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Interrater Reliability Of Skin Hydrometer For Measuring Hydration Of Skin In Prehypertensive Individuals

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Abstract

Background: Epidermis hydration measurement is an important tool to assess its health. Skin hydrometer is a portable device that measures moisture and oil levels of skin through impedance method, it is cheap and has small dimensions, but this equipment has not yet been cited in the scientific literature. The purpose of this study was to examine the interrater reliability of skin hydrometer for measuring hydration of skin in Prehypertensive individuals. 10 individuals (10 female patients; mean age, 40.4± 7.84 years) were assessed to determine the intrarater reliability for skin hydrometer. **Materials and Methods**: Ten subjects had skin hydration measurement on forehead. Measurements obtained with the same instrument by three different therapists. The sensitivity of the equipment to the forearm and their accuracy by different therapist was evaluated. **Results**: The equipment were found for skin hydration, with $P \leq .001$. The instrument presented high sensitivity to the forehead ($P < .001$). The mean of readings taken by each therapist was calculated and then comparasion was done among the values measured by three different therapist. The device has good repeatability in the measurements. Based on the ICC, skin hydrometer displayed an excellent reliability (ICC> 0.75). The interrater reliability showed fair-to-excellent results. In accordance with the intrarater reliability, skin hydration parameter with an ICC below 0.75 for all the samples. Therefore, these protocols should be considered reliable assessment techniques in measuring hydration of skin.**Conclusion**: These results indicate that Skin hydrometer can be used in the future for skin analysis in in vivo assays.

Keywords: capacitance, impedance, skin hydration, stratum corneum

INTRODUCTION

Hydration, the water content of the stratum corneum, is an important factor in both the appearance and the barrier function of the skin.[1] The skin surface of hydration determination, that is, the stratum corneum , is an important tool for the evaluation of its barrier capacity, as well as the proper functioning of cutaneous processes such as cellular metabolism, hydrolytic enzymatic processes needed for normal desquamation, and maturation of the

Stratum corneum. In addition, an adequate amount of water is important for a healthy, smooth, and flexible skin appearance [2-3]. Epidermis hydration measurement is an important tool to assess its health. Determination of moisturizer efficacy are usually performed through a variety of noninvasive methods based on the electrical properties of the skin that change with the water content of the skin.[4] Corneometer® is based on capacitance measurements and is usually referred in literature as the most sensitive instrument for measuring the water content in dry conditions.[5] Skin hydration is a portable device that measures moisture and oil levels of skin through impedance method, it is cheap and has small dimensions, but this equipment has not yet been cited in the scientific literature.[6] The capacitor 'plates' are formed by the probe material and the well-conducting epidermal–dermal skin layers, while the dry layer of SC acts as an 'insulator' of the capacitor. Due to this measurement principle, the measurement depth is not constant, but equal to the thickness of the dry layer of SC. [7] The measurements are reflected as hydration percentage units. Before any measurements or assessments can be utilized for clinical or research related application, the reliability of these techniques must be determined. Intraclass correlation coefficients (ICC) are calculated by mean squares obtained through an analysis of variance. Currently, the ICC has been widely used in evaluation of interrater, intrarater or test-retest reliability.[8] These fundamental evaluations are the basis for clinical or research related assessments, because without them, we cannot conclude the reliability of any drawn conclusion. Thus, the objective of this work was to find out the interrater reliability of skin hydrometer.

MATERIALS AND METHOD

Design

The study was a randomized controlled clinical study with healthy volunteers. Ten female volunteers of age 30 - 55. were enrolled in this study after giving written, informed consent. Subjects with left-right asymmetry, any kind of skin diseases in the forearm and face measuring areas and special occupation such as outdoor workers, with exposure to the sun for long periods of the day or in places with high temperature, were excluded. The participants were asked not to use cosmetics on the test sites in the 12 hours before the test. The hydration measurement was taken with the skin hydrometer by Therapist 1, then by Therapist 2 and then by Therapist 3 on the forehead. Participants signed the free consent form and the experiment was duly approved by the ethics and research committee.

Measurements

All measurements were performed in a room and the participants were at rest for 30 minutes before the procedures. The patient laid supine and the measurement sites were 2 × 2 cm squares, drawn on the skin with a cosmetic eye pencil . Three repeated measurements were performed in each test site by three different physios and a mean calculated.

Repeatability- The instruments had good repeatability in measurements, with low CV%. Measurements on the forehead were the only ones that presented statistical difference of CV% value between the physios.

RESULT

Table 1 Bayesian Unidimensional Reliability

Bayesian Scale Reliability Statistics

Estimate	McDonald's ω	Greatest Lower Bound	Average interitem correlation	mean	sd
Posterior mean	0.925	0.948	0.848	103.548	26.440
95% CI lower bound	0.879	0.915	0.761		
95% CI upper bound	0.967	0.976	0.927		
R-hat	1.001	1.018	1.011		

Note. Of the observations, pairwise complete cases were used.

Table 2 Bayesian Individual Item Reliability Statistics

	McDonald's ω (if item dropped)				
Item	Posterior mean	Lower 95% CI	Upper 95% CI	mean	sd
Physio 1	0.880	0.782	0.952	36.167	6.879
Physio 2	0.892	0.807	0.959	35.767	5.532
Physio 3	0.843	0.724	0.939	35.067	7.027

Note. The following items were reverse scaled: Physio 1, Physio 2, Physio 3.

Table 3 Probability that Reliability Statistic is Larger than 0.70 and Smaller than 0.90

	Probability	
Statistic	Prior	Posterior
McDonald's ω	0.131	0.133
Greatest Lower Bound	0.339	0.011

Table 4 Fit Measures for the Single-Factor Model

Estimate	B-LR	B-SRMR	B-RMSEA	B-CFI	B-TLI
Posterior mean	2.730	0.100	0.364	0.964	0.750
90% CI lower bound			0.000	0.860	0.000
90% CI upper bound			1.007	1.000	1.000
Relative to cutoff			0.372	0.893	0.481

Note. 'Relative to cutoff'-row denotes the probability that the B-RMSEA is smaller than the corresponding cutoff and the probabilities that the B-CFI/TLI are larger than the corresponding cutoff.

Table 5 Standardized Loadings of the Single-Factor Model

Item	Standardized loading
Physio 1	0.888
Physio 2	0.879
Physio 3	0.918

Figure1 Posterior Plots

McDonald's ω

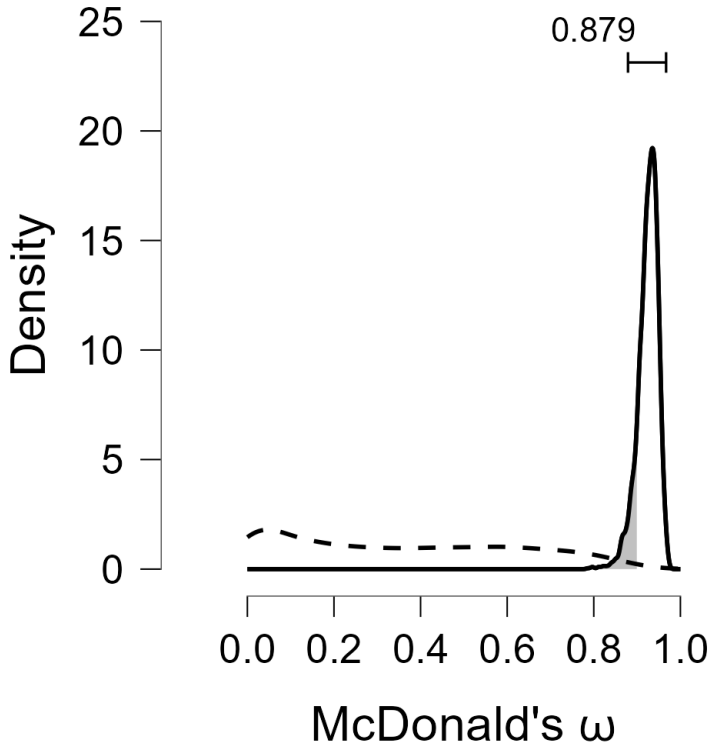


Figure 2 Greatest Lower Bound

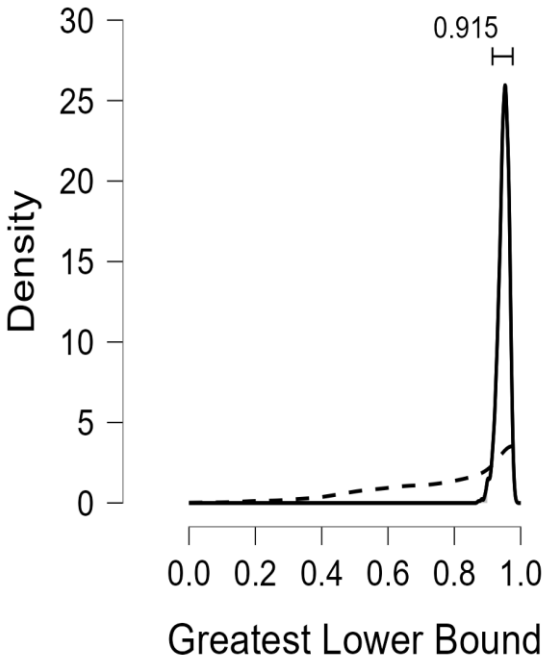


FIgure 3 If Item Dropped Posterior Plots

McDonald's ω

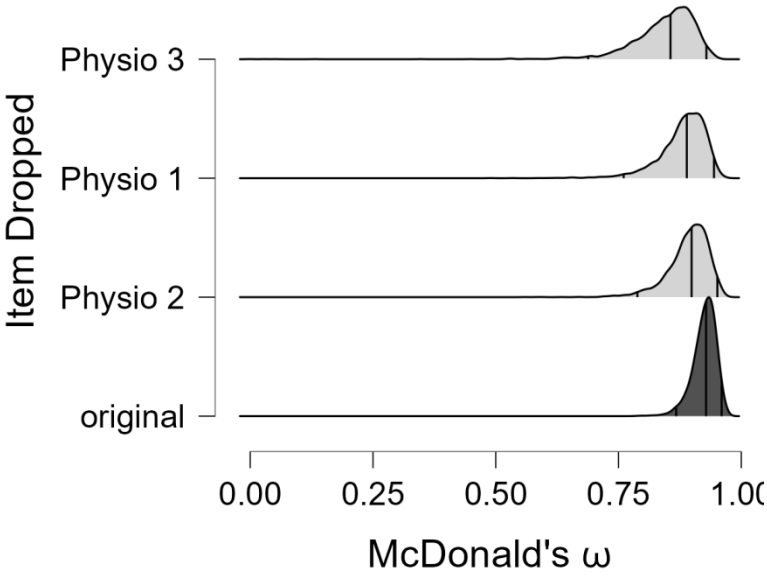


Figure 4 Convergence Traceplot

McDonald's ω

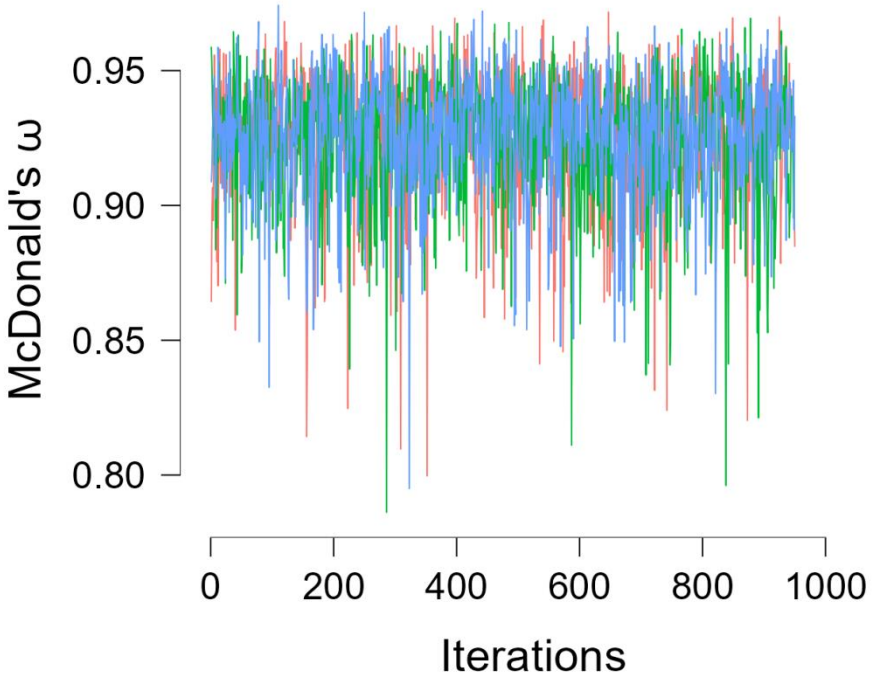
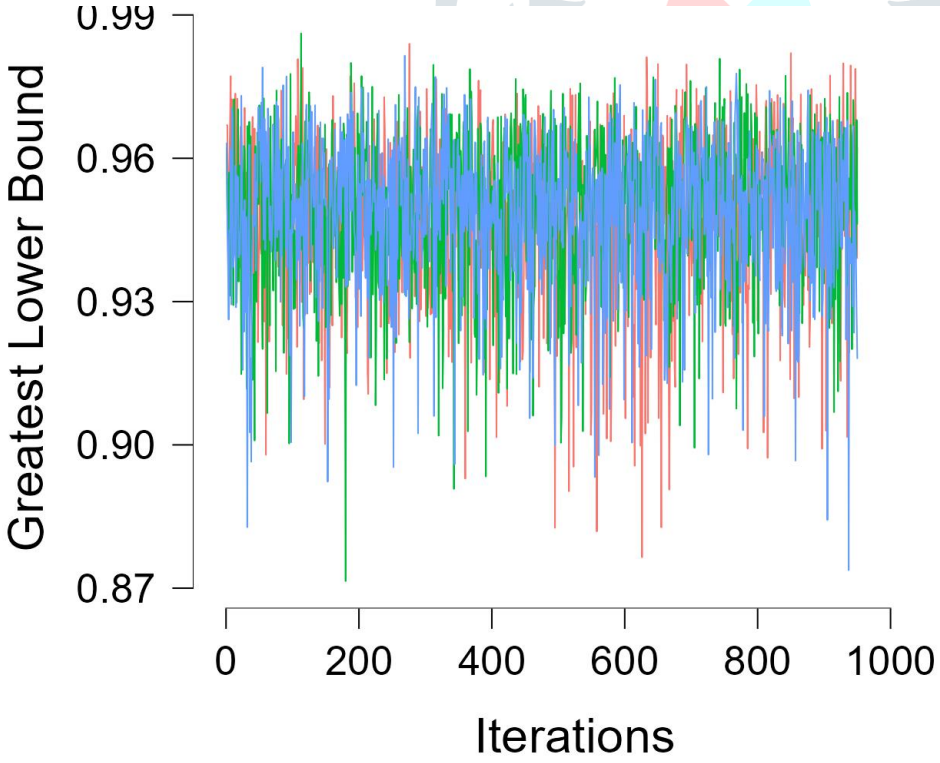


Figure 5 Greatest Lower Bound



DISCUSSION

The skin is the largest organ of the body. Stratum corneum and insoluble lipid envelope formed by corneocytes act as a natural moisturizer and physical barrier against mechanical and chemical stress as well as microbial invasion mainly by its water retention property.[9] Skin hydration is generally evaluated using

devices that measure capacitance or conductance. An instrument skin hydrometer was developed to provide accurate measurements of skin hydration at the contact site. In this study forehead was taken as point of reference. Skin Hydrometer measurements presented good correlation (r = .804). The correlation found for the instrument is compatible to previous studies. Skin hydrometer measurements on the forehead were similar when comparing readings by three physios. The moisturizing effects of the applied formulations measured with Skin hydrometer by all three physios were equal. When applying only water, skin hydrometer had higher sensibility with a variation of 93.8% in the capacitance value as well as on untreated skin (forearm), but when considering a prior cream treatment, Skin hydrometer had a higher sensibility. According to a study by M.M Constantin, Elena Poenaru et al, hydration was at a maximum immediately after the first application, and then maintained an increased level after 7 and 28 days, respectively. In the healthy subjects, the increase in hydration was lower, but progressive. The maintenance effect of hydration lasted for 28 days, while the improvement was important for allergic skin (17.1%) and significant for healthy skin (10.9%).[10] Lee SH, Chung J et al, measured the conductance with the hydrometer and the capacitance with the corneometer in various hydrating conditions and compared both instruments. The hydrometer is a more appropriate tool for the measurement of moisture at a high level, and the corneometer at a low moisture level. The hydrometer is a more sensitive method of measuring the increase and the decrease in the moisture level.[11] Recent studies have introduced a number of new devices that can measure skin hydration. Grinich et al. reported on a novel device for measuring stratum corneum hydration that showed precise and reliable measurements, compared to the currently used devices. Since the device has sensors for measuring skin capacitance and can transmit data to a smartphone application, it can analyze skin barrier function at low cost[12].

CONCLUSION

In conclusion, the Skin hydrometer is a sensitive device to detect changes in skin surface hydration. Skin hydrometer measurements presented good correlation. By evaluating the sensitivity of the equipment the Skin hydrometer was able to identify hydration. However, skin hydrometer is sensitive to a moisturizing emulsion. As for the accuracy of the equipment it presented good reproducibility in the measurements, with low CV%. Thus, it can be stated that the Skin hydrometer is an efficient equipment for analysis of skin hydration measurements and can be used for future in vivo tests

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