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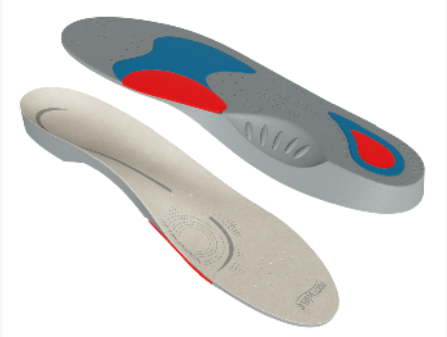

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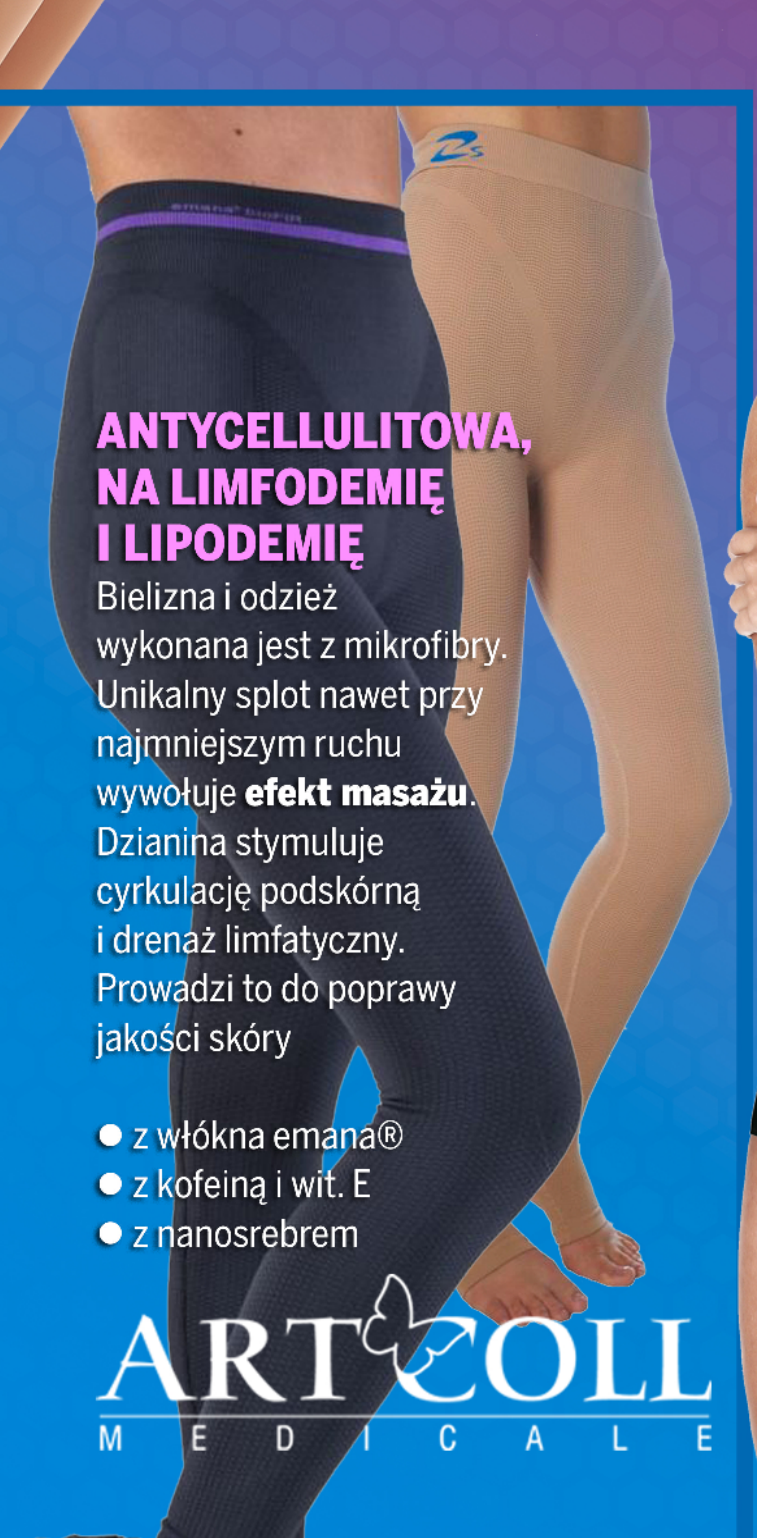

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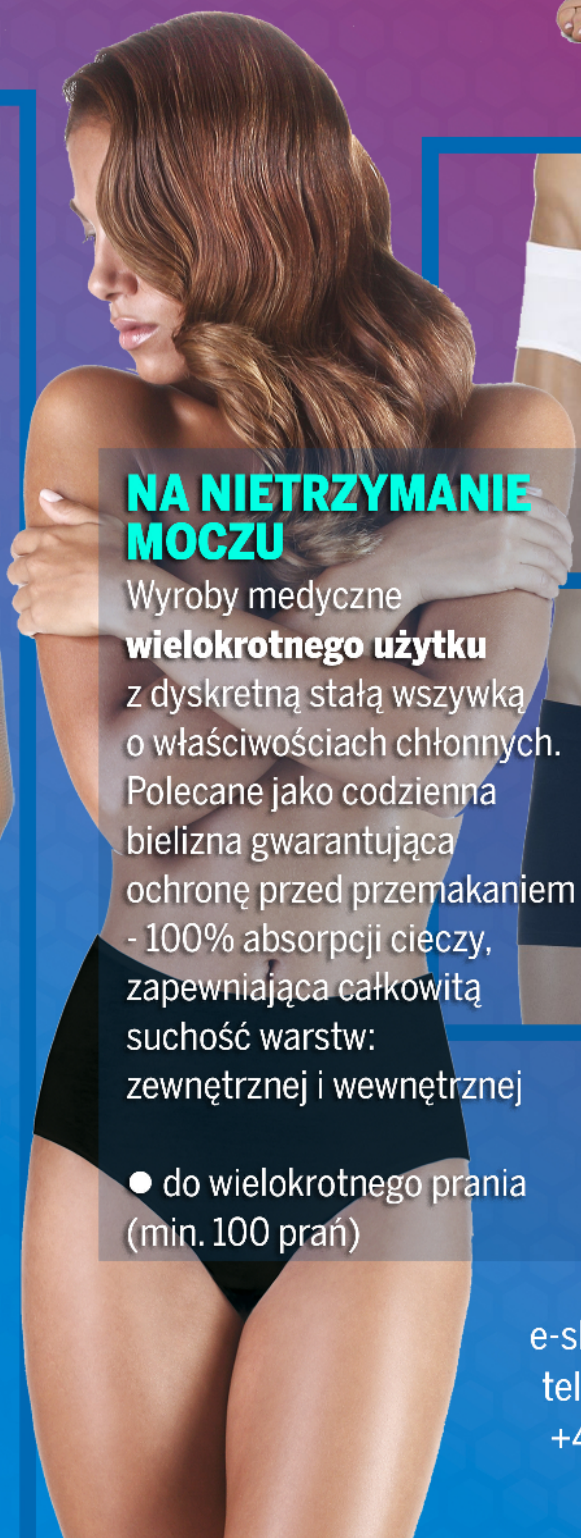

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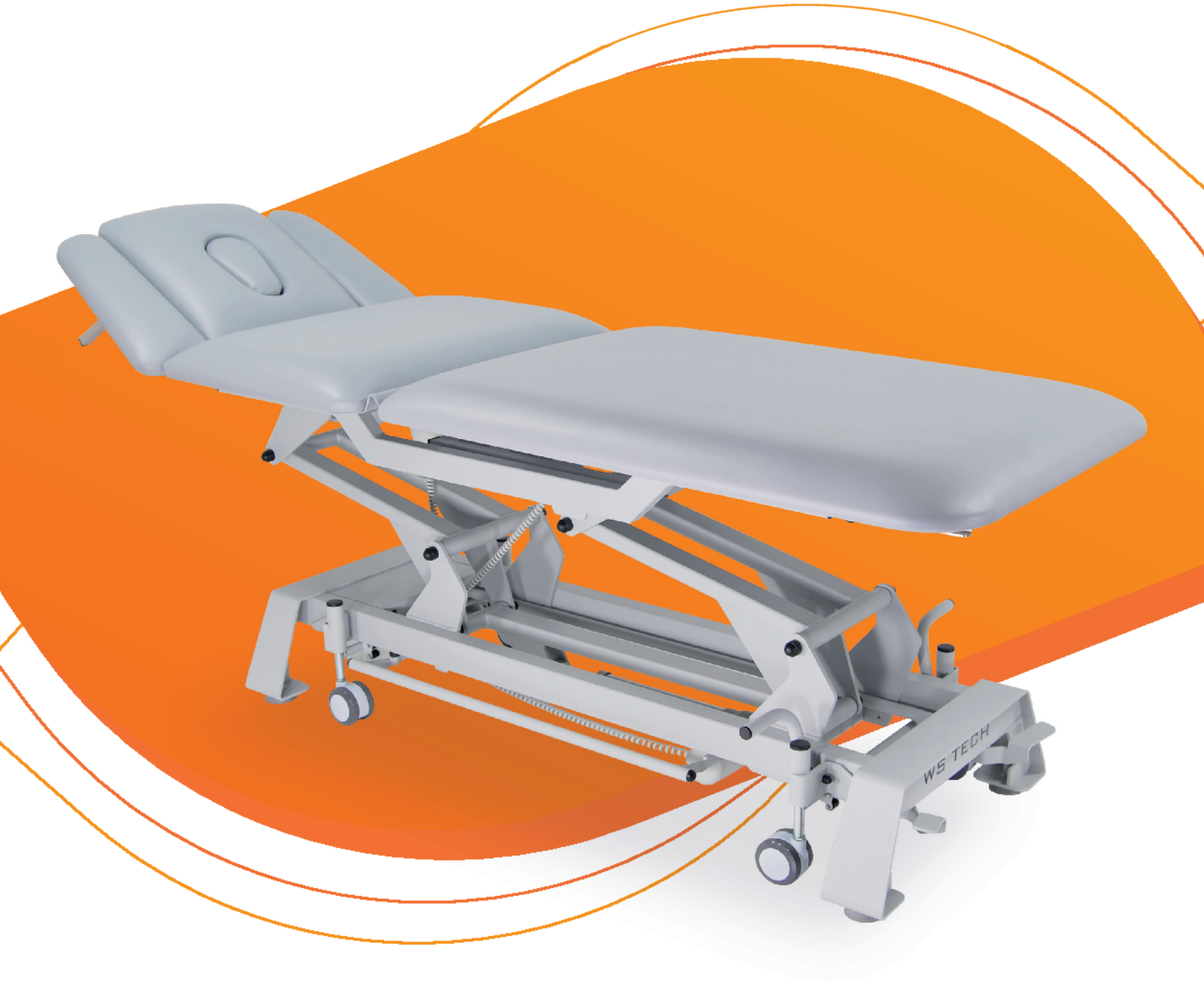

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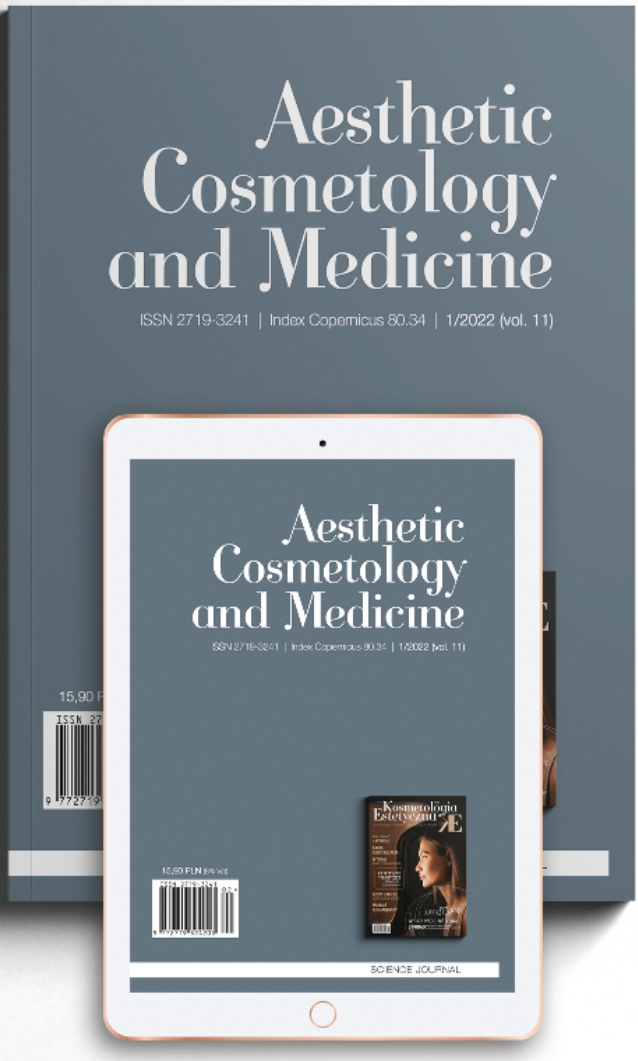

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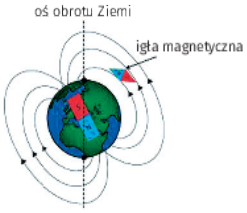

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Early and late effect of unilateral mastectomy on the weight bearing distribution

Wczesny i odległy wpływ jednostronnej mastektomii na statykę ciała

Anna Koralewska[1(A,B,D,E,F)], Małgorzata Domagalska-Szopa[1(A,C,E)], Robert Łukowski[2(B)]

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Abstract

Introduction. A mastectomy is a common treatment for breast cancer. In Poland, the vast majority of women after mastectomy use an external breast prosthesis.
Objective. The aim of the study was to identify differences in the weight-bearing distribution between women in the early and late period after mastectomy.
Material and methodology. 42 women after unilateral complete or radical amputation of the breast were qualified for the study. The study consisted of 3 parts: anthropometric measurements, measurements of the circumference of the upper limbs, assessment of the weight-bearing distribution using the stabilometric platform.
Results. Within the group of women in the early post-mastectomy period, the weight-bearing distribution was similar between the amputated and non-amputated sides in test with and without external breast prothesis. This has also been observed within the group of women in the late post-mastectomy period. There was no statistical difference between both studied groups. The tests were carried out with and without external breast prosthesis and the results indicate no significant effect of prosthesis on the symmetry of the weight-bearing distribution nor the percentage of load on the amputated and non-amputated sides of the body.
Conclusions. Lymphodema occurs in women in both early and late period after mastectomy however that occurrence does not affect the nature of the asymmetry of the weight- bearing distribution between the amputated and non-amputated body sides; The breast prosthesis does not have a significant impact on the weight-bearing distribution between the amputated and non-amputated sides. The analyzed issue requires further comprehensive research.

Key words:
total mastectomy, external breast prosthesis, postural control disorders, posturography, stabilographic platform

Streszczenie

Wstęp. Na podstawie materiałów informacyjnych dla kobiet po mastektomii wydaje się niemal oczywiste, że w wyniku jednostronnej amputacji piersi, a także występowania obrzęku limfatycznego kończyny górnej po stronie amputowanej, zmieniają się warunki statyki ciała. Cel. W ramach podjętych badań podjęto próbę rozpoznania wpływu jednostronnej amputacji piersi na symetrię rozkładu sił nacisku mas ciała na płaszczyznę podporu oraz w zależności od czasu jaki upłynął od zabiegu.
Materiał i metoda.
Badania przeprowadzono wśród 42 kobiet po jednostronnej całkowitej lub radykalnej amputacji piersi. W zależności od czasu, jaki upłynął od zabiegu uczestniczki zostały podzielone na dwie grupy: grupa A – nie więcej niż 12 miesięcy; grupa B – powyżej 5 lat od daty zabiegu. Badania składały się z 3 części: 1) pomiary antropometryczne; 2) pomiary obwodów kończyn górnych; 3) ocena rozkładu sił nacisku masy ciała na płaszczyznę podparcia z wykorzystaniem platformy stabilometrycznej.
Wyniki. Na podstawie uzyskanych wyników można stwierdzić, że: 1) zarówno u kobiet we wczesnym, jak i późnym etapie po mastektomii występują obrzęki limfatyczne; 2) występowanie obrzęków nie wpływa na charakter asymetrii rozkładu sił nacisku mas ciała na płaszczyznę podparcia pomiędzy amputowaną i nieamputowaną stronę ciała; 3) porównanie pomiaru rozkładu mas ciała na płaszczyznę podparcia pomiędzy amputowaną i nieamputowaną stronę ciała w warunkach z protezą zewnętrzną piersi i bez wskazuje, że proteza piersi nie ma większego wpływu na statykę ciała.
Wniosek. Rozpoznanie wpływu zewnętrznej protezy piersi na kontrolę posturalną kobiet po jednostronnej mastektomii wymaga przeprowadzenia dalszych kompleksowych badań obejmujących ocenę ich stabilności statycznej i dynamicznej, jak również kompleksowej oceny postawy ciała.

Introduction

Breast cancer is the most common type of cancer among women globally. The incidence of breast cancer is increasing every year. The survival rate for this neoplasm is high, therefore breast cancer is considered one of the best prognosis neoplasms [1, 2, 3, 4]. Treatment of breast cancer mainly involves surgery, but also radiotherapy, chemotherapy, hormonal therapy, and biological treatment. A mastectomy is a common treatment for breast cancer. There are five main types of mastectomy: 1) total mastectomy; 2) modified radical mastectomy; 3) radical mastectomy; 4) partial mastectomy; 5) sparing mastectomy. The total mastectomy is also called the simple mastectomy. It is a procedure in which the entire breast is removed, along with the nipple, areola, and skin. Often the sentinel lymph nodes are also removed during this procedure to check whether they contain cancerous cells. Total mastectomy is often used in early breast cancer, where cancer has not yet spread to the axillary lymph nodes. The modified radical mastectomy called the Patey procedure allows determining whether the cancer cells have not reached the axillary lymph nodes. This procedure involves the removal of the entire breast with the nipple, areola, skin and some axillary lymph nodes. Occasionally, the chest muscle lining may be removed. The radical mastectomy is a highly invasive procedure that removes the entire breast, nipple, areola and skin, as well as all axillary lymph nodes and the major and minor pectoral muscles. Radical mastectomy was once a very common procedure for the treatment of breast cancer, but thanks to the development of imaging and radiotherapy techniques, it is increasingly being replaced by modified radical mastectomy. The latest research review from 2021 showed that radical mastectomy does not extend the survival rate of patients after this procedure, but remains a good treatment option when cancer has metastasized to the chest muscles. The partial mastectomy is the removal of the neoplastic area along with healthy surrounding tissue. This type of surgery is performed when there is a small area of neoplastic tissue. The conserving mastectomy is one of the least invasive surgical procedures and requires only surgery in the axillary lymph nodes [5, 6, 7].

Treatment of breast cancer may have a number of negative consequences [8]. The consequences are divided into the early ones, occurring during or shortly after treatment, and the late ones, which occur in later years. Early consequences include: infection of the surgical site, prolonged lymphorrhea, bleeding, abnormal blood supply to the wound edges, necrosis, and the perceived phantom pain of the removed breast [9, 10]. Late consequences include: sensory disturbances within the operated site, damage to the breast nerve, lymphoedema on the operated side, contractures within the scar, muscle contractures, limitation of mobility in the shoulder joint on the amputated side, weakness of the muscles of the shoulder girdle and upper limbs, asymmetry of positioning shoulder blades on the amputated side, asymmetry of the shoulder girdle and trunk, changes in muscle tone, changes in body posture, shape of the feet, biomechanics of the whole body, and imbalance.

All of these changes appear after surgery. A significant proportion of women in the world decide to have their breasts reconstructed after total mastectomy. In Poland, this procedure is not that popular, therefore the majority of women after mastectomy use an external breast prosthesis [10, 11, 12, 13, 14, 15, 16].
On the basis of information materials for women after mastectomy, it seems almost obvious that as a result of unilateral breast amputation. The conditions of the body statics change, which inevitably leads to the development of an asymmetrical body posture, including the lowering of the shoulder and the extension of the shoulder blade on the amputated side, but also the asymmetry of the torso and even curvature of the spine. Therefore, the role of external breast prosthesis as the most important link in tertiary prophylaxis is widely emphasized. It is acknowledged that apart from the fact that the external prosthesis allows to cover up the unilateral lack of breasts, it also restores the correct statics of the torso and thus protects against problems with body posture and balance disorders. For this reason, such a great importance is paid to the proper selection of prosthesis weight, size, shape, and even consistency. Moreover, it is believed that only a prosthesis weighing similar to that of a healthy breast will protect against the development of static body disorders, especially after unilateral mastectomy.The literature on the subject indicates the occurrence of postural disorders and disorders of body statics in this population [2, 12, 17, 18, 19]. However, there are also studies that do not confirm such a significant influence of the external breast prosthesis on the occurrence of postural control disorders [11, 13, 20].
It was the above-mentioned controversy that encouraged the authors to recognize the problem of the occurrence of broadly understood postural control disorders in women after unilateral mastectomy in the form of the research project "Postural control disorders in women after unilateral mastectomy". As a part of the research, an attempt was made to identify the influence of unilateral breast amputation on the symmetry of the weight- bearnig distribution and on the time that has elapsed since the mastectomy. Scientific reports about the influence of lymphoedema in the early period after mastectomy and about the later changes in the body's statics that appear over time since radical mastectomy has encouraged us to recognize differences in the weight-bearing distribution between women in the early and late period after mastectomy.

Material and methods

Material

Women after unilateral total or radical amputation of breast were qualified for this study. The studied group was participating in the program (“You are worth it”) sponsored by the European Union. This program was focusing on the comprehensive rehabilitation of breast cancer survived women who had lived, worked, or were educated in the Silesian Voivodeship in Poland. The research was carried out in Niepubliczne Zakład Opieki Zdrowotnej "Sanus" Sp. z o.o. in Zabrze. All study participants had previously received combination treatment (total unilateral mastectomy, chemotherapy and/or radiotherapy).

The study inclusion criteria were as follows: 1) sex - female, 2) unilateral total or radical mastectomy performed within 5 - 12 months (from the date of surgery); or was over 5 years old and did not exceed 12 years (from the date of surgery); 3) use of external breast prosthesis at least during the day, 4) written declaration of informed consent to participate in the study. The criteria for exclusion from the study concerned the following situations: 1) medical history of dizziness, 2) confirmed balance disorders, or taking medications that affect the balance of the body, 3) diagnosed rheumatic diseases in medical records, 4) diagnosed diseases of the nervous system (Parkinson's disease, condition after stroke, peripheral nerve paralysis) in medical records, 5) diagnosed disorders of the skeletal system (posture defects, foot deformities) confirmed by functional assessment, 6) confirmed in a history of trauma, 7) diagnosed cancer metastases to the skeletal system, 8) mental disorders confirmed in the history (depression, dementia).
Participants were included in the study consecutively - in the order of applying to the program "You are worth it" - provided that the inclusion criteria were met and the exclusion criteria were considered. The number of participants in the period from 5 to 12 months (counting from the date of the procedure) was equal to the number of participants with a period after the surgery exceeding 5 years and not exceeding 12 years (from the date of surgery).
Based on the above criteria, 58 subjects were included in the study. Due to the exclusion criteria, mainly musculoskeletal disorders and neurological disorders confirmed in medical records, 11 women were disqualified from the study. Another 5 qualified participants did not complete all the required studies. Finally, 42 participants were included in our study. These women were excluded only from the study. carried out for the purposes of this study, while remaining participants of the comprehensive rehabilitation program "You are worth it." All study participants were using external breast prostheses on a daily basis for at least 12 hours during the day. These breast prostheses were selected in the past by a trained person. All subjects met the inclusion and exclusion criteria and all planned measurements were performed.

Methodology

The research proposal received a positive opinion of the Bioethical Committee of the Medical University of Silesia in Katowice (Resolution No. KNW / 0022 / KB1 / 61/18). The study was conducted in accordance with the Helsinki Declaration.
Before starting the study, each of the participants was effectively informed about the purpose and assumptions of the research project and what the study is about, which was confirmed by informed consent to participate in the study. The respondents were also informed that participation in the study was completely voluntary and could be withdrawn without giving a reason.
The research consisted of 3 parts:
1) anthropometric measurements
2) measurements of the circumference of the upper limbs
3) evaluation of the weight- bearing distribution using a PDM stabilometric platform with software (Zebris Medizintechnik GmbH)

Anthropometric measurements
Anthropometric measurements included the measurement of body height and weight as well as the length of the lower limbs. A tailor's tape was used to measure the length of the lower limbs, measuring the distance between the greater trochanter of the femur and the medial ankle for both the right and left lower limbs.

Measurements of the circumference of the upper limbs
The measurement of the circumference of the upper limbs was made with the help of a tailor's tape. Measurements were performed on two levels in each of the subjects. The first measurement (brachial circumference) was taken 10 cm above the lateral epicondyle of the humerus and the second (forearm circumference) 10 cm below this epicondyle.

Measurement of the weight- bearing distribution
The assessment of the weight-bearing distribution was carried out using a PDM stabilometric platform with software (Zebris Medizintechnik GmbH).
When assessing the weight- bearing distribution, the patient stood in a free-standing position, the upper limbs hung freely along the trunk, and the distance between the lateral ankles was about 10 cm.
The following measurements were made:
1. measurement of the weight- bearing distribution, between the sides of the body with the breast prosthesis with open eyes,
2. measurement of the weight- bearing distribution between the sides of the body without the breast prosthesis with open eyes.
Each measurement lasted 30 seconds, and the final result was the averaged value of the percentage weight- bearing distribution between the sides of the body.

Statistical analysis
Statistical analysis was performed in the Statistica 13.1 TIBCO Software Inc. package. (2017). The significance level was assumed to be $\alpha = 0.05$. The normality of the data distribution was tested using the Shapiro-Wilk test. Based on the criterion of the time from the mastectomy, the participants were divided into two subgroups:
• Group A – participants who on the day of the study did not exceed 12 months after the mastectomy procedure.
• Group B – participants who on the day of the study were between 5 a n d 1 2 years after mastectomy procedure.
The homogeneity of the variance was checked with the Levene test. If the variables met the criteria for parametric tests, the ANOVA test was used for the repeated measures system (the dependent measurement was the measurement with and without the prosthesis and the measurement on the amputated and non-amputated side of the body) or the Student's t-test for independent variables. The differences in the weight- bearing distribution were determined between the amputated and non-amputated sides of the body. For this purpose, the right and left sides of the body were transformed into the amputated and non-amputated sides. The results of the weight bearing distribution were presented using the absolute values of the percentage load on the amputated and non-amputated sides and the symmetry index (SI). SI was calculated according to

the following formula: |XAM–XNA| / avg (XAM, XNA) × 100%, where XAM i XNA are the values of a given parameter on both sides of the body – in this case, the amputated and non-amputated sides. The closer the index value is to "0", the better the symmetry of a given parameter [21].

Results

Following the selected at the beginning of the study criteria, the time from the mastectomy procedure, the subjects were divided into two subgroups A and B. In group A, i.e. in the group of participants in the early phase of rehabilitation, i.e. those who on the day of the study did not exceed 12 months after the surgery, the average age of the respondents was 57.8 years, while the respondents in group B, i.e. in the distant phase of rehabilitation after surgery, were on average 62.3 years old. Age differences between the groups were not statistically significant. As well as body weight, height and BMI. The compared groups, due to the assumptions of the research project, differed statistically significantly in time from the mastectomy procedure. The demographic and anthropometric characteristics of the studied groups are presented in Table 1.

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Table 1. Demographic and anthropometric characteristics of the respondents in group A (participants who on the day of the study did not exceed 12 months after the mastectomy procedure) and in group B (participants who on the day of the study were between 5 and 12 years after the mastectomy procedure)

Parameters	Group A (N = 21)			Group B (N = 21)		
	Min–max	Median	Mean ± SD	Min–max	Median	Mean ± SD
Age [years]	38–77	59.0	57.8 ± 11.15	41–84	62.0	62.3 ± 10.57
Height [cm]	151–172	161	161.0 ± 5.98	144–173	161	160.1 ± 6.43
Weight [kg]	51–96	76	74.1 ± 12.3	56–126	78	84.8 ± 19.93
BMI [kg/m^2]	17–41	28	28.9 ± 5.92	23–47	32	33.0 ± 6.47
Duration of the procedure [group A month, group B years]	5.0–12	12	8 ± 0.26	5.0–12	6	6.1 ± 3.10

A comparison was made of the upper limb circumferences, measured at brachial and forearm circumferences, in order to diagnose the occurrence of lymphoedema in the upper limb on the amputated side (Table 2).

Corresponding circumferences were compared between the amputated and non-amputated limbs and between study groups using the multivariate ANOVA test (Table 3).

Table 2. Upper limb circumference: Circumference 1 – measured at 10 cm above the lateral epicondyle of the humerus, circumference 2 – measured 10 cm below the lateral epicondyle of the humerus on the amputated (AM) and non-amputated (NA) sides in group A (participants who on the day of the study, they did not exceed 12 months after the mastectomy procedure) and in group B (participants who on the day of the study were between 5 and 12 years after the mastectomy procedure)). The circumference on the amputated (AM) and nonamputated (NA)

Measure	Group A (N = 21)			Group B (N = 21)		
	Min–max	Median	Mean ± SD	Min–max	Median	Mean ± SD
AM circumference 1	18.0–29. 5	21	22.2 ± 3.0	19–33	26	25 ± 4.43
AM circumference 2	21.0–41.0	30	30.1 ± 4.54	24–42	31	31.5 ± 4.91
NA circumference 1	17.0–26.0	21	21.5 ± 2.59	19–29	22	23 ± 2.72
NA circumference 2	21.0–34.0	28	28. 4 ± 3.67	24–39	30	29.5 ± 4.04

The conducted analysis showed differences in the arm circumferences of the upper limb, both between the sides of the body in each of the study groups – $F(1, 40) = 12.525$, $p = 0.00103$ (Figure 1A), and between the studied groups of women $F(1, 40) = 5.3426$, $p = 0.02604$ (Table 3).

Table 3. Differences in upper limb circumferences at the brachial level (circumference 1) and at the forearm level (circumference 2) between the upper limb on the amputated side (AM) and the non-amputated side (NA) and between group A (participants who on the day of the study did not exceed 12 months after the mastectomy procedure) and group B (participants who on the day of the study were between 5 and 12 years after the mastectomy procedure)

Independent variable	Effect		MS	Df	F	p
Circumference 1	Main	Side AM/ NA	41.44	1	12.52	0.001
		Group A/Group B	96.43	1	5.34	0.026
	Interaction	side * group	10.71	1	3.23	0.079
Circumference 2	Main	Side AM/ NA	80.05	1	22.70	0.000
		Group A/Group B	37.33	1	1.10	0.299
	Interaction	side * group	1.19	1	0.33	0.564

The arm circumference of the upper limb on the amputated side was statistically significantly greater than that of the non-amputated limb in both study groups. Moreover, the participants in group B had greater brachial circuumferences on both the amputated and non-amputated sides compared to the patients in group A. However, the differences in the upper limb circumference measured on both sides of the body were not modulated by the time since amputation.

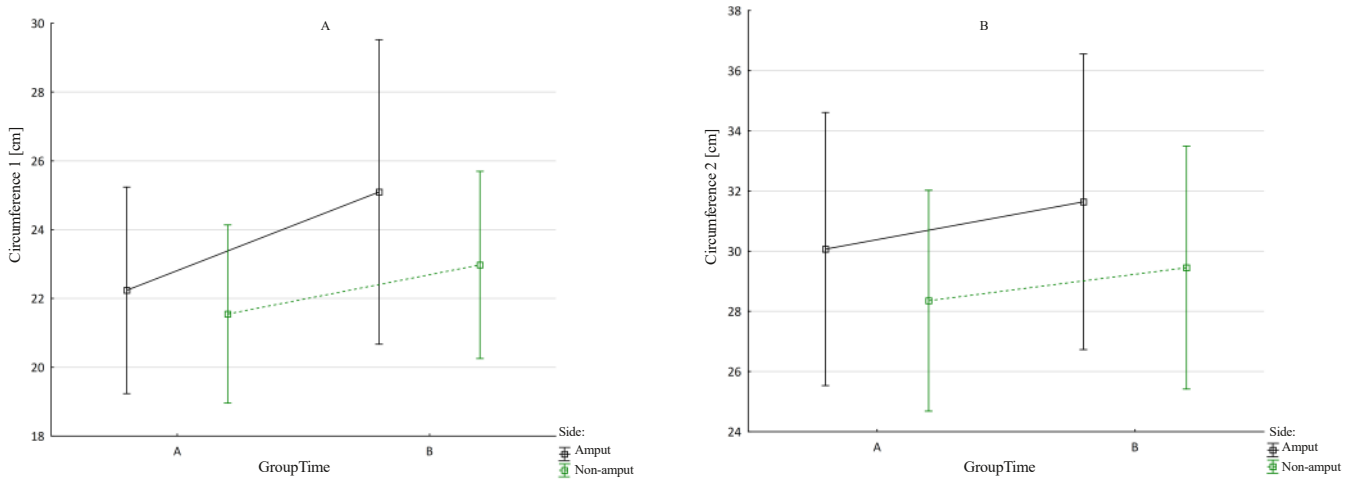

Figure 1. Differences in upper limb circumferences at the brachial level (circumference 1; Figure 1A) and at the forearm level (circumference 2; Figure 1B) between the upper limb on the amputated side (AM) and the nonamputated side (NA) and between group A (participants who on the day of the study did not exceed 12 months after the mastectomy and group B (participants who on the day of the study were between 5 and 12 years after the mastectomy procedure)

The performed statistical analysis also showed the occurrence of statistically significant differences in the forearm circumference between the amputated and non-amputated upper limbs in both study groups – F (1, 40) = 22.707, p = 0.00002 (Table 3). There were no statistically significant differences between the groups, which means that the time elapsed since the procedure and the interaction of factors did not affect the forearm circumference of the upper limb on the amputated side (Figure 1B).

Table 4. Parameters of the weight- bearing distribution (P – load percentage, SI – symmetry index) between the amputated (AM) and non-amputated (NA) sides of the body while maintaining a standing position with an external breast prosthesis (PP) and without an external breast prosthesis (BP) in group A (participants who on the day of the study did not exceed 12 months after the mastectomy procedure) and in group B (participants who on the day of the study were between 5 and 12 years after themastectomy procedure)

Parameter	Group A (N = 21)			Group B (N = 21)		
	Min–max	Median	Mean ± SD	Min–max	Median	Mean ± SD
P AM PP	45–62	51	51.2 ± 4.81	40–56	49	48.8 ± 3.32
P NA PP	38–55	49	48.8 ± 4.81	44–60	51	51.2 ± 3.32
P AM BP	45–64	51	50.9 ± 4.56	39–57	50	49.8 ± 4.48
P NA BP	36–55	49	49. 1 ± 4.56	43–61	50	50.2 ± 4.48
SI P	0–48	12	15.6 ± 11.79	0–40	8	9.9 ± 9.93
SI BP	0–56	16	14.1 ± 11.70	0–44	16	14.1 ± 10.63

The parameters presented in Table 4 do not differ significantly in terms of the mean and standard deviation (SD) between group A and group B, which is confirmed by the results of statistical significance tests (Table 5, 6, 7).

Table 5. Differences in the weight bearing distribution (P), between the amputated (AM) and non-amputated (NA) sides of the body while maintaining a standing position with external breast prosthesis (PP) and without the breast prosthesis (BP) in group A (participants who on the day of the study did not exceed 12 months after the mastectomy procedure) and in group B (participants who on the day of the study were between 5 and 12 years after the mastectomy procedure). ANOVA

Independent variable	Effect		MS	Df	F	p
PP	Main	Side AM/ NA	0	1	0	1
		Group A/Group B	0	1	–	–
	Interaction	side * group	128.8	1	3.77	0.059
BP	Main	Side AM/ NA	9.33	1	0.22	0.635
		Group A/Group B	0	1	–	–
	Interaction	side * group	23.05	1	0.56	0.457

The conducted analysis showed that there is no correlation between the time from the procedure and the loading of the sides of the body in the trial with breast prosthesis (Table 5). On the other hand, the result of the analysis of variance reached the level of p-value close to the assumed significance level α – $F(1, 40) = 3.7781$, $p = 0.05899$ (Figure 2A). This indicates the presence of opposite trends in the studied groups, i.e. patients in the early phase of rehabilitation (group A) were characterized by a greater percentage of load on the amputated side, while in women in the late phase of rehabilitation (group B), a greater percentage of load was greater on the un-amputated side. The analysis of variance showed no statistically significant differences between the amputated and non-amputated sides in the weight- bearing distribution in the trial without breast prosthesis (Table 5, Figure 2B).
The performed Student's t-test showed no statistically significant differences between the studied groups A and B in terms weight-bearing distribution between the measurements with and without the external breast prosthesis (Table 6).
The analysis of the variance of the respondents did not show statistically significant differences in the load on the amputated side, both between the results of the test carried out with and without the prosthesis, as well as the interactions between the study groups (Table 7).
The statistical analysis did not show the influence of the external breast prosthesis on the symmetry of the weight- bearing distribution, nor in the case of comparison of the percent load per amputated and non-amputated sides of the body (Table 7). The analysis of variance did not show any statistically significant differences between the studied time groups in terms of the mean values of the symmetry index (SI). The measurement conditions, i.e. measurement without an external breast prosthesis or prosthesis placement, also had no effect on the SI value (Table 7).

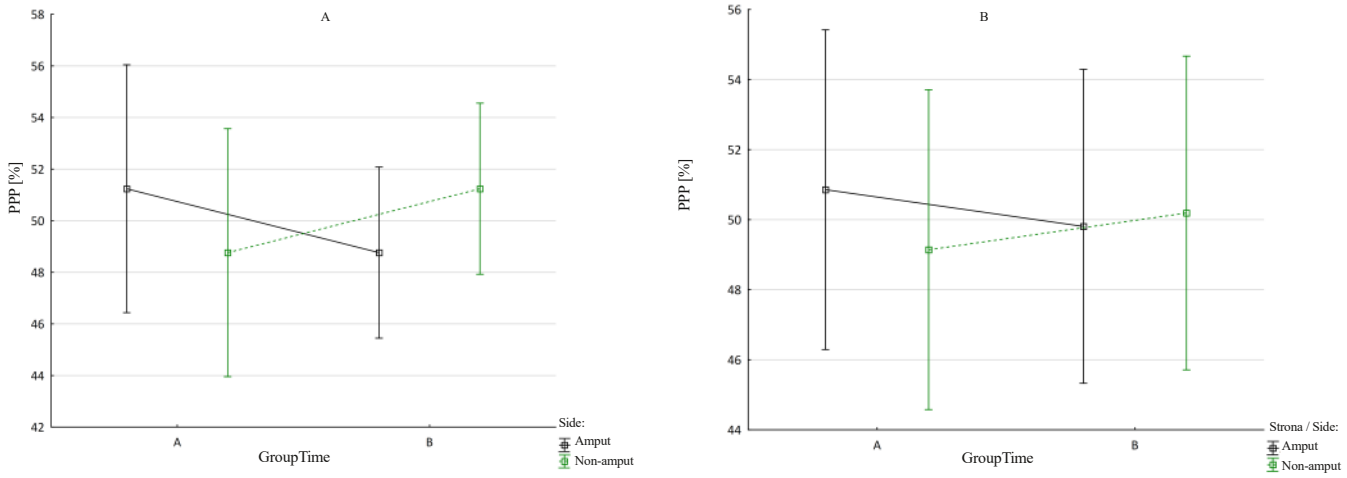

Figure 2. Differences between the percentage weight-bearing distribution between the amputated (AM) and non-amputated (NA) sides between test wwith external breast prosthesis Figure 2A (PP) and without the breast prosthesis (BP) – Figure 2B between groups A and B

Table 6. Differences in the percentage weigth bearing distribution on the amputated (AM) and nonamputated (NA) sides with external breast prosthesis (PP) and without the breast prosthesis (BP) between group A (participants who on the day of the study did not exceed 12 months after the mastectomy procedure) and group B (participants who on the day of the study were between 5 and 12 years after the mastectomy procedure)

Parameter	Group A (N = 21)			Group B (N = 21)		
	Min–max	Median	Mean ± SD	Min–max	Median	Mean ± SD
AM PP	45–62	51	51.2 ± 4.81	40–56	49	48.8 ± 3.32
NA PP	38–55	49	48.8 ± 4.81	44–60	51	51.2 ± 3.32
AM BP	45–64	51	50.9 ± 4.56	39–57	50	49.8 ± 4.48
NA BP	36–55	49	49.1 ± 4.56	43–61	50	50.2 ± 4.48

Table 7. Differences in the percent load of the amputated (AM) and non-amputated (NA) side and the symmetry index (SI) betweent he test with external breast prosthesis (PP) and without the breast prosthesis (BP) in group A (participants who on the day of the study did not exceed 12 months after the mastectomy procedure) and in group B (participants who on the day of the study were between 5 and 12 years after the mastectomy procedure). ANOVA

Independent variable	Effect		t-Student Test (p)
AM	Main	Side AM/ NA Group A/Group B	0.058
	Interaction	side * group	
NA	Main	Side AM/ NA Group A/Group B	0.058
	Interaction	side * group	
Symmetry Index	Main	Side AM/ NA Group A/Group B	0.918
	Interaction	side * group	

Discussion

The main goal of this study was to answer the question whether the unevenly distributed body weight as a result of unilateral breast amputation affects the weight- bearing distribution within the group of women after unilateral total or radical mastectomy, and whether any asymmetry depends on the time elapsed after the surgery. At the initial stage of the pilot tests, including the routine measurement of the circumference of the limb on the amputated and non-amputated side, it was concluded that some of the respondents (mainly those in the early postoperative period) had lymphoedema of the upper limb on the amputated side. Recognizing the influence of edema in the area of the upper limb on the amputated side, the symmetry of the weight- bearing distribution was included as an additional goal of the research. This preliminary hypothesis, assuming that the presence of edema is more typical of early postoperative states, was not confirmed by comparisons of upper limb circumferences. Despite the fact that both measured circumferences (brachial and forearms) of the upper limb on the amputated side were significantly greater than on the non-amputated side, this was the case in both groups, which proves that the differences in the brachial circumference of the upper limb measured on both sides of the body were not modulated with time since amputation. The literature on the subject confirms that in about 20% of women after mastectomy, arm swelling occurs and persists for a period of several days to two years. The percentage of women with edema five or more years after surgery increases to 30% [22]. Only the nature of the swellings that occur here changes with time. As the data presented here refer to patients undergoing only surgery, without any additional forms of adjuvant treatment, they refer to the population studied by us and fully justify the results obtained here. It is also important that the recorded differences in the circumference of the upper limbs between the amputated and non-amputated sides did not exceed 2 cm. However, the arbitrarily accepted value of the difference in the circumference of the arm on the amputated and non-amputated sides of more than 1 cm [23] proves the presence of lymphedema in the group of participants who did not exceed 12 months from the mastectomy on the day of the study, and in the group of participants who studies exceeded 5 years after mastectomy.

Since the presence of upper limb edema on the amputated side may result in an asymmetry of the weight- bearing distribution between the amputated and non-amputated sides of the body, both the results of the percent load of the amputated side and the symmetry index of the weight- bearing distribution between the sides were compared between the groups. An interesting regularity was observed when analyzing the results obtained in this respect. While maintaining a free-standing position in natural conditions, i.e. with an external breast prosthesis, participants in the early stage of rehabilitation (no more than a year after the surgery) showed a tendency to put more strain on the amputated side, while participants in the late stage of rehabilitation (over 5 years after the surgery) showed a tendency to overburden the non-amputated side. Moreover, this relationship was close to statistical significance. Since the results of similar studies have not been published in the literature on the subject, it can only be assumed that since no relationship with the occurrence of edema has been demonstrated here, it is related to the changes

in the nature of compensation in the field of postural control in the situation of asymmetry related to unevenly distributed body weight due to amputation of one breast. side of the body.
The results of the comparison of the weight- bearing distribution between the measurements carried out with and without the external breast prosthesis were also very interesting. Moreover, it was true for both study groups.
The obtained results – contrary to the authors' expectations – did not show statistically significant differences between the load on the sides of the body in conditions with and without a breast prosthesis. Obtained results indicated that the breast prosthesis does not play a significant role in the weight-bearing distribution between the amputated and non-amputated body parts.
Although it is difficult to find the results of similar studies in the literature on the subject, the results of studies conducted by Głowacka-Mrotek et al. concerning the assessment of changes in the shape of the foot in women after unilateral total mastectomy showed statistically significant differences between the weight- bearing distribution between the amputated and non-amputated side [10]. The participants of the study put significantly more strain on the healthy side of the body. In the presented research, there was only a tendency to increase the burden on the healthy side among women more than 5 years after the surgery. Perhaps this is due to the smaller study population in our research experiment. In turn, Manikowska et al. in their studies conducted on a population of women after unilateral radical mastectomy, where the patients were at least 6 months after breast amputation, there were no statistically significant differences between the attempts in terms of the distribution of plantar pressure. Moreover, the obtained results of the distribution of plantar pressure were compared to the results obtained in the group of healthy women, finding no significant differences in this respect [11]. The above results are consistent with the results obtained in this study.
The authors are aware that these studies have some limitations, which include, inter alia, omitting the recognition of natural differences resulting from laterality among the examined, i.e. taking into account the differences between the dominant and non-dominant side of the body. Another imperfection is the use of indirect edema assessment, i.e. by comparing the circumference of the upper limbs. Further studies should take into account the segmental analysis of body mass composition, especially the percentage of water in the upper limbs. The above limitations will be taken into account in further stages of the research.
Summarizing the results of the presented research, it can be stated that: 1) lymphodema occurs within the group of women in the early and late stages after mastectomy; 2) the occurrence of edema does not affect the nature of the asymmetry of the weight-bearing distribution between the amputated and non-amputated parts of the body; 3) a comparison of the measurement of the weight-bearing distribution between the amputated and non-amputated sides of the body in conditions with and without external breast prosthesis shows that the breast prosthesis does not have a significant influence on the weight- bearing distribution between the amputated and non-amputated body sides.

Conclusions

Finally, the following conclusion can be made:
the answer to the question of what is the impact of external breast prosthesis on postural control in women after unilateral mastectomy requires further comprehensive research in this population, including further assessment of their static and dynamic stability, as well as a comprehensive assessment of body posture.

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