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Design and validation of a low cost, high-capacity weighing device for wheelchair users and bariatrics

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Abstract

Accessible high-capacity weighing scales are scarce in healthcare facilities, in part due to high device cost and weight. This shortage impairs weight monitoring and health maintenance for people with disabilities and/or morbid obesity. We conducted this study to design and validate a lighter, lower cost, high-capacity accessible weighing device. A prototype featuring 360 kg (800 lbs) weight capacity, a wheelchair-accessible ramp, and wireless data transmission was fabricated. Forty-five participants (20 standing, 20 manual wheelchair users, and 5 power wheelchair users) were weighed using the prototype and a calibrated scale. Participants were surveyed to assess perception of each weighing device and the weighing procedure. Weight measurements between devices demonstrated a strong linear correlation (R^2=0.997) with absolute differences of 1.4±2.0% (mean±SD). Participant preference ratings showed no difference between devices. The prototype weighed 11 kg (38%) less than the next lightest high-capacity commercial device found by author survey. The prototype's estimated commercial price range, \$500–600, is approximately half the price of the least expensive commercial device found by author survey. Such low cost weighing devices may improve access to weighing instrumentation, which may in turn help eliminate current health disparities. Future work is needed to determine the feasibility of market transition.

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DECLARATIONS OF INTEREST
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This manuscript has not been published elsewhere and has not been submitted simultaneously for publication elsewhere.

Key terms

wheelchair; weight; disability; scale; obesity

INTRODUCTION

Over 20 million Americans over the age of 15 have a severe mobility disability, including 3.6 million individuals using wheelchairs for mobility (Brault, 2012). The majority of the 3.6 million wheelchair users are 65 years of age or older, with this age group accounting for over two million wheelchair users, or 55% of the total (Brault, 2012). The 2010 US Census projected that by 2050, the number of people age 65 years or older will nearly double from 2014 numbers, climbing from 50 to 90 million (Ortman et al., 2014) – and associated wheelchair use will increase from two million to 4.5 million (Brault, 2012; Ortman et al., 2014). Obesity rates are also increasing, with obesity rates greater than 30% in 12 states (Centers for Disease Control and Prevention, 2010). Furthermore, 35.4% of people age 65 years or older are obese (Ogden et al., 2013). Obese (bariatric) persons are more likely to have a mobility impairment requiring wheelchair use, and people with a disability are more likely to be obese (Froehlich-Grobe et al., 2012). The aforementioned patient populations – bariatric, geriatric, and disabled – require special devices for various medical procedures, including measuring patient weight.

Weight measurements provide important data considered by health providers when determining a patient’s health status. Fluctuations in weight can indicate several pathological conditions including obesity, thyroid perturbations, and malnutrition. Morbidly obese patients exceeding 225 kg (500 lbs), patients who have a disability, older patients, and patients who have limitations in balance or standing often require accessible equipment safe for wheelchair use. Unfortunately, high-capacity (>225 kg) and accessible weighing devices are relatively expensive. On average, health providers spend approximately $2,400 on bariatric/wheelchair-accessible weighing devices, a 60% increase in price above standard weighing devices (ECRI Institute, 2012). Results from an internet product survey of commercially available wheelchair and bariatric weighing devices conducted by the authors indicate an average weighing device price of $2,075 and average device weight of 51 kg, or 113 lbs (Table 1). The high cost of such devices coupled with bulky, heavy design likely contributes to the lack of device availability. The relatively high cost of accessible high-capacity weighing devices coupled with an increasingly older population that requires such devices for proper health management suggests that there is a strong need for a lower-cost weighing device that meets the needs of a growingly diverse population (Lagu et al., 2014).

National statistics on availability of accessible weighing scales are scarce. Several studies have qualified the need for accessible high-capacity weighing devices in hospitals and clinics, but none has quantified the national need to our knowledge. In an on-site review of 2,389 primary care facilities in California, Mudrick et al. (2012) found that only 3.6% of reviewed facilities had an accessible weight scale. Graham & Mann (2008) conducted on-site reviews of 68 primary care clinics in South Carolina and found that only one (1.5%) clinic had an accessible weight scale. The United States Department of Veterans Affairs

(VA) health network, with over 1,700 hospitals, clinics and other outpatient centers, has spent $2.2 million over the last seven years on contracts for wheelchair weighing scales (USASpending.gov, 2014). At $2,400 per device (ECRI Institute, 2012), such VA spending would provide less than 950 wheelchair-accessible weighing devices over the past seven years for all VA healthcare facilities. In a survey of Pennsylvania hospitals with 63 hospital respondents, only 66% of hospitals surveyed reported owning a bariatric weighing device (Gardner et al., 2013). Lagu et al. (2014) highlight the lack of equipment such as accessible weight scales and acknowledge the need for “more than just ramps” to accommodate the growing population of people with disabilities. Story et al. (2009) provide anecdotal evidence for accessible weight scale need from interviews with people with disabilities. Finally, Story et al. (2010) reviewed ADA-related legal actions taken against more than 20 hospitals across the U.S. and found that hospital staff often assumed that patient weight had been recorded at a primary care facility or asked patients to guess their weight; the authors recommended purchase of large-platform (at least 32 by 34 inches), high-capacity (600–800 lb.), accessible weight scales to avoid substandard care. We were unable to uncover any statistics on personal use and/or home availability of accessible weighing devices.

Regular self-monitoring of weight has been correlated with improved weight management outcomes (Carels et al., 2005), which is why at-home weight monitoring and regular weight measurement during health provider visits are critical to achieving optimal health care. Wheelchair users are more prone to errors when self-reporting weight measurements compared to the general population (Froehlich-Grobe et al., 2012). Iezzoni (2011) highlights the issue of financial disparities between wheelchair users and the general population, noting that in 2010 only 46% of working age Americans with disabilities were employed. People with disabilities are over twice as likely as people without disabilities to neglect seeing a doctor solely due to cost (Krahn et al., 2015). The currently employed system of spending thousands of dollars on accessible weighing devices is not sustainable for the individual user nor the healthcare system at large.

In order to achieve increased weight monitoring for people who use manual or power wheelchairs or have difficulty standing on a standard scale, access to seated or platform weighing devices must be improved. The purpose of this study was to design and validate a more affordable, user-friendly, and accurate high-capacity weighing device for people who are wheelchair users or have difficulty standing without assistance.

DESIGN CRITERIA

To meet the established needs for a more affordable high-capacity accessible weighing device, the following design criteria were implemented during the design process:

1. Easily accessible by wheelchair users and individuals with other physical disabilities (e.g., cane and walker users, bariatric individuals, etc.).
2. Sufficient weighing capacity to accommodate people who are morbidly obese or use power wheelchairs. Three hundred and sixty kilograms (800 lbs) was selected as the maximum capacity based on currently available weighing devices and normal ranges of combined patient and wheelchair weight.

3. Affordable for clinics and hospitals, with the eventual goal to reach a price range that encourages home use of the device. $500–600 was selected as the maximum selling price range in the market.
4. Accurate for clinical weight measurement purposes.
5. Durable for repeated clinical use.
6. User friendly with an easy to read interface and aesthetic appeal, with potential for smartphone and electronic health record (EHR) or online health intervention platform connectivity.
7. Safe and comfortable for use by people who use wheelchairs with ADA-designated features to prevent accidental falls and other hazards.

METHODS

Device Design

An initial prototype for a more affordable wheelchair-accessible weighing scale was designed and fabricated in a capstone engineering design course at the author's institution (Sherrod et al., 2013). After obtaining feedback from physical therapists and wheelchair users at a local fitness center designed for people with disabilities, a second, revised prototype (Figure 1) was designed and fabricated (Sherrod et al., 2015). The revised prototype features a weight capacity of 360 kg, a platform area of 36 inches by 32 inches, structural steel alloy frame, an aluminum alloy access ramp, liquid crystal display (LCD) weight readout, and wireless smartphone connectivity via Bluetooth with potential for WiFi connectivity. An Arduino microcontroller (MCU) unit (Smart Projects, Strambino, Italy) acquires weight sensor data from four 100 kg capacity strain gauge analog sensors (QY Electronic Company, Hanzhong City, China) and transmits data to a Bluetooth module (RedBearLabs, Hong Kong, China) for wireless transmission (Figure 2). A linear voltage regulator on board the Arduino MCU supplies a constant voltage source for load sensor excitation, and an HX711 analog to digital converter (Avia Semiconductor, Xiamen, China) translates the analog voltage signal to a digital binary signal after amplification. The Arduino Uno MCU processes the digital input signal and uses a calibration algorithm to convert the digital signal to a weight value, which can be displayed on an Android or iPhone smartphone via Bluetooth using custom applications for interface, or on an LCD display module. The Arduino microcontroller acts as a middleman via Serial Peripheral Interface (SPI) between the four sensors, the Bluetooth hardware module, and smartphones. The LCD receives data directly from the Arduino rather than through the Bluetooth module. ADA standards were followed throughout design by incorporating a wheelchair-accommodating platform, sloped access, and edge protection (Americans with Disabilities Act, 2010).

Device cost analysis was performed by summing parts cost, manufacturing/machining cost, assembly time (man-hours), and estimated sales markup. Cost of parts was provided directly by vendors or manufacturers. Manufacturing and machining costs were provided by the University of Alabama at Birmingham School of Engineering Design Lab, an on-campus manufacturing facility. Assembly time was calculated according to estimates of large-scale manufacturing assembly time for mechanical and electrical assembly. Sales markup was determined by estimates provided through collaboration with the University of Alabama at Birmingham Collat School of Business.

Human Participant Testing and Subjective Valuation

Institutional Review Board approval was granted at the authors' institution to study weight measurements of human participants in manual wheelchairs, power wheelchairs, and in the standing position on a calibrated, industry standard scale (Model 6702, Scale-Tronix, White Plains, NY) and on the proposed device prototype. The purpose of this effort was to characterize the device's accuracy and safety profile while also comparing the prototype to a device currently on the market while assessing user preferences and needs. The Scale-Tronix device was calibrated by a trained technician prior to use in the study. All portions of this human participants study were completed at Lakeshore Foundation, Birmingham, AL. A total of forty-five (N=45) participants were divided into three groups as determined by mobility status and Lakeshore Foundation member availability, with twenty standing participants, twenty participants using manual wheelchairs, and five participants using power wheelchairs. Each participant had his or her weight measured on either the investigational device or the calibrated scale; device weighing order was randomized such that participants nor study authors were biased towards one device's previous reading over the course of the study. Weight measurements included chair weight and weight of the individual for the manual wheelchair and power wheelchair groups; participants were not transferred out of their chairs at any point in the study.

After weighing, participants were surveyed to determine their perception of device safety, comfort, aesthetics, and ease of use. Survey questions on device safety, comfort, aesthetics, and ease of use were presented with responses ranging from 1 to 10, with 1 being least favorable and 10 being most favorable. Safety was assessed according to participant perception of how safe they felt on the access ramp and weighing platform. Comfort was assessed according to participant comfort with the device and weighing procedure. Aesthetics, though not an essential component of functionality or safety, were assessed to understand how the prototype device might be better incorporated into the home setting. Participants were also surveyed to assess interest in personal weight monitoring, overall device preference, and maximum dollar amount they were willing to pay for a personal weighing device. These metrics were not assessed solely for comparing the prototype to the calibrated device. Rather, the intent was to establish the baseline user experience with a device they have seen and/or have used before at Lakeshore Foundation (i.e., the calibrated device), and then to establish the user experience for the prototype independently of the calibrated device by asking the participants to rank safety, comfort, etc. separately for each device.

RESULTS

The prototype device is displayed in Figure 1, including computer renderings and device photographs. The prototype features include: weight capacity of 360 kg (800 lbs), platform area of 36 inches by 32 inches (approximately 7500 cm^2), structural steel alloy frame, an aluminum alloy access ramp, liquid crystal display (LCD) weight readout display, and wireless smartphone connectivity via Bluetooth with potential for WiFi connectivity (Figure 2). The device itself weighed 18 kg (40 lbs). Throughout the human participant protocol, the prototype did not undergo any type of mechanical failure or cause harm to any study participant via fall from the platform or ramp, device collapse, tipping, electrical shock, etc.

Table 2 displays weight measurement differences between weighing devices for all study participants and differences between each group. Absolute measurement difference between the criterion measure (commercial device) and the prototype was lowest for manual wheelchair users and highest in the power chair group. Absolute measurement difference in the standing group was 1.6 ± 5.0 kg or 1.2 ± 2.4% error. One weight measurement by the prototype in the standing group was 22 kg less than the commercial device measurement; after removing this outlier, absolute measurement difference in the standing group for the 19 remaining participants was 0.5 ± 0.6 kg or 0.7 ± 0.9% error.

Weight measurement data can be seen in Figure 3, which displays a plot of calibrated weighing device measurements on the x-axis and study weighing device measurements on the y-axis. Goodness of fit studies for linear regression analysis yielded an overall coefficient of determination (R^2) value of 0.9971. Individual study groups had the following goodness of fit results: R^2 for standing group = 0.9918, R^2 for manual chair group = 0.9945, and R^2 for power chair group = 0.9937.

Participants completed a 6 question survey after weight was measured. Responses were reported as mean ± standard deviation of ratings on a scale from 1–10, with 10 being most favorable and 1 being least favorable. Figure 4 displays survey response results for questions related to ease of use, accessibility, safety, comfort and privacy, and aesthetics. Participants reported that they were very comfortable using either weighing device (mean rating of 9.0 ± 1.8 out of 10, with 10 being extremely comfortable and 1 being extremely uncomfortable). However, on the remaining survey items, responses were more favorable for the prototype weighing device with higher average ratings in all categories, including user friendliness, ease of access, safety perception, comfort and privacy, and weighing device aesthetics.

The survey also included questions related to interest in monitoring weight at home, cost, and overall device preference (Table 3). Mean response of participant interest in monitoring weight at home was 7.3 ± 2.9 out of 10, with 10 being extremely interested. The average dollar amount that test participants were willing to pay for a home weighing device was 147.68 ± 192.22 dollars, with a maximum and minimum of $1,000 and $20, respectively. Participants showed equal overall preference for both devices, with both scales each receiving 13 responses for preferred device, while 17 participants had no preference.

Cost analysis yielded a total estimated device selling price between $500–600. Cost of parts was approximately $200 per device when purchasing for single units, with estimated wholesale parts expenses of approximately $160 per device (assuming 20% wholesale savings). Manufacturing costs were estimated at $150 per device when manufacturing in large quantities, including metal machining, platform machining, welding, and electrical soldering. Assembly costs were estimated at approximately $100 per device when assembling in large quantities, including mechanical and electrical component assembly.

Total cost estimate when accounting for parts, manufacturing, and assembly sums to $410. Applying an additional 40% device markup, device selling price is estimated at $575.

DISCUSSION

Access to weighing devices is particularly lacking for people who have a disability and use a wheelchair, and this study was completed in an attempt to bridge the gap between the needs of individuals who have a disability and accessibility of medical equipment (Lagu et al., 2014). People with disabilities, obese persons, and geriatric individuals make up a significant portion of the U.S. population. Health policy makers and providers should consider ways to improve access to medical care and medical instrumentation for these populations, as numerous studies have previously highlighted (Iezzoni, 2011; Krahn et al., 2015; Lagu et al., 2014).

We estimate that after accounting for materials costs, manufacturing costs, assembly costs, and markup/commercialization costs, each device could sell for approximately $575, which is substantially less than the average device price found on author survey ($2,075) and the lowest price found on author survey ($1,030). Additionally, the low device weight of 18 kg (40 lbs), which is 11 kg (25 lbs) less than the next lightest high-capacity device found by author survey, would keep shipping and transportation costs low while allowing users to move the device more easily. The prototype was able to accurately weigh up to 360 kg in the human participants study. Studies have shown that users of wheelchair weighing scales are not satisfied with currently available scales, especially those with low capacity (Story et al., 2009); providing a lower weight, less expensive, high-capacity scale might alleviate these concerns.

Throughout the human participants testing, the prototype device did not undergo any mechanical failure or cause harm to any study participant. Two areas for design improvement were noted during the study: 1) higher edge protection on the platform was needed to prevent power chairs from falling off the platform, and 2) slightly larger platform size was needed for larger power chairs. No power chair users actually fell from the platform during the study, however. There were no observed problems with ramp access, which can also be inferred from post-study survey results.

This study has several strengths. The linear correlation between weighing device measurements was strong, indicating acceptable device accuracy for weight measurement purposes. There were no adverse events (eg, falls, injuries, etc.) during the study, indicating that the prototype weighing device is safe for use. The device was capable of measuring combined loads over 340 kg, which is important in measuring body weight of severely obese individuals using manual chairs or power chair users. The survey response data indicated that test participants slightly favored the investigational prototype weighing device over the industry-standard calibrated weighing device.

There are several weaknesses in this study. Our results are limited by a somewhat small sample size, particularly in the power chair group. This can be explained by a smaller number of power chair users who visit the fitness and rehabilitation facility used in the present study. Readers of this study should therefore exercise caution when interpreting results from the power chair study group. Additionally, the prototype weighing device had areas for improvement in design that were previously noted (including insufficient edge protection and small platform size), which made measuring power chair user weight potentially prone to error due to rear wheels overhanging on the access ramp. These design shortcomings should be corrected in any future weighing device production by increasing platform size and using larger edge protection brackets. Study methodology did not include longitudinal weight measurements over time. Weight was only measured once on each weighing device, which may reduce the ability to more precisely determine weighing device measurement error. Additionally, one sample outlier and individual study groups affected overall measurement difference values significantly.

Food and Drug Administration (FDA) regulations and Americans with Disabilities Act (ADA) guidelines are both critical to consider prior to market entry. According to the FDA, wheelchair platform-based scales are regulated as Class I devices, meaning they are exempt from 510(K) submission and Good Manufacturing Practice (GMP) guidelines except for general requirements concerning record-keeping (U.S. Food and Drug Administration, 2014). The ADA guidelines for wheelchair weighing scales only require that scales have: a spacious weighing platform to accommodate various wheelchair sizes, a sloped ramp that provides a non-abrupt access point to the platform, and edge drop-off protection to prevent accidental falls off the platform (Americans with Disabilities Act, 2010). The proposed new device had all ADA-required features for manual wheelchairs, yet a larger platform and more robust edge protection should be used in future design iterations for power wheelchair use.

Our survey results showed that participants were willing to pay 147.68 ± 192.22 dollars for a home-use personal weighing device, with a maximum and minimum of $1,000 and $20, respectively. The average amount of $147.68 is substantially lower than our estimated selling price ($500–600). The wide response range for amount willing to pay for a personal device reflected that participants also had a wide response range for interest in home weight monitoring (7.3 ± 2.9 out of 10). These results demonstrate that the prototype device may be more appropriate for clinical rather than home use in the short term. However, insurance companies may be willing to subsidize personal weighing device costs due to health benefits from weight monitoring (Carels et al., 2005). Finkelstein et al. (2009) estimate that 10 percent of all annual medical spending is attributable to obesity, and obesity-related costs rose from $78.5 billion in 1998 to $147 billion in 2008. Since Medicare and Medicaid finance approximately half of this value (Finklestein et al., 2008), government insurance programs may be incentivized to subsidize personal weighing devices for individuals. From a simple cost-benefit standpoint, providing a few hundred dollars for insured persons to own a weight monitoring device could help offset aforementioned obesity-related health costs. Future work should focus on engineering similar devices that are less expensive and more appropriate for home use.

Although the focus of this study has been providing a more affordable, lightweight, high-capacity weighing device for wheelchair users, this device is broadly applicable for other patient populations as well. Patients with morbid obesity, movement disorders, or who are uncomfortable using a standard scale may all benefit from having access to a device similar to that described here. Importantly, healthcare providers at clinics and hospitals could provide a single scale that all patients could use, rather than providing two separate scales (i.e., a standard scale and an additional accessible scale), at a lower cost to the provider. Furthermore, pharmacies like CVS have initiatives such as “Project Health” that provide free health screenings including body weight measurement; such pharmacies may be interested in using an accessible weighing device for these initiatives.

One emerging area in healthcare technology is the ability to connect biosensor devices to online platforms (Turner-McGrievy et al., 2013; Yusof & Iahad, 2012). One example is the FitBit ® platform, which allows users to upload exercise activity from a wristband and to also upload weight data from a FitBit ® scale. Another example of such a platform is MyFitnessPal®, which has succeeded as a health intervention and weight monitoring platform in recent years (Turner-McGrievy et al., 2013; Yusof & Iahad, 2012). For future weighing device development, our group will likely include WiFi capability allowing users to upload weight measurements to a data collection server for monitoring weight over time, with the potential for health providers to access the data for appropriate health management and counseling, including potential integration with platforms such as MyFitnessPal ®.

As our population ages, obesity rates increase, and people using wheelchairs increase in number, we must respond appropriately to meet the health needs of these populations. By implementing use of a novel low-cost weighing alternative to currently available weighing devices, healthcare providers could lower costs and increase accessibility to weight monitoring. Future studies are warranted on lowering weighing device costs and improving access to weighing device.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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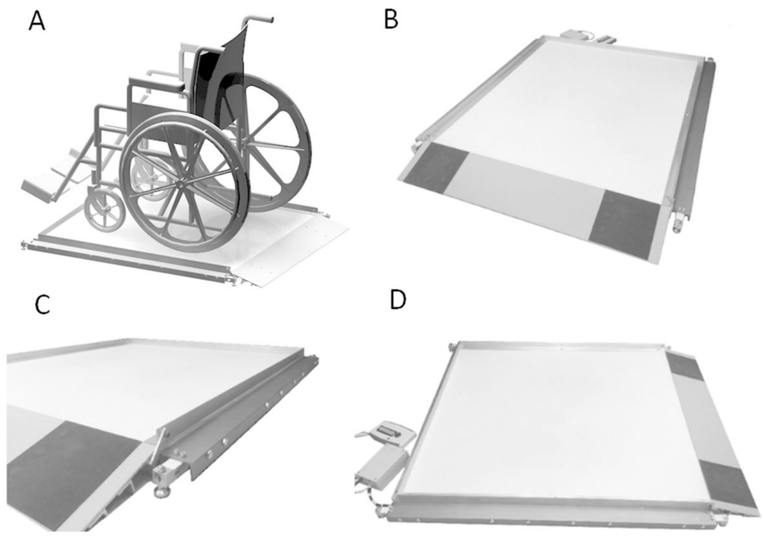

Fig. 1.

(A) Computer Aided Drawing (CAD) of prototype device with simulated wheelchair placement. (B) Front-facing view photograph of prototype unit (C) Corner view of prototype unit (D) Side view of prototype unit with electronics and wiring in rear. The user accesses the weighing platform via an aluminum alloy ramp. Sensors on each corner detect load changes and relay them to an electronics module for processing.

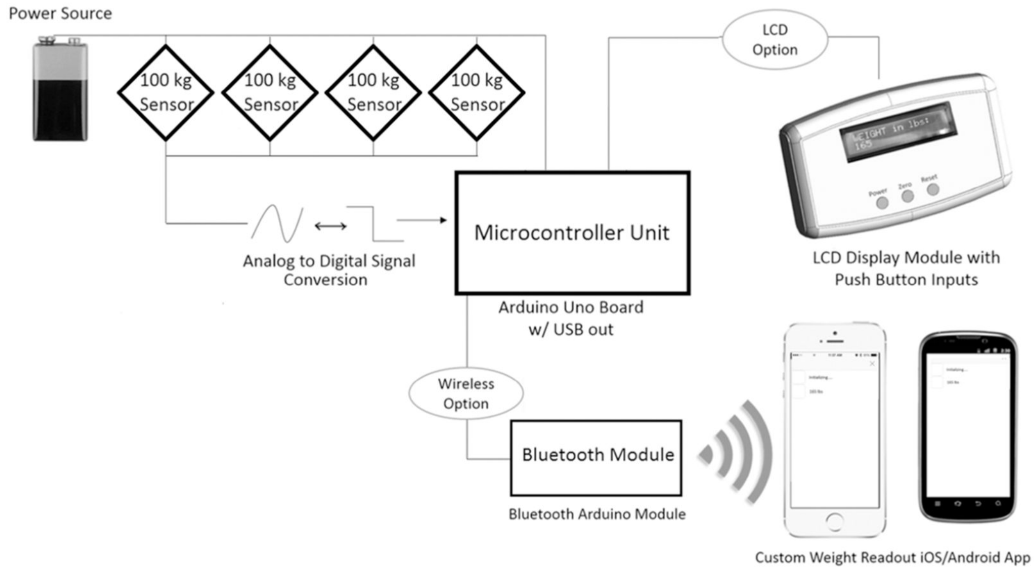

Fig. 2.

Schematic of electronics system for data acquisition and weight display via LCD or smartphone applications. The Arduino microcontroller unit acquires weight sensor data from analog sensors and transmits data to a Bluetooth module for wireless transmission. The Arduino microcontroller acts as a middleman via Serial Peripheral Interface (SPI) between the four sensors, the Bluetooth hardware module, and smartphones. The LCD receives data directly from the Arduino rather than through the Bluetooth module. The device is WiFi capable for direct connection to a health intervention or EHR platform server.

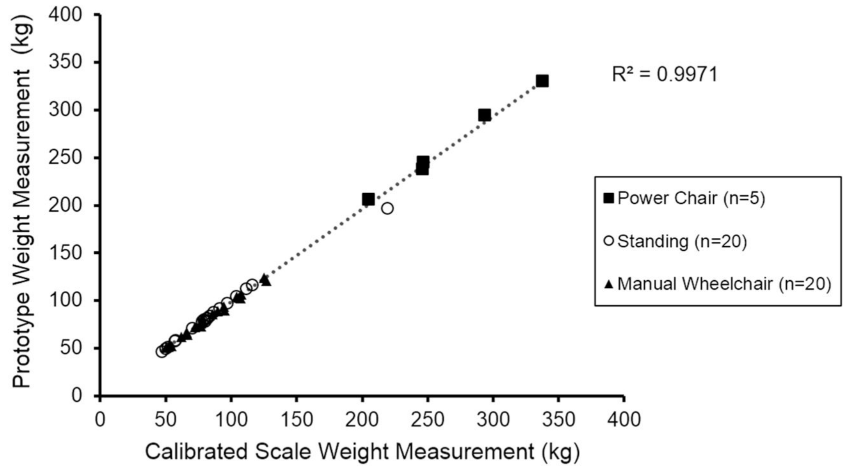

Fig. 3.

Data points plotted for calibrated weighing device measurement vs. prototype weighing device. Linear regression analysis demonstrated strong linear correlation ($R^2 > 0.991$) between device measurements for each study group.

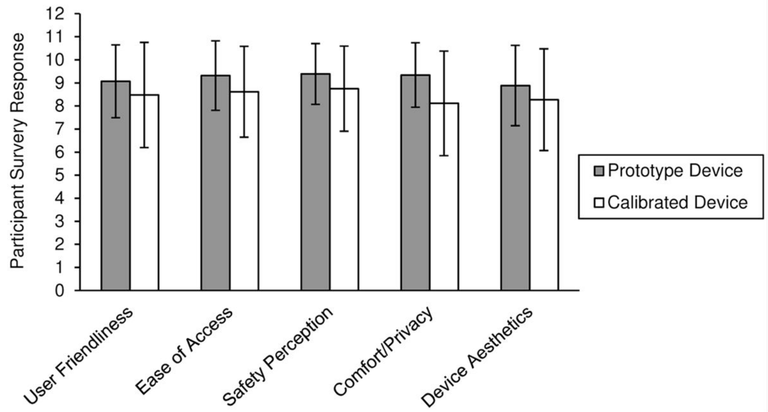

Fig. 4.

Post-study survey response data comparing participant perception of the prototype weighing device and calibrated weighing device. All responses were recorded on a scale from 1–10, with 10 being most favorable outcome. Data expressed as mean (columns) ± standard deviation (error bars).

Table 1

Survey of commercially available bariatric and wheelchair-accessible weighing scales. Results compiled from various manufacturer and vendor product catalogs via internet search. Data sources for each listing are provided within supplementary data (S1).

Model	Capacity, lbs (kg)	Resolution, lbs (kg)	Device Weight, lbs (kg)	Price, USD[a]
HealthoMeter 2650 KL	1000 (454)	0.2 (0.1)	81 (37)	$ 1,750.00
Detecto 6495	800 (360)	0.2 (0.1)	187 (85)	$ 2,508.00
Detecto 6500	1000 (454)	0.2 (0.1)	65 (30)	$ 1,925.00
Detecto 6550	1000 (454)	0.2 (0.1)	91 (41)	$ 1,792.00
Seca-677	660 (300)	0.5 (0.2)	84 (38)	$ 2,400.00
Seca-657	660 (300)	0.5 (0.2)	102 (46)	$ 2,200.00
Brecknell MS-1000	1000 (454)	0.5 (0.2)	185 (84)	$ 1,030.00
Scale-Tronix 6002	880 (400)	0.2 (0.1)	N/A	$ 3,000.00
	Avg. Capacity		Avg. Weight	Avg. Price
	875 (398)		113 (51)	$ 2,075.63

Footnote:

[a]Pricing obtained from various vendors; quotes may vary depending on chosen vendor.

Table 2

Weight measurement data comparing study device with calibrated scale. Difference = calibrated scale measurement - study device measurement. All values expressed as mean ± standard deviation. CW = calibrated weight, kg = kilogram, Δ = difference.

Overall		**Power Chair**		**Standing**		**Manual Chair**	
kg	**% of CW**	**kg**	**% of CW**	**kg**	**% of CW**	**kg**	**% of CW**
Absolute Value of Measurement Δ							
1.8 ± 3.8	1.4 ± 2.0	3.8 ± 3.7	1.4 ± 1.3	1.6 ± 5.0	1.2 ± 2.4	1.6 ± 1.9	1.7 ± 1.9
Absolute Value of Measurement Δ After Removing standing group outlier							
1.4 ± 2.0	1.2 ± 1.5			0.5 ± 0.6	0.7 ± 0.9		

Table 3

Post-study survey response data. Survey responses for questions related to comfort and interest in home monitoring were reported on a scale from 1–10 (1=least favorable, 10=most favorable). PWD = prototype weighing device, CWD = calibrated weighing device, NP = no preference. All values expressed as mean ± standard deviation.

	Comfort using either device (1–10)	Interest in Home Monitoring (1–10)	Amount Willing to Pay for personal device ($)	Device Preference		
Response	9.0 ± 1.8	7.3 ± 2.9	147.68 ± 192.22	PWD	CWD	NP
N responses	43	42	32	13	13	17