

Proceeding Paper

Monitoring of Older Adults' Daily Activity and Sleep with Xiaomi Mi Band 2[†]

María del Carmen Miranda-Duro^{1,2,*} , Laura Nieto-Riveiro^{1,2}, Betania Groba^{1,2} and Nereida Canosa^{1,2}

¹ CITIC (Centre for Information and Communications Technology Research), TALIONIS Group, Elviña Campus, University of A Coruña, 15071 A Coruña, Spain; llaura.nieto@udc.es (L.N.-R.); bb.groba@udc.es (B.G.); nnereida.canosa@udc.es (N.C.)

² Faculty of Health Sciences, Oza Campus, University of A Coruña, 15071 A Coruña, Spain

* Correspondence: carmen.miranda@udc.es

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Abstract: Nowadays, the use of wearable devices is still emerging. Monitoring with wearable sensors is an easy and non-intrusive approach to encourage preventive care for older adults. Wearable devices are becoming an assessment tool for evaluating physical activity and sleep, among other biomedical parameters. The objective of the present study is to explore the daily activity and sleep of older adults from three nursing homes, as measured by Xiaomi Mi Band 2. The results showed that people with a greater number of steps (representing daily activity) could be related to a lower probability of risk of falling, dependency on basic activities of daily living, and mobility problems. Regarding sleep, the results suggest that people at risk of falling tend to be awake longer at night. Independent people get more deep sleep, while people who identify problems in their usual activities have a lower total sleep time. Finally, people who identify pain or discomfort have less light sleep and sleep in total.

Keywords: wearable technology; remote monitoring; occupational therapy



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1. Introduction

The use of wearable technology has been developed in uncontrolled and free-living environments instead of clinical settings. Wearable devices can register physiological parameters, physical activity, sleep quality, gait structures, or plantar pressures and shear, among others. Additionally, the key advantage of wearable sensors is that there is no need for a professional who has to perform tests to obtain clinical data. In addition, monitoring people in a daily living environment and over continuous periods may become more feasible and ecological. The evidence shows that the main wearable devices used in older adults' populations were wristbands, activity monitors, or accelerometers. The main objectives of using these devices are: (1) to explore the relationship between sleep behavior and gait performance; (2) to validate the devices by step count; (3) to evaluate the feasibility and efficacy of the device; (4) to determine the validity of a device compared to Actigraph; or (5) to understand the use of wristbands by older adults by conducting qualitative or mixed studies. Accordingly, this study aims to analyze the utility of the Xiaomi Mi Band 2 to assess older adults' daily activity and sleep [1].

2. Materials and Methods

A cross-sectional study was conducted between March 2017 and December 2019. The participants were people aged over 65 years old residing in or attending a nursing home or day center. The participants had to wear the Xiaomi Mi Band 2 during 30 days/24 h.

The main parameters analysed from the Xiaomi Mi Band 2 were the number of steps taken (daily activity) and sleep quality (daily deep sleep, daily shallow sleep, total daily sleep, and awake time in bed during the night). Additionally, from institutional data, we

analyzed the most recent Barthel Index score, Tinetti Index score, and the presence or absence of cognitive impairment. The Barthel Index measures the level of dependency in B.A.D.L., such as feeding, bathing, grooming, dressing, bowel control, bladder control, toilet use, transfers, mobility on level surfaces, and mobility up and down stairs. In the Barthel Index, the score can range between 0 and 100 points; 100 is considered independency in basic activities of daily living (B.A.D.L.), and >100 is considered any level of dependency in B.A.D.L. The Tinetti Scale assesses the risk of falling based on gait and balance. The total score for the Tinetti Scale can range between 0 and 28; a score ≥ 24 is considered to indicate no risk of falling, and a score < 24 indicates the risk of falling.

Moreover, we analyzed the quality of life of the older adults with EuroQol-5D-5L. This assessment evaluates four elements. The first element consists of a descriptive system of five dimensions: mobility (walking ability), self-care (washing or dressing), usual activities (i.e., work, study, household chores, family activities, or leisure time activities), pain/discomfort, and anxiety/depression. These are assessed as: (1) no problems, (2) slight problems, (3) moderate problems, (4) severe problems, or (5) extreme problems/inability. In this case, we considered those having any problem or no problem to analyze. The second element was a visual analog scale (VAS), in which the participant rates his/her perceived health from 0 (the worst imaginable health) to 100 (the best imaginable health). Finally, the third and fourth elements (the EQ-5D-5L Index and the Severity Index, respectively) are two indexes calculated from the descriptive system's scores. The EQ-5D-5L Severity Index score ranges from 0 (absence of problems) to 100 (more severity), and the EQ-5D-5L Index ranges from 0 (state of health similar to death) to 1 (better health status).

Data analysis was carried out with IBM SPSS version 25, including a descriptive and inferential analysis. The present study was approved by an ethics committee and is registered in clinical trials (NCT03504813, NCT04592796).

3. Results and Discussion

The main findings obtained were that a greater number of steps and distance could indicate a lower probability of presenting a risk of falling, dependency in B.A.D.L., or perception of mobility problems. Nowadays, there is no agreement on what dose of physical activity should be performed to maintain a person's functional independence. However, it is known that with moderate physical activity levels, there can be significant results. Likewise, the relationship between staying physically active and engaging in regular physical activity, with health benefits, particularly in fall rate reduction, has been well documented for decades [1].

Considering participants that did not perceive mobility problems, were without risk of falling and were independent in B.A.D.L., the number of daily steps ranged from 2500 to 6000 steps, approximately. Similar data were obtained in the O'Brien study, in which the intermediate steps of older adults were 2500–4000. However, according to Tudor-Locke et al., this range fits a sedentary profile. These authors suggested that below 6000 daily steps could not provide health benefits [1].

Daily steps are a modifiable factor intrinsically related to the objective assessment of daily physical activity. They have a strong impact on health in any population, but especially in older adults. It affects their level of independence and quality of life, taking into account the repercussions of falls. This study suggested that wearable devices, like Xiaomi Mi Band 2, may be used for appropriate assessments, which can help to identify people with daily activity and sleep problems [1].

Regarding sleep, in this study, we observed that daily awake time at night was weakly associated with the risk of falling ($p = 0.013$, $F = 0.127$). Although the data were not supported by strong associations, the data showed an important aspect of using wearable devices. Wearable devices continuously monitor the person, which provides the approximate time that the person has been awake at night, and, therefore, they can help to understand their needs [1].

The existing literature has supported a relationship between short sleep duration and injury from falling. In addition, maintaining daily routines was associated with a reduced rate of insomnia in older adults. In the present study, 54.83 percent of the participants slept less than 420–480 min, which is the adequate range of sleep per day, while participants with a risk of falling slept 360 ± 118 min per day. This is in comparison with those with no risk of falling, who slept 421 ± 85 min per day. These findings indicate that people who are not at risk of falling tend to sleep more and have sleep levels that are within the appropriate range, although it was not possible to conclude a significant relationship [1].

4. Conclusions

Wristbands may be an effective and fast way to evaluate people without requiring extended time for professionals to determine their day-to-day needs. It will now be useful in the COVID situation to observe how this situation has affected people's physical activity and sleep levels.

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Reference

1. Miranda-Duro, M.d.C.; Nieto-Riveiro, L.; Concheiro-Moscoso, P.; Groba, B.; Pousada, T.; Canosa, N.; Pereira, J.T. Analysis of Older Adults in Spanish Care Facilities, Risk of Falling and Daily Activity Using Xiaomi Mi Band 2. *Sensors* **2021**, *21*, 3341. [[CrossRef](#)] [[PubMed](#)]