

Weight of body, carcass and internal organs as well as paranephric fat index (KFI) as the individual condition indices of the brown hare (*Lepus europaeus*) in eastern Poland

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Abstract: *Weight of body, carcass and internal organs as well as paranephric fat index (KFI) as the individual condition indices of the brown hare (Lepus europaeus) in eastern Poland.* The conducted examination on the individual condition of the brown hare was based on animals obtained by means of group hunting in the western part of the Lublin district in eastern Poland. The weight of body, carcass and internal organs as well as paranephric fat index (KFI) was estimated and compared for separate age and gender groups. The body weight of young hares at the level of just over 4.0 kg and adults amounting to 4.7 kg is higher than in other parts of Poland as well as in the Lublin region compared to previous years. High individual condition is also confirmed by the KFI index, which amounted to 3.6 and was high for this time of year. Carcass mass of acquired hares, which is labeled by means of “slaughtering capacity” (percentage ratio of meat carcass weight with internal parts to live weight of the slaughtered animal), at a level slightly exceeding 60% should be considered as average for the species. Somewhat discomposing are the results regarding the lower mass of internal organs; in particular heart and lungs. Those organs condition the possibility of significant locomotive effort, which consequently plays a very important role in emergency situations when the basic defence reaction of a hare is to escape quickly. Obtained results indicate that the hare population in the western part of the Lublin region is characterized by quite high indicators of individual quality, which should have a positive impact on survivability and repro-

ductive potential of the population. Correlation coefficients between body weight and the weight of internal organs were in most cases, except for adult hares, high and statistically significant.

Key words: brown hare, body weight, individual quality, KFI, internal organs

INTRODUCTION

In order to assess the individual quality of wild animals, body weight is usually used. In case of males of the deer family, the weight of antlers is commonly used in such assessment. However, many scientific studies in assessing the individual condition are also based on data on the body fat stores around the internal organs. The most common measurement is the amount of adipose tissue accumulating around the kidneys, and then the ratio of paranephric fat (KFI) is calculated (Batcheler et al. 1970, Bonino and Bustos 1998, Stephenson et al. 1998, Takatsuki 2000, Majzinger 2004, Karpiński et al. 2008, Flis 2012). For the first time, this indicator was used to assess the condition of the deer population introduced in New Zealand (Riney 1955). In hares this indicator is dependent on sex, age

and season. The largest reserves, which constitute energy reserves, occur before the winter period and decrease with time, until almost exhausted in the spring period (Flux 1971, Pepin 1987, Bonino and Bustos 1998).

The mass of internal organs is used in scientific research as a rule in the field of comparative anatomy and quite often in clinical diagnostics. The size of the heart and other internal organs affects the course of physiological processes, thus also affecting the shaping of the individual condition. This is particularly important in wild animals that face the multidirectional pressures of the environments in which they live and fulfill basic life functions. Quite an important element in this respect is the mass of the myocardium, which determines the possibility of long-term locomotor activity. This is particularly important for the survival of these animals. Although hares have small home range, the only method of avoiding threats is to escape which requires considerable physical effort. Due to the features of the anatomical structure hare moves only in gallop and during the escape can reach speeds of up to 80 km/h (Pielowski 1979, Węgrzyn and Kupczyńska 1986, Bishop 1997, Barszcz et al. 2012, Nasiadka and Dziedzic 2014).

Moreover, lung mass affects quite significantly the gas exchange processes and thus the locomotor processes. Of the 4 species of mammals from the order of lagomorphs covered by the study, it was brown hare that showed the greatest adaptation of lungs and chest to significant locomotor effort (Simons 1996).

All these elements of the individual condition, interacting comprehensively

together with other factors, both endogenous and exogenous, have a significant effect on the fertility and mortality of hares. This, in turn, determines the size of the population, which has been regressing for many years. Therefore, it was justified to carry out these types of assessments, which, due to the lack of material for research, have not been carried out for many years (Dziedzic et al. 2002, Nasiadka and Dziedzic 2014, Misiorowska et al. 2014, Flis 2015).

The aim of the study was to assess the individual condition expressed by weight of body, carcass and selected internal organs, as well as the paranephric fat index (KFI) in brown hares obtained during hunting in the Lublin Upland

MATERIAL AND METHODS

Study material consisted of 30 hares obtained by means of group hunting in 2 hunting areas of the western part of the Lublin region, eastern Poland. The hares were shot in December 2017. In terms of physico-geography, these circuits are located in the mesoregion Kotlina Chodelska and the northern part of Wzniesień Urzędowskich. This region is characterized by the fragmentation of field crops, which directly determines the considerable heterogeneity of hare living habitat. Due to the presence of fertile soils in the crop structure, in addition to typical agricultural crops, a significant proportion are orchards and perennial plantations of soft fruits. In the agricultural landscape there are numerous wastelands as well as small wooded enclaves and forest complexes. Despite the decrease compared to previous years, the hare number in this region is so high

that hunting is conducted every year, and the density ratios are among the highest in Poland (Kondracki 2000).

Age and gender of the hares was assessed directly in the field. Age was determined based on the assessment of the occurrence or disappearance of the Stroh sign (Fig. 1). Such an assessment allows the division of individuals into

two groups: young (up to 1 year old) and adult (over 1 year old) (Stroh 1931, Pielowski 1979). Sex was determined based on the appearance of secondary sexual characteristics (Fig. 2). Immediately in the field, each individual was weighed on a laboratory scale, with an accuracy of 0.1 kg. After the hunt, the hares were skinned and gutted. These

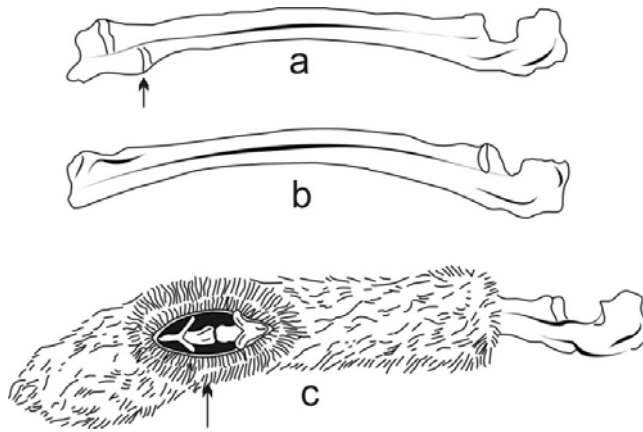


FIGURE 1. Recognition of the age of the hare based on the Stroh sign (based on Pielowski 1979)

a – thickening of the ulna bone – young hare up to the age of about 8 months; b – ulnar bone without thickening – hare over the age of 8 months; c – view of the thickening on the ulna of the young hare after cutting the skin on the stroke

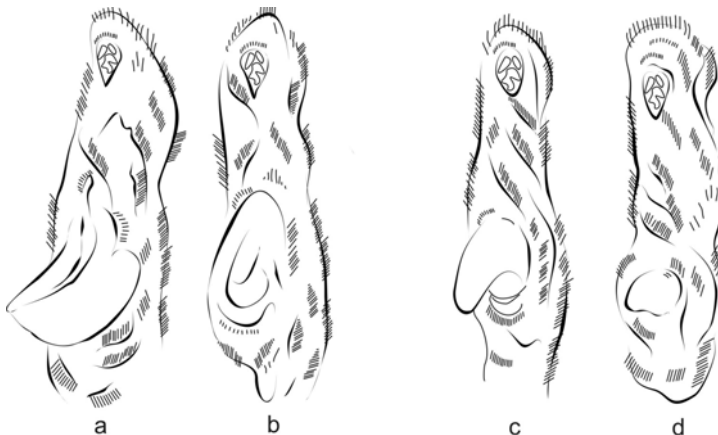


FIGURE 2. Hare sex recognition based on secondary sexual characteristics (based on Pielowski 1979)

a – adult male; b – adult female; c – young male; d – young female

treatments were carried out in accordance with the rules of how to deal with animals after shooting (Gembarzewski and Matuszewski 2009).

Carcass was the body of the animal, without skin, internal organs, head and the lower parts of legs. During the evisceration heart, liver and lungs were dissected and weighed accurately to 1 gram. Kidneys with paranephric fat were also dissected. They were weighed together with fat and without it. Based on these measurements, the paranephric fat index (KFI) was calculated based on the formula (Bobek et al. 1984):

$$\text{KFI} = \frac{\text{mass of kidneys with fat}}{\text{weight of kidneys without fat}}$$

In order to determine the differences between the mean values of the analyzed features depending on the age and sex of hares, a two-way analysis of variance was performed. In order to verify the possible occurrence of differences between the averages, calculations were made using the Newman Keuls test in the Statistica program. Correlation coefficients between body weight and the weight of internal organs were also calculated.

RESULTS

There was a slight variation in body weight and carcass weight between males and females in both the young and adults (Table 1). In males, males were 0.1 kg heavier and in adults the mean body weight was the same. In the case of carcass weight, young animals weighing 0.2 kg were males and 0.1 kg females in adults. There were no significant differ-

ences between the average values of these features ($P \geq 0.05$). In all cases, what was predicted, both body weight and carcass weight of adult animals was higher than young and the differences were statistically significant ($P > 0.05$). Also in all cases, the adults I had had heavier hearts, lungs and liver. Comparison between sexual groups indicates that in the group of younger individuals heavier hearts and livers were males, while heavier lungs were found in females. In males, males had higher heart and lung mass and 2.4 grams lower liver weight. However, the described differences in all cases did not differ statistically significantly ($P \geq 0.05$).

Young males had a higher value of perirenal fat (KFI), compared to young females, however, this difference was not statistically significantly different ($P \geq 0.05$), while in adults, the difference in the mean value of this attribute at the level of 0.6 was statistically significant ($P < 0.05$). In turn, the value of this indicator between young and adult males did not differ significantly different ($P \geq 0.05$), and between young and adult females the difference at level 1.2 was statistically significantly different ($P < 0.05$).

Analysis of the relationship between body weight and the mass of internal organs indicates that in most cases they were high and statistically significant (Table 2). However, in the case of adults, the hare correlation coefficients were not statistically significant, and their value between body weight and heart weight was $R_{xy} = 0.043$, and between body weight and lung weight there was a negative relationship $R_{xy} = -0.043$.

TABLE 1. Body weight and carcass weight (kg), the mass of internal organs (g) and the values of the perirenal fat ratio (KFI) the of hares

Parameter	Young				Adult				Male <i>P</i> -values Young/ /Adult	Female <i>P</i> -values Young/ /Adult		
	male (<i>N</i> = 7)		female (<i>N</i> = 10)		male (<i>N</i> = 5)		female (<i>N</i> = 8)					
	\bar{x}	<i>SD</i>	\bar{x}	<i>SD</i>	\bar{x}	<i>SD</i>	\bar{x}	<i>SD</i>				
Body weight	4.1	0.12	4.0	0.21	0.5131	4.7	0.24	4.7	0.21	0.0503	0.0008	0.0038
Carcass weight	2.5	0.05	2.3	0.26	0.1899	2.9	0.18	3.0	0.08	0.5145	0.0018	0.0013
Heart	34.3	1.50	31.0	4.47	0.1503	42.0	2.94	39.8	2.38	0.3216	0.0064	0.0024
Lungs	31.8	2.36	32.9	3.33	0.5587	42.0	2.94	39.8	2.28	0.2526	0.0004	0.0015
Liver	83.3	2.87	80.0	7.41	0.3583	86.0	3.92	88.4	3.43	0.4949	0.4352	0.1082
Perirenal fat ratio (<i>KFI</i>)	3.5	0.30	3.1	0.45	0.2657	3.7	0.64	4.3	0.40	0.0493	0.5683	0.0083

P-values – the averages difference in statistically significantly at ($P < 0.05$)

TABLE 2. Correlation coefficients between body weight and weight of assessed internal organs

Parameter	Sex/Age	Heart	Lungs	Liver
Body weight	male	0.685	0.750*	0.683
	female	0.933*	0.777*	0.749*
	young	0.829*	0.186	0.694*
	adult	0.043	-0.043	0.566

* – statistically significant correlations

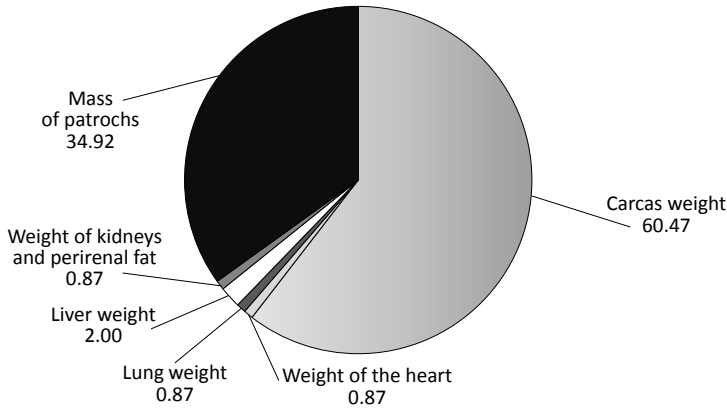


FIGURE 3. Share of individual carcass elements (%) in relation to the hare body weight

Analysis of the weight of the hare carcasses showed a low percentage in relation to body weight (Fig. 3). The low index of slaughter efficiency is conditioned by a fairly high proportion of inedible parts, i.e. skin and head, and inedible insides. The share of edible guts was small.

DISCUSSION

Presented weighting results of hares are higher compared to the data from the same area for brown hares that were shot during the hunting season 2014/2015 (Flis 2015). The body mass of both young and adults is also higher than that of hares in the hunting districts of the Lublin Upland and Podlasie, acquired in the 1990's (Dziedzic et al. 1998). Misiorowska et al. (2014), conducting research in the areas with the highest number of hares, gave a varied weight value depending on the region and age, which was within the range of 3.42–4.32 and it was also lower than at present in the area of conducting this research. In the region of Central Pomerania,

the average hare weight gained in the years 1998–2001 was 4.13 kg (Myslek et al. 2004), hence it was lower than at present in the Lublin Upland. Obtained results also indicate a definitely higher body mass for young hares and only slightly higher in adults in relation to those obtained in eastern Poland in the years 1965–1972 (Caboń-Raczyńska 1974). The presented weight results of hares are also higher than those obtained in Croatia in the 2004/2005 hunting season and in Hungary, both in the age and gender groups (Pintur et al. 2006, Farkas et al. 2016). In turn, the percentage proportion of carcass weight to body weight in our hares (60.47%) was lower in comparison with brown hares shot in eastern Croatia, where it accounted for 64.78% (Škrivanko et al. 2008). The Croatia's hares had also a higher weight of heart, lung and liver compared to the individuals obtained in the Lublin region. In Italy, in a closed breeding, the share of hare carcass weight in the control group was 63.7% of body weight and it weighted 2.17 kg on average (Vizzarri et al. 2014).

The average value of the paranephric fat index in brown hares studied in Argentina in years 1985–1986 expressed as a percentage was around 25% and was dependent on sex, age and season (Bonino and Bustos 1998). This means that the average value of the KFI in the hare population from Lublin Upland in the month of December was higher by over 2%, and thus the results should be considered comparable. The absence of clear and statistically significant differences between the KFI value in males and females in this study confirm the results of other authors that only low and periodic differentiation of this feature happens within the sexes. These results also confirm clear differences in the rate between young and adult hares regardless of gender (Flux 1971, Farfán et al. 2004, Fernández et al. 2010).

The obtained results indicate that the hare population in the western part of the Lublin region is characterized by quite high indicators of individual quality, which should have a positive impact on the survivability and reproductive potential of the population. Such high individual condition is most likely conditioned by environmental conditions and the characteristics of agricultural production in this area. The structure of agroecosystems directly affects living conditions, and in particular the composition of the diet resulting from the nutritional requirements of this species (Pielowski 1979, Reichlin et al. 2006).

CONCLUSIONS

1. The high individual condition of the hare, expressed as body mass and KFI index, in the area of research should

have a significant beneficial effect on the reproductive potential of the population and the survival of hares. This should contribute to the stabilization of the population in this area and even condition its growth.

2. The results regarding the lower mass of internal organs, especially of the heart and lungs, are slightly disturbing. They determine the possibility of significant locomotive effort, which in turn plays a very important role in emergency situations, where the basic defensive mechanism of the hare is to escape quickly.
3. The mass of carcasses from obtained hares, defining the slaughtering efficiency, at a level slightly exceeding 60% should be considered as an average for this species and the differences between the data from the literature result usually from the method of dressing and gutting.

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- wego (KFI), w wyodrębnionych grupach wiekowych i płciowych. Uzyskane wyniki wskazują, że masa ciała młodych zajęcy na poziomie nieco ponad 4,0 kg i dorosłych wynosząca 4,7 kg jest większa niż w innych częściach Polski, jak i w rejonie Lubelszczyzny, w porównaniu z latami wcześniejszymi. Potwierdzeniem wysokiej kondycji osobniczej jest także wartość wskaźnika KFI, który wyniósł 3,6 i był wysoki jak na tę porę roku. Masę tuszy pozyskanych zajęcy określającą wydajność rzeźną (stosunek masy tuszy oraz narządów wewnętrznych z uwzględnieniem części niejadalnych, do masy ciała pozyskanych zwierząt) na poziomie nieco przekraczającym 60%, należy uznać za przeciętną dla tego gatunku. Nieco niepokojące są wyniki odnośnie niższej masy narządów wewnętrznych zwłaszcza serca i płuc. Organy te warunkują możliwość znacznego wysiłku lokomotorycznego, co z kolei ma bardzo duże znaczenie w sytuacjach zagrożenia, gdzie podstawowym odruchem obronnym zajęcy jest szybka ucieczka. Uzyskane wyniki wskazują, iż populację zajęcy w zachodniej części Lubelszczyzny cechują dość wysokie wskaźniki jakości osobniczej, co powinno wpływać korzystnie na przeżywalność oraz potencjał rozrodczy populacji. Współczynniki korelacji pomiędzy masą ciała a masą narządów wewnętrznych były w większości przypadków, poza dorosłymi zającami, wysokie i statystycznie istotne.

Słowa kluczowe: zając, masa ciała, jakość osobnicza, KFI, narządy wewnętrzne

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Streszczenie: Masa ciała i tuszy oraz narządów wewnętrznych i wskaźnik tłuszczu okolonerkowego (KFI) jako wskaźnik kondycji osobniczej zająca szaraka (*Lepus europaeus*), we wschodniej Polsce. Badania kondycji osobniczej zajęcy przeprowadzono na podstawie zwierząt pozyskanych w drodze polowań zbiorowych w obwodach łowieckich położonych w zachodniej części Lubelszczyzny, we wschodniej Polsce. Oparto je na analizie masy ciała, tuszy oraz narządów wewnętrznych i wskaźnika tłuszczu okolonerko-