Promjene ukupne tjelesne površine i raspodjele kožnih površina u odnosu na indeks tjelesne mase

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Zagreb, siječanj, 2023. Godine

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Točna procjena postotka opečene površine kože je ključna ne samo za pacijenta nego i za liječnika. Ovom procjenom se određuju bitni koraci u liječenju ovakvih pacijenata te je preciznost od posebne važnosti. Ovaj rad je istražio točnost Wallace-ovih "devetkih" koji je svjetski standard u procjeni opeklina unazad 70ak godina.

Zahvaljujem mentoru Izv. prof. dr. sc. Milan Milošević, dr. med. na stručnom vodstvu prilikom ovog istraživanja.

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SADRŽAJ

POPIS OZNAKA I KRATICA

TBSA% - postotak ukupne površine tijela (eng. Percentage of total body surface area)

BMI – indeks tjelesne mase (eng. Body mass index)

WHO - svjetska zdravstvena organizacija (eng. World Health Organistion)

Changes in total body surface area and the distribution of skin surfaces in relation to body mass index

Introduction

Burns are one of the leading global causes of death, morbidity and disability, posing a great physical and psychological burden to the patient [1 , 2]. Generally, burns covering more than 15% of total body surface area in adults receive medical intervention, resuscitation due to associated fluid loss and nutritional supplementation. Therefore, adequate resuscitation is the critical therapeutic intervention in the management of acute burns [3 , 4].

The greatest amount of fluid loss in these patients occurs within the first 24 h following injury [5]. It is important that the correct fluid replacement volumes be given as soon as possible in order to maintain homoeostasis and tissue perfusion; as too little fluid will cause hypoperfusion whereas too much will lead to oedema and subsequent tissue hypoxia [6]. In order to determine the amount of fluid replacement necessary, the most commonly used formulas in the clinical setting include the Parkland (1968), modified Parkland (1979), Brooke (1953), modified Brooke (1979), Evans (1952) and Monafo (1970) (Chart 1) and are all based on body weight and the percentage of the total burned body surface area (%TBSA).

Without adequate nutritional support, patients suffer delayed wound healing, decreased immune function, and generalized weight loss [7]. Therefore, optimizing nutrition to cover nutrient utilization is the fundamental goal and should be done with the utmost precision [8 , 9]. Several formulas such as the Burke and Wolfe, Curreri, Davies and Liljedahl, Galveston, Ireton-Jones and Modified Harris-Benedict have been developed in order to estimate the nutritional needs and are generally based on body weight, sex and %TBSA burn [7].

Therefore, in order to determine the amount of fluid and nutritional replacement necessary it is imparative that subjective estimations such as the %TBSA burn percentage be estimated with the utmost precision since minor variations can cause either a over or underfeeding scenario. %TBSA in clinical practice is most often determined using 3 different methods: Wallace rule of nines, Lund and Browder chart and Palmar surface [6]. All three methods of calculating %TBSA have not been significantly modified in the past 65 years despite research showing that the assessment of burn area tends to be conducted incorrectly, subsequently leading to inappropriate fluid resuscitation management [10 , 11]. Furthermore, neither the Wallace chart nor the Lund Browder chart take into consideration a patient's body mass index (BMI) and how obesity changes the body's proportions. Wallace rule of nines is the most commonly used and a quick way of estimating medium to large burns in adults [6].

The World Health Organisation (WHO) defines obesity as having a BMI ≥30 kg/m^2. The worldwide prevalence of obesity has nearly doubled from 1980 to 2008, where 10% of men and 14% of women are now considered obese which amounts to 604 million obese adults world wide [12 , 13]. Since the two-dimensional surface area is directly related to the three-dimensional body volume, changes in body fat will lead to consequent alternations in skin surface area distribution in large population groups. The excess body fat is disproportionately distributed so that it predominantly centres on the abdomen in most individuals [14 , 15].

The "Rule of Nines" and the Lund and Browder paradigms assume all adults, regardless of weight and body shape have the same distribution of %TBSA. However, with the increasing incidence of obesity over the last 50 years and the fact that these charts were developed over 65 years ago, the accuracy of this surface area estimation technique must be challenged since traditional percentages assigned to each body part may deviate significantly from the "Rule of Nines" [6 , 16,17,18].

Due to the increasing prevalence of worldwide obesity and the consequential morphological changes associated with this, the objective of this study was to use precise measurements to determine the relationship between BMI and body surface area percentage distribution, in particular, the reliability of the commonly used charts used to estimate the %TBSA in burn patients.

Materials and Methods

A total of 217 adult individuals (54 males and 163 females) were included in the study, each patient volunteered and had to read and sign a written consent form. The exclusion criteria included patients who had and amputated body part, malignant disease or visible physical deformity. This study was approved by the Institutional Review Board at our University Hospital (Department of Ethical Standards, Kišpatićeva 12, Zagreb, Croatia).

Each patient underwent a complete dual-energy X-ray absorptiometry body scan using the Prodigy DXA densitometer (GE Healthcare, Madison, WI, USA). The data collected included: sex, age, height, weight, BMI and surface area (cm^2) of the head, left arm, left leg, right arm, right leg, trunk, abdomen, pelvis region, back and the total body surface area.

Their weights ranged from 45.3 kg to 157.0 kg with a mean of 82.3 kg. The lowest BMI included was 18.5 kg/m^2 and the highest was 51.0 kg/m^2.

The patients were divided into 4 groups according to the WHO BMI scale (BMI 18.5–25 kg/m^2 (normal weight (60 individuals)), 25–29.9 kg/m^2 (pre-obesity (61 individuals)), 30–34.9 kg/m^2 (obesity class I (55 individuals)), >35 kg/m^2 (obesity class II (41 individuals)).

The data was statistically analyzed using the ANOVA sum of squares and Bonferroni correction methods to determine the changes in distribution of body surface area percentage between the different BMI groups. Furthermore, male and female population groups were analyzed separately using the Pearson Correlation test to determine if gender influences the distribution of body surface area percentages. The obtained data was also compared and correlated with the Wallace Rule of Nines chart to determine if any significant differences exist.

Results

Table 1. Summarizes all of the measured surface area percentages according to body region and BMI in the entire sample population.

		N	Mean	Std. deviation	Minimum	Maximum
Head	<25 kg/m^2	60	10,17%	1,04%	7,75%	13,01%
	25–29,9 kg/m^2	61	9,72%	0,93%	7,87%	11,84%
	30–34,9 kg/m^2	55	9,28%	0,89%	7,50%	11,16%
	>35 kg/m^2	41	9,32%	1,21%	6,75%	11,88%
	Total	217	9,66%	1,07%	6,75%	13,01%
Left arm	<25 kg/m^2	60	8,50%	0,92%	6,52%	11,28%
	25–29,9 kg/m^2	61	8,15%	0,97%	5,73%	9,88%
	30–34,9 kg/m^2	55	8,14%	1,08%	5,49%	10,44%
	>35 kg/m^2	41	8,68%	1,14%	5,61%	11,04%
	Total	217	8,35%	1,04%	5,49%	11,28%
Left leg	<25 kg/m^2	60	17,47%	1,04%	15,44%	20,88%
	25–29,9 kg/m^2	61	17,42%	0,98%	15,07%	20,19%
	30–34,9 kg/m^2	55	17,82%	1,60%	14,94%	25,09%
	>35 kg/m^2	41	18,80%	1,80%	15,82%	23,07%
	Total	217	17,80%	1,43%	14,94%	25,09%
Right arm	<25 kg/m^2	60	8,56%	0,90%	5,39%	10,34%
	25–29,9 kg/m^2	61	8,13%	0,98%	5,66%	10,00%
	30–34,9 kg/m^2	55	8,15%	1,07%	6,25%	10,44%
	>35 kg/m^2	41	8,73%	1,08%	5,88%	11,04%

		N	Mean	Std. deviation	Minimum	Maximum
	Total	217	8,37%	1,03%	5,39%	11,04%
Right leg	<25 kg/m^2	60	17,48%	0,97%	15,93%	20,33%
	25–29,9 kg/m^2	61	17,45%	0,93%	15,03%	19,91%
	30–34,9 kg/m^2	55	17,87%	1,38%	14,94%	24,46%
	>35 kg/m^2	41	18,80%	1,84%	15,82%	23,32%
	Total	217	17,82%	1,36%	14,94%	24,46%
Trunk	<25 kg/m^2	60	37,82%	3,25%	29,13%	43,56%
	25–29,9 kg/m^2	61	39,13%	3,19%	32,79%	46,45%
	30–34,9 kg/m^2	55	38,73%	4,26%	20,76%	45,76%
	>35 kg/m^2	41	35,67%	4,79%	22,22%	43,16%
	Total	217	38,01%	4,00%	20,76%	46,45%

N = Number of participants.

According to the obtained data in the entire sample group, as an individuals' BMI increases, there is a change in the body shape and the distribution of body surface area between certain regions of the body. When comparing the first (18.5–25 kg/m ^{2}) and second (25–29.9 kg/m ^{2}) BMI groups, there is an initial decrease in surface area percentage of the head, arms and legs (10.2%–9.71%, 8.53%–8.14% and 17.48%–17.43% respectively) and an increase in the trunk region (37.82%–39.12%) indicating that individuals who are in the pre-obesity BMI range (25–29.9 kg/m ^{2}), tend to have more central weight distribution than normal weight individuals (Table 1).

When comparing the remaining BMI groups, there is a trend shift as BMI increases. The data suggests that as BMI increases from the pre-obesity group to the obesity class I (30–34.9 kg/m ^{2}) and class II (>35 kg/m ^{2}), the arms and legs increase in body surface area percentage (8.12%, 8.15%, 8.70% and 17.43%, 17.84%, 18.80% respectively) and the trunk decreases (39.12%, 38.73%, 35.67%). The percentage distribution for the head varies only slightly between the BMI groups. It decreases between the first three groups as BMI increases while increasing in the obesity class II group relative the obesity class I group (10.20%, 9.71%, 9.28%, 9.31%). In general, there is a decrease in surface area percentage of the head between the first 'normal weight' and last 'obesity class II' BMI group (Table 1).

This data suggests that there is a difference in body surface area percentage distribution between various body regions as BMI changes; particularly between the pre-obesity, obesity class I and obesity class II groups where weight distribution is not proportional, as the arms and legs tend to increase more in body surface area percentage than do the head and trunk.

When the data was analyzed and compared to the Wallace body percentage distributions (rule of nines) [9], there were statistical significant variations between the head ($p = 0.000$), legs ($p = 0.000$) and trunk ($p = 0.003$) for the entire group. However, when gender based correlations were analyzed, it was found that there are no statistically significant variations between the Wallace body percentage distributions and our results in the male population for all BMI ranges (head $p = 0.331$, arms $p = 0.861$, legs $p = 0.282$, trunk $p = 0.696$). In contrast, when only females were observed, there is a statistically significant change in body surface area distribution among certain body regions (head $p = 0.000$, legs $p = 0.000$ and trunk $p = 0.001$) compared with the Wallace rule of nines (Table 2).

Table 2. Gender based body surface area percentage correlation with Wallace's rule of nines.

		BMI (kg/m^2) All	BMI (kg/m^2) Male	BMI (kg/m^2) Female
Head (%)	Pearson Correlation	−0.304	−0.135	−0.379
	P	0.000	0.331	0.000
	N	217	54	163
Left arm (%)	Pearson Correlation	0.035	−0.032	0.071
	P	0.608	0.820	0.366
	N	217	54	163
Left leg (%)	Pearson Correlation	0.364	0.164	0.417
	P	0.000	0.235	0.000
	N	217	54	163
Right arm (%)	Pearson Correlation	0.053	0.017	0.077
	P	0.434	0.901	0.330
	N	217	54	163
Right leg (%)	Pearson Correlation	0.375	0.136	0.441
	P	0.000	0.328	0.000
	N	217	54	163
Trunk (%)	Pearson Correlation	−0.200	−0.054	−0.250
	P	0.003	0.696	0.001
	N	217	54	163

N = Number of participants.

According to the obtained data, females in the first (18.5–25 kg/m^2) and second (25–29.9 kg/m^2) BMI groups have the same approximated distribution of body surface area percentages (head 10%, each arm 8%, each leg 17% and trunk 40%). The third, obese class I (30–34.9 kg/m^2) female group showed slight variations (head 9%, each arm 8%, each leg 18% and trunk 39%) as did the fourth, obese class II female group (head 9%, each arm 9%, each leg 19% and trunk 35%) (Table 3)

Table 3. Female Body Surface Area Percentages among BMI groups.

		N	Mean	Std. deviation	Minimum	Maximum
Head	<25 kg/m^2	46	10,37 %	0,93%	8,70%	13,01%
	25–29,9 kg/m^2	44	10,01 %	0,89%	8,44%	11,84%
	30–34,9 kg/m^2	42	9,32%	0,90%	7,50%	11,16%
	>35 kg/m^2	31	9,47%	1,09%	7,65%	11,88%
	Total	163	9,83%	1,03%	7,50%	13,01%
Left arm	<25 kg/m^2	46	8,23%	0,69%	6,52%	10,08%
	25–29,9 kg/m^2	44	7,89%	0,82%	5,73%	9,47%
	30–34,9 kg/m^2	42	7,96%	1,00%	5,49%	10,44%
	>35 kg/m^2	31	8,53%	1,17%	5,61%	10,66%
	Total	163	8,13%	0,94%	5,49%	10,66%
Left leg	<25 kg/m^2	46	17,39 %	1,03%	15,44%	20,88%
	25–29,9 kg/m^2	44	17,42 %	1,02%	15,07%	20,19%
	30–34,9 kg/m^2	42	17,96 %	1,64%	15,38%	25,09%
	>35 kg/m^2	31	19,01 %	1,76%	15,82%	23,07%
	Total	163	17,85 %	1,48%	15,07%	25,09%

		N	Mean	Std. deviation	Minimum	Maximum
Right arm	<25 kg/m^2	46	8,32%	0,81%	5,39%	9,52%
	25–29,9 kg/m^2	44	7,95%	0,89%	5,66%	9,92%
	30–34,9 kg/m^2	42	8,02%	0,97%	6,46%	10,44%
	>35 kg/m^2	31	8,58%	1,09%	5,88%	10,66%
	Total	163	8,19%	0,95%	5,39%	10,66%
Right leg	<25 kg/m^2	46	17,37%	0,91%	15,93%	20,33%
	25–29,9 kg/m^2	44	17,46%	0,99%	15,03%	19,91%
	30–34,9 kg/m^2	42	17,98%	1,39%	16,24%	24,46%
	>35 kg/m^2	31	19,03%	1,79%	15,82%	23,32%
	Total	163	17,87%	1,40%	15,03%	24,46%
Trunk	<25 kg/m^2	46	38,30%	3,00%	30,49%	43,56%
	25–29,9 kg/m^2	44	39,27%	3,15%	32,79%	45,40%
	30–34,9 kg/m^2	42	38,76%	4,41%	20,76%	45,76%
	>35 kg/m^2	31	35,39%	4,35%	23,10%	42,42%
	Total	163	38,13%	3,93%	20,76%	45,76%

N = Number of participants.

Discussion

The goal of our research was to determine the accuracy of the currently used burn assessment charts in relation to a patients' body mass index which non of the current methods do. The data suggests that the Wallace Rule of Nines is an accurate method of total body surface area percentage estimation in male patients of all BMI ranges (Fig. 1). However, it was determined that this is not the case for female patients who have slight variations in percentage distributions among different BMI groups. To assist and improve the accuracy of estimating TBSA% in female burn patients, we propose BMI adjusted charts as a guide for medical personnel (Figs 2, 3).

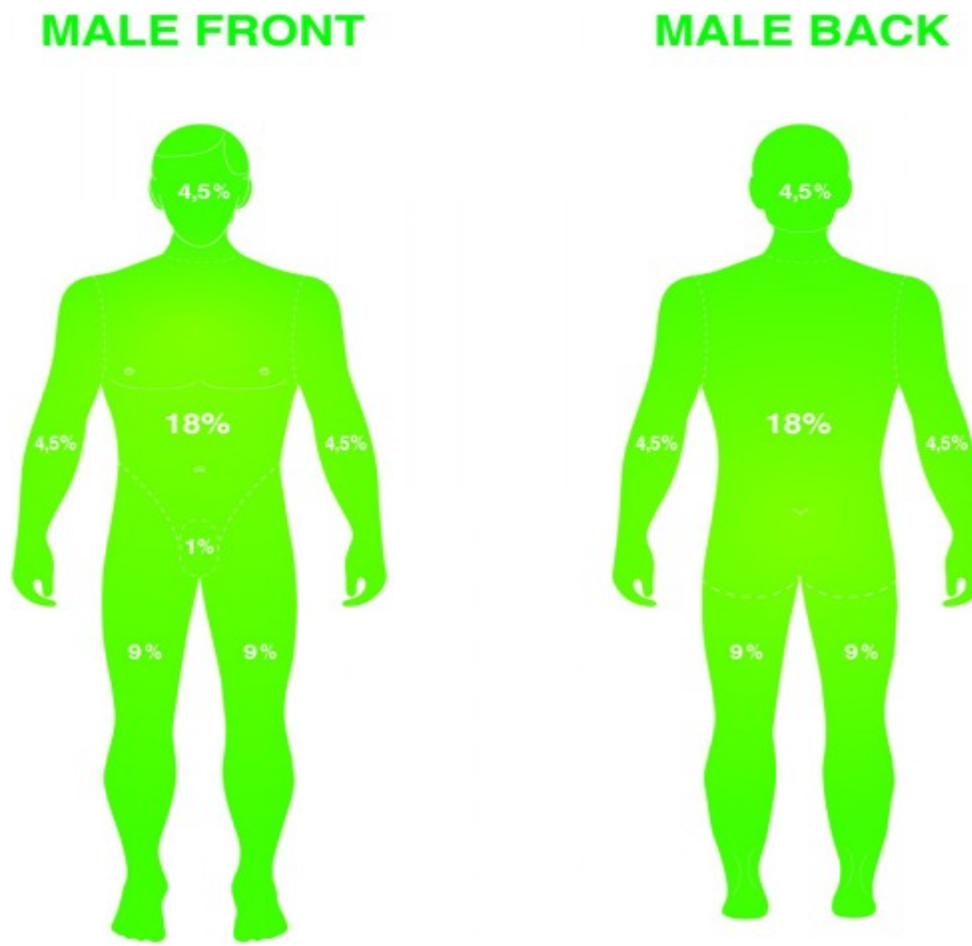

Fig 1. Wallace Rule of Nine charts for TBSA% burn estimations for adult male patients.

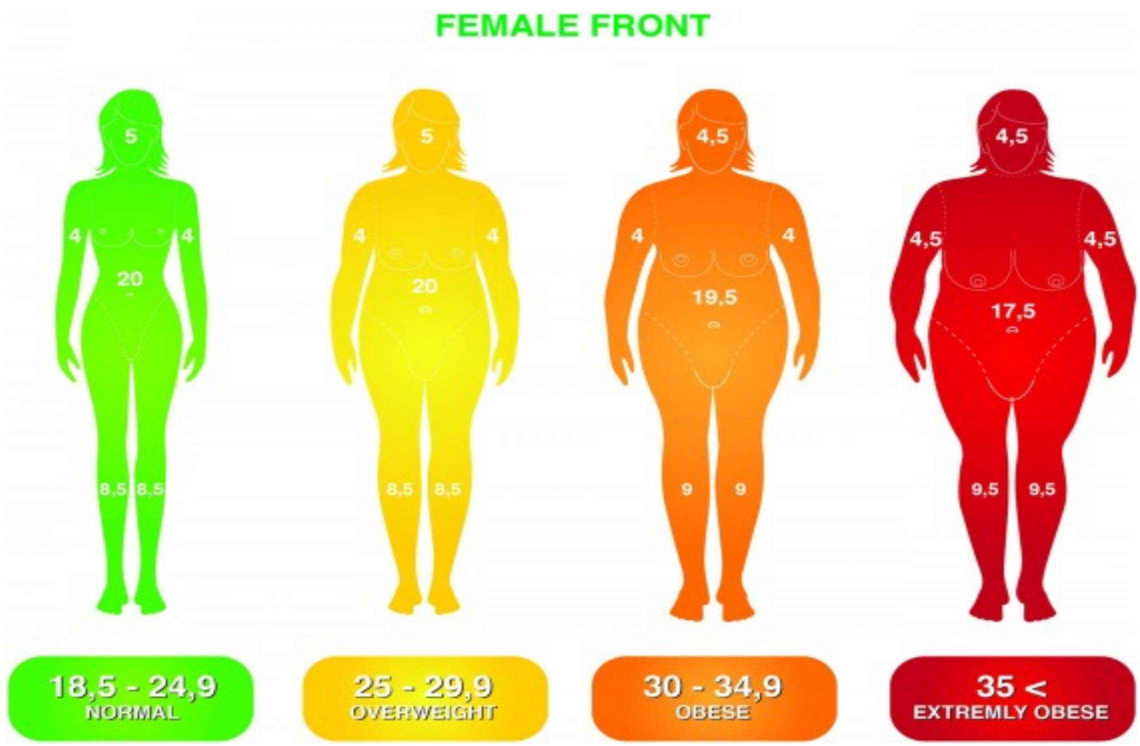

Fig. 2. BMI adjusted TBSA% charts for adult females (front).

Fig. 3. BMI adjusted TBSA% charts for adult females (back).

The World Health Organization estimates that globally, approximately 265 000 individuals die from fire-related burns each year [19]. Severe burns benefit from accurate fluid replacement volumes, nutritional support, long term treatment and are associated with additional socioeconomic burdens for these patients [3 , 20 , 21]. Unfortunately, this initial assessment is often conducted by a medical professional with limited experience with such patients (casualty officer, nurse, resident) with errors in estimation of %TBSA affected by a burn occurring frequently [22,23,24,25,26]. This was also found by Laing et al. who observed in their paper which reviewed 100 hospital referrals that the initial assessment is often inaccurate, resulting in sub-optimal treatment and inadequate fluid replacement with less than 10% of referrals being seen by senior casualty doctor [32].

Chan et al. [27] agree with Laing JH and claim that persistent miscalculation of burn size occurs and is due to "inadequate training or exposure of first responders" with other authors reporting overestimation rates as high as 161% [28,29,30]. Tocco-Tussardi et al. state that the most acute impactful consequence of errors in burn size assessment is probably on fluid resuscitation; meriting more precise estimation methods which we propose by adding BMI as an additional parameter [31]. Thom D. in a literature review aimed to identify the most appropriate method of calculating %TBSA affected by burns. He concluded that the use of the patient's palm including digits multiplied by 0.8 could be used for assessing minor burns. For larger burns, the Rule of Nines has been shown to be quick, familiar and accurate to within 3% of Lund and Browder charts and therefore is feasibly appropriate for pre-hospital clinicians. He concluded that the Lund and Browder chart is the most accurate, non-computerised, method of assessment but its limitations include more time to make a accurate assessment when compared to Wallace's Rule of Nines [22]. To shorten the time needed for initial burn assessment, the proposed BMI adjusted charts are as quick as the Wallace charts, but are more accurate.

Burn injuries of less than 15% are associated with minimal fluid shifts and can generally be resuscitated with oral hydration, except in cases of facial, hand and genital burns. As the %TBSA affected by a burn approaches 15–20%, massive fluid shifts due the a systemic inflammatory response syndrome occur where large volumes of resuscitation fluid are often needed [23]. This strengthens the importance of assessing burn surface area as accurate as possible since minor miscalculations can lead to significant under or overtreatment, increasing the chance of patient morbidity and mortality. Fluid replacement formulas such as the Parkland, Brooke, Evans and Monafo were all developed in the latter half of the last century, with only minor adjustments being made to them. Neither the Parkland formula nor others provide a precise method for determining the fluid estimations. These formulas only provide a starting point since the severity of burn, inhalation injury, associated injury, patient age and comorbidities can alter fluid estimates [24]. Despite the miscalculations made using the available formulas, the "Parkland" formula, which is based on the patient's weight and %TBSA affected by a burn remains the most widely used formula for fluid resuscitation by burn units globally [25 , 26 , 33,34,35,36,37,38,39]. The proposed BMI adjusted charts complement fluid resuscitation formulas, providing a more accurate assessment and thus a more accurate calculation of fluid estimates.

Globally there has been an increasing prevalence of obesity both in developed and developing nations [40]. The proportion of adults with a BMI of 25 or greater increased from 28.8% in 1980 to 36.9% in 2013 for men and from 29.8% to 38.0% (37.5–38.5) for women [41]. In 1986, 1 in 200 adults in America were morbidly obese; by 2004, the figure was 1 in 50. Currently, 1 in 5 adults are obese in America and there is a similar trend in increasing obesity prevalence seen in Europe [40 , 41 , 42]. These statistics support the need to include BMI in the initial assessment for burn victims which further personalizes and more accurately determines treatment modalities.

Fat distribution is not uniform throughout the body with the majority of individuals accumulating fat centrally, peripherally or a combination of the two [43,44,45]. This is concurrent with our findings as well. Due to this regional distribution, one would expect a change in the surface area ratios between different parts of the body at different BMI values. In our study as pre-obese individuals had a more central distribution, as opposed to the high BMI groups with a more peripheral pattern and fat distribution more to the lower extremities.

Similar to our conclusions, research conducted by Livingston and Lee found that body surface area percentages change according to weight. They observed in 47 patients that a "Rule of Fives" was a more accurate predictor of body surface area for obese patients weighing more than 80 kg while the rule of nines provides reasonable estimates for patients weighing less than 80 kg [46]. We sought to expand this observation and included gender differences as well in order to determine the difference of body surface distribution between the sexes.

In another study by Williams and Wohlgemuth, bodyscans from 200 adult patients with a BMI greater than 40 were analyzed and compared with the scans and surface area measurements of 50 non-obese patients with BMI between 20 to 24.9. It was found that that the "Rule of Nines" generally held true in the non-obese population. As in our study, they found that the average surface area of the torso, arms, and legs differed among the two groups. The average surface area of the torso, arms, and legs in the obese patient was 52%, 7%, and 15% respectively compared with 36%, 9%, and 18% in the non-obese population suggesting that the "Rule of Nines" will underestimate the percentage of a torso burn while significantly overestimating the percentage of an extremity burn in obese individuals. Our results show that there are statistically significant changes in total body surface area and the distribution of skin surfaces in relation to BMI in females. Unlike our observations, they found that there is a minimal effect that sex had on the TBSA averages suggesting that there is no need for sex adjusted TBSA charts. They concluded that a "Rule of Sevens" is more accurate and that the "Rule of Nines" provides a poor approximation for the morbidly obese patient [47].

Conclusion

The estimation of TBSA% is an important tool for physicians who treat the acute burn patient since this determines further treatment planning and fluid resuscitation volumes. Therefore, it is imperative that this be done with the utmost accuracy. The data suggests that the distribution of body surface area percentages is not even and is disproportional between the different BMI groups. The pre-obese group (BMI 25–29.9 kg/m ^{2}) generally have a central distribution, while the obesity class I (30–34.9 kg/m ^{2}) and class II (>35 kg/m ^{2}) groups have more area distribution in the extremities than the pre-obese and normal weight individuals. The Wallace rule of nines is a quick and acceptable method for estimating the total burn surface area percentage in males of all BMI values. However, in the female population it is not precise. The observed variations of body surface area distribution seen in females between different BMI groups merits a more accurate method of burn area estimation in this population as proposed by our BMI adjusted charts.

Abstract in Croatian

Uvod: Točna procjena površine tijela zahvaćene opeklinama značajna je radi određivanja volumena nadoknade tekućine, nutritivnih potreba te radi indikacije za hospitalizacijom. Wallace-ovo pravilo “devetki” najučestalija je metoda u upotrebi. Međutim, poznato je da potkožno masno tkivo nije jednoliko raspodijeljeno po tijelu te se ukupna površina kože mijenja s pretilošću. Cilj ovog istraživanja je odrediti vrijedi li pravilo “devetki” pri pojedinim grupama indeksa tjelesne mase (ITM).

Metode: Ukupno 217 odraslih osoba uključeno je u ovo istraživanje. Pacijenti su raspodijeljeni u 4 skupine u odnosu na indeks tjelesne mase (18.5-25kg/m2 (60 osoba)), 25-29.9kg/m2 (61 osoba)), 30-34.9kg/m2 (55 osoba)), >35kg/m2 (41 osoba)). Svakom pacijentu je učinjeno kompletno radiološko utvrđivanje ukupne površine tijela (cm2) metodom apsorpcijske denzitometrije pojedinih dijelova tijela.

Rezultati: Nije pronađeno statistički značajno odstupanje između Wallace-ovih procjena distribucije postotaka površine tijela i naših rezultata za muškarce svih vrijednosti indeksa tjelesne mase (glava p=0.331, ruke p=0.861, noge p=0.282, trup p=0.696). U suprotnosti, kod žena je pronađena statistički značajna razlika u raspodijeli postotka površine dijelova tijela između skupina različitih indeksa tjelesne mase i pojedinih dijelova tijela (glava p=0.000, noge p=0.000, trup p=0.001).

Zaključak: Wallace-ovo pravilo “devetki” brza je i jednostavna metoda za procjenu postotaka površine kože zahvaćene opeklinama kod muškaraca svih vrijednosti indeksa tjelesne mase. Doduše, kod ženske populacije je potrebna točnija metoda procjene postotaka kože zahvaćene opeklinama kao što je predloženo u našim dijagramima koji su korigirani vrijednostima indeksa tjelesne mase.

Abstract in English

Background: A correct estimation of total burn surface area is important since it is used for determining fluid resuscitation volumes, nutritional estimates and hospital admission criteria. Wallace's rule of nines is the most commonly used methods for this purpose. However, fat distribution is non-uniform and the total body surface area changes with obesity. The aim of this study was to determine if the rule of nines applies to all body mass index groups.

Methods: A total of 217 individuals were included in the study. The patients were divided into 4 groups according to their BMI (18.5-25kg/m2 (60 persons)), 25-29.9kg/m2 (61 individuals)), 30-34.9kg/m2 (55 persons)), >35kg/m2 (41 persons)). Each patient underwent a complete duel-energy X-ray absorptiometry body scan to determine the surface area (cm2) of the various regions of the body.

Results: We found no statistically significant variations between the Wallace body percentage distributions and our results in the men for all BMI ranges (head p=0.331, arms p=0.861, legs p=0.282, trunk p=0.696). In contrast, among women we found a statistically significant change in body surface area percentage distribution between the BMI groups and specific body regions (head p=0.000, legs p=0.000 and trunk p=0.001).

Conclusion: The Wallace rule of nines is a quick and acceptable method for estimating the total burn surface area percentage in men of all BMI ranges. However, for women, a more accurate method of burn area estimation is required as proposed by our BMI adjusted charts

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Cirriculum Vitae

Marko Mance rođen je u Kanadi (Mississauga) 05. listopada 1985. gdje je cijelo vrijeme neprekidno živio i završio cjelokupno niže i srednje školovanje. Kako je svake školske praznike provodio u Hrvatskoj, i tako zavolio i odlučio u njoj studirati. Bio je redovni student medicinskog fakulteta u Zagrebu od 2003. godine. Za vrijeme studiranje bio je član studentske udruge (CROMSIC) i sudionik mnogobrojnih studentskih kongresa, znanstvenih istraživanja i aktivnosti. Dobitnik je dekanove i rektorove nagrade za 2009 godine. Nakon studija, obavio je pripravnički staž u KBC Zagreb. U veljači 2011. godine položio je državni ispit. Prvo rado iskustvo kao liječnik medicine stekao je u srpnju i kolovozu 2011 kao zaposlenik Dom zdravlja Dubrovnik kao liječnik turističke ambulante na otoku Mljetu te je i iduće 2012 godine ponovno radio u istoj ambulanti. Od siječnja do srpnja 2012 godine i od travnja 2013 godine do srpnja 2014 godine, bio je zaposlenik Ministarstva pravosuđa (Zatvor Remetinac u Zagrebu) kao liječnik opće prakse. Od srpnja 2014 do listopada 2019 godine bio je specijalizant na Zavodu za plastično-rekonstrukcijsku i estetsku kirurgiju, Klinike za kirurgiju, u Kliničkom bolničkom centru Zagreb. Tijekom specijalizacije uključen je u mnogobrojna znanstvena istraživanja i domaće tečajeve. Položio je specijalistički ispit iz plastične, rekonstrukcijske i estetske kirurgije u listopadu 2019. godine. Bio je na međunarodnoj edukaciji u Ljubljani, Slovenija, Nairobi, Kenija, Toronto, Kanada, Goethe-Universität Klinikum u Frankfurtu, Njemačka, Sveučilište Oxford, Engleska, Milan, Italija te u bolnici Gentofte u Kopenhagenu, Danska. Sudjelovao je na velikom broju stranih i domaćih kongresa i tečaja iz područja plastično-rekonstrukcijske i estetske kirurgije, aktivno, izlaganjima, posterima, hands on radionica te pasivno kao slušač. Doktorski poslijediplomski studij upisao je akademske 2014./2015. godine te je obranio disertaciju; Povezanost veličine, smještaja i histoloških karakteristika duktalnoga invazivnoga karcinoma s termografskim karakteristikama dojke, 2021. godine. Od 2022. godine znanstveni suradnik je medicinskog fakulteta, Sveučilište u Zagrebu. Sudjelovao je u objavljivanju 16 znanstvenih radova u indeksiranim časopisima; 4 kao prvi autor.