficiency. Before beginning the test, the resting heart rate (HRrest) and blood pressure (BPsystolic,BPdiastolic) were measured. In the first minute after completion of the test, the heart rate and blood pressure were re-measured. The length of the distance covered in the attempt was also taken into account.

To assess the functional parameters of the respiratory system, the pattern of flow – volume curve was used. The study was performed using a Jaeger Flowscreen spirometer. The following parameters were determined: forced vital capacity (FVC), forced expiratory volume in one second (FEV1), peak expiratory flow (PEF) and Tiffeneau index (FEV1 in% VC). Measurements were performed in a sitting position, and the obtained results were referred to the absolute value due to gender, age and body height (Miller et al. 2005). Classification criteria for disorders of pulmonary ventilation were adopted from the Standardized Lung Function Testing (1993), where the norm is 80% and above the value of FVC and FEV1, while values below 80% of FVC indicates restrictive disorders of lung ventilation, and FEV1 less than 80% indicates the obstructive type of lung ventilation disorders. Cigarette smoking was also taken into account in the study groups.

For analysis of data the method of descriptive statistics were used. The arithmetic mean ($\bar{x}$), standard deviation (SD) and Student's t-test were calculated to assess the significance of differences between average values of the analysed variables among younger and older women. The criterion for statistical significance assumed size of $p \leq 0.05$. To assess the relationships between all the parameters, cluster analysis was used. Ward's agglomeration method was used and a Pearson distance of 1 – r. All calculations were done with STATISTICA 9.1. data analysis software system.

Results

In this study, younger rural women are significantly taller than older (Table 1),

which is a result not only of changes in body height between generations, but also of involutional changes occurring in the spine and lower limbs of older women. The average value of body weight of younger women is slightly lower than that of older women, but the differences are not statistically significant (Table 1). The body mass index BMI, informs about the correctness of the relationship of the two analysed parameters. The average values of BMI in both groups of women did not differ significantly (Table 1). Both are in the range "overweight" (BMI over 25.0 kg/m^2). Individual analysis indicates that only 37.5% of women in the younger group and 23.4% of women in the older group have a normal BMI. The other women are characterized by overweight (respectively 35.4% and 38.3%) and obesity (27.1% and 38.3%).

Analysis of selected cardiovascular functional parameters did not show statistically significant differences related to age. Such results were observed both in terms of hemodynamic parameters such as HR and BP, as well cardio-respiratory efficiency, measured by the length of the distance covered in the 6MWT (Table 2).

The values of lung ventilation parameters allow assessing the efficiency of the respiratory system, which strongly influences the proper functioning of the human body. Younger women are characterized by higher levels of forced vital capacity (FVC) compared to older women. The difference between means is statistically significant (Table 3). In relation to the value among both younger women and older, mean values are over 100%. Other important parameters: forced expiratory volume in one second (FEV1) and peak expiratory flow (PEF) are measured in the time of forced expiratory. These activities require auxiliary inspiratory and expiratory muscle activity. In the younger group parameters reached higher values than in the older group, and

Table 1. Statistical description of somatic parameters in both age groups

Characteristic	Younger group (<50 years)		Older group (≥50 years)		Student's t-test	
	$\bar{x}$	SD	$\bar{x}$	SD	t	P
Body height [cm]	164.00	5.43	159.93	5.44	3.64	0.0004
Body weight [kg]	72.43	11.94	73.52	12.99	0.43	0.6705
BMI [kg/m^2]	26.93	4.16	28.74	4.80	1.97	0.0520

Table 2. Statistical description of cardiovascular parameters in both age groups

Characteristic	Younger group (<50 years)		Older group (≥50 years)		Student's t-test	
	$\bar{x}$	SD	$\bar{x}$	SD	t	P
6 minutes walk test [m]	483.83	72.21	479.95	92.67	0.22	0.8249
Resting HR [bpm]	72.94	8.98	75.64	10.52	1.34	0.1843
BP systolic – in rest [mmHg]	117.85	12.62	123.27	15.37	1.86	0.0660
BP diastolic – in rest [mmHg]	76.46	11.34	80.20	12.52	1.51	0.1341
HR in 1 minute after exercise [bpm]	81.96	12.72	85.10	10.49	1.26	0.2123
BP systolic in 1 minute after exercise [mmHg]	123.85	15.10	125.49	14.91	0.51	0.6101
BP diastolic in 1 minute after exercise [mmHg]	77.56	11.66	80.98	11.14	1.40	0.1636

Table 3. Statistical description of respiratory parameters in both age groups

Characteristic	Younger group (<50 years)		Older group (≥50 years)		Student's t-test	
	$\bar{x}$	SD	$\bar{x}$	SD	t	P
FVC [l]	3.36	0.62	2.96	0.54	3.13	0.002
FVC [%]	102.72	16.57	104.76	17.89	0.46	0.6474
FEV1[l]	3.00	0.44	2.54	0.53	4.58	0.00001
FEV1[%]	106.5	15.25	105.6	17.89	0.26	0.7952
PEF [l]	5.26	1.38	4.37	1.20	3.32	0.0013
PEF [%]	78.94	20.12	71.46	19.96	1.81	0.0737
FEV1%VC	89.58	6.03	85.57	8.30	2.69	0.0084

Table 4. Prevalence of lung ventilation abnormalities in two age groups of study women

Obstructive type disorder (FEV1 <80%)		Restrictive type disorder (FVC<80%)	
Younger group (<50 years)	Older group (≥50 years)	Younger group (<50 years)	Older group (≥50 years)
2 (4.2%)	4 (8.7 %)	7 (14.6%)	7 (15.2%)

the average difference between compared groups is statistically significant. Also, the average Tiffeneau index in younger women is more favourable in comparison with the group of older women. The difference between the two averages is statistically significant (Table 3).

Characteristics of the occurrence of disorders showed a similar, slight percentage of lung ventilation disorders,

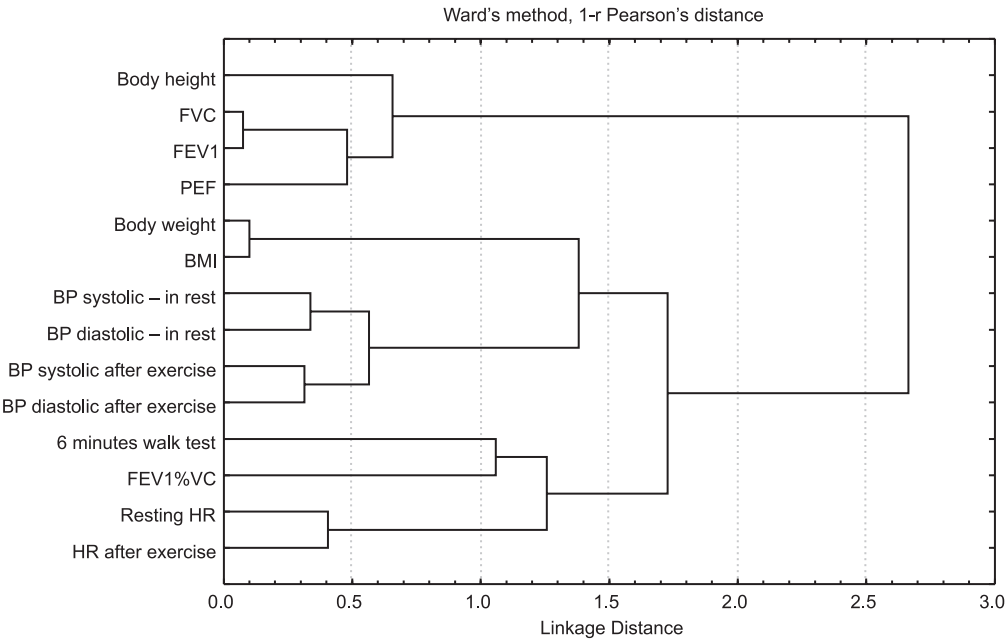

Fig. 1. Grouping of chosen somatic and functional parameters in rural women

including the obstructive and restrictive type in both groups (Table 4). Taking smoking into consideration, the low rate of smokers was reported: in the younger group 6 women (12.8%) and in the older 7 women (14.9%).

The results of cluster analysis indicate the separation of the three groups of interrelated characteristics (Fig. 1). The first cluster includes the height of the body and basic functional parameters of the respiratory system. The second cluster points to the relationship of body weight, BMI and systolic and diastolic blood pressure before and after exercise. And the third cluster includes cardio-respiratory efficiency, associated with the Tiffeneau index and heart rate at resting and after exercise. The greatest likelihood was observed between the second and third cluster.

Discussion

In recent years in Poland during the political and socio-economic transformation, living conditions of the population have improved considerably, and the dynamics of these changes are significantly higher compared to previous years. These changes affect all social groups, except that in some groups these changes proceed more slowly than in others (Bielicki et al. 2003; Frenkel 2003; Gacek 2011). The rural environment is still a more 'disadvantaged' environment compared to the urban environment in terms of the structure of social status, as measured by education level, professional position, the level of income per person, access to health services and cultural goods. (Bielicki et al. 1988; Gacek 2011; Kolodziej 2000; Welon 1992). So social advancement in this group is slower; changes of life conditions in the direction of their improvement are also slower.

The human biological condition can be described by a number of parameters. Among them there are somatic parameters and BMI, analysed by us. The body height is a somatic feature acknowledged by many researchers, which inform about the biological development and regional, environmental, social, or dimorphic distinctions (Bielicki et al. 1988; Gacek 2011). The body height is the somatic characteristic, the final value is achieved by women at about 18–20 years of age and for many years does not change. Only intensified involution processes may cause a slight decrease in body height by deepening the physiological spine curvatures, flattening of the intervertebral discs, contractures in the joints of the lower limbs and the lowering of the arches of the foot. Among the surveyed rural women, the manifestations of a secular trend can also be observed. Younger women are significantly taller than older women. Comparing our data of the body height of the women with the results of other authors, no major differences between peer groups can be observed (Bielicki and Charzewski 1977; Nowak et al. 2005; Zając-Gawlak and Groffik 2010).

Body weight is a parameter which is less genetically controlled, and depends largely on the lifestyle and nutrition, and thus it is a more changeable parameter (Stachoń et al. 2010; Zając-Gawlak and Groffik 2010). In some studies it has been reported that rural women are heavier than their peers in urban areas. Perhaps that characteristic is associated with a specific diet and lifestyle of rural women (Gacek 2011; Stachoń et al. 2010; Zając-Gawlak and Polechoński 2007). In our study there were no significant dif-

ferences in body weight in the studied age groups.

The body mass index (BMI) is currently the most widely used indicator in assessment of normal body weight, overweight and obesity. Obesity is suggested to be a major risk factor for many lifestyle-related diseases such as cardiovascular and metabolic diseases, leads to a series of restrictions and pathology in the musculoskeletal system, reduces physical fitness and is often the cause of low self-esteem and poor body image (Flegal et al. 2002; Janssen et al. 2005; Kopelman 2000; Przybyłowicz and Cichoń 2002). Obesity is therefore a fundamental social, health, and economic problem. Higher average BMI in the group of rural women is often accompanied by lower awareness of regular physical activity. We can also presume a relationship between the women lifestyle amd their nutritional status. A diversity of indicators of nutritional status and lifestyle tie into the level of education, which is higher among urban women (Gacek 2011; Ignasiak et al. 2009; Skrzypczak and Szwed 2005; Zając-Gawlak 2007, 2010). In the younger surveyed group of rural women, the average BMI value slightly exceeds the upper limit of the normal as indicated by the WHO. However, older women after 50 years of age approach the limit of I degree of obesity on the BMI scale. It can therefore be assumed that older rural women are put more at risk of obesity. With regard to the urban population, the average BMI of rural women is higher (Gacek 2011; Ignasiak et al. 2011; Nowak and Ignasiak 2008; Stachoń et al. 2010).

Optimal parameters of the circulatory and respiratory systems are among some of the most important health indicators (Kuński 2000; Rożek 2006). They commonly affect the level of physical fitness, understood as daily human activities at work and in everyday life. In the literature, many authors draw attention to the obvious correlation between the functional parameters of the respiratory and cardiovascular system and physical activity (Dunn et al. 1999; Klimek and Cempla 1997; Rożek 2006; Twisk et al. 1998; Walla et al. 2000). This relationship is a feedback loop. The improvement of functional parameters enables improvement of physical function and vice versa. In addition, the functional parameters of the respiratory and circulatory systems affect age, sex, body height and weight, and environmental conditions. The analysed hemodynamic parameters of cardiovascular system and exercise tolerance expressed as the length of the 6 minute walk distance, in the younger group showed slightly better results, statistically insignificant. Comparing them to the researched women from Wroclaw, conducted by Ignasiak et al. (2011), it can be noticed, that there are significant differences in relation to systolic blood pressure, measured both at rest and after exercise. In our study lower values of this parameter were observed. As to other parameters, such as resting and exercise HR, and diastolic blood pressure or the distance of 6MWT, the two compared groups were similar to each other.

Basic respiratory functional parameters among rural surveyed women have one direction of change. In older women forced vital capacity (FVC), forced expiratory volume in one second (FEV1), peak expiratory flow (PEF) and the Tiffeneau index (FEV1 in% VC) values are significantly lower compared to younger women. Such trends also confirm Hagberg et al. (1988) and Twisk et al. (1998). Moreover, these parameters expressed in percentage values in both groups of women

are within normal limits, and even above, with the exception of PEF%. However the percentages of peak expiratory flow rate in younger women are at limit of normal and insignificant obstruction. In older women, this parameter shows a slight obstructive disorder of pulmonary ventilation (Standardized Lung Function Testing 1993).Similar studies of women were also conducted in urban areas (Ignasiak et al. 2011; Rożek-Mróz 2002). Results of respiratory function tests of rural women in this study compared to the results of women from Wroclaw show lower values for the age group below 50 years, while older women are characterized by higher values than urban women in the same age (Ignasiak et al. 2011; Rożek-Mróz 2002).

The cluster analysis results clearly show that the strongest relations can be observed between cardiorespiratory efficiency (assessed by 6-minute walking test) and the Tiffeneau index and heart rate in older women. By contrast, among the other hemodynamic blood and respiratory parameters, no statistically significant associations were observed.

Conclusions

The results obtained in this study enabled us to draw a conclusion that place of residence still plays an important role for health of Polish women. Women living in rural areas were more prone to be obese and therefore in higher risk to ill-health than their peers from urban areas. Heart rate and blood pressure when at rest and after exercise were normal and with very similar values in younger and older women. As expected, younger women had a significantly higher level of respiratory parameters.

Authors' contribution

TI, ZI, EZŁ paper concept and design; ZI, KR, TSO research concept and design; TI, KR data collection; TI, ZI, EZŁ, KR, TSO, SA – statistical analysis and interpretation; TI, ZI, EZŁ drafted the manuscript. All author read and approved final version of the manuscript.

Conflicting interests

The authors declare that they have no conflicts of interest in the research.

Corresponding author

Zofia Ignasiak, Faculty of Physical Education, University School of Physical Education in Wrocław, al. I. J. Paderewskiego 35, 51-612 Wrocław, Poland.
e-mail address:
zofia.ignasiak@awf.wroc.pl

References

Bielicki T, Charzewski J. 1977. Sex differences in the magnitude of statural gains of offspring over parents. Human Biology 49(3):265–77.

Bielicki T, Welon Z, Żukowski W. 1988. Problem nierównowartości biologicznej warstw społecznych. Materiały i Prace Antropologiczne 109:123–40.

Bielicki T, Szklarska A, Kozieł S, Welon Z. 2003. Transformacja ustrojowa w Polsce w świetle antropologicznych badań 19-letnich mężczyzn. Wrocław: Monografie Zakładu Antropologii PAN 23.

Dunn AL, Marcus BH, Kampert JB, Garcia ME, Kohl HW, Blair SN. 1999. Comparison of lifestyle and structured interventions to increase physical activity and cardiorespiratory fitness: a randomized trial. JAMA 281(4):327–34.

Flegal KM, Wei R, Ogden C. 2002. Weight-for-stature compared with body mass

index-for-age growth charts for the United States from the Centers for Disease Control and Prevention. Am J Clin Nutr 75:761–66.

Frenkel I. 2003. Ludność, zatrudnienie i bezrobocie na wsi. Dekada przemian. Warszawa: Instytut Rozwoju Wsi i Rolnictwa PAN.

Gacek M. 2011. Wybrane zachowanie zdrowotne grupy kobiet w środowisku wiejskim i miejskim w świetle statusu socjoekonomicznego i stanu odżywienia. Prob Hig Epidemiol 92(2):260–66.

Hagberg JM, Yerg JE, Seals DR. 1988. Pulmonary function in young and older athletes and untrained men. J Appl Physiol 65:101–05.

Ignasiak Z, Skrzek A, Dąbrowska G. 2009. Bone mineral density and body composition of senior female student of the University of Third Age In view of their diverse physical activity. Human Movement 10(2):105–15.

Ignasiak Z, Skrzek A, Sławińska T, Rożek-Piechura K, Steciwko A, Domaradzki J, et al. 2011. Wstępna ocena kondycji biologicznej wrocławskich seniorek. Gerontol Pol 19(2):66–70.

Janiszewski M. 2003. Trening zdrowotny osób dorosłych z dysfunkcją narządu ruchu. Med. Sportiva 7:53–63.

Janssen I., Katzmarzyk PT., Srinivasan SR., Chen W., Malina RM., Bouchard C., Berenson GS. 2005. Combined influence of Body Mass Index and waist circumference on coronary artery disease risk factors among children and adolescents. Pediatrics 115 (6):1623–30.

Kabsch A. 2001. Niepełnosprawność towarzysząca procesom starzenia wyzwaniem dla fizjoterapii. Fizjoterapia 3:3–19.

Kaczmarek M, Szwed A. 1997. A review of anthropological approaches to ageing. Przegląd Antropologiczny 60:35–46.

Klimek AT, Cempla J. 1997. Zmiany parametrów fizjologicznych charakteryzujących progi metaboliczne i maksymalne obciążenie wysiłkowe u chłopców w okresie dojrzewania. Antropomotoryka 16:127–45.

Kołodziej H. 2000. Zróżnicowanie sytuacji społeczno-ekonomicznej i stylu życia dorosłych mężczyzn. Wych Fiz i Sport 2:47–58.

Kopelman PG. 2000. Obesity as a medical problem. Nature 404:635–43.

Kuński H. 2000. Trening zdrowotny w umacnianiu zdrowia osób dorosłych – z perspektywy pragmatyka i popularyzatora. Med Sport 100:14–22.

Lewis RD, Modlesky CM. 2000. Odżywianie, aktywność fizyczna a zdrowe kości u kobiet. Medicina Sportiva 4(S1)11–48.

Miller MR, Hankinson J, Brusasco V. 2005. Standardisation of spirometry. Eur Respir J 26:319–38.

Nowak A, Stęplewski R, Szeklicki R, Karolkiewicz J, Pilaczyńska-Szcześniak Ł, Osiński W. 2005. Biochemical markers of bone metabolism in healthy elderly men. The relationship to physical activity. The Aging Male (UK) 8 (2):75–80.

Nowak P, Ignasiak Z. 2008. The state of health of women aged 20–59 at different levels of physical activity. Human Movement 9(1):27–33.

Panek S, Chrzanowska M, Bocheńska Z. 1988. Biologiczne i społeczno-ekonomiczne aspekty selektywnej migracji ze wsi do miast. Materiały i Prace Antropologiczne 109:23–52.

Przybyłowicz K, Cichoń R. 2002. Ocena występowania otyłości wśród studentek przy zastosowaniu klasyfikacji BMI i pomiaru szerokości nasady nadgarstkowej. Nowiny Lekarskie 71(1):40–43.

Reece AC, Simpson JM. 1996. Preparing older people to copy after fall. Physiotherapy 82: 227–35.

Rikli RE, Jones CJ. 1999. Functional fitness normative scores for community – residing older adults, ages 60–94. J Aging Phys Activ 7:162–81.

Rożek-Mróz K. 2002. Zmienność wybranych parametrów czynnościowych układu oddechowego człowieka w świetle rozwoju morfofunkcjonalnego. Wrocław: Wydawnictwo AWF.

Skrzek A, Zagrobelny Z. 2003. Ocena procesów starzenia się narządu ruchu w badaniach izokinetycznych – elementy profilaktyki. Med Sport 19:147–55.

Skrzypczak M, Szwed A. 2005. Assessment of the body mass index and selected physiological parameters in pre- and post-menopausal women. HOMO – J Comp Hum Biol 56:141–52.

Stachoń A, Burdukiewicz A, Pietraszewska J, Andrzejewska J, Chromik K. 2010. Biological symptons of aging in women regarding physical activity and lifestyle. Human Movement 11(2):172–78.

Standardized lung function testing. Official statement of the European Respiratory Society. 1993. Eur Respir J (Suppl) 16:1–100.

Twisk JW, Staal BJ, Brinkman MN, Kemper HCG, van Mechelen W. 1998. Tracking of lung function parameters and the longitudinal relationship with lifestyle. Eur Respir J 12:627–34.

Walla G, Chorąży M, Saulicz E, Żmudzka-Wilczek E, Musialik G. 2000. Wpływ wyczynowego uprawiania sportu na zachowanie się niektórych parametrów spirometrycznych. Ann Acad Siles 44–45:83–90

Welon Z. 1992. Drogi awansu chłopów polskich w świetle wskaźników antropologicznych. Przegląd Antropologiczny 1–2:91–99.

Zając-Gawlak I, Polechoński J. 2007. Fitness of 50–96 Years Old Women. J Hum Kinet 18:99–108.

Zając-Gawlak I, Groffik D. 2010. Ubytki wysokości ciała jako składowa inwolucyjnych zmian w budowie somatycznej kobiet i mężczyzn po 50. roku życia. Gerontol Pol 18(4):183–93.