On the validity of metrics for defining penile distensibility phenotypes

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Yafi and colleagues' recent report [1] on the *grower*/*shower* phenomenon is noteworthy for examining a concept which has arguably received disproportionately little scientific attention in comparison to its lay recognition. As Shindel has noted [2], their results are unfortunately limited by their choice of metric in quantifying penile expansion, though I believe the implications are substantially more serious. As I shall demonstrate, their analysis is both conceptually and quantitatively incompatible with their clinical question, and distorts the relationship of their results to the literature.

The framework for quantifying penile expansion is of central importance, and I agree with the authors' justification of erect rather than stretched length as germane to the conceptual *grower*/*shower* distinction. However, full explication of the phenotypes reveals that they must be characterized by a measure of *relative* rather than *absolute* expansion. This accords with the authors' invocation of relativity in their general definitions and their stated intent to "quantify relative penile length expansion" [1]. In the current study, however, the authors defined *grower*/*shower* phenotypes by comparing individual *absolute* length increases to the group median absolute length increase of 4.0 cm. This choice fails to capture relativity in quantifying individual expansion, and indeed the essence of the phenotypes.

In the theoretical limit, the *shower* phenotype would demonstrate equivalent flaccid and erect dimensions, gaining only rigidity through tumescence. As a foil to the *shower*, the *grower* phenotype ought to denote disparity between flaccid and erect measurements, indicating greater proportional expansion toward the *grower* end of the spectrum. The corresponding theoretical

limiting case is not easily conceivable, but would generally represent paired outliers of small flaccid dimensions and large erect dimensions.

Quantitatively, the *grower*/*shower* distinction is arguably best reflected by penile *distensibility*, that is, the ratio of erect to flaccid penile dimensions as proposed in work by the late Professor Udelson's group [3]. Following from their volumetric definition, we can conceive of *linear distensibility* as the ratio of erect to flaccid penile lengths. This metric has the advantage that the inverse ratio quantifies "*show*" as a proportion of erect size, though relative length increase (as a proportion of flaccid size) could be used as well, as both metrics share the essential property that the scale of absolute change is irrelevant.

That Yafi and colleagues' categorization nonetheless produced greater *relative* length increase on average in the "*grower*" versus "*shower*" groups is simply an artifact of their assignment by *absolute* increase, since the latter appears unrelated to flaccid length among their data [1]. It should be obvious that this difference is then uninformative, but more subtly the authors' analysis obscures any true relationship between flaccid length and phenotype. In fact, simulation reveals that consistent average absolute increase across the flaccid length range (Figure 1, left) corresponds to inverse association of relative increase with flaccid length (Figure 1, middle). Thus, the impact of (in)appropriate metric choice is not limited to "clearly exaggerated" examples [2]. Similarly, although partial association is to be arithmetically expected between absolute increase and relative metrics (Figure 1, right), this does not suffice to defend use of the former: first because it is conceptually unfitting (as described above), and second because the

potential for individual phenotype misclassification precludes the interpretation of group results for non-dimensional variables (e.g. vascular function).

Identification of an inverse relationship between relative expansion and flaccid length in Yafi et al.'s data would mirror their observation of the same in Wessells et al.'s data [1,4], and as-is, the apparent discrepancy between the two is merely an illusion. In their Discussion, Yafi and colleagues draw a contrast between the results of Wessells et al. [4] and their own, describing in the former case,

> …in the aforementioned study by Wessels [*sic*] et al., the authors noted that men with smaller penises had significantly more relative increase in their penis size upon erection than men with larger penises.

and in the latter,

> …however, after using the median cut-off of 4 cm for penile enlargement, there was no significant difference in initial flaccid or stretched penile length between "*showers*" and "*growers*" [1].

Wessells et al. do not in fact make the claimed observation on variation in *relative* length increase within their data, though such variation is indeed apparent [4]. Furthermore, the current authors' claim regarding stretched penile length in their own data appears in error, as their Table 1 reports mean stretched penile lengths of 15.7 cm (*growers*) and 13.4 cm (*showers*) ($p < 0.001$) [1].

Nevertheless, with regard to flaccid length the results of these studies are not in conflict. In Figure 3 from Wessells et al. [4], demonstrating a lack of relationship between flaccid length (on the *x*-axis) and absolute increase (on the *y*-axis), the original authors' comparison of absolute length increase between groups of short and long flaccid lengths represents an oriented cross-section of these data (bipartitioning the *x*-axis into groups and comparing *y* means). In the present study, Yafi and colleagues' comparison of flaccid lengths between groups of above- and below-average absolute length increases is analogous to an orthogonal cross-section (bipartitioning the *y*-axis into groups and comparing *x* means), and the equivalence found is thus consistent with the Wessells et al. data. Further illustrating this consistency is the resemblance between the simulated current study data (Figure 1, left) and Wessells et al.'s Figure 3. The greater *relative* increase among shorter flaccid lengths apparent in the Wessells et al. data can be best understood by examining their Figure 2, where the regression line indicates the ~4 cm average absolute length increase, and the asymmetric origins of the plot axes demonstrate that the same average *absolute* increase corresponds to a greater *relative* increase in length at the low versus high range of flaccid length [4].

The two studies' consistency implies that Yafi and colleagues' data would show similar variation in *relative* expansion if examined across the flaccid range, as also suggested by the simulated dataset (Figure 1, middle). As the reported results cannot be assumed to approximate those based on a relative metric, reanalysis is necessary to provide valid evidence toward the clinical question, and will greatly improve the value of the authors' innovative study.

Conflict of Interest: The author declares no conflict of interest.

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Figure

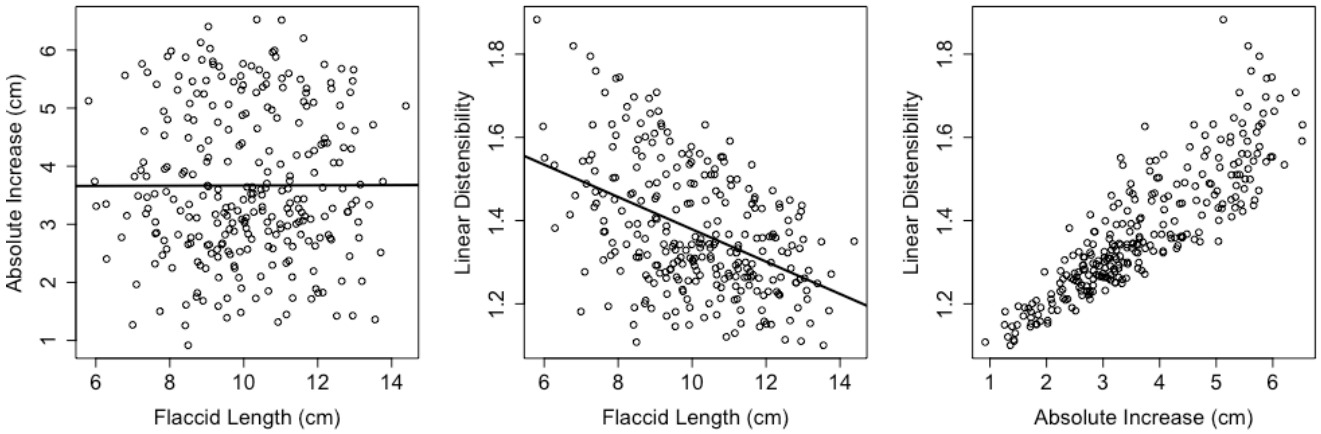

Figure 1: Simulated data (n=278) for flaccid length (*f*) and absolute increase (*i*), drawn from normal distributions given the parameters reported in Table 1 from Yafi et al. [1], plotted in three views with simple linear regression lines; linear distensibility calculated as the ratio $(f + i)/f$. Approximately uniform distribution of absolute increase across the flaccid length range (left) corresponds to an inverse relationship between linear distensibility and flaccid length (middle), and only modest association of relative and absolute metrics (right).