SUPPLEMENTAL DIGITAL CONTENT 1

APPENDICES

(a) ***variables values for which the presented equations are true***

The variables presented in the equations ($\overline{F}_0$, $\overline{v}_0$, $\overline{P}_{\max}$, S_{Fv} and h_{PO}) have to be consistent with push-off dynamics.

- Being a distance, h_{PO} has to be a real positive value:

$$h_{PO} > 0 \qquad \text{[A1]}$$

- In order to takeoff, the mean vertical force developed during push-off (in *N*) has to be higher than the body weight component along the axis of movement direction. Hence, when expressed relative to body mass (in $N.kg^{-1}$), the mean vertical force, and in turn $\overline{F}_0$, have to be a real positive value higher than the gravitational acceleration component along the axis of movement direction:

$$\overline{F}_0 > g\sin\alpha \qquad \text{[A2]}$$

- In the same manner, in order to takeoff, the mean vertical velocity of the CM during push-off has to be a positive value. Hence,

$$\overline{v}_0 > 0 \qquad \text{[A3]}$$

- From equations [1] and [3], $\overline{v}_0$ can be expressed as a function of $\overline{P}_{\max}$ and S_{Fv} :

$$\overline{v}_0 = 2\sqrt{\frac{\overline{P}_{\max}}{-S_{Fv}}} \qquad \text{[A4]}$$

with $S_{Fv} < 0$, since $\overline{F}_0 > 0$ and $\overline{v}_0 > 0$.

Since $\overline{F}_0 > g\sin\alpha$, and according to equation [1]:

$$\overline{P}_{\max} > \frac{\overline{v}_0 g \sin\alpha}{4} \qquad [A5]$$

Substituting equation [A4] in equation [A5] gives:

$$\overline{P}_{\max} > \frac{g\sin\alpha}{2}\sqrt{\frac{\overline{P}_{\max}}{-S_{Fv}}} \qquad [A6]$$

then,

$$\overline{P}_{\max} > \frac{(g\sin\alpha)^2}{-4S_{Fv}} \qquad [A7]$$

- Since $\overline{F}_0 > g\sin\alpha$, and according to equation [3]:

$$-S_{Fv} > \frac{g\sin\alpha}{\overline{v}_0} \qquad [A8]$$

Substituting equation [A4] in equation [A8], and after reduction, gives:

$$S_{Fv} < -\frac{(g\sin\alpha)^2}{4\overline{P}_{\max}} \qquad [A9]$$

(b) *mathematical expression of $S_{Fv}opt$* as a function of $\overline{P}_{\max}$ and h_{PO}

The optimal slope of F-v relationship ($S_{Fv}opt$) is the S_{Fv} value maximizing $v_{TO\max}$. The mathematical expression of $S_{Fv}opt$ as a function of $\overline{P}_{\max}$ and h_{PO} is a real solution of:

$$\frac{d\ v_{TO\max}}{d\ S_{Fv}} = 0 \qquad [A10]$$

The first mathematical derivative of $v_{TO\max}(\overline{P}_{\max}, S_{Fv}, h_{PO})$ with respect to S_{Fv} is:

$$\frac{d\ v_{TO\max}}{d\ S_{Fv}} = \frac{h_{PO}{}^2}{g}\left(\frac{S_{Fv} - \dfrac{4\overline{P}_{\max}}{h_{PO}\sqrt{-\overline{P}_{\max}.S_{Fv}}}}{4\sqrt{\dfrac{1}{4}S_{Fv}{}^2 + \dfrac{2}{h_{PO}}(2\sqrt{-\overline{P}_{\max}S_{Fv}} - g)}} + \frac{1}{2}\right)\left(\sqrt{\frac{1}{4}S_{Fv}{}^2 + \frac{2}{h_{PO}}(2\sqrt{-\overline{P}_{\max}S_{Fv}} - g)} + \frac{1}{2}S_{Fv}\right) \qquad [A11]$$

Equation [A10] has four solutions, of which only one corresponds to real values of S_{Fv} among values for which equation [6] is true:

$$S_{Fv}opt = -\frac{g^2}{3\overline{P}_{\max}} - \frac{(-(g^4)h_{PO}{}^4 - 12gh_{PO}{}^3\overline{P}_{\max}{}^2)}{3h_{PO}{}^2\overline{P}_{\max}Z(\overline{P}_{\max}, h_{PO})} - \frac{Z(\overline{P}_{\max}, h_{PO})}{3h_{PO}{}^2\overline{P}_{\max}} \quad [A12]$$

with

$$Z(\overline{P}_{\max}, h_{PO}) = \left(-(g^6)h_{PO}{}^6 - 18g^3h_{PO}{}^5\overline{P}_{\max}{}^2 - 54h_{PO}{}^4\overline{P}_{\max}{}^4 + 6\sqrt{3}\sqrt{2g^3h_{PO}{}^9\overline{P}_{\max}{}^6 + 27h_{PO}{}^8\overline{P}_{\max}{}^8}\right)^{1/3}$$

[A13]

(c) power output developed during a vertical jump as a function of S_{Fv}

According to basic ballistic principles, the height reached during a vertical jump (*h* in m) can be expressed as a function of the CM vertical take-off velocity (v_{TO}):

$$h = \frac{v^2_{TO}}{2g} \quad [A14]$$

From equations [6] and [A14], and substituting v_{TO} by $v_{TO\max}$, the maximal jump height an individual can reach can be expressed as a function of $\overline{P}_{\max}$, S_{Fv} and h_{PO}.

On the other hand, the mean power output ($\overline{P}$ in W.kg^{-1}) developed during a vertical jump was expressed as a function of *h* and push-off distance (h_{PO} in m) (Samozino et al., 2008):

$$\overline{P} = g\left(\frac{h}{h_{PO}} + 1\right)\sqrt{\frac{gh}{2}} \quad [A15]$$

Consequently, from equations [6], [A14] and [A15], $\overline{P}$ developed during the push-off of a maximal vertical jump can be expressed as a function of $\overline{P}_{\max}$, S_{Fv} and h_{PO}. This allows to analyze changes in $\overline{P}$ according to changes in S_{Fv} (for a given $\overline{P}_{\max}$ and h_{PO}, Fig. 5).