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RESEARCH LETTER

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Correlation of body metrics, assessed with a portable scanning device, with established anthropometrics in people with obesity

Nele Endner MD[1,2] | Harry Merz MD[1,3] | Esmé Wallace MD[1,4] | Vera Lehmann PhD[1,5] | Philipp Nett MD[6] | Iris-Katharina Penner PhD[7] | Christoph Stettler MD[1]

[1]Department of Diabetes, Endocrinology, Nutritional Medicine and Metabolism, Inselspital Bern University Hospital, University of Bern, Bern, Switzerland

[2]Medical University Department, Division of General Internal and Emergency Medicine, Kantonsspital Aarau, Aarau, Switzerland

[3]Department of General Internal Medicine, Kantonsspital Olten, Olten, Switzerland

[4]Emergency Department, Sonnenhofspital, Bern, Switzerland

[5]Department of Internal Medicine, Lucerne Canton Hospital Wolhusen, Wolhusen, Switzerland

[6]Department of Surgery, University Hospital, Bern, Switzerland

[7]Department of Neurology, Inselspital, Bern University Hospital, University of Bern, Bern, Switzerland

Correspondence
Christoph Stettler, Department of Diabetes, Endocrinology, Nutritional Medicine and Metabolism, Inselspital Bern University Hospital, University of Bern, Bern, Switzerland.
Email: christoph.stettler@insel.ch

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1 | BACKGROUND

Given the accepted shortcomings of traditional metrics to characterize obesity (e.g., body mass index [BMI] and waist circumference),[1–3] novel approaches to rapidly and reliably quantifying body shape and composition, including three-dimensional scanning technologies have recently been introduced.[4,5] While demonstrating robustness in assessing anthropometrics, body scanning may still be costly and devices may require substantial space and additional equipment.[6] Consequently, the aims of the present pilot study were twofold: first, to assess body metrics using a portable, commercially available, optical scanning device in people with obesity during weight loss treatment. Second, to investigate correlations between measures obtained through scanning and traditional metrics (i.e., BMI, and visceral and total body fat).

2 | METHODS

Twenty-four participants planned for bariatric surgery (Group A, $n = 11$) or pharmacotherapy with a glucagon-like peptide-1 (GLP-1) agonist (Group B, $n = 13$) were recruited in this exploratory, prospective, single-centre pilot study, conducted at the University Hospital of Bern from June 2023 to December 2023 (Figure 1A). Participants incapable of holding the body position necessary for the scanning process were excluded. The study was conducted in accordance with Good Clinical Practice principles and the Declaration of Helsinki after local ethics committee approval (2023-00559). All participants provided written informed consent.

Nele Endner and Harry Merz contributed equally to the manuscript.

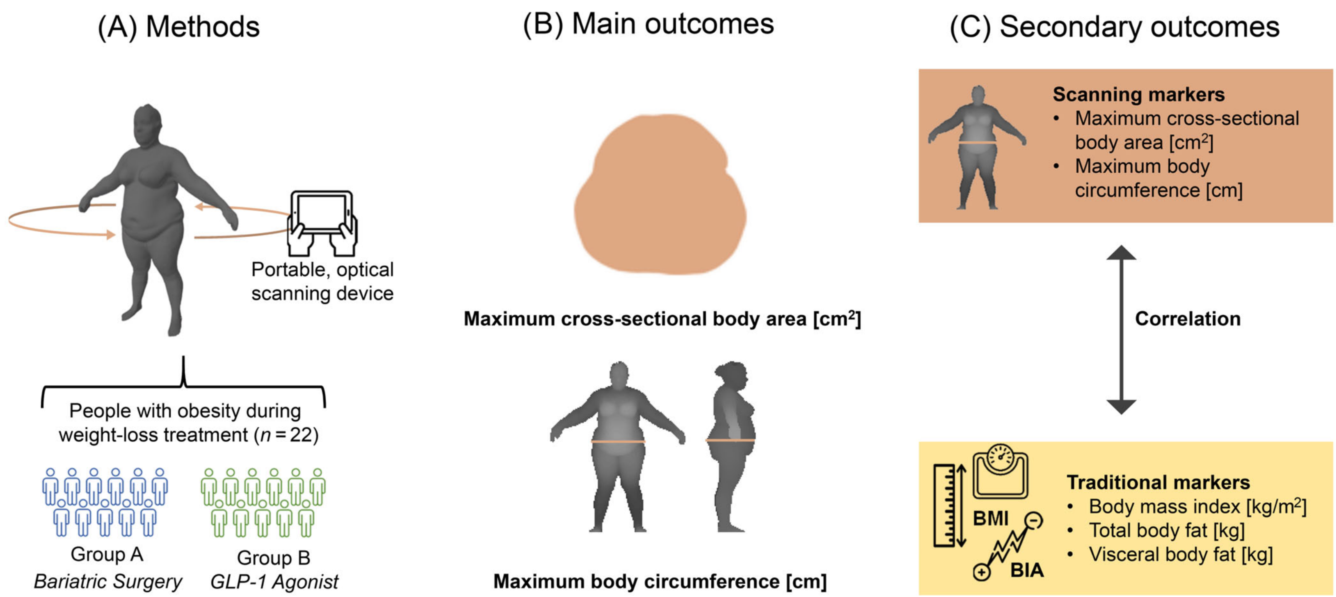

FIGURE 1 Study overview. BIA, bioelectrical impedance analysis; BMI, body mass index; GLP-1, glucagon-like peptide 1.

Eligible participants underwent two study visits, each comprising an optical body scan and a structured interview. The baseline visit was conducted prior to bariatric surgery or initiation of pharmacotherapy. The follow-up visit took place 4–6 weeks after bariatric surgery or 16–20 weeks after the start of GLP-1 agonist therapy. Using a portable scanning device (Structure Sensor Pro, Structure, Boulder, CO, USA) we measured patients in a standardized stance. Participants were asked to position themselves in their underwear, standing with their feet 30 cm apart and arms slightly raised. The scanning process started at the front and involved circling the patient at variable heights to ensure complete surface capture (Figure 1A). On average, a scan took ~30 to 60 s. We then processed the scans to determine the maximum body area and circumference (Figure 1B). A detailed description of the data processing/analysis is provided in the Appendix (see Supplementary Methods and Figure S1). In addition, we evaluated the acceptance of the scanning procedure and of the visual output by the participants within a non-standardized interview.

The main outcomes were maximum cross-sectional body area (cm^2) obtained from the scan and the corresponding body circumference (maximum body circumference [cm]). Secondary outcomes were the correlations of these measures with BMI, total body fat, and visceral body fat (derived from bioelectrical impedance analysis; InBody 770, InBody Europe B.V., 65 760 Germany; Figure 1C). Results are presented as mean ± standard deviation if not indicated otherwise.

3 | RESULTS

The final analysis included 22 participants (Figure S2 and Table S1). The mean weight change from baseline to follow-up was −9.3 ± 4.0 kg (−7.7% ± 2.8%).

The maximum body area determined by the portable scanner was 1500 ± 44.4 cm^2 at baseline, and 1415 ± 41.4 cm^2 at follow-up. The maximum body circumference was 139.6 ± 19.4 cm at baseline, and 136.7 ± 17.9 cm at follow-up.

There was a strong correlation between maximum body area and BMI (overall $r = 0.954 \pm 3.51e\text{-}24$, $r = 0.901 \pm 1.5e\text{-}4$ for men, and $r = 0.954 \pm 1.05e\text{-}15$ for women). The correlation coefficient between maximum body area and total body fat was $r = 0.969 \pm 3.06e\text{-}27$ (overall), $r = 0.884 \pm 7.0e\text{-}4$ (men) and $r = 0.974$ 5.93e-19 (women), and the correlation between maximum body area and visceral body fat revealed coefficients of $r = 0.853 \pm 2.00e\text{-}11$ (overall), $r = 0.825 \pm 1.8e\text{-}3$ for (men) and $r = 0.921 \pm 1.20e\text{-}09$ (women; Figure 2B, D, F). The correlation was also strong between maximum body circumference and BMI overall ($r = 0.918 \pm 6.34e\text{-}19$) and for both sexes ($r = 0.851 \pm 8.9e\text{-}4$ for men and $r = 0.951 \pm 2.78e\text{-}15$ for women). Similar correlations were found with total body fat ($r = 0.924 \pm 3.53e\text{-}19$ overall, $r = 0.828 \pm 3.1e\text{-}3$ for men and $r = 0.969 \pm 5.41e\text{-}18$ for women), and for visceral body fat ($r = 0.721 \pm 4.80e\text{-}07$ overall, $r = 0.781 \pm 4.5e\text{-}3$ for men and $r = 0.961 \pm 1.22e\text{-}12$ for women; Figure 2A, C, E).

To evaluate participants' acceptance of the scanning process and their reaction to the visual output we developed a standardized, non-validated interview. Two questions were used to assess the level of anticipation before undergoing a scan after receiving information about the procedure (maximum score 5 points per question). Data from the initial visit showed an average overall score of 8.8 in both groups, with a nonsignificant increase to 9.3 points in the follow-up ($p = 0.2$). After scanning, participants were asked to rate the presentation of the visual output (maximum of 5 points). The average score was 4.6 points at baseline and 4.9 points at follow-up ($p = 0.3$).

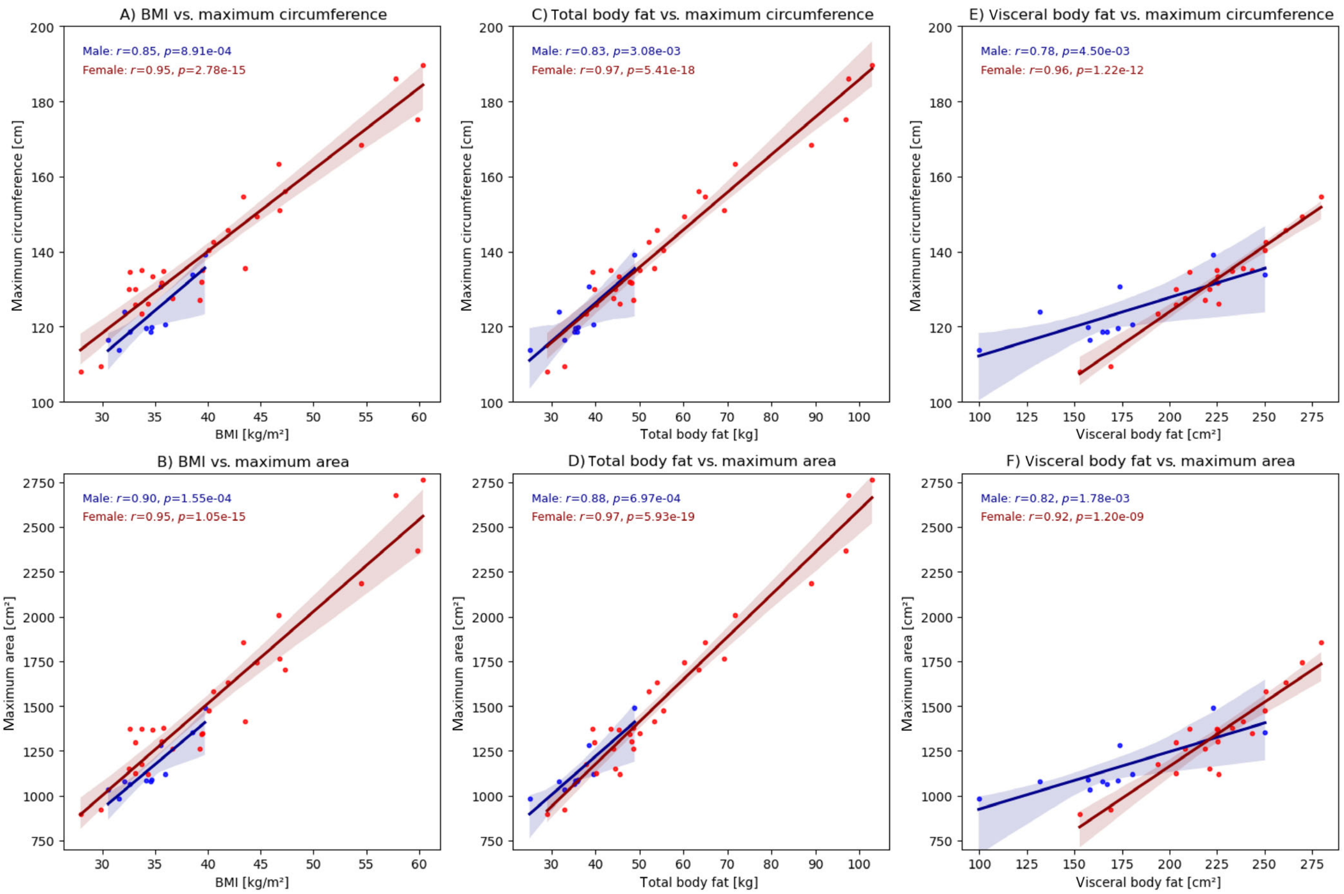

FIGURE 2 Correlations of body scan parameters with body mass index (BMI), total body fat, and visceral body fat according to sex. Total and visceral body fat were determined by bioelectrical impedance analysis. Blue dots: men; red dots: women.

4 | CONCLUSION

The main findings of this exploratory pilot study are twofold: first, a portable, commercially available, and affordable optical scanning device is capable of identifying maximum body area and, consequently, maximum body circumference. Second, these proxy parameters correlate strongly with established parameters (i.e., BMI, total and visceral body fat) throughout weight loss and in both sexes.

Our findings align with previous publications in the field, indicating that body scans provide proxy measures that correlate well with established parameters such as BMI and body fat.[7] However, our study stands out for employing a simpler, smaller, portable and inexpensive scanning device.[8,9] Unlike laser-based or visual scanning devices that require additional equipment such as rotating platforms, our device is more economical and requires less space. This offers a viable alternative option to integrate body measurements at comparably low costs in daily practice.[10]

The potential use-case of optical scanning in clinical practice may extend beyond mere measurement. Compared to a traditional weight scale, the portable optical scanning device provides novel proxy measures that correlate well with established parameters of obesity, empirically corroborating their potential. Furthermore, incorporating body shape into obesity care may increase patient motivation through visual feedback. It offers additional visual information for both patients and healthcare providers to assess and monitor effects of weight loss treatment on body composition and stature. Our study participants reported increased motivation to adhere to their weight loss regimen due to the avatar presentation and reported minimal concerns about the measurement procedure (as evaluated through standardized non-validated interviews). However, further studies are needed to specifically evaluate and quantify the effect of optical body scanning on patient motivation and weight loss outcomes. Additionally, optical scanning holds potential for implementation in other settings where the assessment of body metrics is crucial, such as in rehabilitation, sports, malnutrition and geriatrics (e.g., sarcopenia assessment). Furthermore, it could facilitate integration into home environments for self-monitoring through future development. Again, this hypothesis requires further investigation in subsequent studies.

Strengths of our study include the use of an affordable, portable, optical body scanning device, demonstrating robust correlation with established body metrics. Moreover, our study included people with obesity undergoing different weight loss regimens, including pharmacotherapy and bariatric surgery, emphasizing the broad potential for such a novel method. Notably, our participants reported high acceptance of the optical scanning procedure which may facilitate implementation of this approach into clinical practice. Limitations include the restricted sample size and the lack of reference measurements with a gold standard device. Future research will have to focus on larger cohorts to evaluate the accuracy of the optical scanning approach compared to reference measurements.

In this exploratory pilot study, we have demonstrated that a portable, commercially available, optical scanning device can be used to capture maximal body area and circumference. These measures strongly correlate with BMI and body fat mass (total and visceral), thereby corroborating the potential of this novel and comparatively simple approach to visualizing, quantifying, and following changes in body metrics during weight loss in people with obesity.

AUTHOR CONTRIBUTIONS

Nele Endner and Harry Merz share first authorship. Conception and design of the work: Christoph Stettler, Nele Endner, Harry Merz. Data acquisition: Nele Endner, Esmé Wallace. Data analysis: Nele Endner, Harry Merz. Data interpretation: All authors. Literature review and synthesis: Nele Endner, Harry Merz. Writing of the manuscript: Nele Endner, Harry Merz, Christoph Stettler. Critical revision of the manuscript for important intellectual content: All authors. Christoph Stettler is the guarantor of this work and, as such, had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. All authors approved the final draft of the manuscript for submission.

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CONFLICT OF INTEREST STATEMENT

The authors declare that there is not duality of interest related to this manuscript.

PEER REVIEW

The peer review history for this article is available at https://www.webofscience.com/api/gateway/wos/peer-review/10.1111/dom.15776.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

ORCID

Nele Endner https://orcid.org/0009-0001-1258-5742
Vera Lehmann https://orcid.org/0000-0002-6038-809X
Christoph Stettler https://orcid.org/0000-0003-1691-6059

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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