



# The Ear is the New Wrist: Livio AI's Sensors Lead in Step Accuracy

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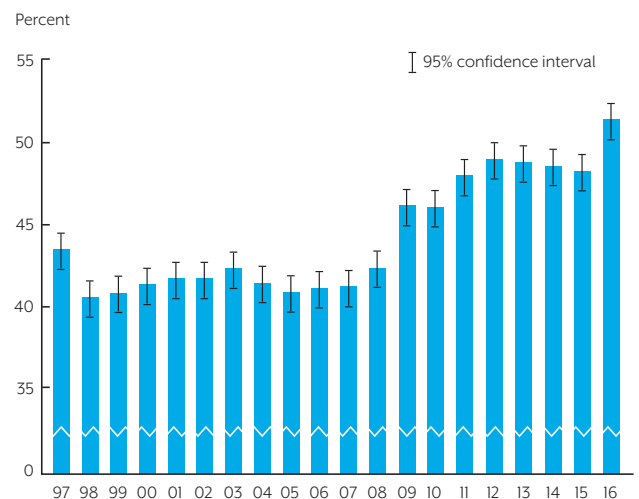
Health and fitness trackers have become an everyday-worn component to patients' digital lives. As patients strive to become healthier, they look to fitness trackers as a gateway to their overall health and wellness. The average American walks as little as 3,000 to 4,000 steps or roughly 1.5 - 2 miles per day. Walking 10,000 steps per day has been shown to lower overall risk of heart disease, obesity, diabetes, high blood pressure, depression and correlates with reduced risk of many common forms of cancer. While leisure-time aerobic activity for adults aged 18+ who met 2008 US Federal physical activity guidelines has increased (Figures 1 and 2), our largest patient demographic of those 65+, trails younger generations.

Unfortunately, commercially available fitness trackers are often highly inaccurate. Stanford Division of Cardiovascular Medicine investigated commonly worn wrist-based fitness trackers and found them to be largely inaccurate in appropriately tracking energy expenditure derived from heart rate and step counts. None of the devices tested (Apple Watch, Basis Peak, Fitbit Surge, Microsoft Band, Mio Alpha 2, PulseOn, Samsung Gear S2) were able to achieve error rates less than 20 percent (Shcherbina et.al., 2017). Further, in a study published in the Journal of Sports Sciences, the iPhone's pedometer function was found to be on average, 1,340 steps or 21.5 percent less accurate compared to a research grade step tracker in free-living situations. (Duncan et.al., 2018).

Our researchers sought to answer the question as to whether an ear-level worn activity tracker was more accurate than either wrist or pocket worn fitness trackers. The results follow.

## METHOD:

Fourteen subjects completed a total of 78 trials while walking on hardwood/pavement and soft surfaces/carpet. They were asked to wear two Starkey Livio AI hearing aids, each with an IMU sensor for tracking steps, a Fitbit Charge HR on their wrist, and carry an iPhone in their front pocket. The appropriate apps were used for step tracking from each



Leisure-time physical activity

Figure 1: Percentage of adults aged 18 and over who met 2008 federal physical activity guidelines for aerobic activity through leisure-time aerobic activity: United States, 1997-2016

DATA SOURCE: NCHS, National Health Interview Survey, 1997-2016, Sample Audit Core component.

- For 2016, 51.7% (95% confidence interval = 50.57%-52.87%) of U.S. adults aged 18 and over met the 2008 federal physical activity guidelines for aerobic activity (based on leisure-time activity). This percentage was higher than the 2015 estimate (49.0%).
- The annual percentage of adults aged 18 and over who met the 2008 federal physical activity guidelines for aerobic activity (based on leisure-time activity) was stable from 1997 through 2006, then steadily increased to 51.7% in 2016.

of the separate manufacturers' devices; Starkey Thrive Hearing Control app, Fitbit app, and the Apple Health app.

Subjects were asked to walk a fixed number of steps and to count the number of steps that they took. Step count accuracy, in percent, was calculated by comparing the actual number of steps completed to the steps reported within each app. Results were plotted per device and by percentage accuracy (Figure 3).

### RESULTS:

Left and right hearing aids had the same step count accuracy with a median of 99 percent and a variance of 13 percent. Fitbit and iPhone had a 95 percent and 98 percent median accuracy, however, variances of 35 percent and 25 percent, were reported, respectively.

### DISCUSSION:

While there is no statistically significant difference in the median accuracy results, the ear-level worn system in the Livio AI devices is less variable and more accurate than both the wrist-worn Fitbit, and the pocket-worn iPhone. Lower variability of the Livio AI devices is attributed to a wear location on the side of the head. This location is a more stable surface and consistent with the movements of the rest of the body, whereas the wrist and pocket have ancillary movements. These ancillary movements (not step related), lead to false positive and false negative step calculations and thus, higher variability.

Because an estimated 85 percent of hearing aid fittings are binaural (one on each ear), the Starkey Livio AI devices can report fitness tracking data with bilateral sensors allowing for a more accurate counting algorithm and less variability. Further, with dual sensor tracking, step data is calculated even when one of two Livio AI devices is temporarily unavailable (e.g., a dead battery).

Lastly, Livio AI devices are more likely to be worn due to their multifunctional nature. Patients with hearing impairment require their hearing aids to communicate with their world. Because the sensors for tracking activity are embedded within the hearing aids, patients are less likely

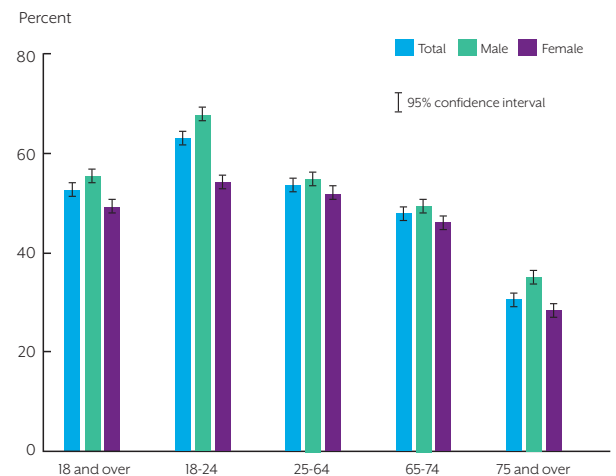


Figure 2: Percentage of adults aged 18 and over who met 2008 federal physical activity guidelines for aerobic activity through leisure-time aerobic activity, by age group and sex: United States, 2016

DATA SOURCE: National Center for Health Statistics. (2017, June). Survey Description, National Health Interview Survey, 2016. Hyattsville, Maryland. Retrieved from: [http://ftp.cdc.gov/pub/Health\\_Statistics/NCHS/Dataset\\_Documentation/NHIS/2016/srnydesc.pdf](http://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2016/srnydesc.pdf)

- For both sexes combined, as age increased, the percentage of adults who met the 2008 federal physical activity guidelines for aerobic activity (based on leisure-time activity) decreased. This pattern also held for males and females.
- For adults aged 18 and over, and for age groups 18-24, 25-64, 65-74, and 75 and over, women were less likely than men to meet the 2008 federal physical activity guidelines for aerobic activity (based on leisure-time activity).

to leave them behind prior to daily activities. Gaps in step count and “step-regret” are less likely due to power failures or forgetfulness with Livio AI over their fitness tracker cohort.

### CONCLUSIONS

The Livio AI ear-worn hearing devices with embedded sensors achieved higher accuracy and lower variability compared to the Fitbit Charge HR and iPhone. Patients that value accuracy and consistency in step and activity tracking will see great benefit with Livio AI hearing aids over step counters and fitness trackers worn on the wrist or on a phone, all within a hearing device they are already wearing throughout their day.

### REFERENCES

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Figure 3: Pedometer Accuracy

