Obesity

Measuring Weight with Electronic Scales in Clinical and Research Settings During the Coronavirus Disease 2019 Pandemic

Rebecca A. Krukowski [1] *and Kathryn M. Ross* [2]

With the coronavirus disease 2019 (COVID-19) pandemic, clinicians and researchers have been suddenly confronted with the difficulty of treatment provision and continuation of clinical trials without face-to-face contact. This predicament has resulted in the rapid adoption of telehealth methodologies (1). Clinicians and researchers focused on obesity management have an additional need: a remote way to measure weight. In this piece, we will describe electronic scales (e-scales) and provide guidance on how clinicians/researchers might best implement e-scales in their clinical practice or research studies to remotely measure weight.

What Are e-Scales?

Although appearing no different from a traditional digital bathroom scale, e-scales transfer weight data directly to research/clinical centers through the cellular network, wireless internet, or pairing with a Bluetooth device that has internet access. In terms of setup, e-scales can be mailed directly to individuals; beyond this, cellular models require no setup aside from placing scales on a hard, flat surface. Wireless internet e-scales need to be set up through a website or smartphone application connected to local wireless internet, whereas Bluetooth e-scales require pairing with a Bluetooth device. Although e-scales cost more than traditional digital scales, costs have decreased enough to make these tools feasible for most clinical and research applications. Commercial scales cost approximately $30 to $150 per unit, with research-grade scales costing $80 to $130. Examples of e-scales previously used in research include BodyTrace (Palo Alto, California), Fitbit Aria (Fitbit, Inc., San Francisco, California), and Withings (Issy-les-Moulineaux, France) scales.

What is the Evidence for e-Scales?

Two studies have shown measurement concordance between e-scales and calibrated clinic scales, with correlations of 0.99 (2,3). Both studies found a 1.0-kg difference between e-scale and clinic scale weights; this consistent difference is likely due to e-scale weights being generally captured earlier in the day than clinic weights, which were measured during clinic hours, likely after at least one meal, with individuals who were wearing more clothing. Importantly, correlations were strong between the measurements, regardless of sex, BMI, race, and age categories (3).

How to Implement e-Scales in Clinical and Research Settings

General guidelines

To obtain the most valid and reliable measurement, individuals are encouraged to weigh first thing in the morning, without wearing clothing, before eating/drinking and after voiding their bladder/bowels.

As calibration may be affected by shipment, individuals should weigh themselves (i.e., by stepping on the scale, waiting for a weight to appear, stepping off the scale, and allowing for the weight to transmit) at least three times. If weights do not appear stable, individuals should repeat this protocol and contact the clinicians/researchers for troubleshooting if the technical problems cannot be resolved. Clinicians/researchers can contact the scale manufacturer on the behalf of the individual for further troubleshooting as a final option.

Addressing common challenges

Individuals are encouraged to refrain from moving the scale or storing it on its side, as this may require scale recalibration before each use. Participants should also discourage other family members from using the scale, unless the scale allows for separate profiles for multiple individuals; although some scale models "filter" out unlikely weights (as may be created by pets or other users), these extra measurements can cause challenges (procedures for "cleaning" e-scale data have been described elsewhere (4,5)). Finally, e-scales may have transmission difficulties with weak cellular or wireless internet connections. Concrete walls can block cellular signals, so cellular scales should be placed near windows for optimal signal. Wireless internet scales should be placed near routers to improve signal strength. Moreover, many scales can retain weights for at least a week; thus, individuals who experience weak connections can weigh themselves and then move the scale to another location to transmit weights weekly.

Comparisons with self-reported weight

When e-scales cannot be used, self-reported weight may serve as an alternative method. There is generally strong agreement between self-reported weight and e-scale weights (6) and between self-reported weight and clinic weights (7); however, relying upon self-reported weights requires individuals to have a digital scale and for them to actively and accurately enter each weight. One method of ensuring accuracy of self-reported weight is to have individuals photograph the

[1] Department of Preventive Medicine, College of Medicine, University of Tennessee Health Science Center, University of Tennessee, Memphis, Tennessee, USA. Correspondence: Rebecca A. Krukowski (rkrukows@uthsc.edu) [2] Department of Clinical and Health Psychology, College of Public Health and Health Professions, University of Florida, Gainesville, Florida, USA.

 Received: 7 April 2020; **Accepted:** 22 April 2020; **Published online 10 June 2020. doi:10.1002/oby.22851**

weight on the scale as it is being measured (8), although this methodology necessitates human processing of resulting images.

Specific populations and considerations

An important consideration when choosing an e-scale is how data will be accessed. Some e-scales are primarily for consumer use and they have limited functionality for clinicians/researchers. Others allow data to be pulled via application-program interface tools (which allow the e-scale system to securely communicate with the clinician's/researcher's data management system, in order to transfer the requested weight data with date/time stamps), although this method often requires assistance from software developers. Finally, some scales have website portals allowing direct access to data from registered scales. Before selecting an e-scale, clinicians/researchers need to answer the following questions. (1) In what format do you want to view data? (2) Do you need data immediately after transmission, or is it sufficient to receive "batches" of data at specified time points? (3) Is data transmission/storage compliant with the Health Insurance Portability and Accountability Act Privacy Rule (9)? Using third-party platforms to collect, transmit, or store data has important security and confidentiality implications; thus, clinicians/researchers interested in implementing these tools should consult with their local privacy office or institutional review board staff. In general, using identifiable personal health information should be limited, and individuals should be informed if their data may be accessed or transmitted by third-party sources.

Clinicians/researchers should also assess which e-scale type (e.g., cellular, wireless internet, or Bluetooth models) would be feasible to implement with the target population. The limited setup required for cellular scales use can be helpful for users with low technology literacy; however, access to cellular signals may be limited in some areas (e.g., in low-resource rural communities). Moreover, use may be limited for individuals with higher weights; existing scales typically have maximum weights between 150 kg and 180 kg.

The COVID-19 pandemic requires particular consideration of disease transmission with e-scales. Because the virus survives on cardboard for about 24 hours, it is recommended that individuals do not handle the box for 24 hours after delivery and that they wash their hands after opening the box to take out the scale. Considering that individuals may be averse to reuse of e-scales that have been repeatedly used with bare feet or stored in the bathroom by others, e-scales are often used by just one individual when provided in an interventional context. For one-time assessments, scales can be mailed and cleaned (with hospital-grade sanitizing or disinfecting wipes) between uses.

Future Directions

Although e-scales can be particularly helpful for managing the move to telehealth services in response to COVID-19, there are also other potential benefits to research and clinical practice. For example, e-scales allow for weight measurement without requiring individuals to attend frequent appointments and thus may help to reduce burden and lower attrition rates. Outcomes collected via e-scales may also be more precise than clinic weights because individuals can weigh in the same standard conditions (as described earlier) on specified days, rather than having data collection windows that may span particularly sensitive times like the holidays.

In addition, e-scale use may help to increase study sample sizes and clinical service reach, as fewer individuals will be deemed ineligible because they will have difficulty attending follow-up appointments (e.g., based on distance from the measurement site, relocation). Thus, e-scales offer promise for evidence-based treatment dissemination in rural populations, in highly mobile individuals (e.g., young adults, active duty military personnel), and in groups that have difficulty attending regularly scheduled in-person appointments (e.g., shift workers, nurses and first responders, new parents). However, it will likely be important to maintain usual screening and behavioral run-in procedures for individuals to sample the intervention before committing and to gauge motivation, which could impact data completeness and retention.

By supporting remote assessment and intervention, e-scales offer promise for widespread benefit to weight-related research and clinical practice. The COVID-19 pandemic is thrusting us into the future of health care and it may represent a crucial moment for adopting innovations that can improve population health, through increased access to care and decreased burden.**O**

Disclosure: The authors declared no conflict of interest.

References

1. Siwicki B. Telemedicine during COVID-19: benefits, limitations, burdens, adaptation. *Healthcare IT News*. Published March 19, 2020. Accessed March 25, 2020. https://www.healthcareitnews.com/news/telemedicine-during-covid-19-benefits-limitations-burdens-adaptation
2. Ross KM, Wing RR. Concordance of in-home 'smart' scale measurement with body weight measured in-person. *Obes Sci Pract* 2016;2:224-228.
3. Pebley K, Klesges RC, Talcott GW, Kocak M, Krukowski RA. E-Scale measurements in comparison to clinic weight measurements. *Obesity (Silver Spring)* 2019;27:1107-1114.
4. Ross KM, Qiu P, You L, Wing RR. Characterizing the pattern of weight loss and regain in adults enrolled in a 12-week internet-based weight management program. *Obesity (Silver Spring)* 2018;26:318-323.
5. Kocak M, Krukowski RA, Talcott GW. Processing and cleaning streaming data in SAS. Paper presented at: *PharmaSUG 2018*; April 29-May 2, 2018; Seattle, WA. https://www.pharmasug.org/proceedings/2018/DV/PharmaSUG-2018-DV11.pdf. Accessed April 6, 2020.
6. Ross KM, Eastman A, Wing RR. Accuracy of self-report versus objective smart-scale weights during a 12-week weight management intervention. *Obesity (Silver Spring)* 2019;27:385-390.
7. Harvey-Berino J, Krukowski RA, Buzzell P, Ogden D, West DS. The accuracy of weight reported in a web-based obesity treatment program. *Telemed J E Health* 2011;17:696-699.
8. Leahey T, Rosen J. DietBet: a web-based program that uses social gaming and financial incentives to promote weight loss. *JMIR Serious Games* 2014;2:e2. doi:10.2196/games.2987
9. Office for Civil Rights, US Department of Health and Human Services. Standards for privacy of individually identifiable health information. Final rule. *Fed Regist* 2002;67:53181-53273.