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Prognosis of Prolongation and Reduction of Human Pregnancy Duration, Using Alometric Relation Between Length of Pregnancy, Body Mass and Metabolism of Mammals

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Using the relationship between length of pregnancy T(day), body mass M(g) and basal metabolism of mammals from type: $T=7.5451\ M^{0.2689}$ and $T.P/M=A_{pr}$, where, P (kcal/day)-rate of metabolism, A_{pr}(kcal/kg)-total metabolic energy of mother during pregnancy, per 1 kg body mass, a method for calculation the prolongation and reduction of pregnancy duration was proposed.

Key words: Prognosis, length of pregnancy, body mass, metabolism

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INTRODUCTION

Body mass, basal energy metabolism and time are main physiological parameters concerning others processes in organisms[1]. Pregnancy duration of mammals and incubation time of eggs in birds are associated with the same parameters in others alometric relations. For the birds Lasiewski and Dawson[2] and Rahl and Paganelli[3] is established relationship between metabolism, body mass and duration of incubation time of eggs. Brody *et al.*[4] studies about metabolism and body mass of mammals "from mouse to elephant" obtains alometric relationship between rate of metabolism and body mass of animals. For mammals Atanasov[5-7] obtains alometric relationship between length of pregnancy and body mass "from mouse to elephant" too. In this sense our interest is directed to the application of these alometric relationships for calculation the changes of pregnancy duration?

MATERIALS AND METHODS

The data for length of pregnancy and body mass are collected from specialized scientific sours[8-11]. Statistic software is used for computing of the relationships[12]. In this study given data was for body mass and length of pregnancy for 20 mammals "from mouse to elephant": mouse (body mass 21 g; length of pregnancy 19-20 day), scorpio hamster (50 g, 33 day), rat (250 g, 25 day), hamster (400 g, 30 day), squirrel (750 g, 41 day), guinea-pig (510 g, 68 day), hedgehog (800 g, 49 day), rabbit (3.5 kg, 50 day), cat (5 kg, 62 day), dog (10 kg, 62 day), leopard (32 kg, 90 day), sheep (49 kg, 148 day), human (60 kg, 280 day), llama (100 kg, 360 day), deer (300 kg, 200 day), camel (460 kg, 400 day), horse (500 kg, 350 day), giraffe (1000 kg, 430 day), rhinoceros (1500 kg, 440 day), elephant (3500 kg, 630 day).

GENERAL THEORY

The relationship between length of pregnancy and body mass of 105 mammals is shown in Fig. 1A. Figure 1B shown the same relationship for 20 mammals (on the given data). The graphic relationship on Fig. 1A approximated with function from type: $T = 7.545\ M^{0.2689}$[5-7] with correlation coefficient 0.899±0.043 and standard deviation of regression 0.177, where, T-length of pregnancy (days), M-body mass of the mammals (g), 7.545-alometric coefficient, 0.268-degree alometric coefficient. The same relationship for body mass M in kilograms is: $T = 48\ M^{0.2689}$.

Brody *et al.*[4,13] studies about metabolism and mass of mammals obtains alometric relationship between rate of

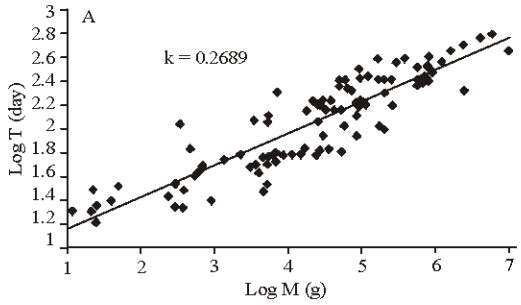

Fig. 1A: Alometric relationship between length of pregnancy (T, day) and body mass (M, g) of the 105 parents-mammals

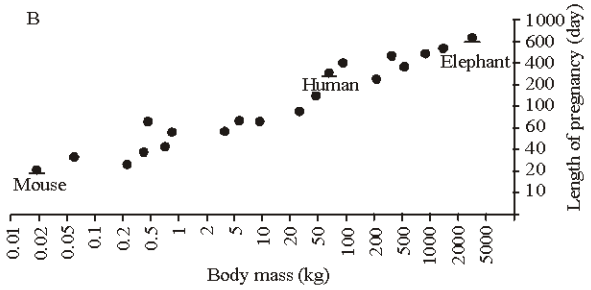

Fig. 1B: The same relationship for 20 mammals for body mass M (kg)

metabolism P(kcal/day) and body mass M (kg) from type: $P = 70\ M^{0.734}$. This relationship per unit body mass is expressed as: $P^* = 70\ M^{-0.266}$; where, $P^* = P/M$. Absolute value of the degree coefficient (-0.266) in relationship of Brody is close to the absolute value of the degree coefficient (0.2689) in the relationship $T = 48\ M^{0.2689}$. From two relationships we obtain mathematics connection between length of pregnancy T, metabolism P and body mass M of mammals: $T.P/M = A_{pr}$, where, A_{pr} (kcal/kg) is total metabolic energy of mother per length of pregnancy, per 1 kg body mass. This equation obtained by statistics analysis from data for 105 mammals, keeps validity about different groups and individuals of mammals and can be applied for calculation of prolongation and reduction of human length of pregnancy. If we represent this equation as: $T_{pr} = A_{pr}/(P/M) = A_{pr}/P^*$, it seen that length of pregnancy depends on metabolism per unit mass of the mother.

Calculation of prolongation and reduction of length of human pregnancy: The prognosis of changes in pregnancy duration is of extreme significance for the survival of the newborn. Data of Hytten[14] show that the normal pregnancy duration is expected at a mean increase in body mass of mother of about 25-30%. The oxygen consumption of the maternal organism also increases by

25-30%[15], but this is not reported in the gynecological practice as factor acting upon pregnancy duration. Relation between length of pregnancy, body mass and metabolism of a pregnant woman: $T_{pr} = A_{pr}/(P/M)$; (where, $A_{pr} = T_{pr}(P/M)$ – total metabolic energy for 280 days per 1 kg body mass of a mother) shows, that the pregnancy duration depends both on the body mass M and metabolism P of a woman. According to Hadgiev *et al.*[16], Durning[17], Ueland and Metcalfe[18], the equal increase of the body mass and metabolism of a pregnant women with 25-30% leads to keeping her metabolism per unit of body mass before $(P/M)_{norm}$ and after conception $(P/M)_{pr}$. The metabolic equilibrium between $(P/M)_{norm}$ and $(P/M)_{pr}$ gives us the possibility to analyze three cases of pregnancy, taking into consideration the changes in the metabolism and body weight of women after conception.

Case one (normal length of pregnancy): the body mass and metabolism after conception increase proportionally, so that $(P/M)_{pr} = (P/M)_{norm}$. Provided before pregnancy the woman's mass is M = 60 kg and her metabolism is P = 1800 kcal/day, the value of normal metabolism per unit mass $(P/M)_{norm}$ would be 30(kcal/day/kg). For the same pregnant woman (with a mean increase in the body mass 12.5 kg from 60 to 72.5 kg and in metabolism with 25% from 1800 to 2250 kcal/day)[14,15], the value of $(P/M)_{pr}$ will also be 30 (kcal/day/kg), i.e. $(P/M)_{pr} = (P/M)_{norm} = 30$ kcal/day/kg.

From the equation $A_{pr} = T_{pr}.(P/M)_{norm=pr}$ it is possible to calculate the total metabolic energy of a mother during 280 day period of pregnancy: A_{pr} = [30 (kcal/day/kg) x 280 days] = 8400 kcal/kg.

Case two (shorter length of pregnancy): The metabolism P increases faster than the increase in the body mass M and $(P/M)_{pr} > (P/M)_{norm}$. As a result, pregnancy duration becomes shorter. It is known that up to the 17th gestation week the body mass and metabolism of the mother do not change to a substantial degree[15-17]. For example: if up to the 21st gestation week $(P/M)_{pr} = (P/M)_{norm} = 30$ kcal/day/kg, during these 21 gestation weeks (147 days) the mother uses up [30 (kcal/day/kg) x 147 day = 4410 (kcal/kg)] of total metabolic energy. In case after the 21st gestation week the relation P/M changes from 30 to 35 (kcal/day/kg), the rest of the total metabolic energy: 8400-4410 = 3990 (kcal/kg) is used not for the remaining 133 days of pregnancy, but for 114 days, accordingly the calculation would be [3390 (kcal/kg)/35 (kcal/day/kg) = 114 days]. In such an instance, the length of pregnancy will be shorter by 133-114 = 19 days, i.e. its total duration would come to 261 days, compared with 280 days of a normal extent of pregnancy.

Case three (longer duration of pregnancy): The metabolism P increases slower than the body mass M and $P/M_{pr} < P/M_{norm}$. As a result, the pregnancy lengthens.

A sudden increase or decrease in the metabolism per unit mass of the mother in stressful situation, diseases and other risk factors can induce a premature birth and also shorten or lengthen the duration of pregnancy.

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