

Hair Fall Count 60-second: Clinic-Based Modified Count Versus Home-Based Count

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ABSTRACT

Background: Female diffuse alopecia is a common dermatologic problem. Consequently, a simple, quick, and quantitative assessment is required to aid in diagnosis. A clinic-based modified hair fall count in 60 seconds is proposed as a new, simple, and quick method for evaluating hair loss.

Objectives: To assess bias and limit of agreement between the new Clinic-based modified hair fall count in 60 seconds (CBMHFC 60-S) and conventional home-based hair fall count in 60 seconds (HBHFC 60-S) determining hair fall in women with diffuse hair loss.

Materials and methods: Seventy-five women with diffuse alopecia recruited from Al-Salam Teaching Hospital, Mosul, Iraq underwent assessment of hair fall count by using two instruments, new single reading (CBMHFC 60-S) and conventional three reading (HBHFC 60-S). A multistage statistical analysis of validity tests was used to assess the performance of CBMHFC 60-S in comparison to HBHFC 60-S. These included the estimation of the difference between both methods; correlation and prediction; and lastly estimating accuracy (amount of bias and limits of agreement) using Bland Altman blot. A P-value of < 0.05 was considered a statistically significant difference.

Results: A non-statistically significant difference (P-value = 0.06) in average hair fall count was estimated by CBMHFC 60-S and HBFHFC 60-S (15.81 ± 7.16 vs 18.18 ± 8.56). A very highly significant linear relationship between both tests ($r = 0.434$, $P < 0.0001$). A regression analysis yields the following prediction equation [$CBMHFC\ 60-S = 9.21 + 0.36 * (HBHFC\ 60-S)$]. Bland-Altman blot revealed a high accuracy of the CBHFC 60-S. The count was less than HBHFC 60-S count by an average of 2.38 hairs. The 95% CI of CBMHFC 60-s in comparison to HBHFC 60-S will fall between -18.95 and 14.19.

Conclusion: The new single reading CBMHFC-60S estimation of hair fall count was a valid test reflected by its strong association with an average of three readings of conventional HBHFC-60 and high concordance (low bias and high precision).

Keywords: Diffuse Hair Loss; Women; Clinic-based modified hair fall count in 60s (CBMHFC 60-S); Home-based hair fall count in 60s (HBHFC 60-S).

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INTRODUCTION

Diffuse hair loss is a common health problem in adult female and carries a negative impact on the quality of life [1]. Among those seeking medical treatment, women outweigh men because they perceive hair loss to be bothersome [2]. The huge number of patients suffering from diffuse hair loss requires simple and

valid hair loss documentation to monitor disease progression and treatment efficacy [3].

The lack of a diagnostic lab for assessing the severity of hair loss obligates physicians to rely solely on clinical manifestations [4]. Various methods are available for evaluation that vary from non-invasive methods like 60-s hair count, semi-invasive like trichogram, and to invasive methods like skin biopsy. Any one of these tools is neither "ideal" nor realistic because they use different principles in the evaluation, while wash test uses already fallen hair, in the pull test, the dermatologist enforced and pulls hair from the scalp, while, and biopsy assesses hair microscopically makes them helpful tools for diagnosing and monitoring patients, but they need to be used

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with care [5–7].

In the past, measuring hair loss involved counting the hair fall in 60 seconds, proposed by Kligman in 1961 [8]. Fifty years later, Wasko *et al.* made an effort to standardize the procedure by recommending pre-shampoo combing and counting hair fall in 60 seconds on 3 successive occasions done by the patient himself at home [9]. A year later, Rachita *et al.* reviewed the 60-S hair fall count and list some of its drawbacks like a week delay in data gathering, complexity of the procedure for some people, particularly, for illiterate or poor complaints, subjectivity of the result, overestimation of hair fallen by counting broken hair during combing and skipping hair lost from the lateral and posterior scalp as the procedure is limited to the upper scalp [5].

The newly proposed clinic-based modified hair fall count 60-S test (CBMHFC 60-S) attempts to overcome the shortcoming of home-based hair count 60-S (HBHFC 60-S). First, switching from three successive home counts to a single clinical count will speed up the results-gathering process. The doctors count will reduce the miscalculation of broken hair as fallen hair. Finally, breaking 60-S into four segments of 15 seconds each, taken from the upper scalp, bitemporal region, and posterior scalp, will allow accurate measurement of hair loss over the entire scalp. The critical step in diagnostic medicine is to ascertain that the suggested tool can safely substitute the conventional tool in providing valid clinical decisions [10]. The commonly employed and highly cited approach of Bland and Altman blot allows the determination of test concordance by evaluating the boundaries of the agreement between both tests. To our best knowledge, no study in the world investigated the comparison between home *vs.* clinic-based regarding hair fall counting in patients with excessive hair loss. Hence, the current investigation was conducted to assess the bias and limit of agreement between the newly proposed CBMHFC 60-S and traditional HBHFC 60-S in determining hair fall in 60 seconds in women with diffuse hair loss.

MATERIALS AND METHODS

A cross-sectional comparative study was conducted between January to September 2021 involving 75 women with acute diffuse telogen effluvium (scalp disorder characterized by diffuse, non-scarring shedding of hair for the last six months that occurred two to three months after stressful psycho-physical stressors) [11]. The age of the enrolled patients ranged from 14 to 52 years. The patients were recruited from the Dermatology Outpatient Clinic at Al-Salam Teaching Hospital, Mosul, Iraq. A patient with diffuse hair thinning or hair falling longer than 6 weeks was excluded from the study. Those patients who decline to participate were excluded too. Eligible patients were asked to participate in the study after signing an informed consent form. The study was approved by the Ethical Committee of the College of Medicine, University of Ninevah, Iraq. Two approaches were used to determine hair loss.

Home-Based Hair Fall Count 60-S (HBHFC 60-S)

The eligible patients received Rubber Barber, Hair Artist Comb, and Krest Cleopatra 400 special comb (15 cm long comb's teeth were spaced 1 millimeter apart on one half and 2 millimeters apart on the other) for the procedure and asked to count hair fallen as follows: before shampooing, comb upper scalp hair for 60 seconds from the back to the front, count

down hair fallen onto a white cushion or on the comb. The patients repeated the procedure daily for three days. Lastly, utilize the average of 3 days as patient hair fall count.

Clinic-Based Modified Hair Fall Count 60-S (CBMHFC 60-S)

The patients were evaluated once more in the clinic. Before the appointment, the patient was urged not to shampoo her hair. Hairs were separated into 4 regions (upper scalp, two lateral, and posterior regions). Hair was combed for 15 seconds in each area using the same comb. The hair that had fallen onto the comb or on a white pillow was counted.

Statistical analysis

IBM SPSS version 26 was used to process and tabulate the results. Paired samples *t*-test was utilized to compare the significance of the mean hair count differences between the HBHFC 60-S and CBMHFC 60-S. A Shapiro-Wilk normality test was performed to assess how much the distribution of both tests and their difference fit the normal distribution curve. Additionally, a Q-Q plot was utilized to compare the probability of the quantiles in the sample to the probability of the quantiles in a theoretically normal distribution. A Pearson correlation test was utilized to assess the association between HBHFC 60-S and CBMHFC 60-S. Based on HBHFC 60-S, a regression test was utilized to build an equation for predicting and estimating expected variation in the CBMHFC 60-S. Agreement between both tests was measured using a Bland and Altman plot [12]. The average of both tests [(HBHFC 60-S + CBMHFC 60-S)/2] and their difference (HBHFC 60-S - CBMHFC 60-S) were shown on the X-axis and Y-axis, respectively, of a scatterplot. The mean bias (average of HBHFC 60-S - CBMHFC 60-S) and its confidence bounds (limits of agreement = mean \pm 1.96* standard deviations) were then depicted. A P-value of less than 0.05 was considered to be statistically significant difference.

RESULTS

The ages of the women with telogen effluvium who participated in the study were ranging from 14-52 years with a mean age of 27.81 ± 9.63 years.

The results revealed that HBHFC 60-S ranges from 5-35 hairs with a mean of 18.18 ± 8.56 (95% CI for mean 16.20-20.17). The CBMHFC 60-S ranges from 4-32 hairs with a mean of 15.81 ± 7.16 (95% CI for mean 14.15-17.47). The difference between both tests ranged from -22.00 to 15.00 hairs with a mean of -2.38 ± 8.45 (95% CI for mean difference -4.33 to -0.42) and it was statistically non-significant (P-value = 0.06). Figure 1 reveals the box blot distribution and comparison of both tests.

An S-W normality test revealed a significant difference between HBHFC 60-S and CBMHFC 60-S in comparison to the normal distribution curve (P-values = 0.004 and 0.003 respectively). In contrast, the difference in both tests did not significantly vary from the normal distribution curve (P-value = 0.07). The distribution of the difference between both tests compared to the theoretical normal distribution curve is depicted in Figure 2. This satisfies the assumption that the differences (errors) between the measurements are normally distributed to estimate a 95% limit of agreement.

Under the normality assumption, 95% of the differences will lie between the LoA intervals $e -1.96SD$ and $e +1.96SD$.

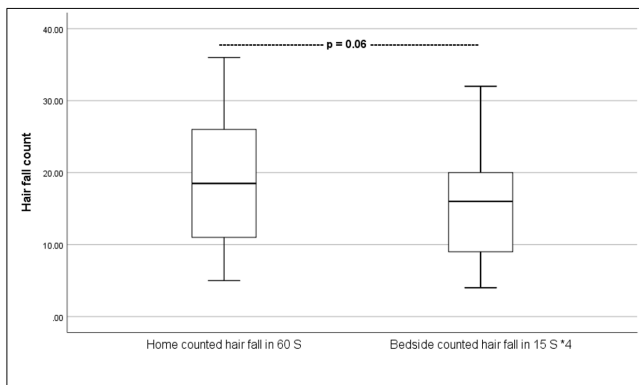


Figure 1. Comparison of differences between home-based hair fall count in 60-S and clinical-based modified hair fall count in 60-S. P-value = 0.06.

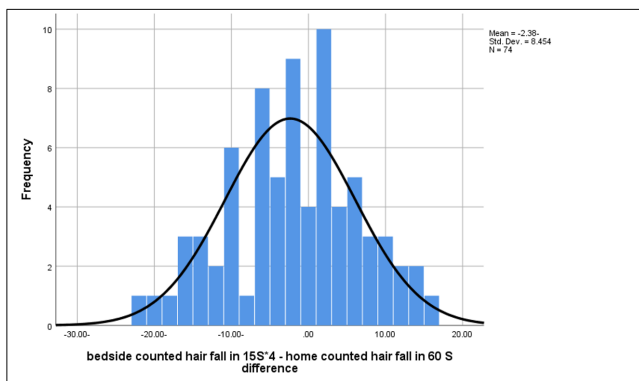


Figure 2. Histogram distribution of the difference between home-based hair fall count in 60-S and clinical-based modified hair fall count in 60-S. P-value = 0.2.

Figure 3 depicts the Q-Q plot, a graphical method to elaborate and evaluate the normality of the difference (The probability of the sample’s quantiles is compared to the probability of the theoretical normal distribution quantiles). The results indicate that the two compared distributions are similar and linear, particularly the central, which points most of them are closely spaced and lie along or near the identity line ($Y = X$).

The Figure 4 scatter blot graph displays the relationship between HBHFC 60-S and CBMHFC 60-S. The results show a highly significant correlation between them ($r = 0.434$, P-value = 0.0001). A regression test was performed to further evaluate the relationship and revealed that CBMHFC 60-S explains 18.8% of HBHFC 60-S. A fit line analysis revealed the following prediction equation models: $CBMHFC\ 60-S = 9.21 + 0.36 * (HBHFC\ 60-S)$.

The discrepancies between CBMHFC 60-S (new instrument) and HBHFC 60-S (existing reference instrument) were assessed by constructing the Bland-Altman plot. The plot’s y-axis shows the difference in measurements between the two instruments (CBMHFC 60-s - HBHFC 60-S), while the x-axis shows their average $[(CBMHFC\ 60-s + HBHFC\ 60-S)/2]$. The result is depicted in Figure 5. The average measurement discrepancy between the two instruments and how far they are from zero is depicted by the central horizontal line, which stands for "bias". The amount of bias was -2.38 (95% CI = -4.34 to -0.420). Two more horizontal lines show the

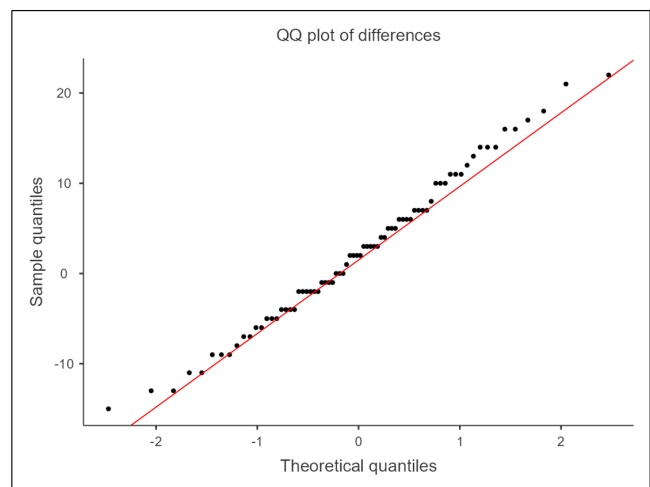


Figure 3. The normal QQ plot comparing quantile distribution generated from the difference between (home-based hair fall count in 60-S and clinical-based modified hair fall count in 60-S) on the vertical axis to a standard normal distribution quantile on the horizontal axis. Q-Q plot can provide an assessment of goodness of fit that is graphical, rather than reducing to a numerical summary statistic.

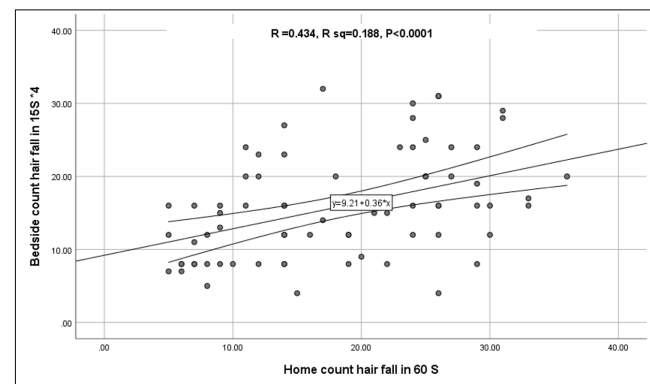


Figure 4. Correlation of home-based hair fall count in 60-S and clinical-based modified hair fall count in 60-S (correlation coefficient $r = 0.434$, $R^2 = 0.188$, P-value = 0.0001).

two instruments’ windows of agreement (the upper and lower confidence interval lines). The lower limit of agreement equals -18.95 (95% CI -22.31 to -15.586). The upper limit of agreement equals 14.19 (95% CI =10.83 to 17.554). Bland-Altman Statistics ($t = 2.4$, $df = 73$, P-value = 0.02). In other words, the CBHFC 60-S count was less than the HBHFC 60-S count by an average of 2.38 hairs. The 95% CI of CBMHFC 60-s in comparison to HBHFC 60-S will fall between -18.95 and 14.19.

DISCUSSION

Although hair is a nonvital organ, it has a major cosmetic concern, in particular for women [13]. Even clinically undetectable hair loss has had a negative influence on the sense of self and well-being of women [14]. Hair loss is also a prevalent issue in the dermatology clinic that frequently causes individuals a great deal of distress. Dermatologists are becoming

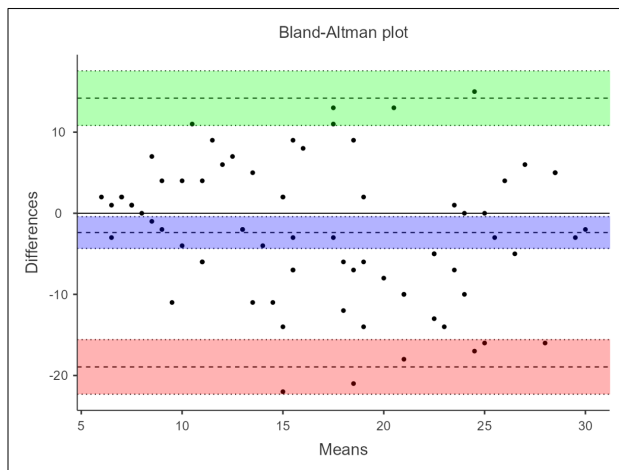


Figure 5. The Bland-Altman blot of agreement between home-based hair fall count in 60-S and clinical-based modified hair fall count in 60-S. (bias = -2.38, Agreement limit = -18.95 to 14.19). Bland-Altman Statistics ($t = 2.4$, $df = 73$, P -value = 0.02).

increasingly interested in the examination of the hair and the scalp. The spectrum of assessment techniques ranges from non-invasive to annoying techniques [15]. One of the primary issues in biology is to ascertain whether evaluating parameters by two distinct procedures, two operators applying a single procedure, or an investigator performing multiple estimations at various points in time would provide equivalent results in terms of accuracy (how closely a measure matches its true value?) and precision (how closely measurements agree with one another?). A new measurement method must be comparable to the standard method to be validated for use in medical practice [16]. The incorrect outcomes can be attributed to bias (systematic exaggeration or under-estimation error particularly when comparing clinic- versus patient-reported outcomes) or chance (random mistake) [17].

The Long-term usage of a variety of incorrect methods to address this subject has produced results that are often unreliable or even misleading. The Pearson correlation test was frequently used to determine how closely the pairs (two procedures, two observers, or duplicate readings) compared to one another. Criticizing these papers revealed that even a test with outstanding correlation cannot guarantee agreement if one reading is incorrectly higher or lower than the other because of systematic errors [18]. A recently invented Bland and Altman diagram helps determine the pattern and level of the agreement by comparing the discrepancies between pairs of readings. Furthermore, it provides a diagram that depicts the difference between two pairs versus their average. This method is considered the best test to display the concordance of pair of results [19].

The study's significance stems from the fact that this is the first attempt to apply standardized HBHFC 60-S in a clinical situation. Previously scanty published literature evaluated it in normal healthy subjects and the figures yielded from them represent the average and normal range of hair shedding [20]. Furthermore, the study presents a new quick, simple, and valid instrument to assess hair fall in patients with diffuse hair loss. It provides a numerical figure to assess the severity of hair loss rather than rely on subjective symptoms and physical

manifestations.

Wasco *et al.* during the standardization of hair fall count 60-S test, found low intra-patient variability in hair fall count and consistency of readings throughout the three consecutive days [9]. The concordance between the conventional three-reading test (i.e. HBHFC 60-S) and single reading test (i.e. CBMHFC-60S) supports Wasco *et al.*'s conclusion, making the traditional repetition of readings unnecessary and time-wasting. According to this study, women with diffuse hair loss (age range from 14 to 52 years) experience a hair fall count of 18.18 ± 8.56 hairs after one minute of combing. The figure was lower than the 44 hairs predicted by Kligmans study [8]. This disparity may be attributed to Kligmans insufficient description of the hair-counting procedure. The current figure was higher than the count of 10 hairs reported by Wasco *et al.* after revising the procedure. Again, it is higher than the figure reported by Miller and Fang [21] when they used the standardized hair count 60-S. The discrepancies among the reported results by these studies in comparison to the current investigation may be explained by differences in the enrolled samples regarding gender (men *vs.* women) and health status (healthy *vs.* diffuse hair loss). Additionally, frequent hair washing in standardized hair count 60-S may lower the average hair count by reducing the number of hairs that fall out between sessions [22].

As a result of a lacking a gold standard test for assessing hair shedding count, the validity of the new test (CBMHFC 60-S) was based on assessing its concordance with conventional hair shedding count (HBHFC 60-S) and used as a reference test. A multi-strategy was used to assess the concordance of both tests. First, a non-significant difference in mean hair fall count between both tests (18.18 *vs.* 15.81 hairs). Second, a moderate strength, but highly significant correlation coefficient between both tests. Thirdly, regression analysis yields a prediction equation model that allows us to predict HBHFC 60-S based on CBMHFC 60-S. Lastly, the most common agreement test Bland Altman blot was used to calculate the accuracy of the new CBMHFC 60-S in comparison to the conventional HBHFC 60-S reference test. The estimated bias was small and the rest of the data were dispersed within the bounds of upper and lower limits of agreement.

The studied sample is limited to childbearing Mediterranean women with diffuse hair loss. This makes extrapolation of the results to individuals with varying age ranges, genders, racial backgrounds, and health statuses. The test was also unable to differentiate between hair shedding (transient natural course of the hair cycle) and hair loss (permanent and worse with time).

CONCLUSION

The study shows that the new single CBMHFC-60S is strongly associated with three HBHFC-60S. The concordance of the two tests is highly reflected by low bias and high precision. Further assessment of the variation of bedside hair count in different gender, age groups, ethnic groups, and scalp hair disorders is recommended before the implementation of this easy, useful, and unbiased tool for monitoring hair shedding.

ETHICAL DECLARATIONS

Acknowledgements

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Ethics Approval and Consent to Participate

The written agreement had been obtained from the Ethical Committee (Reference number: 169, issued on January 17, 2023) of the College of Medicine, Ninevah University, Iraq. Consent to participate was obtained from patients who participated in the study.

Consent for Publication

Not applicable (no individual personal data included).

Availability of Data and Material

Data generated during this study are available from the corresponding author upon reasonable request.

Competing Interests

The authors declare that there is no conflict of interest.

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Authors' Contributions

All stated authors contributed significantly, directly, and intellectually to the work and consented it to being published.

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