

Comparison of a New Digital Device to Measure Grip Strength and the Jamar Dynamometer

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PURPOSE

Use of a dynamometer to measure handgrip strength is widely accepted due to its simple, non-invasive marker of muscle strength of the upper extremities (Norman et al., 2010). In addition to its evaluative usefulness in rehabilitation, deficits in grip strength may be an indicator of impairments in the upper extremities and occupational performance skills. Studies also indicate a correlation between a person's grip strength and nutrition, fragility, diabetes, length of hospital stay, mobility, mortality and other risk factors (Bohannon, 2008; Fain & Weatherford, 2016; Kilgour et al, 2013; Massy-Westropp, 2011; Vaz 2002).

The gold standard of grip strength measurement is the Jamar dynamometer with repeated studies indicating a high level of inter-rater validity and reliability (Mathiowetz, 2002; Myers & Triscari, 2015). BTE Technologies, Inc. is developing a new digital handgrip dynamometer to be used in physical dysfunction and industrial rehab settings. To ensure that their product meets user requirements, the device must go through a field testing process and that usability issues are identified prior to manufacturing (Soares, Jacobs, Woodcock, Fielden, & Bartlett, 2012).

The purpose of this study is to determine if the digital handgrip dynamometer developed by BTE Technologies, Inc. is comparable and reproducible to the performance of the Jamar dynamometer. By following the ASHT protocol throughout data collection, similar results between the two devices may suggest reproducibility of the BTE Device as compared to a precisely calibrated Jamar dynamometer.

METHODS

Design

- Comparison of hand grip strength using the Jamar dynamometer and BTE device
- Descriptive research design
- Coefficient of variation (CV) calculated for each participant
- Bland-Altman plot and Intraclass Correlation Coefficient (ICC) used to compare performance

Subjects

- Convenience population of participants aged 20-50 years drawn from Southwest Florida
- Exclusion criteria: Age < 20 or > 50 years old. Individuals with a history of upper extremity pathology and/or currently pregnant
- Comparison Trial: 337 participants: Men (N=138) and women (N=199)
- Reproducibility Trials: 68 participants: Men (N=23) and women (N=45)

PROCEDURE

- The BTE Technologies, Inc. handgrip device is compared to the Jamar Hydraulic Hand Dynamometer. The Jamar devices were calibrated through an independent laboratory
- Determine if participant met study criteria and consent acquired
 - Participant randomly assigned to begin study with either BTE or Jamar device
 - Testing conducted following protocol established by the American Society of Hand Therapists (Myers & Triscari, 2015)
 - Average grip strengths for gender and age were calculated manually for the Jamar device while the BTE device recorded data automatically
 - Participants were given the opportunity to return for a repeat of the protocol to assist in determining reproducibility

INSTRUMENTS



The BTE Handgrip Device is composed of Wheatstone Bridge transducers embedded within the handle. When the device is squeezed the pressure is converted into a force reading sent to the computer through a Bluetooth connection. The device is a prototype and is being tested on human subjects for the first time (BTE Technologies, Inc., 2018).



The Jamar Dynamometer is a standardized hydraulic tool used to measure static grip strength and is considered to be the gold standard for measuring grip strength by the American Society of Hand Therapists (Mathiowetz, 2002; Myers & Triscari, 2015).



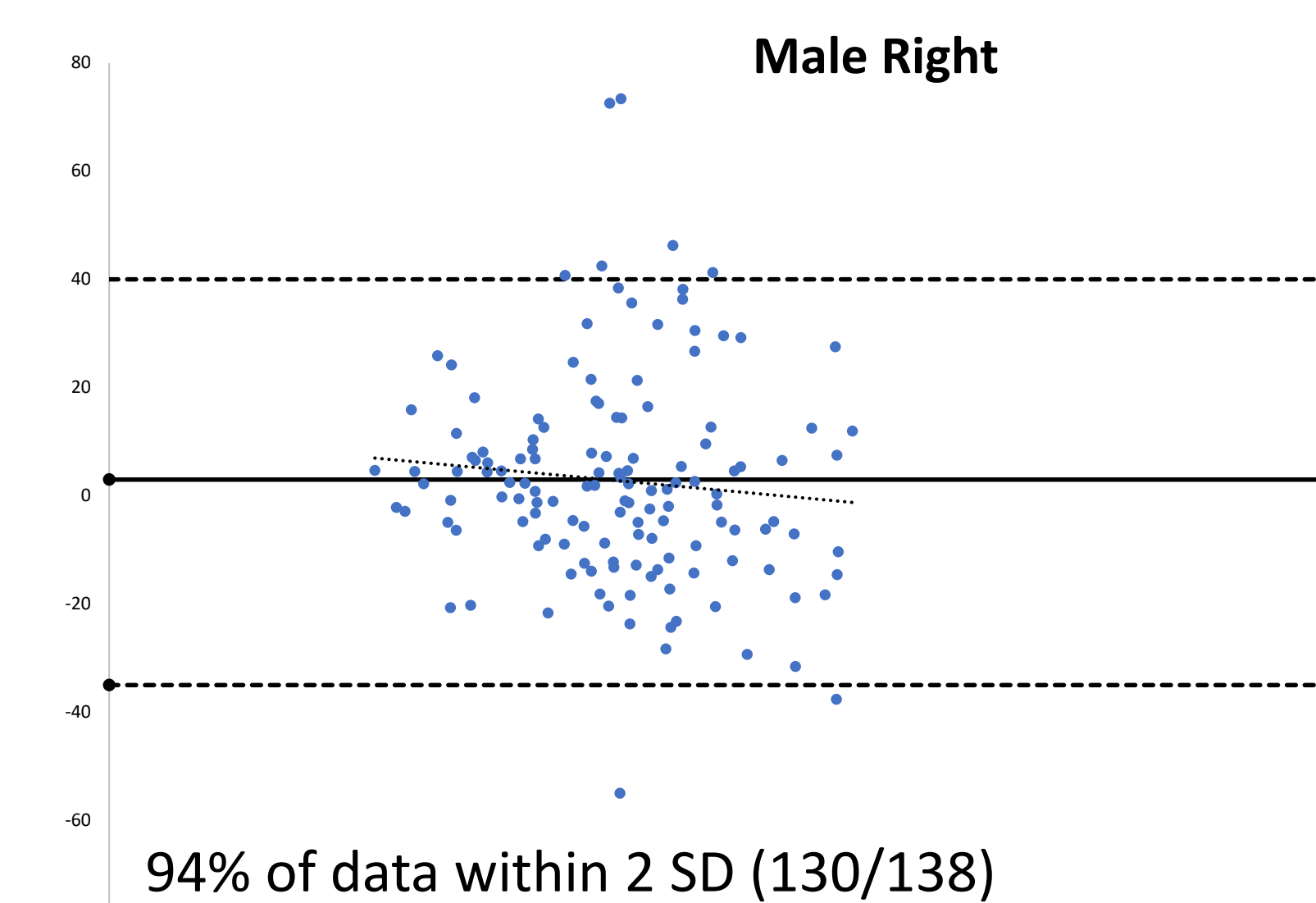
BTE Device



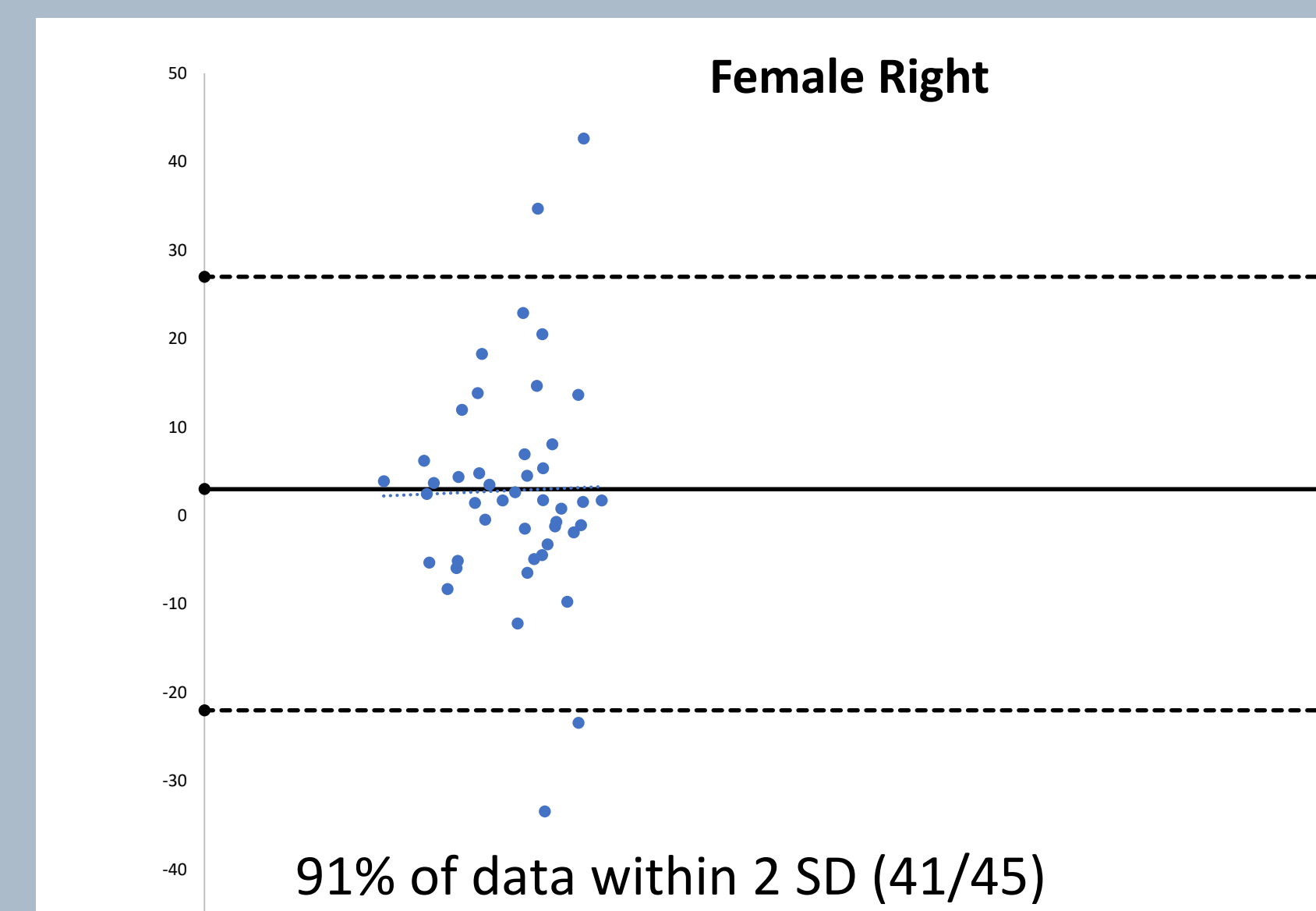
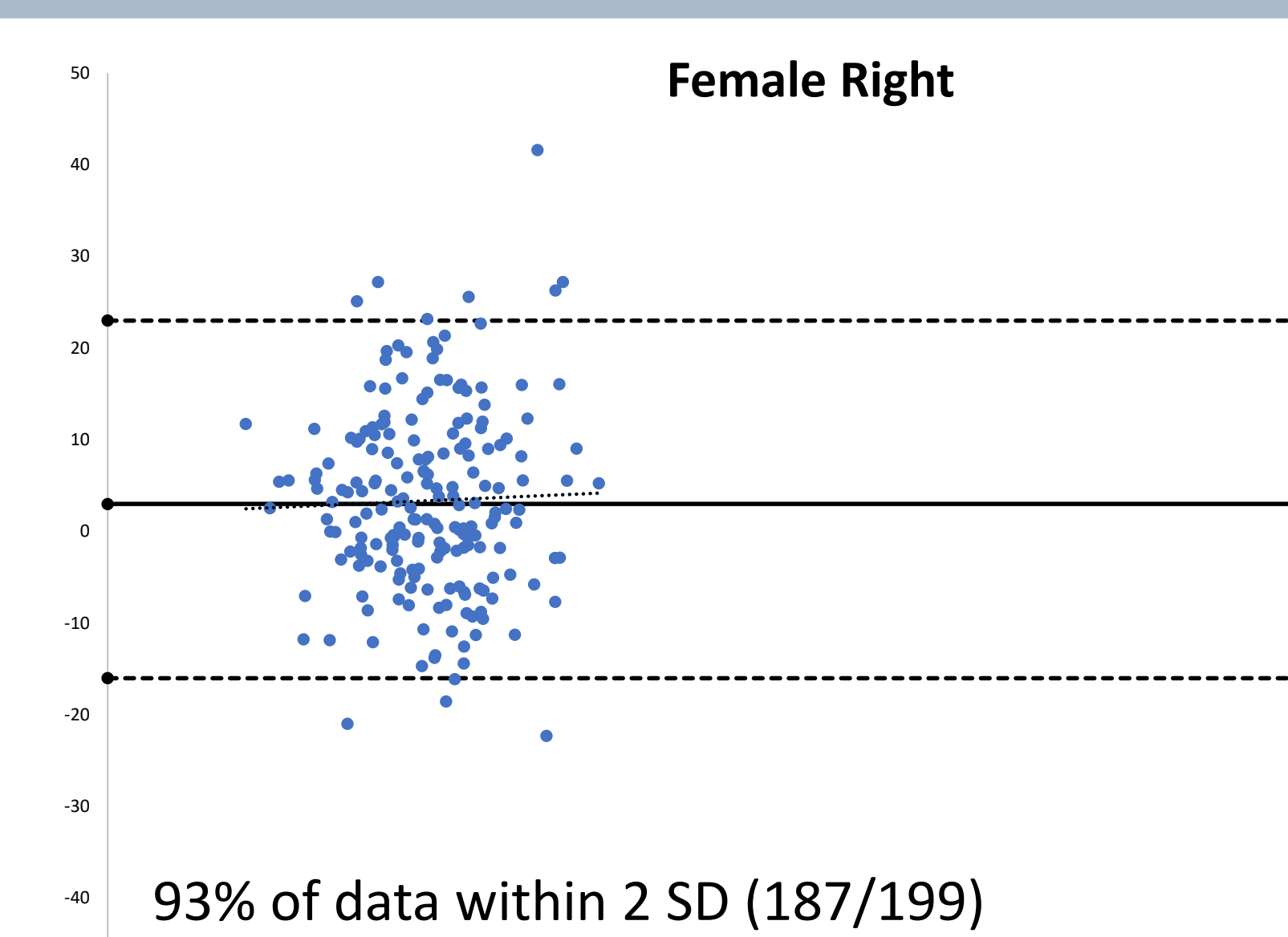
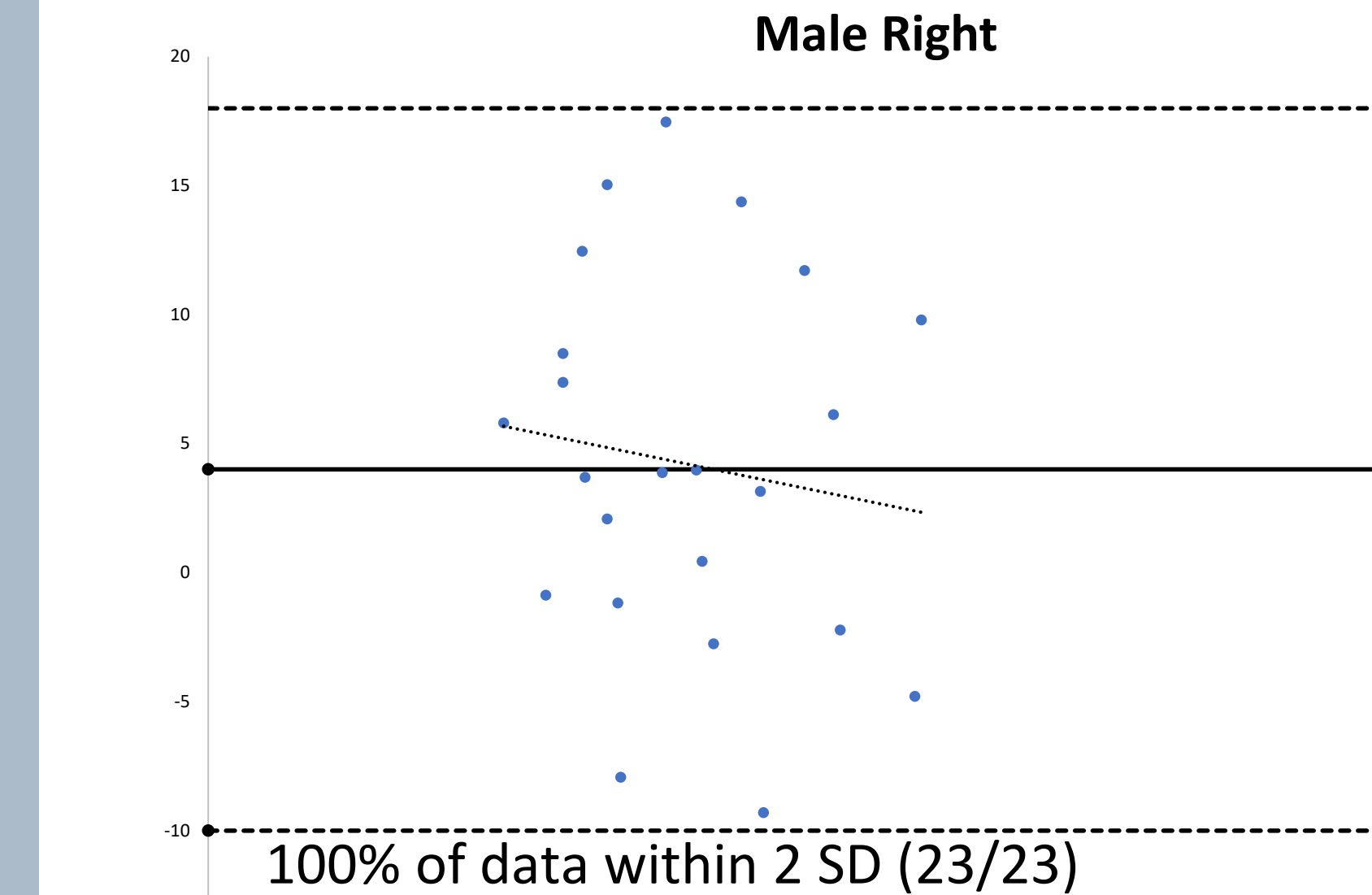
Jamar Device

RESULTS

COMPARISON



REPRODUCIBILITY



	ICC	Lower	Upper
Male Right	.806	.728	.756
Male Left	.835	.751	.887
Female Right	.839	.768	.886
Female Left	.836	.691	.902

	ICC	Lower	Upper
Male Right	.972	.913	.989
Male Left	.939	.789	.978
Female Right	.661	.391	.813
Female Left	.686	.434	.826

DISCUSSION

Bland-Altman Plot:

- Comparison: Indicates high confidence comparing Jamar Dynamometer to BTE device (94% male and 93% female within 2 SD of the mean)
- Reproducibility: Indicates high confidence comparing Jamar Dynamometer to BTE device (100% male and 91% female within 2 SD of the mean)

ICC:

- Comparison: ICC at 95% CI indicates overall good correlation between Jamar Dynamometer and BTE device
- Reproducibility (Males): ICC at 95% CI indicates excellent correlation between Jamar Dynamometer and BTE device
- Reproducibility (Females): ICC at 95% CI indicates moderate correlation between Jamar Dynamometer and BTE device

Conclusions

- Results for single trials generated by the BTE Device are comparable to those of the Jamar Dynamometer, demonstrating initial reliability
- However, inconsistencies were noted between the devices for reproducibility trials
- Thematic analysis of post-trial questionnaire indicated 41% of participants favored the comfort of the Jamar device versus 34% for the BTE device.

"The BTE initially gave less force back into the metacarpals but toward the end of the duration became uncomfortable. The Jamar device gave equal comfort/discomfort throughout."

"I feel that the Jamar device was more comfortable in my hand, but the BTE as easier to squeeze. I like the materials in the Jamar device instead of the plastic from the BTE."

Recommendations

- BTE Device may be beneficial for healthcare professionals as it can generate measurements via Bluetooth and provide additional calculations adding to the quality of client data collection
- The sample was taken from a convenience population. Would benefit from additional age groups
- Consider adjustment to BTE grip to improve comfort

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