**An extension of Janmahasatian’s fat-free mass model to incorporate differences due to ethnicity**

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**Introduction:** Janmahasatian’s [1] model for fat-free mass model ($FFM\_{Jan}$) was developed based on a population that descended from European ancestry. There is some evidence that humans from different ethnic backgrounds may have different body composition based on standard phenotypic characteristics (e.g. sex, weight and height) and hence the model may not predict well into these groups. In particular, the model is known to over-predict $FFM\_{Jan}$ in Indian patients [2]. Therefore, there is a need to extend Janmahasatian’s model in a mechanistic way in order to accommodate ethnicity specific deviations, should they exist. This would enable application of the model to other populations when data have been collected.

**Aim:** *Part-1:* To derive an extended version of Janmahasatian’s $FFM$ model structure ($FFM\_{Ext}$).

*Part-2:* To apply the extended $FFM$ model to an Indian population ($FFM\_{Ext(Ind)}$).

**Method:** *Part-1:* A primary assumption in Janmahasatian’s derivation is a proportional relationship between bioimpedance ($Z$) and density. This can be relaxed by allowing either a different proportional relationship (e.g. due to different composition of biomaterials, but relatively constant to density alteration) or a nonlinear relationship (e.g. due to variable composition with respect to density alteration) which may more readily reflect the composition in different ethnic groups. This was achieved by incorporating correction factors $Ψ \left\{ψ\_{1}, ψ\_{2}, ψ\_{3}\right\}$ to the existing $Z$ model parameters. *Part-2:* Individual data of age, sex, height, and weight of 100 adult Indian medical patients was obtained from PSG Hospital, Coimbatore, India. Individual $FFM$ data calculated by Kulkarni’s model ($FFM\_{Kul}$) [3] was used as the dependent variable (DV), and the $Ψ $parameters of the $FFM\_{Ext}$ equation were estimated to develop the model for $FFM\_{Ext(Ind)}$ using NONMEM (version 7.3).A combined error model was used to account for the residual error. A visual plot of observed (DV) vs. predicted $FFM$ was used to evaluate the $FFM\_{Ext(Ind)}$ model.

**Results:** The full extended model is given in Eq 1 and 2, where $Ψ=1$, for all elements of $Ψ$ representing the European population and we propose these elements can be estimated when considering data from other ethnic groups. For part 2, the estimate of$ψ\_{1}$ was 0. The value of $ψ\_{2}$ (a proportional term) was 0.75 (RSE: 2.4%) for males and 0.68 (RSE: 2.5%) for females respectively, and $ψ\_{3}$ (a nonlinear term) was not influenced by sex and was 0.71 (RSE: 1.0%). Note, for the Indian population the first term of the denominator drops.

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| For males: | $$FFM\_{Ext}=\frac{9270.WT}{ψ\_{1}.216.BMI+ψ\_{2}.6680.BMI^{(1-ψ\_{3})}}$$ | (1) |
| For females: | $$FFM\_{Ext}=\frac{9270.WT}{ψ\_{1}.244.BMI+ψ\_{2}.8780.BMI^{(1-ψ\_{3})}}$$ | (2) |

**Conclusion:** This work further supports the applicability of Janmahasatian’s model to populations other than what it was developed from. For this purpose, ethnic specific correction factor(s) need to be estimated and has been illustrated for Indian people in this work.

**References:**

[1] Janmahasatian et al. Clin Pharmacokinet. 2005. 44(10): p. 1051-65.

[2] Srigiripura et al. Int J Nutr Pharmacol Neurol Dis. 2017. 7(4): p. 94-100.

[3] Kulkarni et al. J Appl Physiol. 2013. 115(8): p. 1156-1162.