Hair Mass Index (HMI) derived from hair photographs: how did we get there ?
Van Neste Dominique

Skin and Hair Clinic, Skinterface, 9 rue du Sondart, B-7500 Tournai, Belgium.

This short historical note recapitulates 2 concurrent hair evaluation methods aiming at measuring growth. While reviewing hair assessment methods[1] we considered qualitative and quantitative methods. The paper concluded 'that a combination of a highly resolutive analytical approach with a global calibrated method' would be 'advisable in the context of the monitoring of hair growth changes for better or worse'.
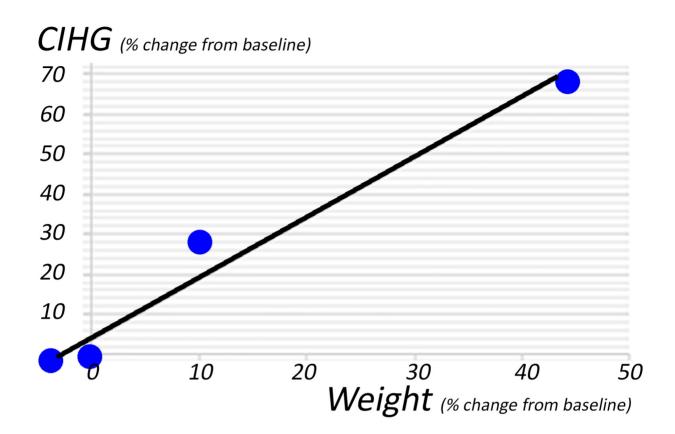
The latter have been the focus of interest of our work during the last 40 years: the first 20 years were devoted to technological development and the last 20 years challenged and scientifically probed the clinical value of some of our methodological proposals with drugs approved by the FDA for treatment of patterned hair loss. In the early years of this millennium, we demonstrated that our non-invasive contrast enhanced phototrichogram approach equalled resolution in terms of hair detection with serial sectioning of scalp biopsies[2]. It was only recently that we completed the publication of controlled drug trials using this methodological combination[3].
At last, this allowed comparative evaluation of historical data generated by 2 independent methods based on hair dynamics[4-7]. The repeat hair clipping and weighing of those clipped hair for hair growth measurement under placebo-controlled conditions helped us in solving this rather semantic question and, as illustrated in figure 1S1, we conclude that the term 'Hair Mass Index (HMI)' was appropriate.
The estimates by the clinician can be translated via an abacus into measurable productivity i.e. amount of hair per unit time or its mirror parameter: 'time to complete coverage (TTCC)'.

We coined the term 'Hair Mass Index' (HMI) by analogy with the measurements that lead to the well known 'Body Mass Index' (BMI). The concept and 'founding' measurements were part of the then called segment 'social physics'. The process, initiated in the middle of the 19th Century by Belgian Adolphe Quetelet[8], became a universally acknowledged index more than a century later, the 'BMI'.
As from the early days of 21st century, technology is evolving very fast and it would not be surprizing that Artificial Intelligence finds an application for HMI in the field of scalp hair evaluation. Our preliminary data show that SCS can be performed by duly trained (initially naïve) observers. Why not a duly trained computer? Concepts, designs and ideas for future applications are subject to intellectual property rights (Benelux I-DEPOT 130713).

In conclusion, periodic measurements of hair weight from the 'hair mass method' and the scalp hair productivity (CIHG as per our phototrichogram method) explore the same phenomenon. Herein, the term "Hair Mass Index" encompassed the unified concept under one heading. While the term 'hair mass' has been used extensively in everyday language, it was proposed more recently in books, forums and/or websites[9-10]. Nevertheless, prevailing rules and/or criteria for precision-accuracy[11] were unlike the ones employed in our approach with methods evolving from the mid-80ies till validated techniques at entry in the millennium[3,12] and consistently used herein.

Figure 1S1. Correlation between the so-called Hair Mass Method and CIHG derived from phototrichogram measurements i.e. CE-PTG-EC.

Relative changes of our Compound Index of Hair Growth (CIHG; y axis) were compared with published relative changes of hair weight (Weight; x axis) employing the so-called 'hair mass method' during placebo controlled drug trials. Baseline was 100% and average changes from baseline were expressed as percentages (% change from baseline).

Studies including controls and drugs like oral finasteride and/or topical application of minoxidil 5% solution (within a 3 months period[4-7]) were compared with our personal data[3].

The small negative values on placebo reflect technological and/or biological variations (x-y intercept: 3.53%). Data collected with active compounds demonstrate a remarkable relative increase of hair productivity (slope: 1.51).

*Hair weight from the so-called 'hair mass method' and our CIHG values that encompass all hair growth measurements into one parameter showed a linear correlation between the 2 techniques. The correlation coefficient (R^2 = 0.97087) supports the idea of coining the name **Hair Mass Index**. The new HMI-abacus will be derived from our combined clinical-analytical estimates of coverage-growth (SCS-phototrichogram).*

REFERENCES

1. Van Neste MD. Assessment of hair loss: clinical relevance of hair growth evaluation methods. *Clin Exp Dermatol* 2002;27:358-65.

2. Van Neste, D. Contrast enhanced phototrichogram (CE-PTG): an improved non-invasive technique for measurement of scalp hair dynamics in androgenetic alopecia - validation study with histology after transverse sectioning of scalp biopsies. *Eur J Dermatol* 2001;11:326-31.

3. Van Neste D. Placebo-controlled dose-effect studies with topical minoxidil 2% or 5% in male-patterned hair loss treated with oral finasteride employing an analytical and exhaustive study protocol. *Skin Res Technol* 2020;26:542-57.

4. Price VH, Menefee E. Quantitative estimation of hair growth. I. androgenetic alopecia in women: effect of minoxidil. *J Invest Dermatol* 1990;95:683-7.

5. Price, VH, Menefee E. Quantitative estimation of hair growth: comparative changes in weight and hair count with 5% and 2% minoxidil, placebo and no treatment. In Hair research for the next millenium. D. Van Neste and V. A. Randall, editors. Elsevier Science B.V., Amsterdam. 1996; p. 67-71.

6. Price VH, Menefee E, Strauss PC. Changes in hair weight and hair count in men with androgenetic alopecia, after application of 5% and 2% topical minoxidil, placebo, or no treatment. *J Am Acad Dermatol* 1999;41:717-21.

7. Price VH, Menefee E, Sanchez M, Ruane P, Kaufman KD. Changes in hair weight and hair count in men with androgenetic alopecia after treatment with finasteride, 1 mg, daily. *J Am Acad Dermatol* 2002;46:517-23.

8. Wikipedia. Adolphe quetelet. Available from: https://en.wikipedia.org/wiki/Adolphe_Quetelet

9. Forhair Blog Release. Hair mass index and hair mass transferred. Available from: https://www.forhair.com/studies/hair-mass-index-and-hair-mass-transferred/ [Last modified on 03 May 2020]

10. Marritt E. The death of the density debate. *Dermatol Surg* 1999;25:654-60.

11. Physic News Release. Accuracy, precision, and significant figures. Available from: https://courses.lumenlearning.com/physics/chapter/1-3-accuracy-precision-and-significant-figures

12. Van Neste D. Why care about linear hair growth rates (LHGR)? A study using in vivo imaging and computer assisted image analysis after manual processing (CAIAMP) in unaffected male controls and men with male pattern hair loss (MPHL). *Eur J Dermatol* 2014;24:568-76.